PTE P2B1-2/P5

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Abstract

This document Contains a report on the Archtectural Design Phase of the development phase P2B1 of the PTE-P1/P2 tool to fully support the FAT phase of the POEMS Ground Station. The document elaborates on the different sub modules required for the development and details the design features of these sub modules.

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EXECUTIVE SUMMARY

As part of the Mode S development program, standard analysis tools are required to evaluate the performance of the Pre-Operational European Mode S (POEMS) stations being developed. It is intended that the POEMS Test Environment (PTE) will fulfil this objective by combining the capabilities of various test tools - the PTE -P1, P2A, P2B1, P2B2, P3, P4 and P5.

Intersoft Electronics was honored with the development of phases P1, P2A, P2B1 and P2B2 . As a result, this document represents the Intersoft Ideas on the development of PTE P2B1. This Section of the development deals with new functions for the target simulator, data recording, data exporting and Factory Acceptance Test tool (PTE-P1/P2B1

Part of the requirements of this tool will be covered by the adaptation or upgrading of existing PTE P1 software, whereas some subsections will require new development of tools.

1. Introduction

This document describes the Design of the P2B1 development phase of the PTE (POEMS Test Environment) project.

The l Design is based on the specifications as laid down in the "System Requirement Document PTE P2B1" created by Intersoft prior to creating the ADD.

Furthermore, PTE P2B1 is intended to be a preparation stage for the PTE P2B2 stage, in which enhanced Datalink analysis will be implemented. Since Intersoft was also honoured with the development of this further stage, some sections of this ADD will already deal with design items intended for the PTE P2B2 stage.

1.1 The PTE P2B1 Project

As a logical enhancement of the PTE P1 tool, the PTE P2B1 project will add a number of additional functions to the PTE set of tools.

P2B1 will especially deal with some additional data generation and the exporting and preparation of capture P1 data.

The PTE-P2 (Phase P2B1) additional capabilities are the following :

§ PSR Scenario Generation: to Define the Characteristics of the PSR Information that will be provided through the Real Time PSR Data Simulation.

§ data link Model B Capabilities

§ Additional Scenario Capabilities

§ Sector Message Delay Analysis

§ Data Export

Several of these functions will be embedded in existing PTE P1 functions or tools, since this will be the most logical way of design. These changes will be visible to the user under the form of new buttons, new user interface windows or simply an improved functionality. Additionally, some completely new tools will emerge in the PTE toolbox.

The Primary scenario generation will form an implicit part of the existing P1 Trajectory scenario generator. This generator will be enhanced with a simulated PSR scenario data output. The parameters defining this scenario (rotation speed, location of PSR radar, jitter, clutter, etc..) can be entered from within the trajectory scenario generator's user interface.

A second part of the tool will read the generated PSR scenarios and play the data in real time using the P1 EDR hardware platform. This will supply the POEMS radar with Asterix Cat 1 and 2 data under LapB protocol.

A second enhancement of the trajectory scenario generator is the automatic generation of "data link" scenarios. These scenarios are predefined by Eurocontrol and will allow extensive testing of the data link features of any POEMS radar. The P2B2 phase of the project will deal with the analysis of the recorded data.

1.2 Relation with PTE P2B2 Phase

For the P2B2 analysis, the P2B1 tool must combine a number of existing data files and generate sufficient data for the automatic analysis in PTE P2B2.

PTE-P2B2 (Phase P2B2) is a specific tool for the assessment of the data-link performance of the POEMS station.

The PTE-P2 (Phase P2B2) capabilities are the following :

- Importing of Data from PTE-P1 / P2B1.
- Linking, Filtering and Managing the Imported Data.
- Data Link Performance Analysis.
- Display and Output of Analysis Results.

P2B1 will prepare all recorded data such that it can be analysed in the next development phase.

1.3 Project Sections

1.3.1 PSR Scenario Generation:

A first major development task in P2B1 is the generation of Primary data. For this purpose, the design will be split in four modules

§ PSR Scenario Preparation / Generation: Embedded in P1 Trajectory scenario generator

§ .S4 to Asterix and RDIF Compiler : Embedded in P1 Trajectory scenario compiler.

§ EDR replay File streamer: New user interface

Additionally, two test modules will be added, namely an RDIF protocol viewer and an RDIF convert tool, allowing for better debugging and verification of the generated RDIF.

1.3.1.1 PSR Scenario Preparation/Generation :

This module produces .a S4PR data file with PSR positional information, to be converted into RDIF or Asterix

The tool is Embedded in P1 Trajectory scenario generator

As an input, the scenario generator will use the parameters specified by the user in the trajectory scenario generator (P1 development). These parameters are defined in the SRD.

As an output, the Scenario generator shall create an S4 data file (positional information) which contains one record per generated PSR plot. The datafields will include position, power, etc.. of each PSR plot.

1.3.1.2 .S4 to Asterix/RDIF Compiler :

This module converts the generated S4 file into Asterix Cat 001 and 002 or RDIF .

The tool is embedded in the P1 Trajectory scenario compiler..

As input, the module requires a .S4 data file. This can be generated by the trajectory scenario generator.

As an output, the module produces an EDR replay file , to be replayed by the EDR replay module.

Optionally, SSR and Mode S data can be converted into asterix Cat 048 data for test purpose. This function will be implemented into a new user interface test tool. (Not part of P2B deliverable.

1.3.1.3 EDR Replay file streamer:

From the generated Asterix and RDIF EDR Replay files , the EDR replay tool will generate live RDIF or Asterix using the EDR active playback line.

The tool will use a new user interface

As input, the module requires an EDR replay file. This can be generated by RDIF or Asterix generator modules

As an output, the module produces RDIF or Asterix under LapB dataflow on the PTE P1 specified hardware connections (EDR channel)

1.3.1.4 RDIF Protocol Viewer:

For debug and test features, it is required to verify the generated RDIF data. The protocol viewer can be tested on its own using a known data set (e.g. DERA RDIF data) , after which the PTE P2B1 generated RDIF can be verified using the protocol viewer.

The tool will be embedded into the existing P1 Protocol viewer.

As an input, this module requires an RDIF recording as recorded by the P1 EDR hardware platform.

As an output the tool produces text data and files explaining the contents of the RDIF and other protocols.

1.3.1.5 RDIF Convert:

After RDIF generation, it is a good practise to verify the generated RDIF with the initial S4 data set. This can be done by entering the RDIF format in the EDR Convert program. This will allow S4 data to be generated from recorded LapB RDIF data.

This tool is embedded into the existing P1 EDR Serial Convert tool.

As an input, this module requires an RDIF recording as recorded by the P1 EDR hardware platform.

As an output the tool produces an S4 positional datafile converted from the contents of the RDIF protocol.

1.3.2 Data Link Model B Capabilities

A second important part of the project is the automatic generation of a datalink scenario. This will be implemented using the existing PTE P1 scenario generator and event scenario generator. Both tools will include new functions for the generation of these scenarios.

1.3.2.1 Data link Model B Surveillance Scenario:

The trajectory scenario generator must be enhanced with a Randomiser function which can generate a data link positional scenario as described in the SRD.

This tool is an enhancement of the existing P1 trajectory scenario generator tool.

As an input the module uses a user interface panel specifying the Random positional parameters for the datalink model.

As an output, the module produces a scenario specification list, which can be compiled, edited or saved using the trajectory scenario generator.

1.3.2.2 Data link Model B Event scenario

The Event scenario generator must be enhanced with a Randomiser function which can generate a data link event scenario as described in the in the SRD .

This tool is an enhancement of the existing P1 event scenario generator tool.

As an input the module uses a user interface panel specifying the Random event parameters for the datalink model.

As an output, the module produces an event scenario specification list, which can be compiled, edited or saved using the event scenario generator.

1.3.2.3 Data Link Analysis preparation :

The Generated .S4EV data file from the event scenario generator shall contain some fields entered for future data link analysis (PTE P2B2). SRD .

This tool is an enhancement of the existing P1 event scenario generator tool.

As an input the module uses a user interface panel specifying the Random event parameters for the datalink model.

As an output, the module produces an S4EV file, which can later be analysed using PTE P2B2 functions.

1.3.3 Additional Capabilities

Some specific requirements have been included in PTE P2B1, which call for specific research work to include the correct protocols for the simulation of Annex 10 amendment 69 or 71 compatible transponders.

This tool is an enhancement of the existing P1 event scenario generator tool.

Some minor changes are required to the trajectory scenario generator to allow generation of amendment 69 or 71 transponders. Also the handling of CA fields shall be improved with better user interface.

1.3.4 Sector Message Delay Analysis:

The sector delay analysis deals with the analysis of the delay between timestamps of Sector messages and internal time stamping of these sector messages. This requires an adaptation of the Asterix EDR convert tool so that it can generate “Sector” message- formatted S4 records and includes time and azimuth of recording in the required fields for such a record. The real analysis of the delays can be performed using the inventory tool.

This tool is an enhancement of the existing EDR serial Convert tool and the existing Inventory tool.

As an input the module uses an EDR recording containing Cat 34 radar data.

As an output, the module produces line graphs representing sector delay versus time, scan number or azimuth, and / or histogram graphs.

1.3.5 Data Export

An important part of P2B1 is the data export feature. This requires the conversion of generated PTE P1 data into user specified data formats (excel formats) which can be used for later analysis.

These export functions also include the creation of sufficient data for the PTE P2B2 project analysis features.

1.3.5.1 RFS Export:

The generated S4 data file can be exported into an Excel format after generation and time stamping. This is done by using the “Scenario Time Merger” tool and exporting it using the Inventory tool. This export needs an update to incorporate all data fields present in the S4 data.

This tool is an enhancement of the existing Inventory tool.

The tool will import any .S4 data files

The tool will generate a tab spaced excel compatible data file containing all S4 fields as an output.

1.3.5.2 I/VS Export:

The RVI-RVR recorded data must then be exported in a specific format described in Ref. 29. This export function shall be incorporated in the “Reference Extractor” function of the PTE tool.

This tool is an adaptation of the existing P1 “Analysise Pulse Recordings.vi” tool and requires a new user interface tool, “Reply-Interrogation Viewer”.

The module will use RVI and RVR recorded “ Pulse recording” (PTE P1 functionality) .

The module will produce the I / VS data from the required input.

1.3.5.3 I/RS Export :

A special tool needs to be created which creates the I / RS (Interrogation and Reply data , as generated from the RES result recordings) from the current recorded RES data files.

This tool is an adaptation of the existing P1 “Scenario Time Merger” tool

The tool will import RES recorded Interrogation / reply file and a scenario file .

The tool will generate a tab spaced excel compatible data file containing all Interrogation and Reply data fields as an output.

1.3.5.4 A17 Export:

A special convert tool will be generated which creates a text file (format described in Ref. 29) containing all Asterix Cat 17 fields and sub-fields.

This tool a new user interface tool, “Asterix Export”.

As an input, this module requires an EDR Asterix Cat 17 recording as recorded by the P1 EDR hardware platform.

As an output the tool generates a tab spaced excel compatible data file containing all Asterix Cat 17 data fields as an output.

1.3.5.5 A18 Export:

A special convert tool will be generated which creates a text containing all Asterix Cat 18 fields and subfields.

This tool a new user interface tool, “Asterix Export”.

As an input, this module requires an EDR Asterix Cat 18 recording as recorded by the P1 EDR hardware platform.

As an output the tool generates a tab spaced excel compatible data file containing all Asterix Cat 18 data fields as an output.

1.3.5.6 A34 Export:

A special convert tool will be generated which creates a text containing all Asterix Cat 34 fields and subfields.

This tool a new user interface tool, “Asterix Export”.

As an input, this module requires an EDR Asterix Cat 34 recording as recorded by the P1 EDR hardware platform.

As an output the tool generates a tab spaced excel compatible data file containing all Asterix Cat 34 data fields as an output.

1.3.5.7 A48 Export:

A special convert tool will be generated which creates a text file (format described in Ref. 29) containing all Asterix Cat 48 fields and subfields.

This tool a new user interface tool, “Asterix Export”.

As an input, this module requires an EDR Asterix Cat 48 recording as recorded by the P1 EDR hardware platform.

As an output the tool generates a tab spaced excel compatible data file containing all Asterix Cat 48 data fields as an output.

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Ref. 24. User application profile for extractor monitoring messages (Version 1, 05.08.92) + Encoding rules for Data Items Category 2 (Version 2, 21.04.93), Ref. DFS HV SNO3 DZ.

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Ref. 28. PTE P2B1 Project Plan Edition 1.0 31/1/2000

Ref. 29. PTE P2B1 System Requirement Document Second edition v 1.2 20/7/2000

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3. PTE - P2B1 Project Design

3.1 Introduction

In the first phase (P1) of the PTE (POEMS Test Environment) development the emphasis was put on the simulation of the environment, the recording and analysis of signals at different levels in the radar chain.

In the second stage (P2B), additional simulation capabilities will be added and further development effort will be put in the analysis of all recorded data.

3.1.1 Purpose

The purpose of the PTE P1/P2 is to create a test environment by mimicking the behaviour of multiple aircraft at antenna level for MSSR/SSR and at plot level for PSR to simulate the future environment in which a POEMS station is to be used. Furthermore, PTE P1/2 has the task of recording all required analysis data and formating it into the right format for further analysis. Some of this analysis can be done on the PTE P1/P2 platform itself, other must be performed on the P4 platform or using external analysis tools (e.g. Excel spreadsheet program).

By recording the interrogations and output of the station for such a repeatable “virtual“ environment, the performance of the radar can be analysed.

Three important parts can be distinguished :

- § 1. The generation of test signals to simulate a specific environment
- § 2. The recording of all important signals
- § 3. The Analysis of all Recorded data

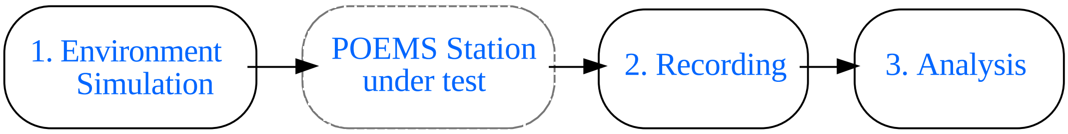

Figure 3-1: POEMS Context

3.1.2 Scope of PTE P2B1

The scope for the P2B1 project must be seen within the general PTE P1/P2 project.

At the end of the P2 development, the PTE P1/2 shall provide the user with the possibility of generation of a arbitrary scenario and compile this scenario into sufficient data files to feed two types of hardware devices:

- § The RES (or Radar Environment Simulator)
- § The EDR (Extended Data Recorder / Replayer)

These devices will then provide in turn the required input to the POEMS radar for it to operate under simulated conditions which are as close as possible to a future (highly loaded) real environment. For this purpose, PTE will create scenario information and provide the radar with SSR or Mode S replies, simulate Mode S protocols (among which all data link protocols) , simulate possible outputs of a co-located or nearby PSR radar (P2B1) and generate cluster information (P3).

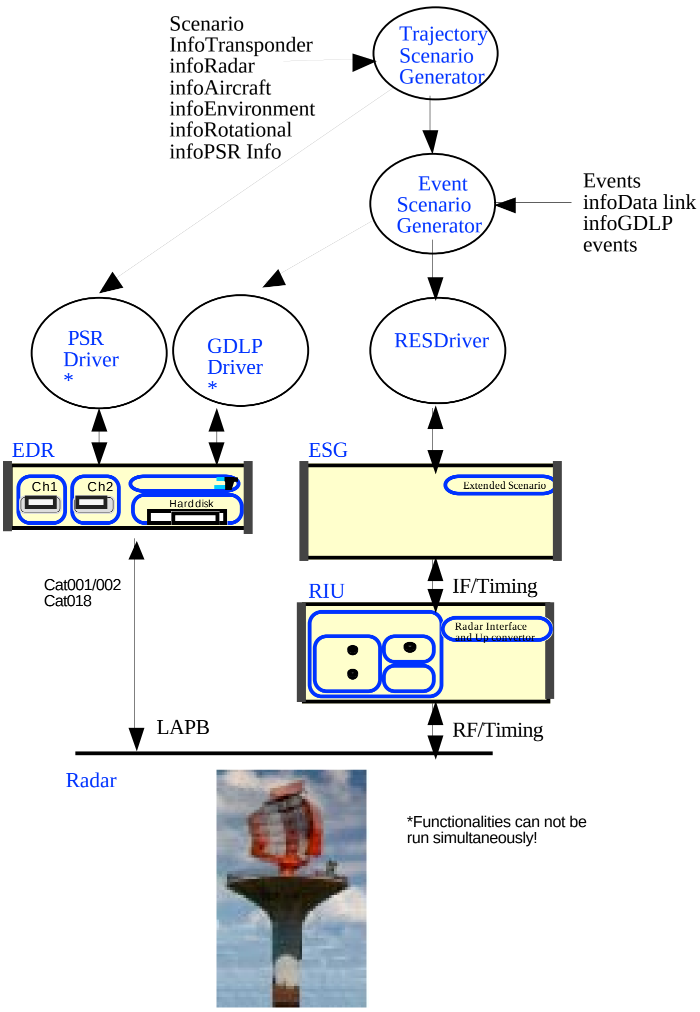

Figure 3-2: PTE Generation overview

Once the scenario is running, PTE P1 Records data at different levels:

§ Air level: : Interrogations send by Radar captured by RFA

§ Interrogations and Replies: I/RS data : Recorded by RES at generation

§ Video Level: Interrogations and Replies and Video Data recorded by RVR/RVI

§ Digitised level: No recording performed

§ Service level: Syncro time, Pimary input,

§ Network level: Asterix Cat 34,48,17 and 18

PTE P2B1 will use this data and convert it into the necessary formats such that analysis is possible.

Some important sections of the analysis are already available in PTE P1:

§ Pd calculation

§ Accuracy Calculation

§ Data Visualisation in numerous combinations.

§ Interrogation schedule analysis

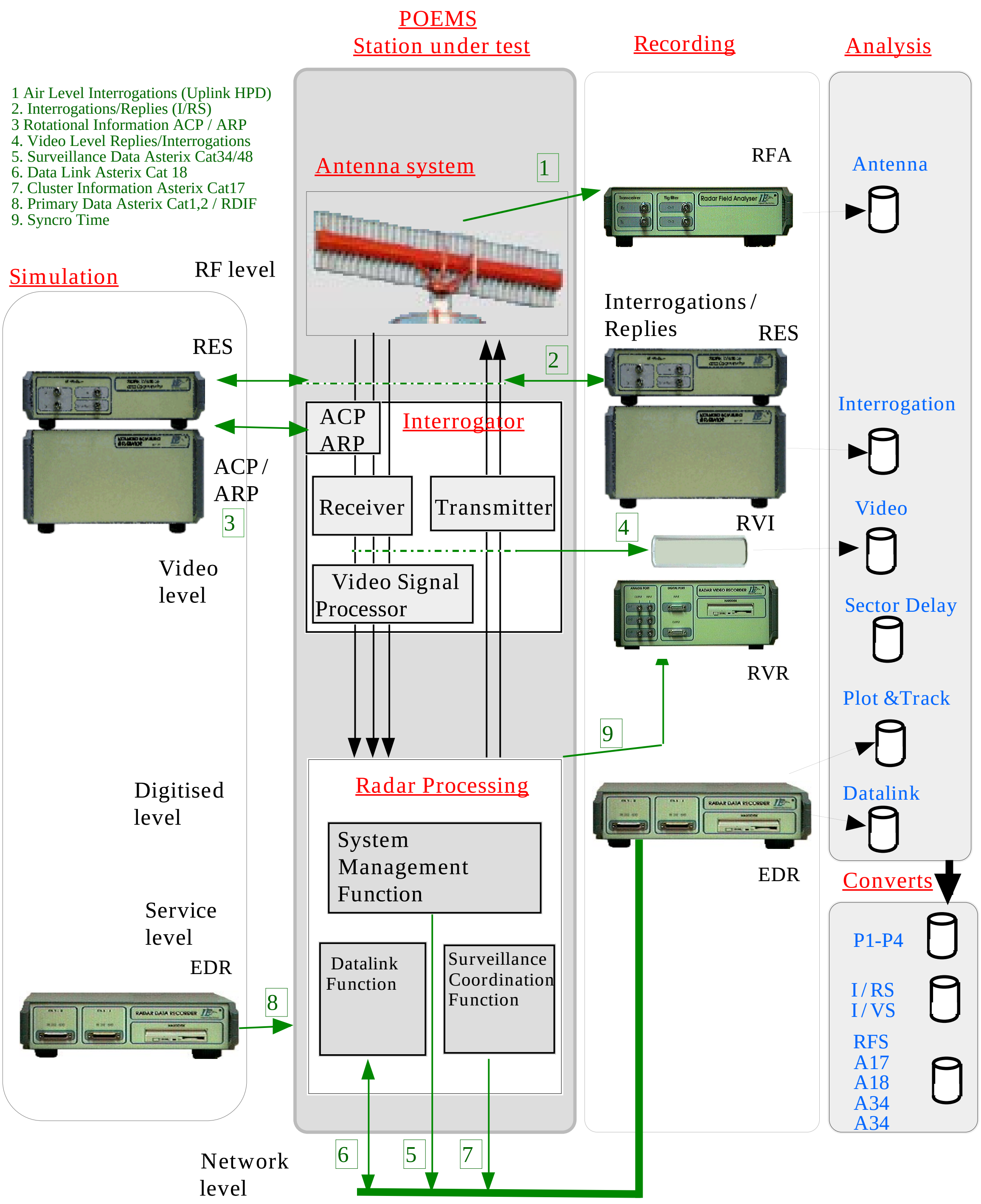

Figure 3-3: POEMS Recording Data

Additional analysis need to be developed in PTE P2B:

§ Sector message delay analysis (P2B1)

§ Datalink analysis (P2B2)

3.1.3 General Design Features

The PTE P2B1 project is mostly a Software project. No real Hardware modules are to be designed, except for a small redesign of the RVI, which is required for the correct recording of the I/VR data.

For the creation of the software, we will make use of LabVIEW, which is the programming language of the other PTE P1 and P2A tools. LabVIEW provides the user of the final product with a number of build in features, such as on line documentation using a floating window.

The user interface of PTE P2B1 will be no different from the PTE P1 design, since the same basic building functions and user interface design will be used.

PSR Scenario Generation

3.2 PSR Scenario Generation

A large part of the PSR scenario generation already exist in the form of the PTE P1 scenario generator. As an input to the P1 scenario generator, the user can define a arbitrary surveillance scenario in the form of “sentences” plus a set of start conditions. On top of this, the user needs to define additional radar information such as rotation speed, reflection definitions, etc.. All input parameters are defined in the SRD (Ref. 29. The trajectory scenario generator will output (after the embedded compilation stage) sufficient data for the EDR Reply function to generate Asterix or RDIF type messages for PSR data simulation. (Remark: Figure 3-4 shows the S4 to Asterix/RDIF compiler as a separate tool, but in reality it is embedded in the existing Trajectory scenario compiler)

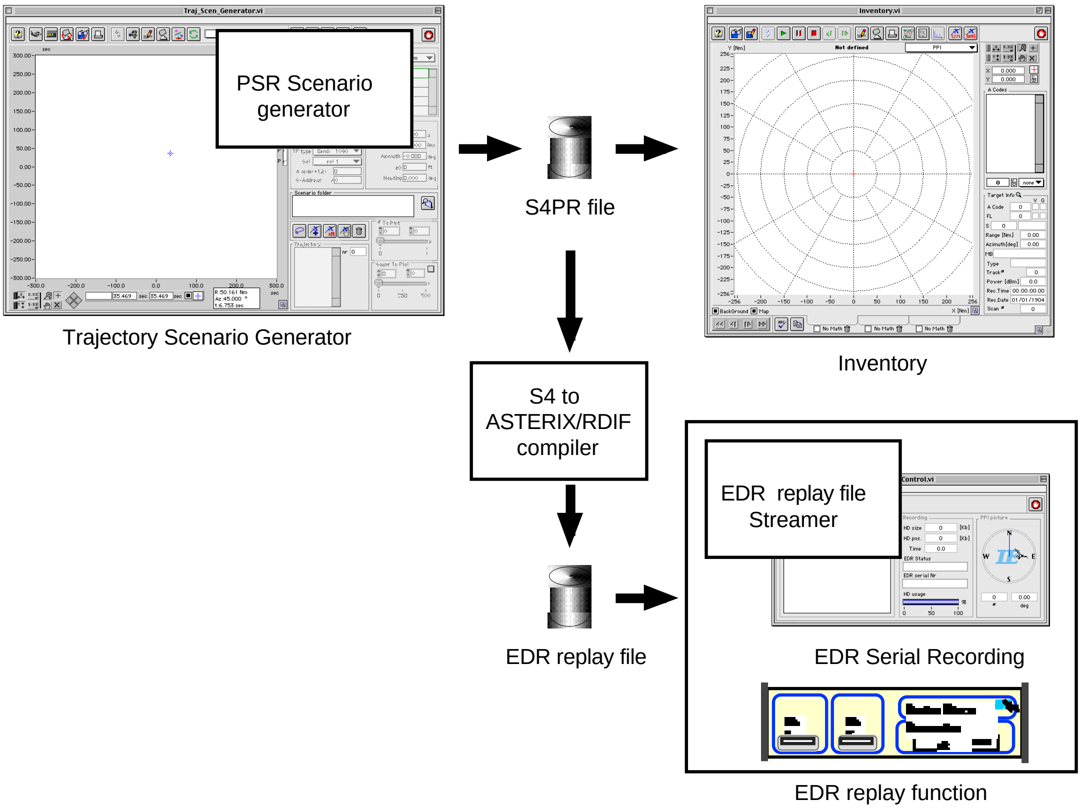

Figure 3-4: PSR Scenario replay functions

3.2.1 PSR scenario preparation/generation

3.2.1.1 Specifications

Following Specifications are of importance for this module of the PTE P2B1 development. Details can be found in the SRD (Ref. 29).

[P2B1-SR-CAP-0100] An additional compiler module shall be created as a sub module of the Trajectory scenario generator. This compiler shall generate a new S4 positional file (. S4PR) , which includes all the specified targets. (including clutter etc...) . This implies that the scenario selected in the trajectory scenario generator will be used to generate the asterix or RDIF data. All scenario definition, loading, saving and modifications shall be performed from the trajectory scenario generator. All random parameters definitions of the scenario shall be embedded in the scenario after compilation. If a new random seed is required, the scenario shall need to be recompiled.

[P2B1-SR-CAP-0101] The PTE-P2B1 tool shall enable the user to specify a target scenario on which the generation of PSR target report and radar service messages for input to the POEMS SUT is to be based and to which it will be associated. This selection shall be performed from within the trajectory scenario generator .vi , which is an existing tool in P1.

[P2B1-SR-CAP-0102] The PTE-P2B1 tool shall enable the user to specify the following parameters to be used during the PSR scenario replay run for the simulated PSR radar . The parameters shall be selectable from within the trajectory scenario generator.

§ user selection of either (a) simulated PSR co-mounted and synchronised with the POEMS SUT or (b) simulated PSR co-located and not synchronised with an azimuth start offset (in the interval 0 to 360 degrees with a granularity of 1 degrees) from the POEMS SUT

§ for selection (b) only, the simulated PSR position as the combination of a range offset (in the interval 0 to 5 nm with a granularity of 0.01 nm) and an azimuth offset (in the interval 0 to 360 degrees with a granularity of 0.01 degrees) from the POEMS SUT.

§ for selection (b) only, the simulated PSR rotation speed (in the interval 4.5 to 15 rpm with a granularity of 0.1 rpm).

§ simulated PSR probability of detection (in the interval 85 to 100% with a granularity of 0.1%)

§ simulated PSR maximum detection slant range (in the interval 0 to 256 nm with a granularity of 1 nm)

§ simulated PSR background false target report message generation rate (in the interval 0 to 100 false target reports per radar per scan with a granularity of 1 false target report per radar per scan)

§ simulated PSR clutter area parameters - minimum range, maximum range, minimum azimuth, maximum azimuth and rate of false PSR target report generation (in the interval 0 to 100 per radar scan with a granularity of 1 per radar scan)

§ simulated PSR azimuth bias parameter (in the interval 0 to 0.2 degrees with a granularity of 0.01 degrees)

§ simulated PSR range gain and offset bias parameters (gain in the interval 0 to 2 metres/nm with a granularity of 0.1 metres/nm, offset in the interval 0 to 150 metres with a granularity of 1metres)

§ simulated PSR time stamp bias parameter (in the interval 0 to 200 ms with a granularity of 1 ms)

§ simulated PSR azimuth stochastic error standard deviation (interval 0 to 0.2 degrees with a granularity of 0.01 degrees)

§ simulated PSR range stochastic error standard deviation (interval 0 to 150 metres with a granularity of 1 metres)

[P2B1-SR-CAP-0103] Within the PTE-P2B1 tool, the user shall be able to define, load, modify, save (to be retrieved in a later session) and delete these PSR scenario parameters under one PSR scenario file name associated to the corresponding POEMS target scenario.

[P2B1-SR-CAP-0104] The PSR scenario generation functionality of the PTE-P2B1 tool shall enable the user to specify re-use of the same random number generator seed values used in a previous simulation run or the use of new seed values. The intention of this requirement is to enable the user to exactly duplicate or not the results of a previously run scenario. This shall be achieved via replay of identically the same scenario file or by recompiling the scenario.

[P2B1-SR-CAP-0105] The PSR scenario generation of the PTE-P2B1 tool shall be capable of generating PSR target reports and service messages from a simulated radar which is co-mounted and synchronised with the POEMS SUT when specified in the PSR scenario.

[P2B1-SR-CAP-0106] The PSR scenario generation of the PTE-P2B1 tool shall be capable of generating PSR target reports and radar service messages from a simulated radar which is co-located and not synchronised with the POEMS SUT . In this case the PSR target report messages shall take into account the user specified PSR position using a flat earth model.

[P2B1-SR-CAP-0107] For the co-located simulation case the PTE-P2B1 tool shall generate the PSR target report and service messages from a PSR radar head that is offset in position from the POEMS SUT by the PSR scenario specified values.

[P2B1-SR-CAP-0108] For the co-located simulation case the PTE-P2B1 tool shall generate the PSR target report and radar service messages from a PSR radar head with PSR scenario specified rotation speed.

[P2B1-SR-CAP-0109] The algorithm used by the PTE-P2B1 tool in order to calculate the time and position of the simulated PSR target shall be that currently used in the PTE-P2B1 scenario generator for the simulated transponder target.

[P2B1-SR-CAP-0110] The PSR scenario generation of the PTE-P2B1 tool shall include simulation of the PSR scenario specified probability of detection. This is defined as the probability that for any particular simulated target, the radar is capable of generating the corresponding target report message, i.e. in the event that the plot is not detected no target report message is generated.

[P2B1-SR-CAP-0111] The PSR scenario generation of the PTE-P2B1 tool shall include simulation of the radar’s PSR scenario specified maximum detection slant range. This is defined as the slant range beyond which the simulated PSR will not generate PSR target report messages for a target.

[P2B1-SR-CAP-0112] The PSR scenario generation of the PTE-P2B1 tool shall include simulation of the PSR scenario specified background false target report message generation. This is defined as the rate of generation of PSR target report messages for targets that are not present in the simulation scenario over the entire radar coverage volume.

[P2B1-SR-CAP-0113] The slant range and azimuth of every background false PSR target report message generated by the PTE-P2B1 tool shall be independently randomly drawn from uniform distributions in the intervals 0.5 nm to maximum slant range and 0 to 360 degrees for the range and azimuth respectively.

[P2B1-SR-CAP-0114] The PSR scenario generation of the PTE-P2B1 tool shall include simulation of false target report generation originating from up to one PSR scenario specified clutter area.

[P2B1-SR-CAP-0115] Each target report generated within the defined clutter area (in slant range and azimuth) by the PTE-P2B1 tool shall be independently randomly drawn from uniform distributions in the PSR scenario at specified intervals between minimum range to maximum range and minimum azimuth to maximum azimuth. The Tenderer’s attention is drawn to the fact that in order to satisfy this requirement the density of the false target reports generated will be a function of the size of the clutter area.

[P2B1-SR-CAP-0116] The false PSR target report messages generated (either background or clutter area) by the PTE-P2B1 tool shall be indistinguishable from the genuine target report messages. The intent of this requirement is that as far as the POEMS SUT is concerned it will not be possible to determine a-priori whether a PSR target report arises from a genuine target.

[P2B1-SR-CAP-0117] The PSR scenario generation of the PTE-P2B1 tool shall include application of separate radar bias models to determine the systematic components of the PSR target report range and azimuth position errors, both for genuine and false target reports. These position errors are defined as the deviations of the position given in the target report message compared to the scenario trajectory data or false plot position from which it was generated.

[P2B1-SR-CAP-0118] The radar bias model for azimuth systematic errors applied by the PSR scenario generation of the PTE-P2B1 tool shall be that given in equation 1 below.

$$\theta_{sys} = \theta_{true} + \theta_{bias} \theta_{sys} = \theta_{true} + \theta_{bias}$$ Equation 1

In equation 1, the systematic component (“sys”) of the target report measured azimuth is computed by taking the scenario trajectory or false plot component (“true”) and adding the PSR scenario specified azimuth bias parameter (“bias”).

[P2B1-SR-CAP-0119] The radar bias model for range systematic errors applied by the PSR plot simulation of the PTE-P2B1 tool shall be that given in equation 2 below.

$$\rho_{sys} = \rho_{true} * \rho_{gain} + \rho_{offset} \rho_{sys} = \rho_{true} * \rho_{gain} + \rho_{offset}$$ Equation 2

In equation 2, the systematic component (“sys”) of the target report measured range is computed by taking the scenario trajectory or false plot component (“true”) multiplying by the scenario specified range gain bias parameter (“gain”) and adding the PSR scenario specified range offset bias parameter (“offset”).

[P2B1-SR-CAP-0120] The PSR scenario generation of the PTE-P2B1 tool shall include application of a radar time stamp bias model to determine the detection time stamp reported in the target report message.

[P2B1-SR-CAP-0121] The radar bias model for time stamp systematic errors applied by the PSR scenario generation of the PTE-P2B1 tool for target report and radar service message generation shall be that given in equation 3 below.

$$T_{meas} = T_{\det n} + T_{bias} T_{meas} = T_{\det n} + T_{bias}$$ Equation 3

In equation 3, the target report detection time stamp (“meas”) component is computed by taking the detection time (“detn”) and adding the PSR scenario specified time stamp bias parameter (“bias”).

[P2B1-SR-CAP-0122] The PSR scenario generation of the PTE-P2B1 tool shall include application of separate stochastic error models to determine the stochastic components of the PSR target report range and azimuth position errors.

[P2B1-SR-CAP-0123] The error model for azimuth stochastic errors applied by the PSR scenario generation of the PTE-P2B1 tool shall be to independently randomly draw the stochastic error component of each simulated PSR target report from a Gaussian distribution function with the PSR scenario specified standard deviation.

[P2B1-SR-CAP-0124] The PSR scenario generation of the PTE-P2B1 tool shall compute the value to be used as the measured azimuth in the generated target reports by addition of the systematic and stochastic azimuth components for each simulated PSR target report.

[P2B1-SR-CAP-0125] The error model for range stochastic errors applied by the PSR scenario generation of the PTE-P2B1 tool shall be to independently randomly draw the stochastic range error component of each simulated PSR target report from a Gaussian distribution function with a PSR scenario specified standard deviation.

[P2B1-SR-CAP-0126] The PSR scenario generation of the PTE-P2B1 tool shall compute the value to be used as the measured slant range in the generated target reports by addition of the systematic and stochastic range components for each simulated PSR target report.

Note : The stochastic error models applied by the PTE-P2B1 tool contain no allowance for the eventual truncation errors induced by formatting to a particular message. Therefore the stochastic errors measured for the simulated radars by examination of the output target report data may be greater (+ or -) than the values specified by the user for the simulation run.

3.2.1.2 Dataflow and User Interface

The P2B1 PSR scenario generation will use the user defined P1 MSSR scenario plus a set of user defined parameters to calculate the PSR scenario.
As an output, the module produces a file containing all generated PSR plot data in the form of the S4 format. This data can then further be processed.

It is the intention for the PTE P2B1 development to reuse most modules of the P1 scenario generator, including the main user interface (Trajectory Scenario generator.vi) . This means that the existing user interface of P1 Trajectory scenario generator will be reused. The preference window will be the only visible changed window between the P1 and P2B1 versions.

First, the user has to select the scenario he wants to use for PSR scenario creation. This can be a new or existing scenario. This functionality is standard for the P1 Scenario generator.

Next, the user must specify that a PSR scenario is to be generated. This is the specification of an additional output for the scenario generator compiler, namely a PSR scenario. The user interface for the “Trajectory Scenario Generator” uses a specific window, called via an on screen button, to specify this: The preference window. The preference window of the P1 trajectory Scenario Generator has five “tabs”, each of which defines a separate set of parameters. In P2B, two additional tabs will be added:

- PSR Generation: Used for input of all PSR plot related information
- PSR Reply: Used for all Asterix or RDIF related data

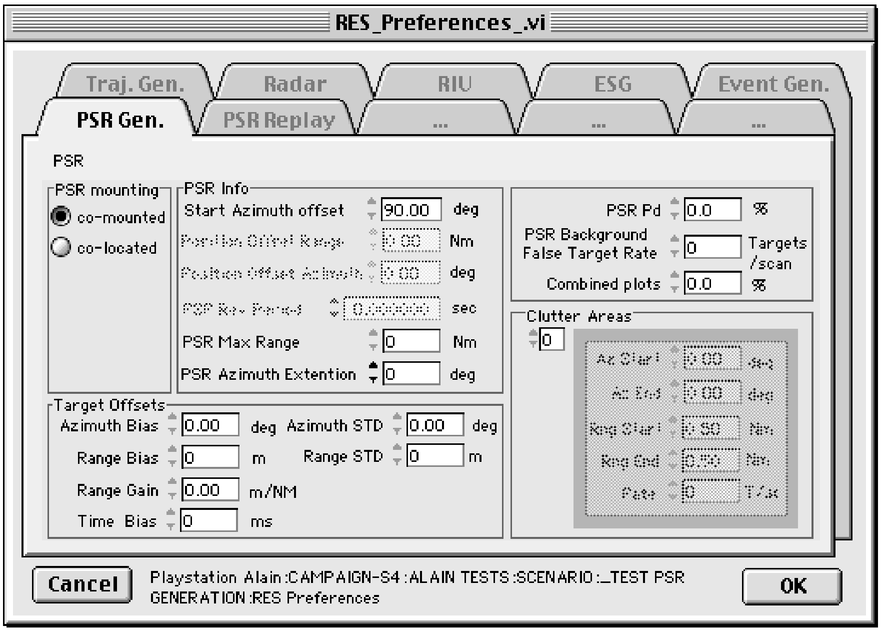

Figure 3-5: Preferences input for PSR Scenario preparation

PSR Generation parameters:

§ -(a) Co-mounted and synchronised or (b) co located and not synchronised

§ -for (b) Azimuth start offset [0..360,1]

§ -for (b) Range [0..5 Nm,0.01] and Azimuth [0..360,0.01] offset for co-located PSR

§ -for (b) Simulated PSR rotation time [4..15 seconds rpm,0.01 second]

§ -Simulated PSR Pd of detection [85..100,0.1%]

§ -PSR max range [0..256, 1 Nm]

§ -PSR Minimum and Maximum background false target rate [0..100,1 targets/scan]

§ -PSR clutter area parameters (min Range, Max range, min Azimuth, Max Azimuth, Minimum rate, maximum rate)

§ -PSR azimuth bias (0..0.2,0.01 deg)

§ -PSR range gain [0..2 ,0.1 m/Nm]

§ -PSR range offset [0..150,1 m]

§ -PSR time stamp bias [0..200 ,1 ms] (asterix time stamp will limit granulity to 1/128 s)

§ -PSR stochastic Azimuth error STD [0..0.2, 0.01 deg]

§ -PSR stochastic Range error STD [0..150,1 m]

§ Default PSR run length [0.1..5,0.1 deg]

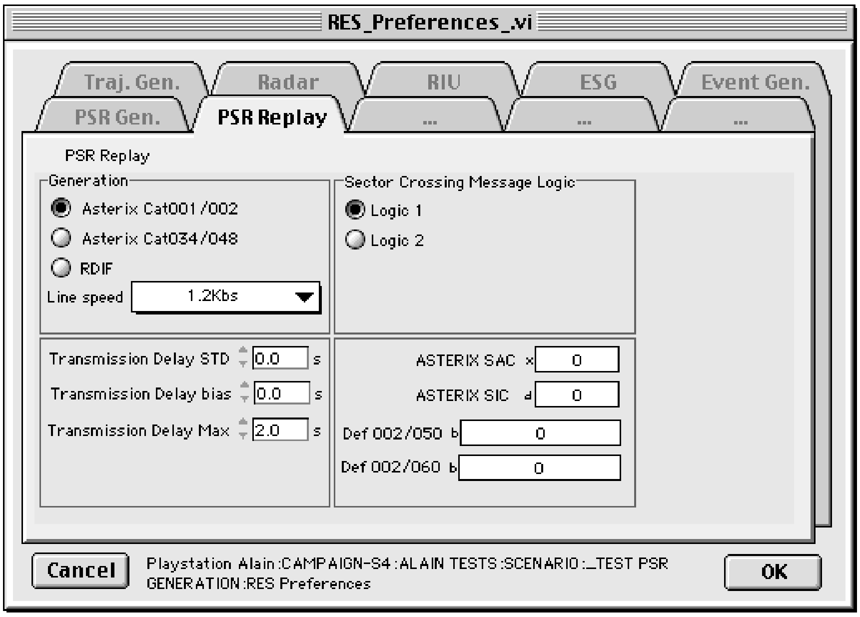

Figure 3-6: PSR Replay Preferences

PSR Replay parameters:

§ Format of generated data

§ Line speed of generated data

§ Sector message sending logic

§ PSR Radar SIC and SAC codes

§ Transmission delay bias, Maximum and Standard deviation

§ PSR Radar Default values for items 002/050 and 060 in North messages in asterix. (Optional)

All defined parameters are entered in the preference window, and are automatically saved (upon closing the window) in the selected scenario Folder. (This is a folder which contains all required PSR scenario data). At any time, the user has acces to earlier entered parameters through this user interface. When the user reloads an earlyer saved scenario, the parameters are automatically reloaded from disk.

3.2.1.3 Functional Description

The user specifies the scenario in exactly the same way as in P1. (In fact, it is the P1 scenario, since the same data is used for the PTE scenario and the PSR scenario). He can make use of sentences to define each individual trajectory. The compiler will translate the trajectory position into S4 records (plots) which are saved in a file with name “xxx.S4PR”, where xxx stands for the lower case version of the Scenario folder name . This file has a format according to Ref. 22 § 3.3.4 and shall contain at least the following fields for every record:

§ PSR Bit

§ Polar Coordinates (Plot_Range, Plot_Azimuth)

§ Timestamp

§ Processing Delay

Further, a number of parameters need to be defined by the user, and are copied in the “attributes” section of the S4 file :

- SIC,SAC code
- PSR Run length

The details of the compilation are explained in the next paragraph.

Each time a scenario is recompiled, new random seeds will be used for all random S4 records to be generated. (clutter and false targets). The user can opt for stable and identical data set each time he replays the same scenario by not recompiling the scenario.

Depending on the preference parameters, the scenario will be compiled for a co-mounted radar of for a co-located radar. Incase of the co-located radar, the scenario will take into account the positional offset of the PSR radar toward the POEMS radar. The scenario is always defined relative to the POEMS radar.

The possible offset shall be recalculated towards the POEMS radar using a flat earth model. This will not generate large errors since the maximum offset defined is 5 Nm.

The rotation speed of the co-mounted radar is derived from the POEMS radar.

The rotation speed of the co-located radar is freely programmed by the user.

In both cases the rotation speed is constant and will not be derived from a rotational scenario.

The scenario generation will include a Probability of detection algorithm.

Once the user has entered all specifications, the scenario generator can compile the Primary scenario into a .S4PR file. This file has the standard S4 layout (Which can be found in the PTE P1-P2 ICD (Ref. 22).

3.2.1.4 Generation Design Description

3.2.1.4.1 1. Generation Rules

The scenario generation will include a Probability of detection algoritm. For this purpose, the user defined parameter Pd will be used as a threshold for a randomiser function determining whether a certain plot is generated or not. This randomising is repeated for every target and for every scan. (The Pd has no influence on trajectory in total.)

Rule1 : If rnd(1) [1]* 100 >= Pd(%) then Miss = True

The compiler will take into account an individual PSR maximum range.

Rule2 : If RngPSR > MaxRng then Miss = True

3.2.1.4.2 False Target and Clutter Generation

A defined random rate of background false target plots will be programmable., The rate will be determined using a user defined rate.

For every scan n = 0 to N

[1] Rnd(1): This function results in a random number between 0 and 1 with a uniform distribution.

```
        Irate
        For  i = 0 to I:
                Plot_Range( i ,n ) = (MaxRange-0.5)*rnd(1)+0.5
                Plot_Azimuth( i ,n) = 360 * rnd(1)
                Plot time( i ,n) = Scan_Time * (n+Plot_Azimuth / 360)
        Next i

Next n
```

Secondly, in order to simulate clutter plots, additional false plots can be created in a specific area . These false plots will be added on top of the background false plots and of the genuine target plots.

```
For every scan n = 0 to N

        I=(Max_Clut_Rate-min_clut_Rate)*rnd(1)+min_clut_rate
        For  i = 0 to I:
                Plot_Range( i ,n ) = (Max_Clut_Range -
                        min_Clut_range)*rnd(1)+min_Clut_range
                Plot_Azimuth( i ,n) =mod( (Max_Clut_Azim -
                                min_Clut_Azime)*rnd(1)+min_Clut_Azim),360)
                Plot time( i ,n) = Scan_Time * (n+Plot_Azimuth / 360)
        Next i

Next n
```

No stochastic error model is applied to the azimuth and range data, since it has no use to add stochastic errors onto issolated random positions..

Zero values are inserted in the “Delta Azimuth” and “Delta Range “ fields of the generated S4 data .

3.2.1.4.3 Generation of Genuine Radar Plots

Genuine targets positions are derived from the parametric description of the trajectories in the scenario and are calculated in the cartesian XYZ plane using the PSR Radar as orgin. For this, all trajectory descriptions will receive a translation of their start positions prior to calculating their trajectory plot positions.

Following datastructure is used: See ADD P1 (Ref. 31) §5.2.10. 2

- -Start position : xn(m),yn(m),zn(m),tn(s),Azn(rad)
- -Special data : { Trajectory ID, Set nr, transponder nr, Reflection nr,Aircraft type, Transponder type}
- -Array of trajectory sections with { Speed: vn(m / s):, heading: qn(rad), Vertical speed:Vzn(m / s), Tangential Acceleration: aT(m / s2), Turn rate: w(rad / s),Time:t(s) }]

Only the start position needs to be translated:

A new trajectory input will be created, containing new trajectory start positions:

Start position : xpn(m),ypn(m),zpn(m),tpn(s),Azpn(rad)

- xpn=xn+ PSR_Range_offset*sin(Azimuth Range_offset)
- ypn=yn+PSR_Range_offset*cos(Azimuth Range_offset)
- zpn=zn

- tpn=tn
- Azpn=atan[2] (ypn, xpn)

The scenario is then compiled identically to the SSR scenario. See ADD P1 (Ref. 31) §5.2.10. 3.
For the calculation of the PSR target positions, the same algorithms (and internal subvis) are used as in the SSR (RES) trajectory scenario generator.

This results in a number of plots described in XYZ coordinates in a flat earth model with the PSR radar in its orgin. These coordinates are then recalculated toward PSR Range, PSR Azimuth , PSR altitude, Detection time (using rotation information).

A separate stochastic error model is applied to the azimuth and range data.

- Az_out=Az_psr + Az_bias_error+Az_stoch_error*Gsn(1)[3]
- Rng_out=Rng_psr * Rng_Gain + Rng_bias_error+Rng_stoch_error*Gsn(1)
- Time_out = Time_det+Time_bias)

Az_stoch_error*Gsn(1) andRng_stoch_error*Gsn(1) are inserted in the “Delta Azimuth” and “Delta Range “ fields of the generated S4 data for analysis purposes.

3.2.1.4.4 Generation of Sector Messages

A final set of S4 records must still be created, namely the sector messages. The user has defined the number of sector mesassages in the scenario preferences. The tool will add these sector messages (as regular S4 records) to the target reports of every scan.

A sector message only contains valid Azimuth, Timestamp and status data. (Range and other fields are zero)

3.2.1.4.5 Combination of data

The thus generated positional data is added to the set of random False targets and clutter information. The calculations are scan based (one scan is calculated in one step), and the data is sorted towards azimuth before it is written to a xxx.S4PR data file on scan basis. (one record contains a full scan of data).

Following data is copied into the S4 data:

- Range=Rng_out
- Azimuth = Az_out
- Timestamp=86400+Time_out
- Delta Azimuth = Az_bias_error+Az_stoch_error*rnd(1)
- Delta Range= Rng_bias_error+Rng_stoch_error*rnd(1)
- Delta_Time=Time_bias
- Track number=Target ID (genuine plots only)
- Scan number = Mod(Timestamp,Rotation time)

[2] Atan(y,x): This function is a two input function (x and y) resulting in the signed arc tangent of the angle y/x, keeping correct values if x is equal to 0 (resulting in pi/2 redsult)
[3] Gsn(1) : This function generates a random number out of a gausian distributed set of numbers. The standard deviasion of a sufficiently large set of numbers will be equal to 1.

- 3D Height = PSR Altitude
- Status = x0002 0400 for simulated PSR targets ;
  Status = x0002 0410 for simulated false PSR targets
  Status = x0000 0001 for sector messages

Remark: the timestamp in LabVIEW is absolute and starts with 0 on 1/1/1904. Due to display problems when displaying times of day 1 (around 0) on systems with non-UTC settings , resulting in negative times, the timstamp is increased with 86400 or the number of seconds in one day.

This data is then passed to the next design module, namely the Asterix or RDIF Generation module.

3.2.2 S4 to ASTERIX/RDIF compiler

3.2.2.1 Specifications

The following specifications are relevant for this section

[P2B1-SR-CAP-0200] The generated .S4PR file shall be converted into asterix cat 001 and 002 data. (**Asterix Convertor**) or RDIF format (**RDIF Convertor.vi)** The tool will generate PSR target reports and service messages from an input S4PR scenario file (generated by the scenario generator).. The file shall have a flat data structure , similar to the PTE P1 GDLP replya files , but shall be accompanied by a “playback” section (headers) , which determine the exact time , ACP and ARP of transmission of each Asterix or RDIF message.

[P2B1-SR-CAP-0201] The PTE-P2B1 tool shall enable the user to specify the following parameters to be used during the PSR scenario replay run for the simulated PSR radar . The parameters shall be selectable from within the Asterix Convertor. All parameters shall be saved and reloaded when the user selects a specific scenario.

- selection of the message format for output of the PSR from a user selectable choice of RDIF [Doc Ref. 21] or ASTERIX Cat 001 and 002 [Doc Ref. 15, Ref. 16, Ref. 23 and Ref. 24].
- simulated PSR line speed (selectable between 1.2, 2.4 , 4.8 , 9.6 , 19.2 and 38.4 kbs)
- stochastic message transmission delay component standard deviation (in the interval -2 to +2 seconds with a granularity of 0.1 seconds)
- systematic message transmission delay component (in the interval 0 to 2 seconds with a granularity of 0.1 seconds)
- maximum message transmission delay (in the interval 2 to 5 seconds with a granularity of 0.1 seconds)
- selection of the logic for sector crossing message (Cat 002) sending. Logic 1 : Cat 002 sector crossing Message is sent after the last Cat 001 target report message of the previous sector is send. Logic 2 : Cat 002 sector crossing Messages is sent when the antenna passes to the start azimuth of the corresponding sector.

[P2B1-SR-CAP-202] The PSR target report and radar service messages generated and output by the PTE-P2B1 tool shall be produced in the PSR scenario specified message format (either RDIF or Asterix Cat 001 & 002).

[P2B1-SR-CAP-0203] The message transmission delay imposed by the PTE-P2B1 tool for each particular message shall be independently calculated according to the following model :

§ drawing a stochastic message transmission delay component from a Gaussian distribution with the PSR scenario specified standard deviation

§ adding the PSR scenario specified message transmission delay systematic component

§ if the sum of these components is less than zero, setting the message transmission delay to zero

§ if the sum of these components is greater than the PSR scenario specified maximum transmission delay setting the transmission delay to the maximum.

3.2.2.2 Data Stream and User Interface

The Compiler itself is an embedded routine which takes generated S4 files as an input and which produces the required EDR replay files as an output.

The tool is therefore embedded in the existing P1 Trajectory scenario generator and will therefore not be noted by the user. The user can follow the process of compilation using the trajectory scenario generator compiler statistics window and follow the progress: see Figure 3-7: PSR Compilation Monitoring

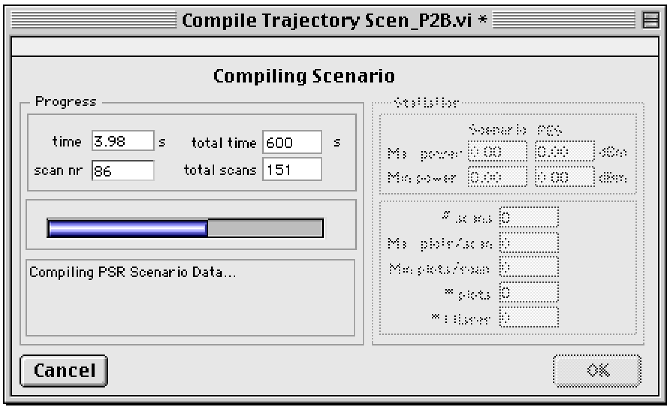

Figure 3-7: PSR Compilation Monitoring

3.2.2.3 Functional description

The S4 to ASTERIX / RDIF compiler takes any S4 format file (according to Ref. 22 § 3.3.4) , in this case a S4PR file from the PSR Scenario Generator, and compiles it into an EDR replay file format (format according to) .

This EDR replay file format is similar as for the GDLP functionality. The EDR replay file format consists of records, each with a replaying section and a data section. The replaying section contains information like the size of the data section and the exact moment of transmission relative to the start time of the scenario. The data section contains the actual data to be transmitted. This data can be ASTERIX or RDIF depending on the choice of the user. The exact file format of the EDR replay file can be found in the PTE ICD (Ref. 22 § 3.5.7) under the chapter file formats.

The result of the compilation is a file ready to be streamed by the EDR replay file streamer. All the timing information incorporated in the EDR replay file is relative to the start time of the scenario and will be recalculated towards UTC time at the moment of transmission. The following figure illustrates this compilation process.

Figure 3-8: EDR Replay functionality

The S4 to ASTERIX / RDIF compiler is incorporated in the Trajectory Scenario generator. The compilation process is completely transparent for the user. If the “make PSR scenario” checkbox is checked, the PSR scenario is compiled in one go right after the POEMS scenario and put in the correct scenario folder ready for streaming to the serial line.

3.2.2.4 ASTERIX Cat001/Cat002 format

The ASTERIX Cat001 format contains the following items for PSR target report generation:

§ Cat001 / 010 Data Source Identifier

§ Cat001 / 020 Target Report Descriptor

§ Cat001 / 040 Measured Position in Polar Coordinates

§ Cat001 / 141 Truncated Time of day

The standard user application profile according to the Eurocontrol standard document for Radar Data Exchange SUR.ET1.ST05.2000-STD-02a-01 edition 1.0 dated November 1997 (Ref. 15) is used to transmit the PSR target reports. This is compliant with Ref. 23

The ASTERIX Cat002 format contains the following items for North marker message and Sector crossing message generation:

§ Cat002 / 000 Message type

§ Cat002 / 010 Data Source Identifier

§ Cat002 / 020 Sector Number (only Sector crossing message)

§ Cat002 / 030 Time of Day

§ Cat002 / 050 Station Configuration Status (fixed, only North marker message)

§ Cat002 / 60 Station Processing Mode (fixed, only North marker message)

The standard user application profile according to the Eurocontrol standard document for Radar Data Exchange SUR.ET1.ST05.2000-STD-02b-01 edition 1.0 dated November 1997 (Ref. 16) is used to transmit the radar service messages. This is compliant with Ref. 24

3.2.3 RDIF format

The RDIF format contains the following items for PSR target report generation:

§ Field 1 Identification

§ Field 2 Range

- Field 3 Azimuth
- Field 4 Runlength and Time in Store

The RDIF format contains the following items for sector message generation:

- Field 1 Identification and Sector number
- Field 2/3 Time and Time Source

The CAA Paper 87002 , Radar Data Interchange Format, dated November 1991 (Ref. 21)is used to define the RDIF format data to be transmitted.

3.2.3.1 Message transmission delay

Message transmission delay is not applicable for ASTERIX Cat002 sector crossing messages when logic 1 is chosen: ASTERIX Cat002 sector crossing messages are sent after the last ASTERIX Cat001 target report of the previous sector. In this case the message transmission delay has a whole other meaning since the time inside the sector crossing messages is the time at the beginning of the corresponding sector. In the case of logic 1, the sector-crossing message is sent immediately after the last target report, taking into account its message transmission delay, of the previous sector.

In all other cases, message transmission delay is defined by a systematic component and a stochastic component but limited between zero and a maximum value. Messages are arranged according to their time of transmission: this is the time of detection plus the message delay. Whenever two consecutive messages are in overlap (taking into account their length and the transmission speed), they are transmitted behind each other in one LAP B frame if possible in one ASTERIX message. Notice that this message transmission delay is a theoretical calculated value. The real message transmission delay is influenced by the status of the transmission protocol at the moment of transmission and can not be predicted at compilation time.

The stochastic message transmission delay component is drawn from a Gaussian distribution with standard deviation in the interval -2 to +2 seconds with a granularity of 0.1 seconds. The systematic message transmission delay component is specified in the interval 0 to 2 seconds with a granularity of 0.1 seconds. The combination of both message delay components is limited by zero at the lower side and by a maximum in the interval 2 to 5 seconds with a granularity of 0.1 seconds at the higher side.

3.2.4 EDR replay file streamer

3.2.4.1 Specifications

The following specifications are relevant for this section

[P2B1-SR-CAP-0300] The Asterix or RDIF file generated by the PSR scenario generation shall be spooled to the PTE P1 EDR platform for replay using the **EDR playback.vi** .The tool shall load a selected scenario folder. The replay function shouldn't work simultaneously (on one EDR) with the GDLP function. The tool will not slave on radar generated ACPs and ARPs.

[P2B1-SR-CAP-0301] The PSR scenario replay functionality of the PTE-P2B1 tool shall enable the user to replay any previously compiled PSR scenario in conjunction with the corresponding POEMS target scenario.

[P2B1-SR-CAP-0302] The PSR scenario replay functionality of the PTE-P2B1 tool shall be capable of generating and outputting to the POEMS SUT simulated PSR target report and radar service messages from a simulated PSR radar. The capability for PTE-P2B1 to replay PSR scenarios is not functional when either (a) ASTERIX Cat 018 simulation is being executed by the other components of PTE-P1 / P2B1 or (b) the PTE-P1 / P2B1 is being operated in the live data environment (i.e. is slaved to the POEMS SUT) or (c) a non-constant antenna rotation speed is defined for POEMS. These limitations shall be clearly stated in the User Manual.

[P2B1-SR-CAP-0303] The PSR target report and service messages generated by the PTE-P2B1 tool shall be transmitted in real time using targets as specified in the associated POEMS target scenario as currently replayed by the PTE-P2B1 tool.

[P2B1-SR-CAP-0304] The PSR target report and radar service messages generated by the PTE-P2B1 tool shall be output on a serial line to the POEMS SUT (the User is free to select from either RS-232 or RS-422) at the PSR scenario defined line speed using HDLC LAPB .

[P2B1-SR-CAP-0305] The PSR scenario replay of the PTE-P2B1 tool shall include simulation of message transmission delay. This is defined as the delay between the internal time stamp of the message and the transmission of the first bit of the message on the serial line. This delay shall be defined at the Asterix or RDIF generation stage.

It should be noted that these performance figures assume no overload conditions are present, in the event of an overload it is acceptable for the tool to discard data before message transmission.

[P2B1-SR-CAP-0307] The PTE-P2B1 tool shall then queue the PSR messages for later automatic transmission over the serial line at the appropriate time.

[P2B1-SR-CAP-0308] In the event that during the course of the simulation the PSR scenario replay experiences an overload condition on the number of messages awaiting transmission, the PTE-P2B1 tool shall provide a visual indication on screen to this effect for the remainder of the simulation run.

[P2B1-SR-CAP 0310] When the PSR data are sent under the Asterix format, the PSR scenario replay of the PTE-P2B1 tool shall send the sector crossing messages (Cat 002) according to the selection

More details about these specifications can be found in the SRD.

3.2.4.2 Data Stream and User Interface

The EDR Replay function will consist of a NEW user interface panel, which will be called from the RASS-S Toolbox. The tool will read the generated EDR Reply files and will stream them to the EDR. As an output, the tool produces Asterix and RDIF data under Lap-B protocol.

The user interface of the tool simply requests the user to define the scenario folder containing the EDR Replay data files. After the scenario folder is defined, the tool also required that the connection between the SUT and EDR is accomplished. This can be performed using the standard P1 EDR Serial Recorder tool, which must run simultaneously with the PSR reply function. (This also automatically creates a log of all data send to the SUT.

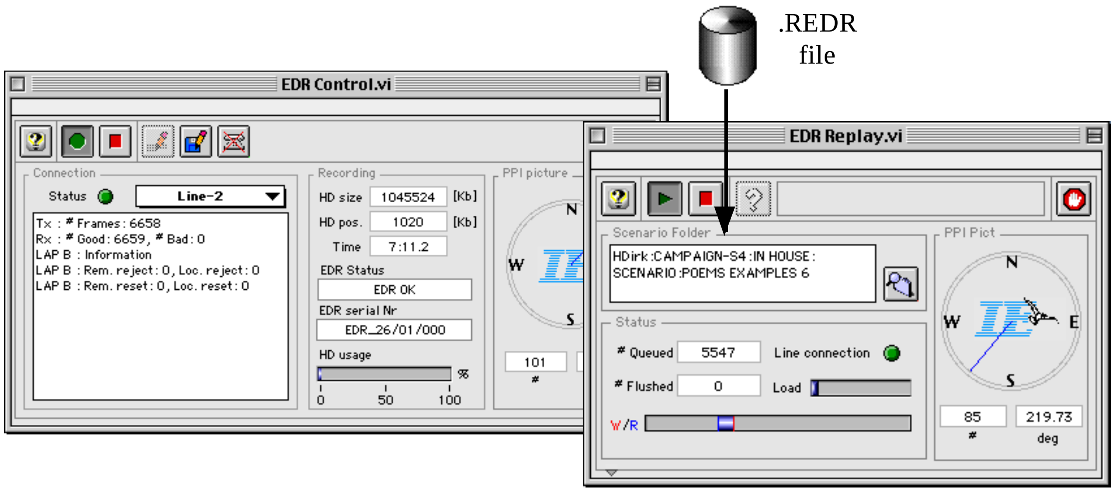

Figure 3-9 EDR Replay file streamer user interface

Once the link is ready, the RES must be started on the separate platform, and the MSSR and PSR scenario will be replayed. The EDR replay file streamer will wait for the first RES ARP to synchronise.

3.2.4.3 Functional description

The EDR Replay File Streamer streams the compiled PSR scenario (this is an EDR replay file generated by the S4 to ASTERIX/RDIF compiler) into a queue for automatic transmission over a serial line by the EDR hardware. This concept is already used in the PTE GDLP function. A new feature is the real time UTC time adjusting of the internal time stamp of the PSR messages. For this purpose, the GPS is used in a similar way as it is used for UTC time stamping of the recorded messages.

The EDR serial recording tool and the EDR hardware are capable of supporting one active bi-directional LAP B connection. All the functionality of the PTE Serial Recording tool is available during the PSR scenario replay. The EDR Replay File Streamer allows the user the select a compiled PSR scenario and streams it to the serial line. In the case that during the course of the simulation the PSR scenario replay experiences an overload, a visual indication to this effect is given for the remainder of the simulation run.

The following figure illustrates the EDR Replay File Streamer in cooperation with the EDR Serial Recording tool.

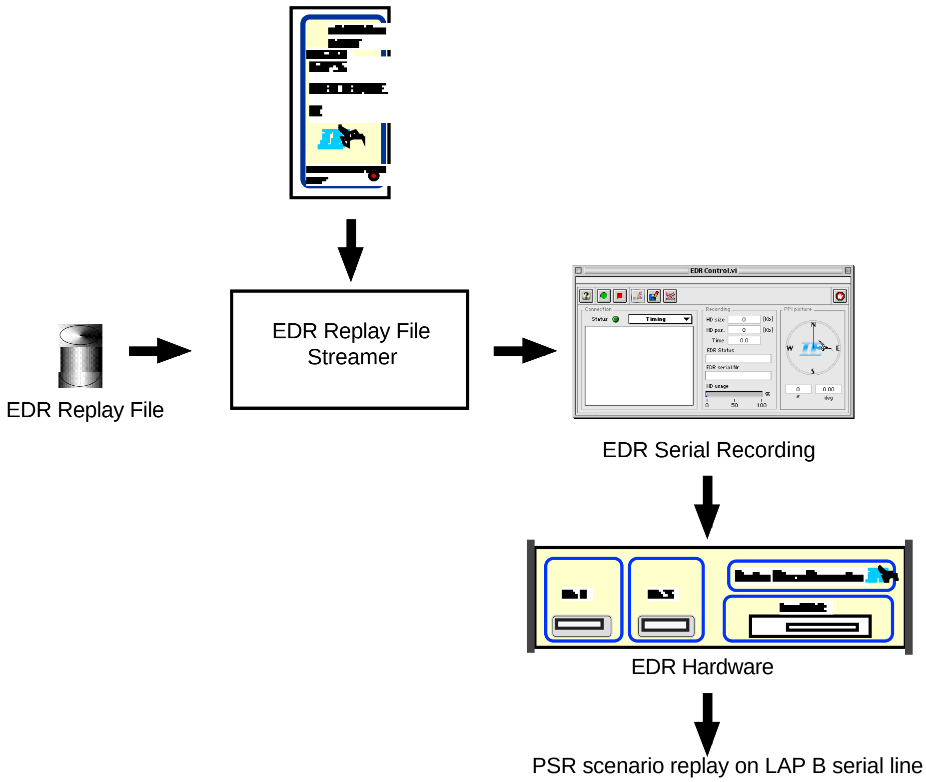

Figure 3-10: EDR Replay Functional overview

3.2.4.4 Firmware

The current PTE firmware used for driving the EDR Serial Recording tool is sufficient to replay a PSR scenario on a serial line. The EDR Serial Recording tool is capable of supporting one bi-directional LAP B connection on the RS323 or RS422 electrical standard using line speeds up to 128 Kb/s. The moment of transmission is regulated using the ARP/ACP signals. The compiled PSR messages are queued until their ARP/ACP moment of transmission is reached.

There is an 8 Kb FIFO buffer available for storing the queued messages awaiting transmission. In the case of an overload of this buffer caused by transmission problems, additional messages are flushed from the moment their ARP/ACP stamp of transmission is elapsed. A visual indication of this flushing is given to the user.

The firmware allows for an UTC time synchronisation using the PPS of the GPS and the internal 50 microsecond resolution counter of the DSP. This principle is already successfully used for UTC time stamping of the recorded messages. The same UTC time synchronisation principle is used for adjusting the internal time stamp of the PSR messages according the moment of transmission. This is possible because the rotation speed is fixed (mandatory) and therefore there is a known relationship between the PSR scenario and the corresponding POEMS scenario. The following figure illustrates the UTC time synchronisation principle.

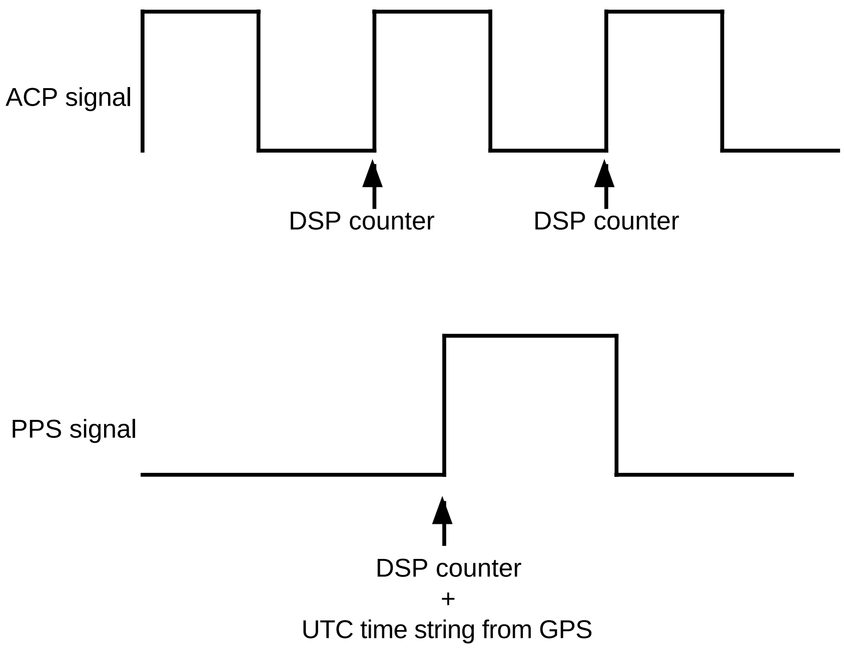

Figure 3-11: UTC Synchronisation for EDR Replay

Each ARP pulse is UTC time adjusted using the internal DSP counter and the UTC time string from the GPS. With this information and the fixed rotational relationship between POEMS and the PSR, the UTC time of day item inside the ASTERIX PSR messages is recalculated at the moment of transmission.

3.2.4.5 Software

Just like the PTE-GDLP tool, the EDR Replay File Streamer runs in parallel with the EDR Serial Recording tool. The set up of the transmission protocol and the adjusting of the parameters is done using the EDR Serial recording tool interface. From the moment the connection is established, a PSR scenario can be selected and replayed. The actual data is spooled to the transmission queue and held there until the moment of transmission. The PSR scenario will only start running from the moment ARP / ACP signals are detected because these signals declare the moment of transmission. This means that the complete set up can be prepared in advance and then launched synchronously with one button.

Data Link model B capabilities

3.3 Data-Link Model B Capabilities

The Data link Model B definition needs to be automated in PTE P2B1. Under the PTE P1 scenario generator, the user could already generate the required data link model manually, but this required a lot of manual editing. It is the intention for this project section to create an automatic input for both the trajectory scenario generator and the event scenario generator. This input would allow the user to define the positions of the targets for a data link model plus all frequencies and scan numbering of certain data link events to be defined by the user.

Due to the nature of the PTE P1 Scenario generation (using the double editor, trajectory and events) , it is required to split the automatic scenario generation in two modules:

- Surveillance scenario
- Event Scenario

3.3.1 Data link model B Surveillance Scenario

3.3.1.1 Specification

The following specifications are relevant for this section:

[P2B1-SR-CAP-0400] The Data-link model B scenario generation shall be split into two sections:

- -Surveillance scenario generation (Trajectory positional information)
- -Data-link event generation

[P2B1-SR-CAP-0401] Using the PTE-P1 / P2B1, it shall be possible for the user to generate targets and associated data-link scenarios corresponding to all of the simulations required to fully exercise the POEMS station according to the data-link model B section of the POEMS FS doc Ref. 3(see paragraph below).

[P2B1-SR-CAP-0402] An automatic randomiser function shall be added in the "**Trajectory Scenario Generator**" in order to implement the five Data link model B scenarios defined in the following specs.
The function shall be implemented under the "scenario randomise " sub menu of the trajectory scenario generator. The user interface shall be similar as the existing load scenario generators.
Most of the functions to generate this scenario already exist in PTE P1, but a new user interface shall be added to facilitate the creation.
Note : The tool assume the user uses a fixed scan rate (no rotational scenario) . This is an agreed limitation of the implementation.

[P2B1-SR-CAP-0403].Definitions applicable for the data link model B scenario creation :

- Run : a set of one or two adjacent peak sectors. A run is repeatable.
- Peak sector : angular sector of 3,5° containing a number of aircraft (fixed position). The aircraft are equally distributed in azimuth and are distributed in range according to a given range cell distribution. A peak sector has a certain duration (in scans) during which the targets are present.
- Background : remaining of the space outside the peak sectors containing a number of aircraft (fixed position). The aircraft are equally distributed in azimuth.

[P2B1-SR-CAP-0404] The PTE-P1 / P2B1 tool shall enable generation of surveillance and data-link scenarios (static targets) as per the following description (see also figure 1 and figure 2 below) (REQ_3015) :

§ Target trajectory scenario characteristics

- POEMS station parameters would be : min range 5 nm, max range 150 nm, scan period 4 seconds
- traffic azimuth **shall** be distributed evenly
- traffic range **shall** be randomly drawn from a uniform distribution for each range cell in the peak sectors
- traffic range **shall** be randomly drawn from a uniform distribution in range cell in the backgroundPeak run characteristics :
  - the scan number[4] of the first peak run P_S (1..20,1) > S_B.
  - the peak run duration in scan numbers P (1..20,1).
  - the number of peak runs in each scan (1..2,1)[5]
  - the number of peak sectors in the run(1..2,1)
  - the position (start azimuth) of the first peak sector of the run
  - the number N_R (0..20,1) of aircraft in the peak sector(s) of the run and in each range cell
  - the number of times the peak runs are repeated M (1..300,1) and its periodicity in scan numbers N > P (1..50,1). Each peak run **shall** correspond to a new random distribution of target positions.

§ Background characteristics :

§ The number (1..700,1) of aircraft located in the background

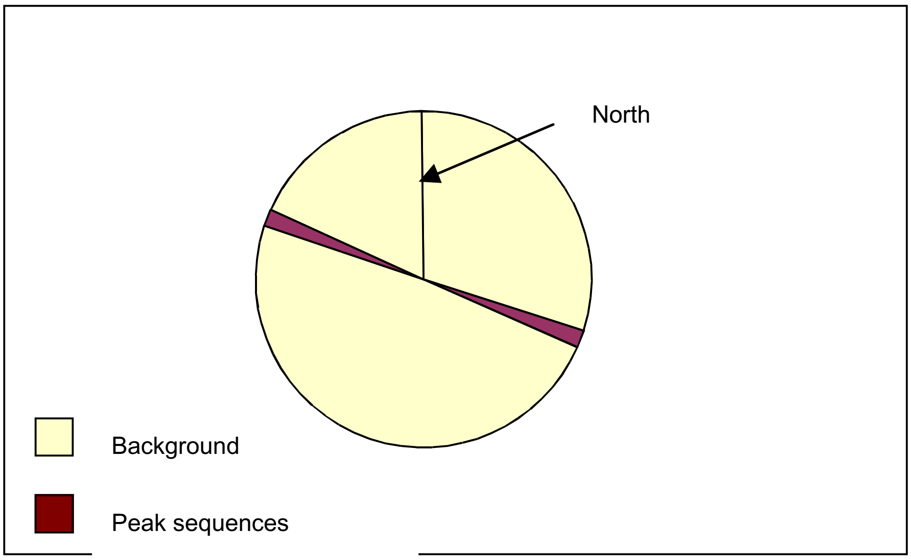

Figure 1 : Datalink Model B scenario - Aircraft partitioning

[P2B1-SR-CAP-0405] Using the parameters listed above, the PTE-P1 / P2B1 shall enable generation of the surveillance and data-link peak runs described in the following tables :

4 Means at the time of the ARP marking the start of this scan

5 In case of 2 peak sector sequences in the scan the two peak sequences **shall** be diametrically opposite

Scenario 1

Range NM	5-10	10-20	20-40	40-60	60-80	80-90	90-130	130-150
Distribution	1	3	12	7	7	2	6	10

Scenario 2,3,4

Range NM	5-10	10-20	20-40	40-60	60-80	80-90	90-130	130-150
Distribution	1	1	6	4	3	1	3	5

Scenario 5

Range NM	5-10	10-20	20-40	40-60	60-80	80-90	90-130	130-150
Distribution	0	1	3	2	2	1	1	2

[P2B1-SR-CAP-0406] The PTE-P1 / P2B1 tool shall ensure that the generated scenario does not represent for each range cell a load higher than the POEMS maximum load specified in the table below :

Range NM	5-10	10-20	20-40	40-60	60-80	80-90	90-130	130-150
Max	60	75	90	112	113	45	98	162

[P2B1-SR-CAP-0407] Within PTE-P1 / P2B1, the user shall be able to generate, load, modify, save (to be retrieved in a later session) and delete previously generated surveillance scenarios.

3.3.1.2 Data Stream and User Interface

The trajectory randomiser will input a number of user parameters which define the random scenario. This input will defined one of the five predefined Model B Data link scenarios as defined in Ref. 29. As an output, the tool will produce a complete scenario file. This file can be loaded, saved or compiled using the standard P1 scenario generator tools.

The generated file will comply with one of the five data link models.

An automatic randomiser function will be added in the “Trajectory Scenario Generator” in order to implement the five Data link model B scenarios defined in the specs. The function will be called from the existing function button “Scenario Randomiser”. The P1 Scenario randomiser already included two options for automatic scenario generation, namely “Load Model” and “Random area”.
A third one is added under P2B1, called “Data-Link Model B”. The template of the user interface is shown in Figure 3-12.

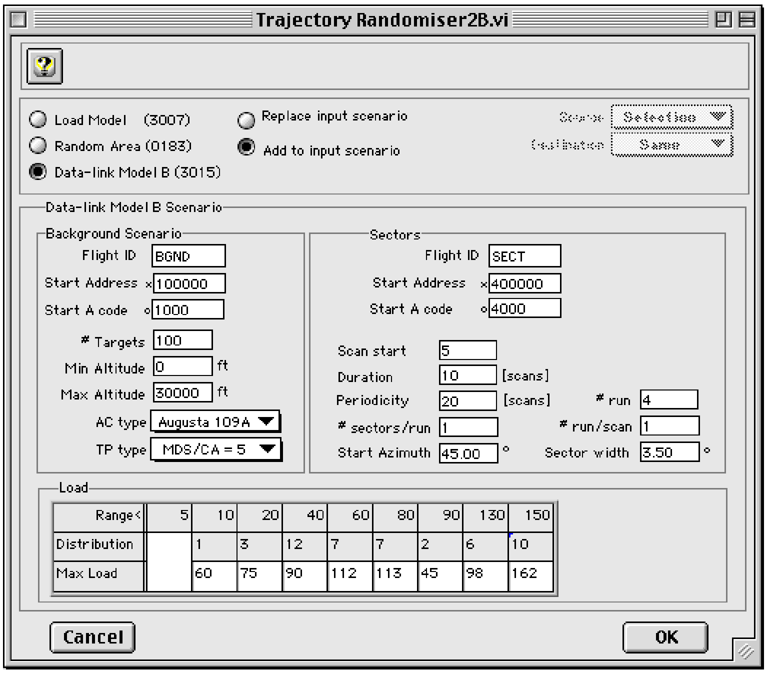

Figure 3-12 Trajectory Scenario Generator Randomiser Input

3.3.1.3 Functional Description

The tool will assume the user uses a fixed scan rate (no rotational scenario) of N [4..16,0.1 seconds].

The tool will allow the user to define :

- Nr_Run_Scan : Number of Runs per scan [1..2,1 runs]
- Nr_sec : Number of sectors in one run
- BG_Load : Background activity load [1 .. 700 ,1targets]
- Az_start_peak: Peak sequence position
- Peak_width : Peak sector width [0..7,0.1deg]
- N_cell : Number of range cells
- R_cell i : Range cell distribution range cells 5..150,0.1Nm],
- T_cell i :Number of targets <u>per sector cell</u> [0..50,1 targets/cell]
- T_ring_max i : Maximum target load per range ring (for total scenario)
- S_0 : Start Scan nr of first sequence [1..20,1scan]
- S_tot_Seq: sequence duration [1..20,1scans]
- N_Runs: Repeat factor run [1..300,1]
- S_period: Sequence periodicity [2..50,1scans]
- Rot_time: Scenario rotation time [4..16,0.1 seconds]
- S_BG_start_address : S address of first target in Background
- S_Sec_start_address: S address of first target in Sectors

§ A_BG_start: A code of first target in Background

§ A_Sec_start: A code of first target in Sectors

§ A_incr: Increment of consecutive A codes

All entered randomising parameters are saved along with the scenario preferences. This allows simple checking of the type of scenario that was generated, and this allows the event scenario generator to use some of this information in later event distribution.

The load distribution and maximum load shall be entered separately for each range cell. The tool will ensure the maximum load is not surpassed is each cell.

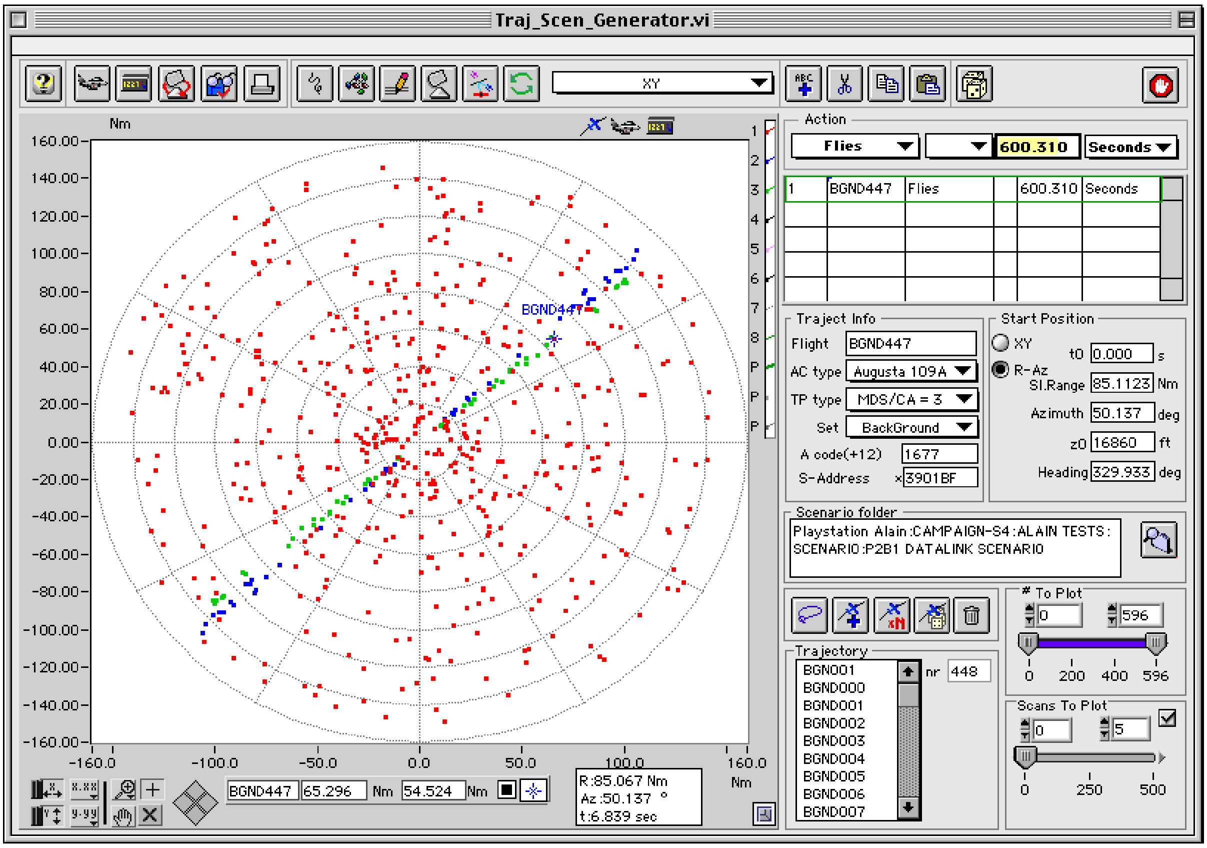

Figure 3-13 Example of generated Surveillance part of Datalink Scenario

The generated scenario will be a static scenario. (Using the sentence Aircraft… Flies x seconds" for targets with static aircraft (speed = 0) , where x is derived from the Peak sector or background load duration and the rotation speed) . The data link randomiser will generate random start positions.

After generation, the target data will be generated and compiled. A special type of compilation will be created, since the datalink scenario is actually a repetion of the same targets each time at a different position. Therefore the S address and target ID of each sector sequence will remain the same.

The Data link model is assumed to operate on a constant rotation speed of 4 seconds, but can also be created for different constant rotation speeds. No rotational scenario is allowed, since this would unnecessarily complicate later analysis of the scenario. In all cases, the flight times are adjusted automatically according to the number of programmed scans.

3.3.1.4 Detailed Description

3.3.1.4.1 Background scenario generation

After input of the user parameters, following data is calculated:

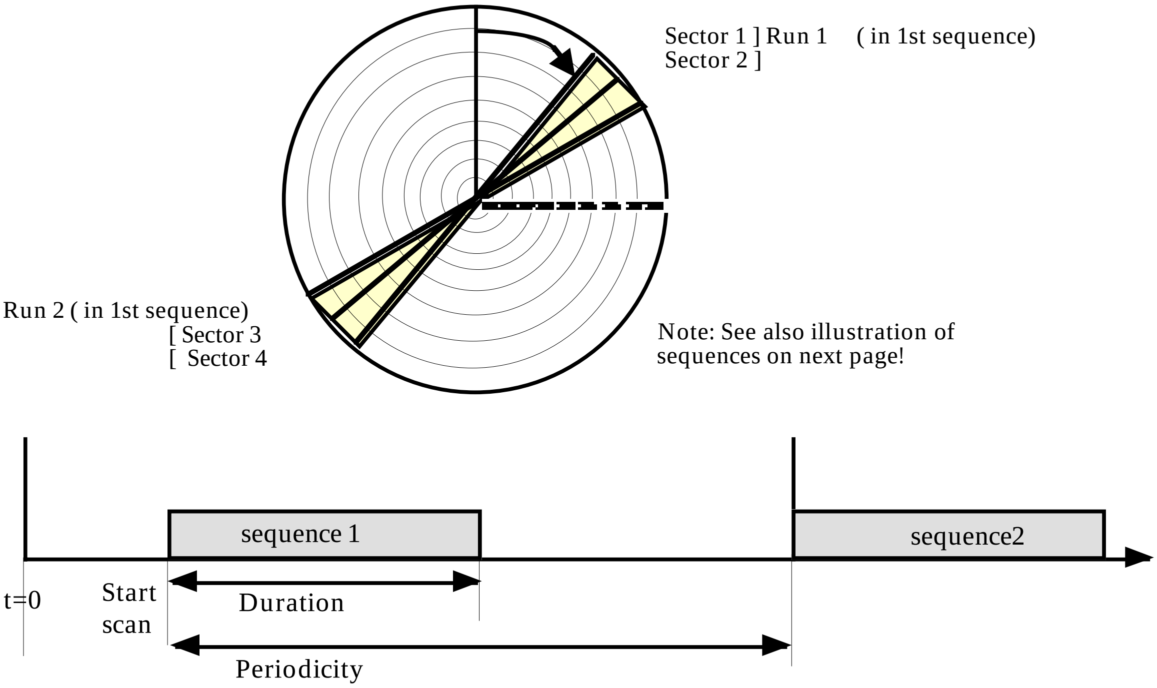

Figure 3-14: Sector distribution

- T_seq i : Number of targets per range ring in sectors
- T_max_BG i : Maximum number of targets in background per range ring
  For i = 1 to N_cell
  T_seq i = T_cell i * Nr_Run_scan * Nr_sec
  T_max_BG i = T_ring_max i - T_seq i
  Next i
- T_BG i : # of target in background generation per range ring
  For i = 1 to N_cell
  T_BG i =T_max_BG i / ∑ T_max_BG *BG_Load
  Next i
- Start and end azimuth of all sectors. (up to 4 sectors: A,B,C,D) and load of targets outside these sectors: N_A,N_B,N_D
  A= Az_start_peak;
  N_A = BG_Load*A / (360-Peak width*N_sec*N_seq)*BG_Load

  B= (Az_start_peak+Peak width*N_sec)
  C=(Az_start_peak+180deg

  N_B=(C-B) / (360-Peak width*N_sec*N_seq)*BG_Load

  D=(Az_start_peak+Peak width*N_sec+180)
  N_D=(360-D) / (360-Peak width*N_sec*N_seq)*BG_Load
- Azimuthal distribution of background targets:
  n=0
  For i = 0 to N_A
  Az n = i / N_A *A

```
n=n+1
Next i
For i = 0 to N_C
Azn=B + i / N_C * (C-B)
n=n+1
Next i
For i = 0 to N_D
Az n = D+ i / N_D * (360-D)
n=n+1
Next i
Scramble indexes of Az imuth array
```

§ Range distribution calculation:

```
m=0
For i = 0 to N_cell-1
For j = 0 to T_BG i
        Range m = R_cell i  + (R_cell i +1 - R_cell i )*rnd(1)
        m=m+1
Next j
Next i
```

§ Now the background distribution is calculated. (BG_load) targets are created, each with start position a randomly drawn azimuth from the azimuth array *Az n* and range from the range array *Rng m* .
The start time of all targets is put to 0 seconds.
The heading is made equal to the azimuth
The sentenses are all : Target BGN xxx flies 0 Nm / h ; Target BGN xxx flies N_Seq * S_period * Rot_time where xxx is a 3 character string from 001 to 700 (or the number of targets in backgroud)). In case of a rotational scenario, the flight time is calculated according to the rotational scenario. (starting from the number of scans)

§ All targets in the background have unique S addresses which are normally numbered from S_BG_start and incremented by S_incr for each new target. The same applies for A codes: A_BG_start and incremented by A_incr.

3.3.1.4.2 Sector generation

Each sector is calculated individual and separately

The procedure is repeated N_Run times. Each time, the same targets are reused.

§ Calculate Total Targets in one sector:
T_sect= ∑ T_cell i

§ Generation of Sectors and sequences

```
For q=0 to N_Seq-1                                  Sequence repitition loop
For  i = 0 to N_seq-1                     Sequence loop
    For j=0 to N_sec-1                    Sector loop
        For k = 0 to T_sector–1           Target loop
              Az k = Az start + j*Peak_width +i*180+Peak_width *k / T_sect
        Next k
        Randomise  Az k array ( in position)
        m=0
        For r=0 to N_cell                 For each range cell
              For n = 1 to T_cell i       Generate ranges for cells
                    Rng m = R_cell r +(R_cell r+1 – R_cell r)* rnd(1)
                    Azimuth m =Az m
                    T0 m = (S_0 +q) * S_period*Rot_time
                    m=m+1
              Next n
        Next r
```

Next i
Next q

- Use Rng m , Azimuth m and T0 m data to create targets with sentence
The start time of all targets is put to T0 m seconds.
The heading is made equal to the azimuth = Azimuth m
The sentenses are all : Target DTL xxx flies 0 Nm / h ; Target DTL xxx flies S_tot_peak* Rot_time where xxx is a 3 character string from 001 to 048 (or the number of targets in the sectors). In case of a rotational scenario, the flight time is calculated according to the rotational scenario. (starting from the number of scans)
- All targets in the sectors have unique S addresses which are normally numbered from S_Sec_start and incremented by S_incr for each new target. The same applies for A codes: A_Sec_start and incremented by A_incr.
- After the generation of one sequence , the same target Ids and S addresses are reused for the next generation. Only their positions are recalculated.
- Special care will be given to the use of the "Set" variable in the target generation. Each of the possible four sectors is attributed a set number between 1 and 4. Set 5 is reserved for background data. This allows simple datalink definition for all peak sectors.

3.3.2 DatalinkModel B Event Scenario Generation

3.3.2.1 Specification

The following specifications are relevant for this section:

[P2B1-SR-CAP-0450] An automatic randomiser function shall be added in the "Event Scenario Generator" in order to implement the five Data link model B scenarios defined in the specs.

[P2B1-SR-CAP-0451] The PTE-P1 / P2B1 tool shall enable the automatic generation of data-link scenarioas per the following description (see also figure 1 and figure 2 below) (REQ_3015) :

- the POEMS station will operate in multi-site (data link model B) or non selective (other purposes) mode and each data-link transaction will include all consequent protocols (reservation, close-out, etc.)
- all requested BDS registers **shall** end in '0'. Only BDS registers above and including 0x40 will be used. (0x40,0x50,0x60 etc..) for the datalink generation, and all transponders **shall** provide 100 % probability of reply.
- Peak run characteristics :
    - For the first (and optionally third) peak sector of the run, (1..10,1) data link events of the following types :
    - GICB request - a GICB rate G_P (0..5,1) **shall** be requested for all aircraft in the peak sector at S_G (1..20,1) scan number[6] during the run (only one event of this type **shall** be allowed).
    - The GICB shall be definable using the following parameters: (Valid for all used events)
        - GICB number start and increment (number shall be automatically incremented for each transaction)
        - BDS Code

[6] Means at the time of the ARP marking the start of this scan

- GICB Periodicity (optional)
- GICB Properties (Priority, PC,AU,NE flags, RD field) (Optional)

- UELM request - for a selected aircraft, an UELM (multi-segment Comm C) of N_C (1..16,1) segments **shall** be requested through a Cat 018 message at S_C (1..20,1) scan number[3] during the sequence and Δazimuth (-90..+90°,0,1°) relative to the theoretical time of POEMS beam interception with the target.
- The UELM Parameters shall be definable using the following parameters: (Valid for all used events)
    - Packet number start and increment (number shall be automatically incremented for each transaction)
    - Packet Priority
    - Packet type
    - Packet Contents
- DELM request - for a selected aircraft a DELM (multi-segment Comm D) of N_D (1..16,1) segments **shall** be announced from S_D scan number[3] during the sequence.
- The DELM Parameters shall be definable using the following parameters: (Valid for all used events)
    - Packet Contents
    - Used II code (Directed or Non directed DELM)

§ For the aircraft located in the second (and optionally fourth) peak the background GICB rate G_B **shall** be requested from S_G scan number[3]

- Background characteristics :
- G_B rate of (0..5,1) GICB per scan for all these aircraft,
- S_B (1..10,1) scan number[3] from which GICB are requested.

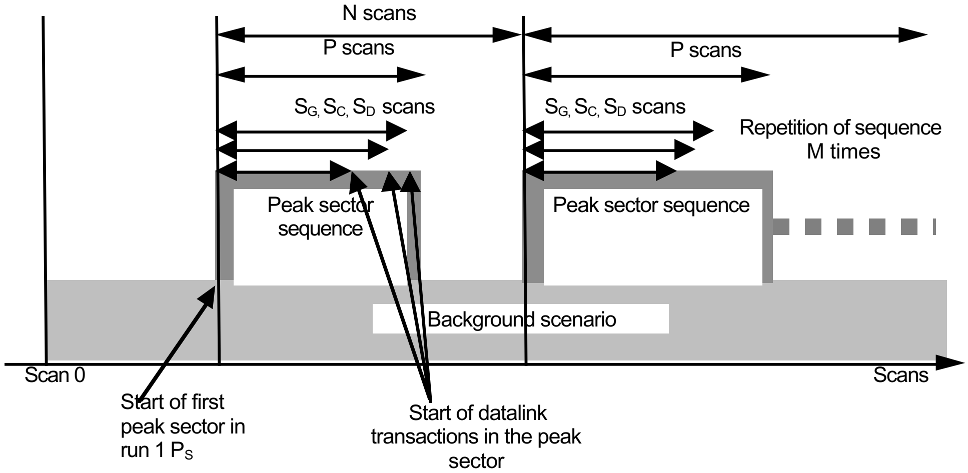

Figure 2 : Datalink Model B scenario – Data link transaction timing

[P2B1-SR-CAP-0452] Using the parameters listed above, the PTE-P1 / P2B1 shall enable generation of the surveillance and data-link peak sector sequences described in the following table :

Sequence type	Number of adjacent peak sectors	Peak sectors description
1	1	Traffic density : 48 aircraft in 3.5 degree sector, GICB rate : 1 GICB per aircraft, Data-link transactions : 4 comm-C and 4 comm-D on three of them.
2	2	Traffic density : 24 aircraft in 3.5 degree sector, GICB rate : 3 GICBs per aircraft
3	2	Traffic density : 24 aircraft in 3.5 degree sector, GICB rate : 2 GICBs per aircraft, Data-link transactions : 16 comm-C on ~~seven~~ two of them.
4	2	Traffic density : 24 aircraft in 3.5 degree sector, GICB rate : 2 GICBs per aircraft, Data-link transactions : 16 comm-D on one of them.
5	2	Traffic density : 12 aircraft in 3.5 degree sector, GICB rate : 3 GICBs per aircraft, Data-link transactions : 16 comm-C on three aircraft and 16 comm-D on three other aircraft.

[P2B1-SR-CAP-0453] Within PTE-P1 / P2B1, the user shall be able to generate, load, modify, save (to be retrieved in a later session) and delete previously generated data-link scenarios.

[P2B1-SR-CAP-0454] The PTE-P1 / P2B1 tool shall generate Comm C respectively Comm D messages. The contents of the MC and MD packets is according toAnnex 10 Vol III (am 71) §5.2.7.3 for both downlink and uplink Mode S packets, the short form is used, the channel (M / CH field) is set to 8 and the user data (UDfield) contains x0C or x0D in the first byte, run number (between 1 and M or 2*M) in the second byte and the segment number in the third byte of every segment. A segment contains 80 bits for Comm D and 76 bits for Comm C. =**[P2B1-SR-CAP-0455]** The PTE-P1 / P2B1 tool shall transmit Comm D segments in order of increasing segment numbers (i.e. lowest segment number first followed by the next highest segment number).

3.3.2.2 Data Stream and User Interface

The Data Link event generation can be performed in two ways:

-Manual generation

-Automatic generation

In both methods, the input of the process are a number of user defined parameters plus a precompiled surveillance scenario.
As an output, the tool will produce the event scenario, which can be saved, loaded or compiled using the standard P1 Event scenario tools.

The event scenario generator already allows the manual generation of all required data link scenario events. This method is described under §3.3.2.3.1.

No intrusive user interface changes have to be implemented under P2B. For simplicity reasons, an additional “Wrap” parameter has been added in the event scenario generator user interface. This parameter allows a set of defined events to be automatically repeated after a predefined number of scans. Furthermore, the event scenario generator now also supports the use of a different colour per set. This is handy for the selection between “Background” and “Sector” targets. Typically, each of the four sectors in use will have a different colour.

Finally, a button is added to evoke the automatic data link randomiser function.

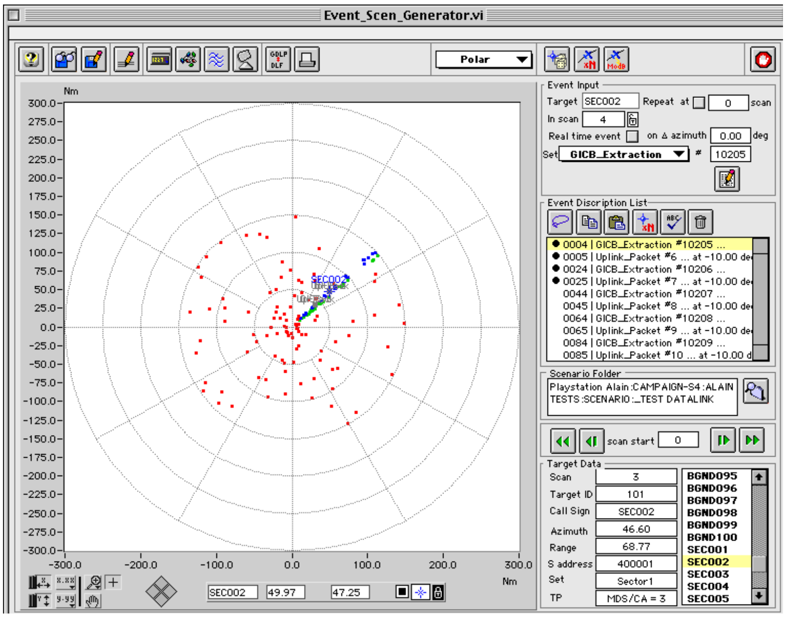

Figure 3-15: Event scenario Generator panel

A second method which was included in P2B development is the automatic data link model generation. This method is evoked using an additional button in the event scenario generator, called “Model B Data link”. This button in turn evokes a separate window which allows user input of the required parameters.

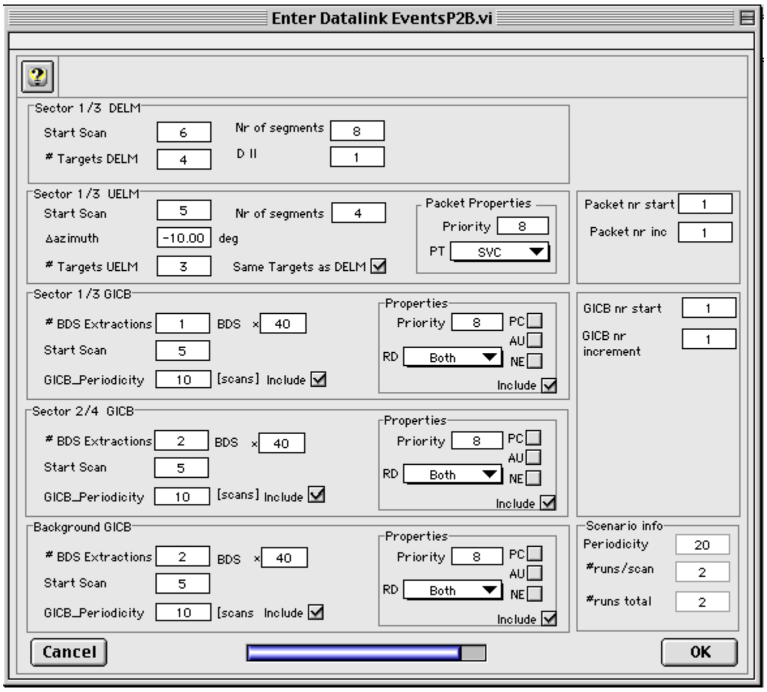

Figure 3-16: Input of Data-Link event parameters

3.3.2.3 Functional Description

3.3.2.3.1 Manual Method of event generation

The event scenario generator already allows extensive editing of data link events. It also allows the definition of different types of data link events for different sets of targets. Using this function, the user can define complex data link scenarios. The intention for this method is to create scenario which are more complex than the ones described in the P2B1 SRD. The simple scenarios desribed in the SRD will be generated automatically as described in §3.3.2.3.2.
The manual method uses the following steps:

1) Load the generated trajectory scenario

2) Select the first target from the first sector (recognisable by its color , set name and target ID)

Define the data link events for the first sector using the standard user interface of the event scenario generator using this first target: Enter the “Wrap “ parameter with a value N, which means that they will be repeated every Nth scan. N shall be the S_period: Sequence periodicity parameter (see § 3.3.1.3).
(New feature, to be included in PTE P2B1).

This way the user only needs to define once the data link events for the complete scenario of up to 300 repetitions.

§ -From 1 to 10 (or more) events can be defined for the target: Following events can be used:

- GICB: Ground Initiated Comm B (BDS Extractions): In order to create a “rate” (as defined in the SR) , multiple GICB extraction events must be created in the same scan.

        - GICB Periodicity [0..100,1 scans][7]
        - GICB relative start scan nr [0..20,1]
        - GICB BDS register
        - GICB Priority parameters
    - UELM : Uplink ELM Packets
        - UELM request Nc segments [2..16,1]
        - UELM relative scan number [1..20,1]
        - UELM Δazimuth [-90..+90,0.1deg]
        - UELM Packet numbering
        - UELM Packet type
        - UELM Priority
    - DELM
        - DELM request Nd segments [2..16,1]
        - DELM relative scan number [1..20,1]
        - DELM DII code
        - DELM Δazimuth [-90..+90,0.1deg]

§ The Comm C and Comm D data contents will be as follows:

- first byte = 0C or 0D ; second byte peak sector sequence number, third byte segment number

Next, evoke the “event duplication” tool. This tool will allow the user to duplicate the edited data link events to all other targets of the first set (or peak sector).

Next, select a target from the second sector. Again, define for the targets in this sector (or set) the required data link events:

§ -For each target in the second sector:

- S_period: Sequence periodicity [2..50,1]
- GICB:Ground Initiated Comm B (BDS Extractions)): In order to create a “rate” (as defined in the SR) , multiple GICB extraction events must be created in the same scan.
    - GICB Periodicity [0..100,1 scans]
    - GICB relative start scan nr [0..20,1]
    - GICB BDS register
    - GICB Priority parameters

Continue with the duplication of the defined data links for all targets of sector 2.

Finally, define the data link actions for the background set:

§ The user will be able to define :

- GICB: Ground Initiated Comm B (BDS Extractions)): In order to create a “rate” (as defined in the SR) , multiple GICB extraction events must be created in the same scan.
    - Background GICB Periodicity [0..100,1 scans]
    - Start scan nr for GICB request[1...20,1 scans]
    - Background GICB periodicity parameters

[7] The BDS periodicity is entered in scans and is recalculated towards seconds to be included in the Cat 18 messages using the constant rotation speed.

- GICB BDS register

Continue with the duplication of these parameters for the background targets.

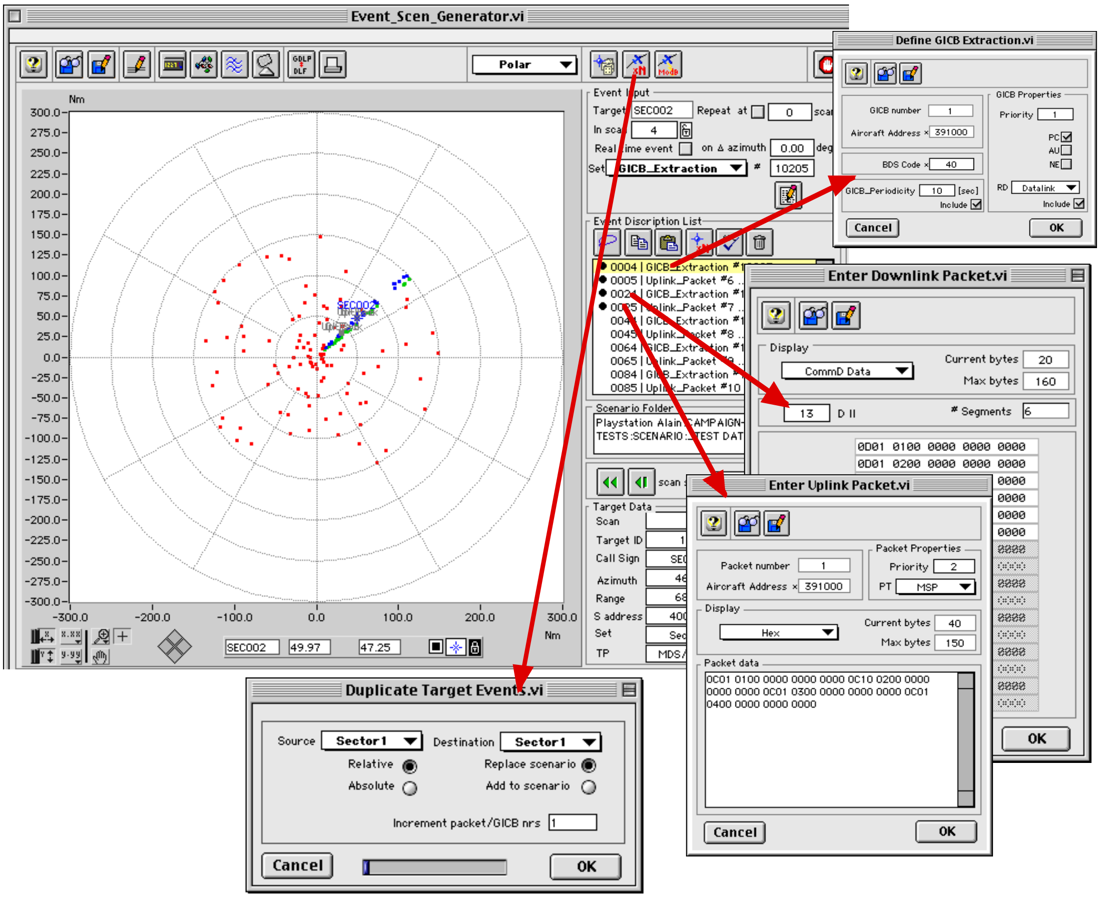

Figure 3-17: Overview of datalink Event editing for Manual Datalink Model Generation

After definition, the tool allows the user to display the targets and the created data link events.

Once all events are defined, the scenario can be compild and run on the RES. This functionality is inherited from PTE P1.

3.3.2.3.2 Automatic Method of event generation

Under P2B, the event scenario generator will allow the automatic generation of a complete set of data link events. Using this function, it is simple for the user to define the requested data link scenarios as described in the P2B1 SRD.

1) Load the generated trajectory scenario

2) Click the "DataLink Model " button in the event scenario generator toolbar.

Now define all following parameters in the user interface:

§ For Sector 1 and 3:

- GICB: Ground Initiated Comm B (BDS Extractions):
  - GICB rate [0..5,1] In order to create a "rate" (as defined in the SR) , multiple GICB extraction events will be created in the same scan.
  - GICB Periodicity [0..100,1 scans]

- GICB Relative start scan nr [0..20,1]
- GICB BDS start register[x40…xF0,x10]: depending on the “rate” parameter, one or more BDS extraction commands will be issued. The BDS code for each of these commands will be taken from the “GICB BDS start register: “ parameter plus i times 0x10.
- GICB Priority parameters
- Start GICB Packet number [0…Inf,1] and Increment [1..1000,1]

- UELM : Uplink ELM Packets
    - Nr of Targets with UELM events
    - UELM request Nc segments [2..16,1]
    - UELM relative scan number [1..20,1]
    - UELM Δazimuth [-90..+90,0.1deg]
    - Start UELM Packet number [0…Inf,1] and Increment [1..1000,1]
    - UELM Packet type
    - UELM Priority
- DELM
    - Nr of targets with DELM
    - Flag to indicate if targets must be unique or may also have UELM events attributed to them.
    - DELM request Nd segments [2..16,1]
    - DELM relative scan number [1..20,1]
    - DELM DII code
    - DELM Δazimuth [-90..+90,0.1deg]

§ The Comm C and Comm D data contents will be as follows:

- first byte = 0C or 0D ; second byte peak sector sequence number, third byte segment number

§ -For Sector 2 and 4:

- GICB: Ground Initiated Comm B (BDS Extractions):
    - GICB rate [0..5,1]
    - GICB Periodicity [0..100,1 scans]
    - GICB Relative start scan nr [0..20,1]
    - GICB BDS start register[x40…xF0,x10
    - GICB Priority parameters
    - Start GICB Packet number [0…Inf,1] and Increment [1..1000,1]

For the background set:

- GICB: Ground Initiated Comm B (BDS Extractions):
    - GICB rate [0..5,1]
    - GICB Periodicity [0..100,1 scans]
    - GICB Relative start scan nr [0..20,1]
    - GICB BDS start register[x40…xF0,x10]:
    - GICB Priority parameters
    - Start GICB Packet number [0…Inf,1] and Increment [1..1000,1]

Once the user clicks the Ok confirmation in the window, the program will create all required data link events automatically.

3.3.3 Data-link model B Replay

3.3.3.1 Specification

The following specifications are relevant for this section:

[P2B1-SR-CAP-0460] When replaying any data-link scenario, the PTE-P1 / P2B1 tool shall automatically generate all of the required command signals for the Interrogator related Events through the ASTERIX Cat 018 / GDLP interface and for the Transponder related events through the RES interface. This functionality is already supported by PTE P1. (EDR GDLP function and RES scenario replay. Datalink Analysis

3.3.3.2 System overview

The data link scenario replay functionality is already supported by the PTE P1 project. No development has to be done for this purpose.

All required hardware and software is described in the User Manual of the PTE P1 v 4.1 platform.

3.3.4 Data link Analysis

3.3.4.1 Specification

The following specifications are relevant for this section:

[P2B1-SR-CAP-0470] The PTE-P1 / P2B1 tool shall enable replay and analysis of the results of scenarios.

[P2B1-SR-CAP-0471] For this purpose, some data link scenario information shall be entered into the scenario S4EV file, generated by the event scenario generator. Under P2B1 following extra fields with the following data shall be entered, allowing for data link analysis from the inventory tool:

One record per target per scan in the RES10 field of the S4 file (see PTE P1 ICD)

§ -2 bits counter: # of Broadcast Comm B events ([0..3,1])

§ -2 bits counter: # of Resolution advisory events ([0..3,1])

§ -4 bits counter: # of Ground Initiated CommB (BDS extraction) events [0..15,1]

§ -2 bits counter: # of Air Initiated CommB events [0..3,1]

§ -2 bits counter: # of single element Comm A events [0..3,1]

§ -2 bits counter: # of multiple element Comm A events [0..3,1]

§ -2 bits counter: # of Comm C events ([0..3,1])

§ -2 bits counter : # of Comm D events ([0..3,1])

§ -1 bit counter : # of A Code Change events ([0..1,1])

§

[P2B1-SR-CAP-0472] All of these fields shall be shown in the inventory tool, using the “any field vs any field” option.

- § **[P2B1-SR-CAP-0473]** Additionally, the **scenario time merger tool** (as created under P1-ECP Pd & Accuracy) shall time stamp the created S4EV file and will therefore also time stamp the events. This tool will also link the data link result data (as found in the “xxx.rlg” file, see **Error! Reference source not found.**, ch IV § 3.5.6) into the S4EV file. This shall add the following data in the scenario file: -1 bit flag: Comm B broadcast closeout ([0..1,1])
- § -2 bits counter: # AICB closeout([0..4,1])
- § -2 bits counter : Comm A acknowledge ([0..15,1])
- § -2 bits counter : Comm C acknowledge ([0..2,1])
- § -2 bits counter : Comm D closeout ([0..2,1])

Both the event scenario generator as the data link scenario merger will fill certain bits in the “Data link type” field of the S4EV or S4SC file. The “inventory tool” allow filtering and selection on these bits:

DataLink type field (byte 125..127

- Bit Use
- 0 Broadcast Comm B Announcement
- 1 Broadcast Comm B Extraction
- 2 Broadcast Comm B Reply
- 3 Resolution Advisory Announcement
- 4 Resolution Advisory Extraction
- 5 Resolution Advisory Reply
- 6 Ground Initiated Comm B Extraction
- 7 Ground Initiated Comm B Reply
- 8 Air Initiated Comm B Announcement
- 9 Air Initiated Comm B Reservation
- 10 Air Initiated Comm B Extraction
- 11 Air Initiated Comm B Reply
- 12 Air Initiated Closeout
- 13 Comm A sgl el Transmission
- 14 Comm A sgl el Reply
- 15 Comm A mlt el Transmission 1 sgmnt
- 16 Comm A mlt el Transmission n sgmnt
- 17 Comm A mlt el Reply last el
- 18 Comm C Reservation
- 19 Comm C Delivery 1st seg
- 20 Comm C Delivery n th seg
- 21 Comm C Delivery last seg
- 22 Comm C Technical Acqnowledgement
- 23 Comm C Closeout
- 24 Comm D Announcement
- 25 Comm D Reservation
- 26 Comm D Extraction
- 27 Comm D Reply Intermediate
- 28 Comm D Reply last segment
- 29 Comm D Closeout
- 30 Code Change
- 31 Broadcast Comm A

3.3.4.2 Functional Description

The data link scenario will be entered into the scenario S4EV file, generated by the event scenario generator. No User interface changes are anticipated.

The P2B1 event scenario generator will fill some extra fields with the following data, allowing for data link analysis from the inventory tool:

One record per target per scan in the RES10 field of the S4 file (see PTE P1 ICD)

- -2 bits counter: # of Broadcast Comm B events ([0..3,1])
- -2 bits counter: # of Resolution advisory events ([0..3,1])
- -4 bits counter: # of Ground Initiated CommB (BDS extraction) events [0..15,1]
- -2 bits counter: # of Air Initiated CommB events [0..3,1]
- -2 bits counter: # of single element Comm A events [0..3,1]
- -2 bits counter: # of multiple element Comm A events [0..3,1]
- -2 bits counter: # of Comm C events ([0..3,1])
- -2 bits counter : # of Comm D events ([0..3,1])
- -1 bit counter : # of A Code Change events ([0..1,1])

All of these fields can be shown in the inventory tool, using the “any field vs any field” option.

Additionally, the scenario time merger (as created under P1-ECP Pd & Accuracy) will time stamp the created S4EV file and will therefore also time stamp these events.

This tool will also link the data link result data (as found in the .rlg , see PTE P1 ICD v 2.2, ch IV § 3.5.6) into the S4EV file. This can add the following data in the scenario file:

- -1 bit flag: Comm B broadcast closeout ([0..1,1])
- -2 bits counter: # AICB closeout([0..4,1])
- -2 bits counter : Comm A acknowledge ([0..15,1])
- -2 bits counter : Comm C acknowledge ([0..2,1])
- -2 bits counter : Comm D closeout ([0..2,1])

Both the event scenario generator as the data link scenario merger will fill certain bits in the “Data link type” field of the S4EV or S4SC file. The “inventory tool” allow filtering and selection on these bits:

Additional capabilities

•

3.4 Additional Capabilities

3.4.1.1 Specification

The following specifications are relevant for this section:

[P2B1-SR-CAP-0500] IE shall verify under this contract that the PTE P1 can operate accordingly the two versions of Annex 10 (am 69 and 71). The transponder database shall be enhanced such that it will become easier to distinguish between am 69 and am71 transponders.

[P2B1-SR-CAP-0501] The PTE-P2B1 shall enable the user to select, and hence simulate, targets as either Amendment 69 or 71 transponders as specified in ICAO Annex 10 Volume III Part 1.

[P2B1-SR-CAP-0502] The PTE-P2B1 shall propose user friendly methods to distinguish between Amendment 69 and 71 transponder equipped targets to the user i.e. use of colour. The current implementation of PTE P1 already allows the use of colour to distinguish between two sets of targets. It shall be made possible to automatically link the set number to the type of transponder used.

[P2B1-SR-CAP-0503] The PTE-P2B1 shall set the Mode S Sub-network Version Number default parameter to ‘1’ for Mode S transponders. The Mode S subnetwork version number shall be verified and put to 1 as default for am 71 transponders. A warning shall be issued when incorrect combinations are made between the Mode S subnetwork version number and the CA field of the transponder. These warnings shall be as defined in the next specification:

§ **[P2B1-SR-CAP-0504]** If the User sets the Mode S Sub-network Version Number to 0 and the CA sub-field to 4, 5 or 6 (x), the PTE-P2B1 shall display the warning “The combination of Mode S Sub-network Version Number = 0 and CA sub-field = (x) is not ICAO compliant. Continue Y / N” and allow the user to continue (Y) or re-edit (N). If the User sets the Mode S Sub-network Version Number to 1 or 2 (y) and the CA sub-field to 1, 2 or 3 (x), the PTE-P2B1 shall display the warning “The combination of Mode S Sub-network Version Number = (y) and CA sub-field = (x) is not ICAO compliant. Continue Y / N” and allow the user to continue (Y) or re-edit (N).

3.4.1.2 User Interface

The Transponder properties of generated trajectories are defined in the “Transponder Database” tool.

Under PTE P2B1 the transponder database shall be enhanced such that it will become easier to distinguish between am 69 and am71 transponders. Furthermore, the user interface will note the user of the fact that certain combinations of level and CA field setting or Capability Report settings are in contradiction with Annex 10. If , for any reason (e.g. Spec P1191, end note, which calls for simulation of data link actions on transponders not properly equiped for such actions) , the user wishes to change the relation between real simulated transponder level and transponder level forwarded to the interrogator using the CA field and BDS 10, he can still overrule the user interface which requests to auto-correct the data.

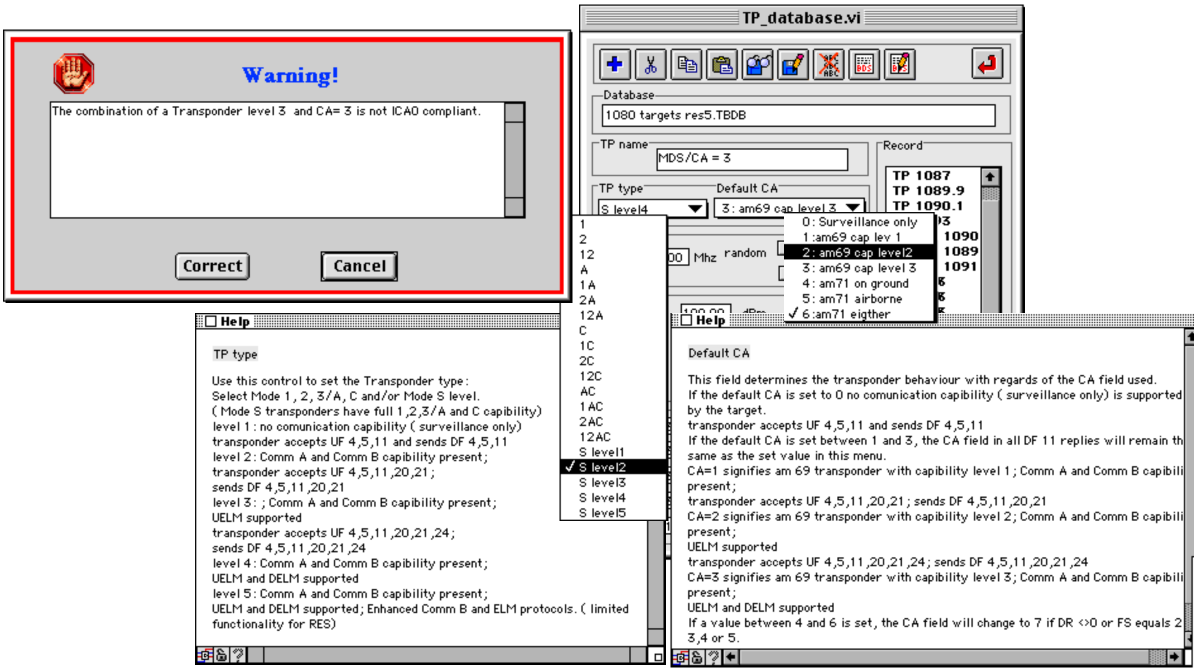

Figure 3-18: Transponder database changes for PTE P2B1

The only change for the user is the replacement of the “Default CA” field type from a numerical input field into a menu.

3.4.1.3 Functional Description

IE verified under this contract that the PTE P1 can operate accordingly the two versions of Annex 10 (amendment 69 and amendment 71). From the study, following differences are noticed:

- The different use of the CA field for am 69 and am71 transponders
- The different definition of “level” in both versions
- The lack of level 5 transponders in am 69. (and therefore also the lack of the “enhanced” protocol for ELM and COMMB.
- The difference in the “Mode S Sub network number”
- The difference in BDS 10 definition between am 69 and 71 transponders

Under PTE P1, most of these items were already dealt with in the following way:

- The user could already discriminate between am 69 and am 71 transponders using the “default CA” and “ TP level” input field of the transponder database. The RES Firmware correctly distinguishes between am 69 transponders and am 71 transponders using the “default CA” field as an input. No simple user interface was provided to link the two inputs.
- The definition of the TP level under PTE P1 was according to am 71 (level 1 through 5)
- Level 5 transponders do not really differ from level 4 transponders for the RES, since no multiple II codes for one interrogator are allowed and the RES is a single sensor test equipment.
- The definition of BDS 10 was according to am 71. The Mode S Sub network number could be entered freely by the user using the BDS 10 editing function, hereby simulating an am 69 transponder. All other bits should remain set at 0. .

In order to improve this user interface, a number of things are required:

§ A simpler link between the TP level and the default CA field

§ A clear indication when a Transponder was am 69 or am 71 compliant

§ A link and automatic check between the contents of the “TP level” and “default CA “ fields of the transponder database and the contents of the programmed BDS 10 (data link capability report)

3.4.1.4 Transponder Level Checks

For amendment 69 transponders, following behavior is defined:

- If default CA is put to 0 and TP level is set to 1, the transponder will be simulated as a surveillance only Mode S transponder. This transponder will only reply to UF 4,5 and 11 and only replies using DF 4,5 and 11. It will perform all actions required under §3.8.2.5.2.2.1 of Annex 10 Vol I am 69.:
    - Mode A identity and Mode C pressure altitude reporting
    - Inter mode and Mode S all-call transactions
    - Addressed surveillance altitude and identity transactions
    - Lockout protocols
    - Flight status protocol
    - Capability reporting in CA field, which remains at 0 for all replies.
- If default CA is put to 1 and TP level is set to 2, the transponder will be simulated as capability level 1 am 69 Mode S transponder. This transponder will only reply to UF 4,5, 20 , 21 and 11 and only replies using DF 4,5,20,21 and 11. It will perform all actions required and §3.8.2.5.2.2.1 of Annex 10 Vol I am 69.
  Additionally to the surveillance only TP it will perform:
    - Standard length Comm A and Comm B data link
    - Data link capability reporting
    - Aircraft Identification reporting
    - Capability reporting in CA field, which remains at 1 for all replies.
- If default CA is put to 2 and TP level is set to 3, the transponder will be simulated as capability level 2 am 69 Mode S transponder. This transponder will reply to UF 4,5, 20 , 21,24 and 11 and replies using DF 4,5,20,21,24 and 11. It will perform all actions required under §3.8.2.5.2.2.1 of Annex 10 Vol I am 69.
  Additionally to the capability level 1 TP it will perform:
    - Ground to air (Uplink) Extended Length Message Communications
    - Capability reporting in CA field, which remains at 2 for all replies.
- If default CA is put to 3 and TP level is set to 4, the transponder will be simulated as capability level 3 am 69 Mode S transponder. This transponder will reply to UF 4,5, 20 , 21,24 and 11 and replies using DF 4,5,20,21,24 and 11. It will perform all actions required under §3.8.2.5.2.2.1 of Annex 10 Vol I am 69.
  Additionally to the capability level 2 TP it will perform:
    - Air to Ground (Down link) Extended Length Message Comm.
    - Capability reporting in CA field, which remains at 3 for all replies.

For amendment 71 transponders, following behavior is defined:

- If default CA is put to 0 and TP level is set to 1, the transponder will be simulated as a surveillance only Mode S transponder. This transponder will only reply to UF 4,5 and 11 and only replies using DF 4,5 and 11. It will perform all actions required under § 2.1.5.1.1 of Annex 10 Vol IV am 71.

- Mode A identity and Mode C pressure altitude reporting
- Inter mode and Mode S all-call transactions
- Addressed surveillance altitude and identity transactions
- Lockout protocols
- Flight status protocol
- Capability reporting in CA field, which remains at 0 for all replies.

- If default CA is put to 4,5 or 6 and TP level is set to 2, the transponder will be simulated as level 2 am 71 Mode S transponder. This transponder will only reply to UF 4,5, 20 , 21 and 11 and only replies using DF 4,5,20,21 and 11. It will perform all actions required under 2.1.5.1.2 of Annex 10 Vol IV am .

  Additionally to the level 1 TP it will perform:

  - Standard length Comm A and Comm B data link
  - Data link capability reporting
  - Aircraft Identification reporting
  - Capability reporting in CA field, which is set at the default CA value (4,5 or 6) and changes to 7 in case of DR ≠ 0 or FS = 2,3,4 or 5

- If default CA is put to 4,5 or 6 and TP level is set to 3, the transponder will be simulated as level 3 am 71 Mode S transponder. This transponder will reply to UF 4,5, 20 , 21,24 and 11 and replies using DF 4,5,20,21,24 and 11. It will perform all actions required under 2.1.5.1.3 of Annex 10 Vol IV am 71. Additionally to the level 2 TP it will perform:

  - Ground to air (Uplink) Extended Length Message Communications

- If default CA is put to 4,5 or 6 and TP level is set to 4, the transponder will be simulated as level 4 am 71 Mode S transponder. This transponder will reply to UF 4,5, 20 , 21,24 and 11 and replies using DF 4,5,20,21,24 and 11. It will perform all actions required under 2.1.5.1.4 of Annex 10 Vol IV am . Additionally to the level 3 TP it will perform:

  - Air to Ground (Down link) Extended Length Message Comm.

- If default CA is put to 4,5 or 6 and TP level is set to 5, the transponder will be simulated as level 5 am 71 Mode S transponder. This transponder will reply to UF 4,5, 20 , 21,24 and 11 and replies using DF 4,5,20,21,24 and 11. It will perform all actions required under 2.1.5.1.5 of Annex 10 Vol IV am . Additionally to the level 4 TP it will perform:

  - Enhanced Extended Length Message Comm. (limited to one interrogator II code at one time)

Obviously, several erroneous combinations could be entered by the user without any error message or warning. A level 4 transponder with its CA set to 1 could cause strange behavior from the POEMS radar. The same can happen if the user specifies a level 1 transponder with its CA field set to 3. Therefore the following design is presented:

First, the “default CA” parameter in the transponder database is changed from a numerical input towards a menu input. This menu is presented *Figure 3-18*. This does not change the database structure on disk, which is very important for compatibility reasons between PTE P1 and P2B1. The menu clearly differentiates between am 69 and am 71 transponders.

Next, the user interface is changed such that the user can no longer accidentaly enter an erroneous combination of CA code and transponder level. If he changes the TP level input, the corresponding CA data is checke. If an erroneous condition is present, the user is warned. He can opt for an automatic change or no change.
If the CA data is changed, it is checked against the TP level and again a warning is issued upon an error. Following procedure is followed:

§ If user changed TP level:

- Changed to SSR: No change required to CA
- Changed to level 1: Set CA to 0
- Changed to level 2 : If 0 < previous CA < 4 : Set CA to 1
- Changed to level 3 : If 0 < previous CA < 4 : Set CA to 2
- Changed to level 4 : If 0 < previous CA < 4 : Set CA to 3
- Changed to level 5 : If 0 < previous CA < 4 : Set CA to 5

§ If user changed CA field:

- Changed to CA=0 : Set TP level to 1
- Changed to CA = 1: Set TP level to 2
- Changed to CA=2: Set TP level to 3
- Changed to CA =3: Set TP level to 4
- Changed to CA =4: If TP level =1 : Set TP level to 2; else no change
- Changed to CA =5: If TP level =1 : Set TP level to 2; else no change
- Changed to CA =6: If TP level =1 : Set TP level to 2; else no change

§ All changes are detected and require confirmation by the user before implementation. This is done by using a dialog box

3.4.1.5 BDS 10 contents Verification

Once the transponder level and version of Annex 10 are correctly defined, the user can enter the contents of the data link capability report (BDS 10) using the BDS editor, called from the PTE P1 transponder database.

The BDS input user interface will be updated such that it complies with Ref. 7Annex 10 Vol.IV §4.3.8.4.2.2.2. (coding of ACAS bit in BDS 10)

In P1, there was no verification over the correct input of the BDS 10 contents and the TP level. Under PTE P2B1, following checks will be implemented:

- Verification of am69 or am 71 type of BDS input. If tp is am 69 type, limited nr of input fields are definable.
- Verification of Mode S subnetwork version number: If CA is 1,2 or 3 Mode S sub network number must be 0. If Ca is 4,5 or 6 the number may be 1 or higher.
- Verification of the Transponder level bit in BDS 10. If TP level = 2 through 4 bit must be set to 0. Level 5 sets the bit to 1.
- Verification of the UELM throughput. If TP level is higher than 2 , UELM throughput must be at least equal to 1
- Verification of DELM throughput. If TP level is higher than 3 , DELM throughput must be at least equal to 1

Each error will be reported through a warning dialog. The user will have the option of auto-correction or can opt for manual correction. (or he may still opt to use the non-ICAO compliant data anyway.

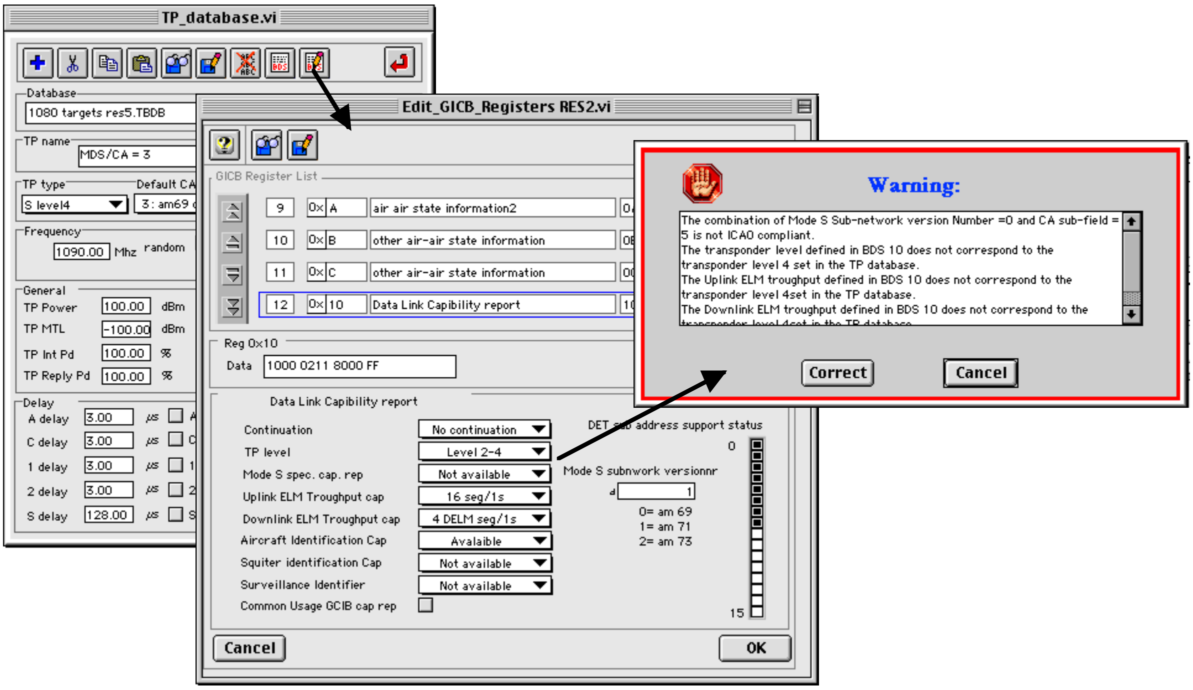

Figure 3-19: BDS 10 verification

3.4.1.6 Use of colours for specific transponders.

The current implementation of PTE P1 already allows the use of colour to distinguish between two sets of targets.

It is up to the user to specify a specific transponder for a specific target. The tool also allows an easy way to change the transponder type for a specific set of targets. Therefore the PTE P1 tool already complies with this requirement.

In order to put e.g. two specific colours for two types of transponders (e.g. am 69 and am 71 level 4 transponder) create two sets and name them according to the two selected transponder names. Now create several targets and attribute each target to a specific set. Next, use the property randomiser to atribute all targets of the first set the first selected transponder and all targets of the second set the second transponder.

Sector Message Delay Analysis

3.5 Sector message delay analysis

3.5.1 Specifications

The following specifications are relevant for this section

[P2B1-SR-CAP-0600] Sector messages to be analyses shall be derived from PTE P1 (EDR) recorded asterix data containing asterix Cat 002 or Cat034 data.

A difference shall be made between real North messages , south messages and sector 0 messages (if available), using flag bits.
The processed sector messages shall allow time and azimuthal information comparison to calculate sector message delay and sector message azimuth offset (sector message leap).

[P2B1-SR-CAP-0601] The sector delay analysis shall be conducted from the inventory tool by using the standard PTE filter techniques The PTE-P2B1 Sector message delay analysis shall provide a facility to filter the ASTERIX Cat 034 recorded messages to be analysed as follows :

- no filter,
- only the North Marker Messages,
- only the sector 0 sector Messages.

[P2B1-SR-CAP-0602] The PTE-P2B1 Sector message delay analysis shall calculate (by comparison of the time stamping of the relevant ASTERIX Cat 034 filtered and recorded messages and of the time stamping of the corresponding ACP / ARP recorded data) the delay (in seconds with a granularity of 0,01 s, and in number of scans and degrees - e.g. 1 scan and 12° - with a granularity of 1°).

[P2B1-SR-CAP-0603] The inventory tool shall show sector message delay in time or azimuth versus time or scan number in a line chart. The inventory histogram can be used to produce statistical analysis and histogram data. When the Sector message delay analysis calculation results are presented in the inventory tool, the PTE-P2B1 tool shall enable, as user selectable options, presentations as histogram (x-axis delay, y-axis number of corresponding occurrences) and / or line chart (x-axis scan number, y-axis delay) displays.

[P2B1-SR-CAP-0604] The histogram function of the inventory tool shall calculate and display statistics (sample size ; minimum, maximum, mean and rms. values ; standard deviation around the mean) on this delay.

[P2B1-SR-CAP-0605] The Sector message delay analysis calculation and display processing time shall depend on the amount of data to be processed. A recording of 2.5 hours of asterix data recorded at maximum line speed should be processed in less than 10 minutes when run on the PTE P1 Platform (Macintosh G3).

[P2B1-SR-CAP-0606] When the Sector message delay analysis calculations have been completed, the PTE-P2B1 tool shall present the results to the user.

3.5.2 User Interface

For the purpose of sector message delay analysis, no new hardware or changes to existing hardware are necessary. Likewise, no new software tools need to be developed. Specific adjustments to existing software tools allow a complete sector message delay analysis as required in PTE P2B1.

3.5.3 Functional description

The ASTERIX Cat034 / Cat002 radar service messages are recorded together with the ASTERIX Cat048 / 001 messages using the existing PTE EDR hardware. This means all functionality of the PTE EDR recording is available. Each of the Cat034 / 002 radar service messages is UTC time stamped at the moment of recording by means of the PTE GPS hardware. Additionally each of the radar service messages gets a 14 bit ACP stamp at the moment of recording.

According to the POEMS document for Radar Data exchange SUR.ET2.ST03.3115-SPC-04-01 edition 1.3 dated 16 March 1999, one and only one North marker message and exactly 32 sector crossing messages are transmitted. The North marker message signals the local geographical north and contains the UTC time of day of the crossing of the local geographical north by the antenna. The sector crossing messages signal the beginning of the respective sector and contain a sector number and UTC time of day.

The difference between the ASTERIX UTC time of day and the recording UTC time stamp defines the radar service message delay expressed in time and the difference between the sector number based azimuth and the ACP stamp at the time of recording defines the radar service message delay expressed in degrees.

By use of the PTE EDR serial convert tool, the North marker messages and Sector crossing messages are converted towards the S4 format (S4RD file). (file has a format according to Ref. 22 § 3.3.4) This means that all functionality for S4 analysis is available.

Sector messages have a specific structure in the S4 fields:

All fields are set to 0 except

- Azimuth: Azimuth of start of sector
- Range: 0 if North marker message, 256 if Sector crossing message
- Time : Entered with time of recording
- Time of detection: As found in asterix data
- Delta Azimuth: Running Azimuth of detection
- Status: Sector message=1 (bit 0)

3.5.4 Sector message delay recording

The following set up is necessary to record data obligatory for sector message delay analysis according to PTE P2B1.

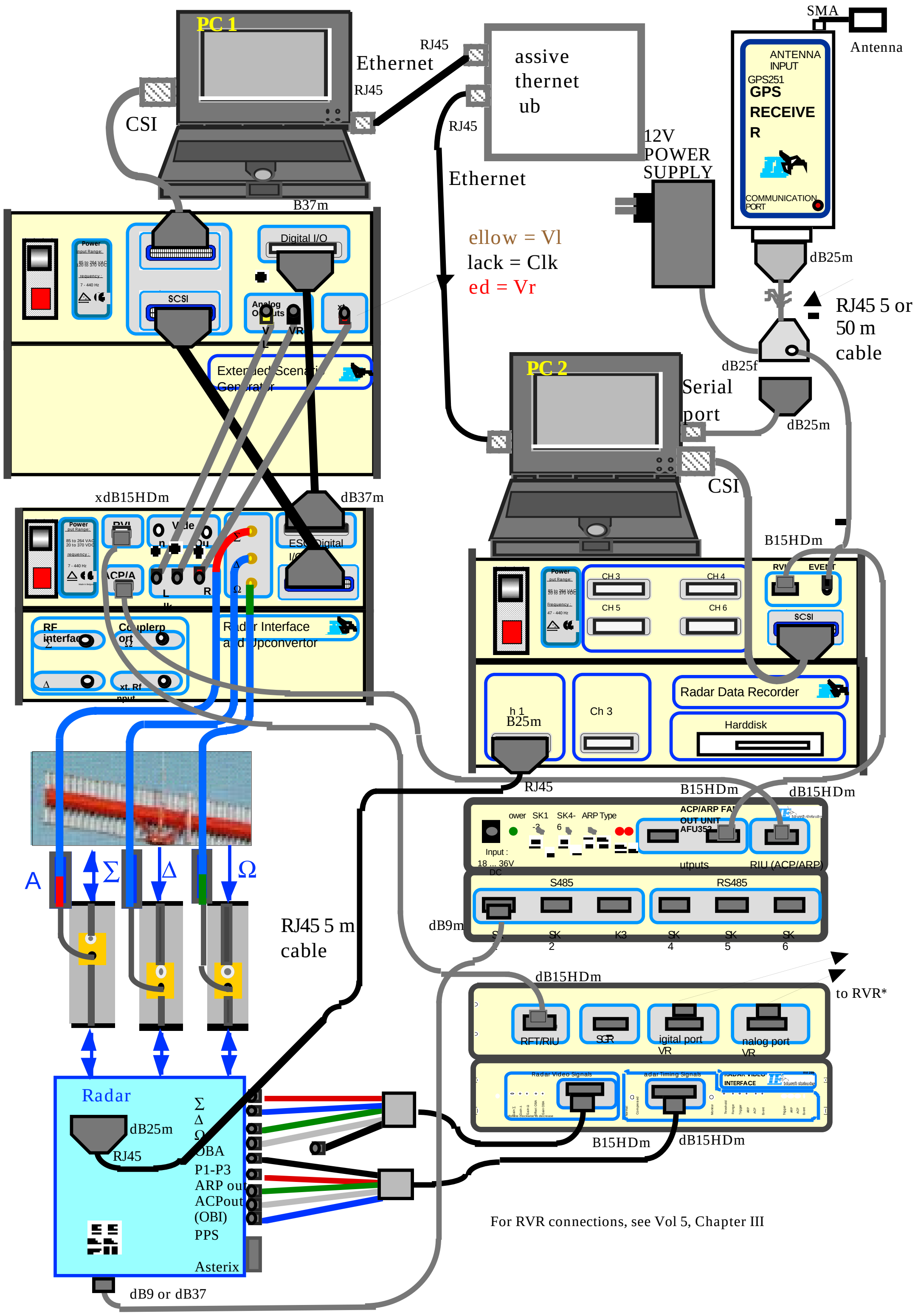

Figure 3-20: Setup for EDR Recording For sector delay analysis

For more details about making an UTC time stamped EDR recording , please consult the RASS-S User Manual version 4.1, Volume 4, Data Recording and Analysis, chapter VI, Pd and Accuracy (Ref.26).

The time stamping is done with a resolution of 50 microseconds and the ACP stamping is done with a 14 bit resolution. The UTC timing is corrected with the PPS pulse of the GPS. This concept is already used and approved in PTE P1. In case that the GPS information is not available, sector message delay analysis based on azimuth information (delay in degrees) is still feasible. In this case the recording of ACP and ARP together with the ASTERIX data is sufficient to insure a sector message delay analysis based on azimuth.

Notice that sector message delay analysis based on ACP/ARP information is completely independent form sector message delay analysis based on UTC time stamping. Therefore both methods can have different analysis results although they originated from the same test run.

3.5.5 Sector message delay analysis

The following software tools are necessary to execute a sector message delay analysis according to PTE P2B1.

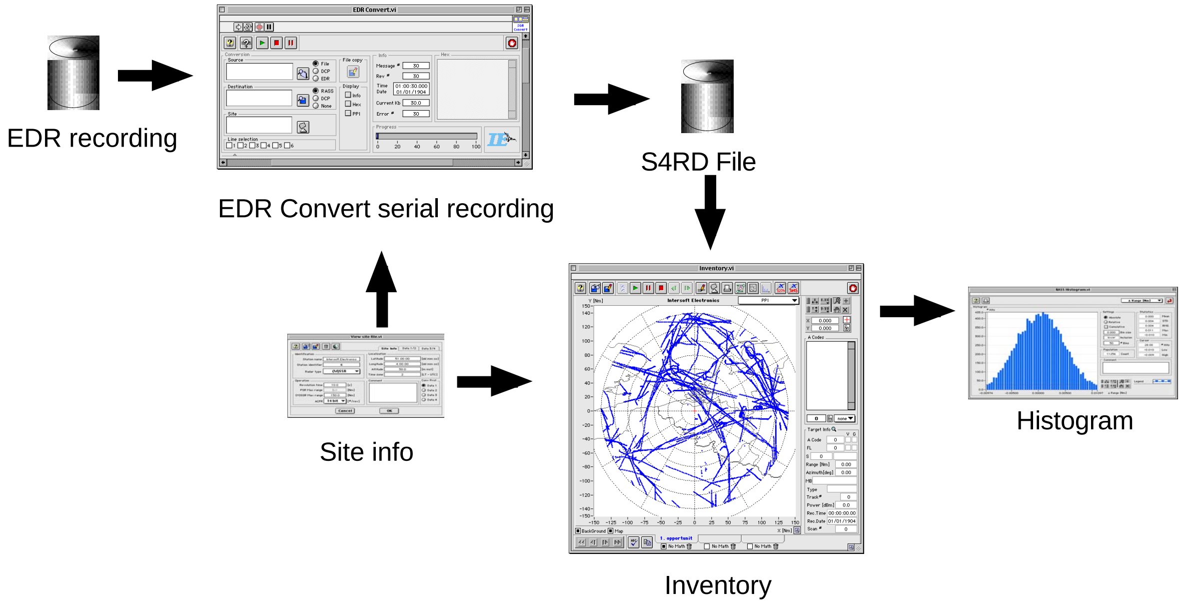

Figure 3-21: Sector message Analysis

The EDR recording containing the ASTERIX Cat034/002 messages, the ACP and ARP pulses and the GPS UTC information is converted towards an S4RD file format using the EDR Convert Serial Recording tool. The Cat034/002 North markermessages and Sector crossing messages are marked with flag bits to distinguish them from ordenary target reports. For this conversion, site information like SIC and SAC parameters, used protocol and lines stored in the site information file is used. The result of the conversion is a S4RD file containing the information necessary for the sector message delay analysis. This analysis can be done using the Inventory tool. For this purpose two new filter items are added to the existing filter item list:

§ North message [Boolean] = to filter out North marker messages

§ Sector message [Boolean] = to filter out sector crossing messages

By specifying an azimuth value in the filter, individual sector crossing messages can be filtered out.

For displaying the sector message delay analysis, two new custom definable fields are added to the list:

§ Processing leap [deg] = delay in degrees

§ Fractional scan number = scan numbering with integer and fractional part

The field “Processing delay [s] (delay in seconds)” is already available as a custom definable field.

By means of the Histogram function available in the Inventory tool, statistics on the sector message delay can be calculated and displayed.

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Data Export

3.6 Data Export

3.6.1 RFS Export

3.6.1.1 Specifications

The following specifications are relevant for this section:

[P2B1-SR-CAP-0700] The PTE P2B1 Tool is not required to export IRS and IVS data correctly for duplicate S addressed targets within one beam. This limitation is implied by the RES since it will not store more than one reply field per roll call interrogation. (This does not mean that the scenario should not be generated. Duplicate S address generation is an inherrent PTE P1 capibility)

If the scenario does contain duplicate S addresses scheduled whithin one beam, the trajectory scenari generator shall issue a warning to the user.

[P2B1-SR-CAP-0701] The PTE-P2B1 tool shall be capable of off-line exporting of the following data :

- "RFS" – the R/F Scenario replay data containing the target information resulting of a scenario simulation
- "I/RS" – Mode S Interrogations/Replies containing the Mode S interrogations produced by the station (recorded by PTE-P1) and the corresponding Mode S replies generated by the PTE-P1 tool.
- "I/VS" – Mode S Interrogations/Video replies containing the Mode S interrogations produced by the station (recorded by PTE-P1) and the corresponding Mode S replies derived from the recorded video.
- "A17" – Asterix Cat 017 containing the Surveillance co-ordination information (ASTERIX Cat 017 messages) sent and received by the station and recorded by the PTE-P1 tool.
- "A18" – Asterix Cat 018 containing the Data link information (ASTERIX Cat 018 messages)) sent and received by the station and recorded by the PTE-P1 tool.
- "A34" – Asterix Cat 034 Radar service data information (ASTERIX Cat 034 messages) sent by the station and recorded by the PTE-P1 tool.

"A48" – Asterix Cat 048 Target report information (ASTERIX Cat 048 messages) sent by the station and recorded by the PTE-P1 tool.

[P2B1-SR-CAP-702] The PTE-P2B1 tool shall provide a facility to the operator to select the scenario/campaign , the starting scan S_S, the ending scan S_E and the type of data to be exported and then to export the corresponding data to an external file to be further interpreted and exploited by Excel, with a user specified file name.

[P2B1-SR-CAP-0710] The P2B1 tool requires the export of the scenario data. This consists of the generated Scenario replay file (Generated by the P1 Scenario generator) , which is linked with the UTC time stamp recording (as recorded by the EDR) . This function was developed under the Pd_Acc ECP contract.

Following additional valuable data is not yet provided by the trajectory scenario generator under P1 and shall be included in the data:

- -Resolution case (flag)

-Duplicate S address (flag) (This allows elimination of such targets in the export)

[P2B1-SR-ITF-800] The file shall be structured in lines separated by a "Carriage Return" (CR).

[P2B1-SR-ITF-801] A line shall be constituted by the fields described in the tables below.

[P2B1-SR-ITF-0802] Fields shall be separated by one tab even if the field is not present (except if it is located at the end of the line).

[P2B1-SR-ITF-0803] The first line of an exported file shall contain the content of the cells of the Field name row of the corresponding table.

The DI row of the following tables provides a reference to the corresponding data item in the case of Asterix message.

[P2B1-SR-ITF-0804] The value and size of each individual field shall be derived from its encoding rule and format and from the size of the corresponding data item or sub-field data item for Asterix messages (cf. Doc Ref. 17, Ref. 18, Ref. 19 & Ref. 20) or from the size of the corresponding interrogation / reply field or sub-field for interrogations and replies (cf. Doc Ref. 5). E.g. a two byte Asterix data item formatted in Char Hex will be a 4 character string, the same data item formatted in Char Dec or Int will be a 5 character string (< 65535).

[P2B1-SR-ITF-0805] The Unit row of the following tables provides the unit in which the value shall be expressed (if needed).

[P2B1-SR-ITF-0806] The Format row of the following tables provides the format(s) under which the field shall be represented in the exported file.

[P2B1-SR-ITF-0807] When several formats are specified (e.g. Char Hex Bin), the field shall be repeated in as many formats as indicated (e.g. AB 10101011).

[P2B1-SR-ITF-0808] Each column of the following tables represent one or several fields (if several formats are specified see above), each field shall be separated by a tab.

[P2B1-SR-ITF-0809] In case of repetitive field without a maximum number of repetition (except DI 120 Raw doppler speed for cat 048) defined, the corresponding data shall be exported as several identical lines except for the field corresponding to the repetitive DI. In this case the data item shall be preceded by a counter showing the number in the repetition. They are written in italics in the following tables.

[P2B1-SR-ITF-0810] For DI 120 raw doppler speed in cat 048 this repetitive DI shall be exported as a flag indicating that it is present. It is written in italics.

In case of repetitive field with a maximum number of repetition (M) defined, the corresponding data can be exported. In this case M fields are foreseen to cover all the cases.

3.6.1.2 User Interface

The scenario reference data (RFS data) generated by the PTE-P1 Scenario Generator consists of a S4 format file. This file has to be synchronised in time according to the actual moment of generation. This is done using the Time Merge tool developed under the Pd & Acc ECP contract. The time-synchronised file can be loaded in the Inventory tool. All functionality of the Inventory tool can be used to select and filter a particular part of the RFS data.

3.6.1.3 Functional description

A “S4 export function” with corresponding “S4 export button” integrated in the Inventory tool HMI allows the user to export the selected data according the RFS format. All the general data export specifications (par.3.6.1 of the SRD) are relevant for the RFS format export function.. The following Figure 3-22 illustrates the RFS data format export function.

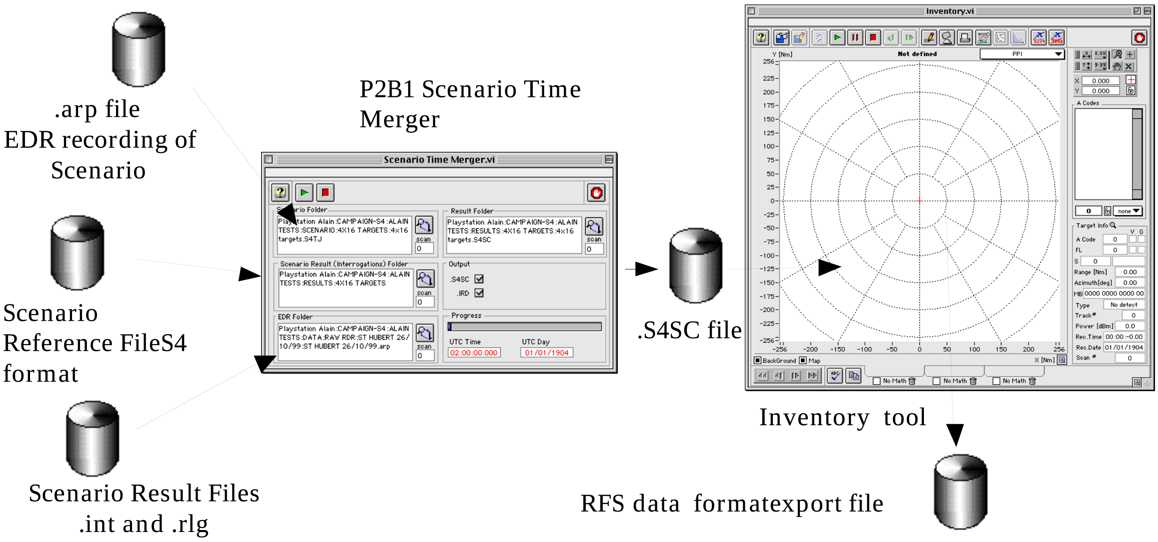

Figure 3-22: RFS Data Export functionality

3.6.1.4 RFS data format

[P2B1-SR-ITF-0811] The R/F Scenario replay data file shall be structured as a RASS-S4 target report file corresponding to the output of the scenario generator. This format is described in the PTE-P1/P2 Interface Control Document Version 2.2

The format of the RFS data is as follows:

Field Name	Nidex	Recording Time	Recording Date	Target ID	Track	Scan	Mode 1	Mode 2	Mode 3/A	Altitude	Detection Time	Range	Delta Range	Azimuth	Delta Azimuth	Plot Quality	Power
DI																	
Unit		s								ft	s	Nm	Nm	°	°		dBm
Format	Int	T.6	Date	Int	Int	Int	Char Oct	Char Oct	Char Oct	Int	T 6	R 3	R 3	R 4	R 4	Char Bin	Int

Field Name	Sector Message	Roll Call	All Call	A Code Swap	False Plot	Reflection	Mil Emergency	Mil Ident	Mode S Data	RFM	Simulated	RA Present	SPI	Hijack	Radio Fail	Emergency
DI																
Unit																
Format	Int	Int	Int	Int	Int	Int	Int	Int	Int	Int	Int	Int	Int	Int	Int	Int

Field Name	SSR	PSR	Plot	Track	Garbled S	Garbled 2	Garbled 1	Garbled 3D	Garbled C	Garbled A	Valid S	Valid 2	Valid 1	Valid 3D	Valid C	Valid A
DI																
Unit																
Format	Int	Int	Int	Int	Int	Int	Int	Int	Int	Int	Int	Int	Int	Int	Int	Int

Field Name	X Position	Y Position	Velocity	Heading	# SSR/Roll call replies	# PSR/Roll Call BFReply	Mode S Address	MB data	Com. ACAS and FL ST	Delta Time	Target Gen.	Overlap	Set	Rotation Speed
DI														
Unit	Nm	Nm	kt	°						s				°/s
Format	R 3	R 3	R 2	R 2	Int	Int	Char Hex	Char Hex	Char Bin	R6	Int	Int	Int	R 3

Field Name	TCC	SUP	GHO	TRE	CDM	MAH	DOU	RAD	CNF	Aquisition	Manual Designation	Duplicate Mode S	Resolution	#MB Data	AC ID Present	AC Identity
DI																
Unit																
Format	Int	Int	Int	Int	Char	Int	Int	Char	Char	Int	Int	Int	Int	Int	Int	Char

3.6.2 Export of I/RS Data

3.6.2.1 Specifications

The following specifications are relevant for this section:

[P2B1-SR-CAP-0720]] The **Interrogation _Reply Merger**.vi shall provide the export of both the Mode S interrogation data and the Mode S (Roll call only) reply data as it is recorded and generated by the PTE P1 RES . This tool shall take the interrogation file, the UTC time stamp file and the Data link scenario as an input.
The tool shall export the required interrogation / reply data files.

[P2B1-SR-CAP-0721] The Mode S interrogation / reply "line" shall be structured in two parts. The first part corresponds to the interrogation and is described in § **Error! Reference source not found.**. The second part corresponds to the reply to the corresponding interrogation (if generated) and is also described in § **Error! Reference source not found.**

[P2B1-SR-CAP-0722] For IRS data in case of All Call or SSR interrogations, one record per target is entered in the file, showing the number of SSR or All Call replies per target. If one or more targets replied in a certain scan this will indicate how many replies were generated . The Time stamp, Range and azimuth will be derived from the scenario data.

[P2B1-SR-CAP-0723] If no reply is generated by the PTE-P1 tool for a given Mode S interrogation (e.g. UELM), the reply part shall be blank.

[P2B1-SR-CAP-0724] If several replies are generated by the PTE-P1 tool for a given Mode S interrogation (e.g. DELM), the interrogation part corresponding to the last replies shall be blank..

P2B1-SR-ITF-0812] The format of the Interrogation part of the I/RS and I/VS file shall be as follows :

Note:The meaning of the different field names used below is defined in ICAO Annex 10 Vol. III and IV (Doc Ref. 7 and Ref. 5).

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Field Name	Index	Time of interrogation	Date of interrogation	Interrogation type*	Azimuth (ACP) of Mode S interrogation	Scan N°	Interrogation power	S Address	UF	RL	AQ	PC	RR	DI	SD	IIS	MBS	MES	
Unit		s			°														
Format	Int	T.6	Date		R.4	Int	R.2	Char Hex	Int	Int	Bool	Int	Char Dec Bin	Int	Bool	Int	Int	Int	
Field Name	LOS	RSS	TMS (bits 30-32)	TCS	RCS	SAS	SIS	LSS	RRS	PR	II/IC	CL	AP	MA	RC	NC	MC	SRS	Interrogation
Unit																			
Format	Bool	Int	Int	Int	Int	Int	Int	Bool	Int	Int	Int	Int	Int	Char Hex	Int	Int	Char Hex	Int	Char Hex

If no interrogation is found (e.g. FRUIT reply), all fields will be empty.

* Interrogation type: List of No Interrogation, 1,2,A,C,A+SP4,A+LP4,C+SP4,C+LP4,UF4,UF5,UF20,UF21,UF24

[P2B1-SR-ITF-0813] The format of the Reply part of the I/RS and I/VS file shall be as follows :

The format of the Reply part of the I/RS for Roll Call replies and I/VS for any reply data is as follows :

Field Name	Time of reply	Date of reply	Reply Type*	Azimuth (ACP) of Mode S reply	Scan N°	Azimuth of Target	OBA Value	S Address	DF	FS	DR	UM	IIS	IDS	Decoded AC	Decoded AC
Unit	s			deg		deg	V								ft	m
Format	T.6	Date	Char	R.4	Int			Char Hex	Int	Int	Int	Bool	Int	Int	Int	Int

Field Name	ID	CA	AA	PI	MB	AIS	KE	ND	MD	TAS	Rep;ly data
Unit											
Format	Char Octal	Int	Char Hex	Char Hex	Char Hex	Int	Int	Int	Char Hex	Int	Char Hex

If no reply was found, All fields except “Reply type” will be empty.

* Reply type: List of: No Reply, 1,2,A,C,DF4,DF5,DF11,DF20,DF21,DF24

The format of the Reply part of the I/RS for All Call and SSR replies are all empty fields, since the RES does not remember the details of these replies.

Optionally, one record line per target can be foreseen, containing the number of replies in all call or SSR the target produced in that scan:

Field Name	Time of Target	Date of target	Reply Type*	Not Used	Scan N°	Azimuth of Target	Not Used	S Address Target	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	Target AC	Target AC	Target A Code
Unit	s					deg									ft	m	
Format	T.6	Date	Char		Int			Char Hex	t			l			Int	Int	Cha Octa

3.6.2.2 Functional description

The export function of data called “I/RS” actually comprises of two parts:

- Export of interrogation data
- Export of Reply data

Under the PTE P1 development, sufficient preparation was taken for the logging and recording of both interrogations and replies of Mode S roll calls. Unfortunately, the RES has not sufficient capacity to include logging of generated SSR or Mode S all call replies. In that case, multiple replies need to be linked to one interrogation, which causes a too high overflow risk for the target processors. This would seriously endanger the generation capabilities of the RES.

For this reason, a decission was made during the presentation of the IE proposal for the P2B1 implementation not to include the full SSR or All Call replies in the I/RS data. The main purpose of the IRS data is to serve as input for the PTE P2B2 development (data link analysis function) . In that case, the I/RS data will only be used after filtering of roll call interrogations anyway, so this limitation is not critical.

Under P1, the RES already stores critical data for the interrogations and replies. This data is:

- Timestamp of interrogation , relative to start of generation
- ACP(16 bit) and ARP relative to start of generation
- Type of interrogation (1,2,A,C,intermode,All Call, UF x…)
- Mode S interrogation data contents (14 bytes)
- First 32 bits (4 bytes) of Mode S reply data

The data is stored in the xxx.int file , where xxx is the lower cased name (only first 25 characters) of the SCENARIO RESULT Folder.

If we want to convert this data to the IRS data as stated in the SRD (Ref. 29) §4.2.3, following data needs to be added:

- UTC time of every ARP crossing
- Range of target (to determine time of reply)
- Tangential speed of target (to determine azimuth of reply)
- Last 10 bytes of reply data (to determine MB or MD data)

This extra data must be extracted from the scenario data file and the .arp file (as recorded by the EDR, (see also §3.5.4)

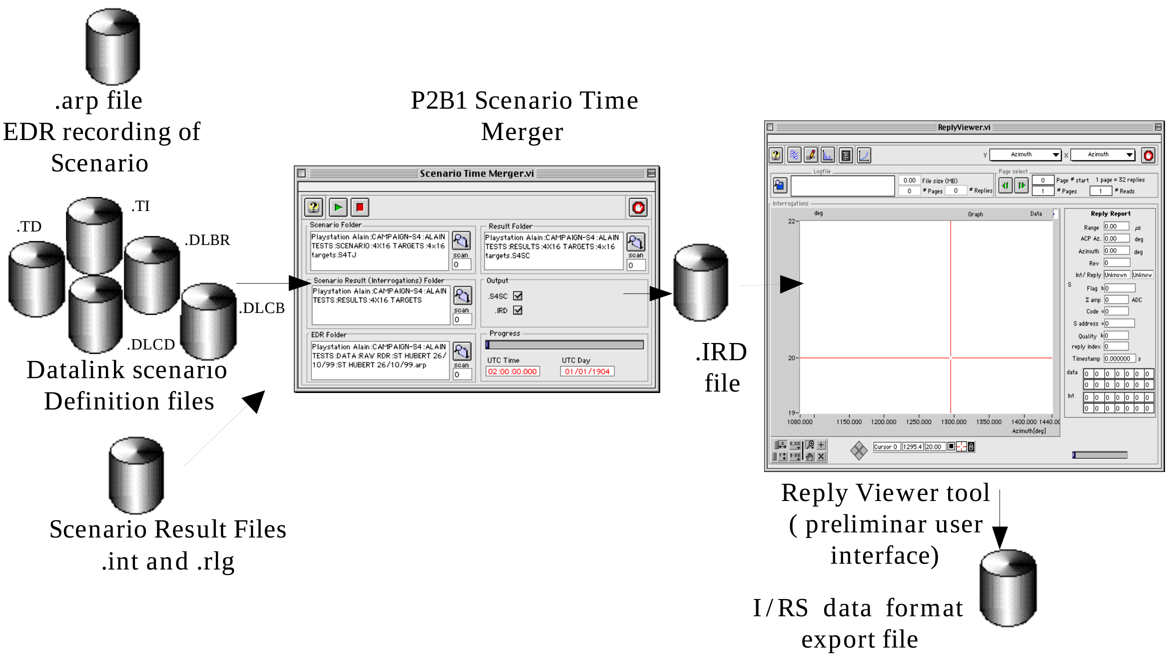

Figure 3-23: IRS Export from Scenario Time merger

This gathering and combination of data will be performed in the P2B1 developed “Scenario Time Merger” tool. This tool was originally developed under the PTE P1 Pd & Accuracy ECP, but needs be enhanced in PTE P2B1. As an output, this tool will produce a “Reply-interrogation” file, under a specific DSS format (see ICD P1-P2 (Ref. 22 §) for more details on the DSS format) .

This interrogation-reply datafile can be converted to an excell type I/RS data of I/VS data.

3.6.2.3 Interrogation-Reply DSS file

The contents of the Interrogation-Reply DSS file (xxx.IRD) as created by the IRS export function in the Scenario Time Merger tool is as follows:

Bytes	*Type*	*Contents*	*Unit*
8	Sgl	Range Reply	µs
	Dbl	Azimuth(ACP) Interrogation	deg
8	Dbl	UTC Time of day Int	sec
8	Dbl	Azimuth Reply (ACP)	deg
8	Dbl	Azimuth Target	deg
2	U16	Scan nr	
1	U8	Interrogation type	List
1	U8	Reply Type	list
4	U32	S address	
2	U16	ID/SSR Code	
4	Sgl	Interrogation Power	dBm
4	Sgl	Reply Power	dBm
4	Sgl	OBA Value	V
1	U8	Reply Flag	Status field
1	U8	#SSR/All Call Replies	
4	U32	Data link type	Status field
14	14*U8	Interrogation	
14	14*U8	Reply or Code	
4	U32	Index	
32	8*U32	Spare IRD1..IRD8	
64		Spare	

In the scenario time merger, the following actions are taken: Please note that the .TI file is created by the P1 Trajectory scenario generator, the .DLBR, .DLCB ,.DLCD and .TD files are created by the P1 event scenario generator and the .int and .rlg are created by the P1 RES Main control tool.

- Read .TI file (Transponder Information) of scenario and construct a BDS table (32 entries) for every target in the scenario. This table is two dimensional and provides up to 2048 entries (one per transponder or target) in one dimension and 32 entries (one for every BDS register) in the second dimension.
- Read .DLBR (down link Broadcast) file and create Broadcast array. Array is one dimensional and provides up to 2048 entries (one per transponder or target) of Broadcast data. The data contains 28 bytes of data (BDS 0, 2,3 and 4 contents)
- Read .DLCB (downlink Comm B) file and create Comm-B array. Array is two dimensional and provides up to 2048 entries (one per transponder or target) in one dimension and 4 entries in the second dimension. (up to 4 Comm Bs can be processed per scan) of AICB data. The data contains 28 bytes of data (BDS 0, 2,3 and 4 contents)

§ Read .DLCD (down link Comm D) file and create Comm-D array. Array is two dimensional and provides up to 2048 entries (one per transponder or target) in one dimension and 2 entries in the second dimension. (up to 2 Comm Ds can be processed per scan) of DELM data. The data contains 160 bytes of data (16 segments of 80 bits)

§ Read .int (Interrogation and reply) file and create Interrogation array. Array contains a "window" of interrogation 10 degrees before up to 10 degrees after the processed target.

§ For all scans in scenario file:

- Read 1 scan of the input scenario (.S4TJ or .S4EV)
- Read .arp file and correct timestamping of scan for all targets
- Read TD file (Transponder Data) and update BDS table if required for all targets.
- Read .DLBR file and update Broadcast array if required.
- Read .DLCB file and update AICB array if required.
- Read .DLCD file and update CommD array if required.
- For all targets in scan:
  - Take nth target in scan; determine azimuth
  - Read interrogations from interrogation data file from RES (.int file) until azimuth interrogation > azimuth target+10 degrees.
  - Cut interrogation array such that 1st azimuth interrogation in array > azimuth target –10 degrees.
  - This way we have created a "window" of interrogations around one target.
  - In this "window", search for the target S address in the interrogations. If found, use target range information and speed in scenario to determine IRD range data. Use target Azimuth information to determine reply azimuth (+OBA) . Use target speed and heading to determine azimuth (ACP) of reply.
  - Filter out Roll Call interrogations and determine # Roll call replies and # roll calls before first reply. Determine interrogation power and include in .S4SC (input for RFS export data)
  - For all interrogations to specific target
  - If SSR or All Call reply: fill "reply type" field in IRD file with correct type. No reply data (DF11 or A or C code) is available in the RES logging, so this can not be entered in the IRD file.
  - If UF 4,5,20,21: Check DF: if DF 4 or 5: Fill "Reply" field with first 32 bits of reply from .int file and AA from interrogation.
  - If UF 4,5,20,21 and DF=20 or 21: Determine MB contents:
    -If RR >16: Use RR,RRS (BDS) to index BDS array and determine BDS contents. MB= BDS (i)
  - If RR=16 and RRS=0 : check DR
  - If DR = 1 or 3 : Read MB contents from AICB array.
  - If DR= 4 or 5 : Read MB contents from Broadcast array
  - Build Reply using 32 bits from int file and MB and AA
  - If UF 24 and RC<3 : Build Reply using 32 bits from int file and AA; MD=0 ; TAS can be read from 32 bits in int file.
  - If UF=24 and RC=3 : Determine # of replies to be send from SRS field. Read MD data segments from CommD array. Create N replies using 32 bits of int file, Comm D data and AA from int. Duplicate N IRD records.

        - If UF 4,5,20,21 with PC=4 or DI=1 and MBS=2 : Closeout of AICB=> Verify if Closeout accepted in .rlg (result log file) (Entry in result log with correct target ID, ACP and ARP and Code = 1) : Increment pointer in Comm B array to next record.
        - If UF 4,5,20,21 with PC=6 or DI=1 and MES=4,5or 7 : Closeout of Comm D=> Verify if Closeout accepted in .rlg (result log file) (Entry in result log with correct target ID, ACP and ARP and Code = 3) : Increment pointer in Comm D array to next record.
        - If result log has entry for Broadcast CommB closeout (Entry with correct Target ID and code = 2) :Increment pointer in Broadcast array to next record.
    - Next Target
- § Next scan

Once the .IRD file has been created, it can be loaded in the “Interrogation/Reply Viewer” tool. This tool allows direct export of the data in the I/RS or I/VS format.

3.6.2.4 Interrogation/Reply Viewer tool

The Interrogation/Reply viewer takes the .IRD file, as generated by the Scenario Time Merger tool, as an input and allows visualisation of interrogation and reply data. The user can load any .IDS file and filter the data according to his wishes, using an extensive filter including a filter on all interrogation and reply sub fields.

The tool will contain a double display, which allows replies and interrogations to be visualised simultaneously. The upper graph will default show reply range (in µs) versus reply azimuth or fractional scan number. The lower graph will show by default interrogation stagger time versus azimuth or fractional scan number.

The two x axis of this tool will be linked and can be selected from a default list of options. (typically scan number, fractional scan number, azimuth, ACP, time) . The two Y scales of the graphs are independent. The tool will allow the user to select any Reply field plus a number of calculated fields as a Y scale of the upper graph. The tool will allow the user to select any Interrogation field plus a number of calculated fields as a Y scale of the bottom graph.

Both graphs will have a vertical cursor line which links the interrogation with the reply. A colour and symbol coding will differentiate between the different types of interrogations and replies: the user can select a different symbol for SSR Mode A, SSR Mode C, S UF/DF 11 , S UF/DF 4, S UF/DF 5, S UF/DF 20, S UF/DF 21 and S UF/DF 24 interrogations or replies.

The cursor will also link its position with the contents of the interrogation and the reply. The interrogation and the reply will be decoded in detail (showing all sub fields in a list, plus a decoding towards the data link activity (e.g. Comm B closeout, Multi site Comm D reservation etc..) .

The data shown in the interrogation/reply viewer will be linked to the scenario data , allowing the “multi level “ linking feature of the P1 inventory tool to be further expanded.

All data in the IRD file can be exported into the IRS or IVS file formats, as specified in the SRD (Ref. 22) . This data is sufficient for the export tool itself to create all fields described in [P2B1-SR-ITF-813]

All data can also be printed to a table format or the graphs can be printed or included in a RASS-S4 style automatic report file.

3.6.3 Export of I/VS Data

3.6.3.1 Specifications

The following specifications are relevant for this section:

[P2B1-SR-CAP-0730] For the generation of the export I/VS Data, the P2B1 tool shall use the existing PTE P1 tool for the recording of video replies. The interrogations are decoded by the RES and recorded by the RVR as well.

[P2B1-SR-CAP-0731] The decoding of the recorded Mode S video data into the I/VS data format was not subject to any previous EC contract, and shall therefore be treated with some care. Under PTE P2B1 , IE shall review the RVI video Recording facility for Mode S with the aim that the I/VS data can be generated correctly

[P2B1-SR-CAP-0732] The Mode S interrogation / reply "line" of the I/VS data shall be structured in two parts. The first part corresponds to the interrogation and is described in §4.2.4. The second part corresponds to the reply to the corresponding interrogation (if generated) and is described in § **Error! Reference source not found.**

[P2B1-SR-CAP-733] For I/VS data in case of All Call or SSR interrogations, a line **shall** be created for each reply generated by PTE-P1 (including the same all-call interrogation) given that the Mode S reply data is correctly recorded by the PTE RVR. Limitations in the recording, such as recording under FRUIT conditions can lead to incomplete I/VS data sets.

[P2B1-SR-CAP-0734] If no reply is generated by the PTE-P1 tool for a given Mode S interrogation (e.g. UELM), the reply part of the I/VS data shall be blank.

[P2B1-SR-CAP-0735] If several replies are generated by the PTE-P1 tool for a given Mode S interrogation (e.g. DELM), the interrogation part corresponding to the last replies of the I/VS data shall be blank.

3.6.3.2 Functional description

The export function of data called "I/VS" actually comprises of two parts:

- Export of interrogation data recorded by the Radar Video Recorder (RVR)
- Export of Reply data as recorded by the RVR

In fact, PTE P1 already records this type of data using the RVI connected to the RVR. The recording was used initially for PTE P1 testing and validation, but soon became a standard part of the PTE P1 tool. IE has experienced some problems in recording data =. Therefore we require a small redesign of the existing RVI (Radar Video Interface) device to accommodate the recording of I/VS Data.

Once the RVI redesign is ready, the existing PTE P1 tool " Analysise Pulse RecordingS" will be used to create the above specified IRD file from the recorded video data. The IRD file can than be exported using the interrogation/Reply viewer.

3.6.3.3 RVI redesign

The Existing RVI has some limitations when it is used to record a full POEMS Mode S scenario(using high loads). These limitations lead to a decreased Pd (probability of detection) of all recorded data items. At this point, we estimate the Reply Pd of the RVI for a Mode S (acquired) load scenario (e.g. 900 targets) to 99 %. In some situations, the Pd will drop to lower values. (e.g. in high FRUIT environment, or in multiple overlap situation).

In order to determine the gravity of the limitations of the RVI, IE scheduled a few test campaigns to each POEMS manufacturer in order to evaluate the conditions of pulse shapes etc. On site.

A number of improvements can be made to the RVI design in order to increase the Pd : Following items point out the known limitations and their possible solutions:

3.6.3.3.1 Video Problems

The RVI did not perform according to the required expectations when recording Mode S replies on some types of receivers. The reason behind this lies in the fact that these receiver monitor outputs, which serve as PTE interface points do not deliver correct annex 10 specified Pulse shapes. (The fall time of the pulses is longer than 200 ns

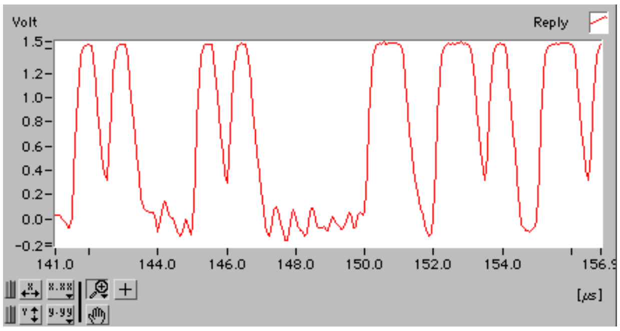

Figure 3-24: Mode S reply at close range on bad monitor outputs

This limitation creates a strange effect within a high power (close range) Mode S reply, namely that the zero level between two adjacent reply pulses (belonging to the same reply) only drops about 30 dB below the maximum power. This fact causes that the RVI, which uses a rather simple threshold detection circuit to detect Mode S pulses, can no longer distinguish the Mode S reply pulses in a reply when the threshold level is put relatively low. This reduces the actual dynamic range of the video recording to less than 30 dB.

A solution was found by creating a dynamic threshold level, which “tracks” the maximum power of every pulse entering the RVI. This “dynamic” threshold level in fact allows an increased dynamic range up to 50 dB.

3.6.3.3.2 Inclusion of OBI recording in firmware and Software

The RVI connected to receivers without OBA outputnow use the Sum, Delta and OBI signal to create a pseudo-OBA signal internally. This is done by using a “piggy back” PCB inside the RVI. A better solution would be to simply record the Sum,Delat and OBI signal alone, and construct the OBA curve in software.

3.6.3.3.3 Retrigger Feature

The RVI has a special feature which causes strange pulseshapes (as they occur during garbling or overlap) to be detected by using double trigger pulses. This feature is not supported by the processing software since it was found to cause more problems when decoding the recorded data than it actually created gain for the Pd of the RVI. Therefore this feature should be removed of the RVI firmware.

3.6.3.3.4 Range Limitation

The earliest RVI designs have a “Range” limitation. This feature was originally intended for load reduction , such that the RVI did not produce event triggers after a certain range limit was passed. This feature causes some problems for Mode S Roll calls. The feature has been removed from the PCB in a production change, but should be finalised .

3.6.3.3.5 Digital Pulse Compression Limitation

The Digital pulse compression firmware inside the RVI can produce in certain conditions (ACP edge within 200 ns of a Mode S interrogation edge) a trigger signal for the Radar Video Recorder which can not be recorded. (two “events” are generated closer then 200 ns). This can cause the loss of the ACP pulse (which is not dramatic) or in the loss of a data bit of the Mode S interrogation (which is not acceptable in case of PTE P2B1 recording).

The problem will be dealt with in an improved firmware design of the RVI.

1.1.1.1.1. Miscellaneous design improvements

The RVI can cause a power supply problem when devices are switched on in the wrong order or not switched on at all.

The RVI PCB contains a lot of production changes, which need to be removed from the PCB.

The Range trimmer must be removed, since it has no valid use in case of Roll – Call Mode S recording.

The possibility of setting the RVI potentiometers under software control must be studied, but will most probably not be subject of this redesign.

3.6.3.4 IRD file generation

Once the RVI is redesigned, the data can be read and analysed using the existing PTE P1 Multi- level analysis tool , also called the “Reference Extractor” . This tool already has the possibility of exporting a “reply-Interrogation file, although the format somewhat differs from the one proposed in § 3.6.2.3. The exported file under P1 was in fact only used internally by Intersoft to evaluate and asses RES performance during in-house tests.

It will be a minor change to adapt the old format to the IRD format described above. The IRD format will then be an suitable input for the “Interrogation-Reply viewer “ tool

3.6.3.5 IVS export

Once the Reference extractor data is exported as the IRD file, it will be analysised and exported using the “Interrogation-Reply viewer “ tool , as described in §3.6.2.4.

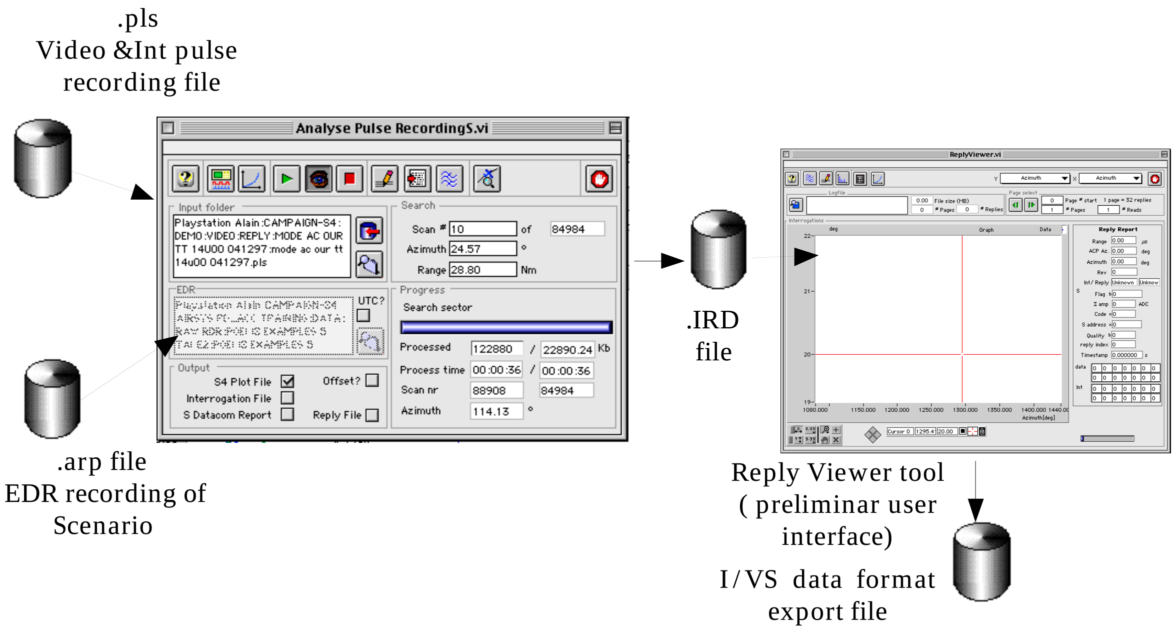

Figure 3-25: Export of IVS data

3.6.4 Export of ASTERIXCat 17,18,34 and 48 data

3.6.4.1 Specifications

The following specifications are relevant for this section

[P2B1-SR-CAP-0740] The asterix Cat 17,18,34 and 48 data is recorded by P1 in a raw EDR data file. It shall be decoded and time stamped by the PTE P2B1 **enhanced EDR Convert.vi** tool. The tool will create additional .A17,.A18,.A34 and .A48 files . The format of the exported (Excel) files is hereafter.

3.6.4.2 File Format A17 Data

[P2B1-SR-ITF-814] The format of the A17 file shall be as follows :

Field Name	Index	Recording Time	Recordding Date	Azimuth (ACP)	Scan N°	Type	SAC	SIC	DAC	DIC	Latitude	Longitude	Mode C VG	Flight level	Mode 3/A VGL	Mode 3/A
DI						000	010	010	012	012	045	045	050	050	070	070
Unit		s		°							°	°		ft		
Format	Int	T.6	Date	R.4	Int	Int	Hex	Int	Hex	Int	R.5	R.5	Char Bin	Int	Char Bin	Char Octal

Field Name	Time of day	Ground speed	Heading	*Counter of Mode S address list*	*Mode S address in the list*	Aircraft Address	DRN	Transponder capability	Track Status	*Counter of station/node list*	*station/node SAC in the list list*	*station/node SIC in the list list*	CC command state
DI	140	200	200	210	210	220	221	230	240	350	350	350	360
Unit	s	kt	°										
Format	T.3	R.2	R.4	Int	Char Hex	Char Hex	Int	Char Bin	Char Bin	Int	Int	Int	Int

3.6.4.3 File Format A18 Data

[P2B1-SR-ITF-0815] The format of the A18 file shall be as follows :

Field Name	Index	Recording Time	Recordding Date	Azimuth (ACP)	Scan N°	Type	Cause	Diag	Time of day	Former II	Current II	S address	*Counter of Mode S address list*	*Mode S address in the list*	Data link command	Data link status	
DI						000	001	001	002	004	004	005	006	006	007	008	
Unit		s		°					s								
Format	Int	T.6	Date	R.4	Int	Char Hex	Char Hex	Char Hex	R.3	Int	Int	Char Hex	Int	Char hex	Char Bin	Char Bin	

Field Name	Data link report request	Transponder communication capability	Capability report	FS	CQF	CQF method	Aircraft Rho	Aircraft Theta	Aircraft X	Aircraft Y	Packet number	*Counter of packet number*	*Packet number*	Packet priority	Packet type	Mode S packet	Broadcast number
DI	009	010	011	012	012	013	014	014	015	015	016	017	017	018	018	019	020
Unit							NM	°	NM	NM							
Format	Char Bin	Char Bin	Char Bin	Bool	Int	Int	R.3	R.4	R.3	R.3	Int	Int	Int	Int	Int	Char Hex	Int

Field Name	BP Priority	BP Power	BP Duration	BP Coverage	Broadcast prefix	Up/down link broadcast	GICB number	BDS code	GICB extraction periodicity	GICB extracted	GICB property Priority	GICB property Periodicity constraint	GICB property Async. Update	GICB property Non extraction	GICB property Reply destination	Aircraft identity	Mode 3/A VGL
DI	021	021	021	021	032	023	025	027	028	029	030	030	030	030	030	031	032
Unit			s						s								
Format	Int	Int	Int	Char Bin	Hex	Char Hex	Int	Hex	Int	Char Hex	Int	Bool	Bool	Bool	Int	Char	Char Bin

Field Name	Aircraft Mode A	Mode C VG	Aircraft height	Aircraft speed	Aircraft heading	SAC	SIC	DAC	DIC
DI	032	033	033	034	035	036	036	037	037
Unit			ft	kt	°				
Format	Char Octal	Char Bin	Int	R.2	R.4	Hex	Int	Hex	Int

3.6.4.4 File Format A34 Data

[P2B1-SR-ITF-0816] The format of the A34 file shall be as follows :

Field Name	Index	Recording Time	Recordding Date	Azimuth (ACP)	Scan N°	Type	SAC	SIC	Sector number	Time of day	Antenna Rotation period	SCS COM	SCS PSR	SCS SSR	SCS MDS	SPM COM
DI						000	010	010	020	030	041	050	050	050	050	060
Unit		s		°					°	s	s					
Format	Int	T.6	Date	R.4	Int	Int	Hex	Int	R.2	R.3	R.3	Char Bin	Char Bin	Char Bin	Char Bin	Char Bin

Field Name	SPM PSR	SPM SSR	SPM MDS	Range collimation error	Azimuth collimation error	Generic polar window rho start	Generic polar window rho end	Generic polar window theta start	Generic polar window theta end	Data filter	Source height	Source latitude	Source longitude	Counter 0	Counter 1	Counter 2
DI	060	060	060	090	090	100	100	100	100	110	120	120	120	070	070	070
Unit				NM	°	NM	NM	°	°		m	°	°			
Format	Char Bin	Char Bin	Char Bin	R.3	R.3	R.3	R.3	R.4	R.4	Int	Int	R.5	R.5	Int	Int	Int

Field Name	Counter 3	Counter 4	Counter 5	Counter 6	Counter 7	Counter 8	Counter 9	Counter 10	Counter 11	Counter 12	Counter 13	Counter 14	Counter 15	Counter 16
DI	070	070	070	070	070	070	070	070	070	070	070	070	070	070
Unit														
Format	Int	Int	Int	Int	Int	Int	Int	Int	Int	Int	Int	Int	Int	Int

3.6.4.5 File Format A48 Data

[P2B1-SR-ITF-0817] The format of the A48 file shall be as follows :

Field Name	Index	Recording Time	Recordding Date	Azimuth (ACP)	Scan N°	SAC	SIC	Target report descriptor	Warning/error condition	Rho measured position	Theta measured position	X calculated position	Y calculated position	Mode 2 VGL	Mode 2 code	
DI						010	010	020	030	040	040	042	042	050	050	
Unit		s		°						NM	°	NM	NM			
Format	Int	T.6	Date	R.4	Int	Hex	Int	Char Bin	Char Bin	R.3	R.5	R.3	R.3	Char Bin	Char Octal	
Field Name	Mode 1 VGL	Mode 1 code	Mode 2 code confidence factor	Mode 1 code confidence factor	Mode 3/A VGL	Mode 3/A code	Mode 3/A code confidence factor	Mode C VG	Flight level	Mode C code	Mode C code confidence factor	Measured height	Calculated doppler speed	*Presence of raw doppler speed*	SSR Plot runlength	Number of received (M) SSR replies
DI	055	055	060	065	070	070	080	090	090	100	100	110	120	120	130	130
Unit									ft	Gray		ft	m/s		°	
Format	Char Bin	Char Octal	Char Bin	Char Bin	Char Bin	Char Octal	Char Bin	Char Bin	Int	Char Hex Octal Bin	Char Bin	Int	Int	Bool	R.3	Int

Field Name	Amplitude of (M) SSR reply	Primary Plot runlength 8	Amplitude of primary plot	Mode 1 code confidence factor	Mode 3/A VGL	Mode 3/A code	Mode 3/A code confidence factor	Mode C VG	Flight level	Mode C code	Mode C code confidence factor	Measured height	Calculated doppler speed	*Presence of raw doppler speed*	SSR Plot runlength	Number of received (M) SSR replies
DI	130	130	130	065	070	070	080	090	090	100	100	110	120	120	130	130
Unit	dBm	°	dBm						ft	Gray		ft	m/s		°	
Format	Int	R.3	Int	Char Bin	Char Bin	Char Octal	Char Bin	Char Bin	Int	Char Hex Octal Bin	Char Bin	Int	Int	Bool	R.3	Int

Field Name	Amplitude of (M) SSR reply	Primary Plot runlength 8	Amplitude of primary plot	Difference in range between PSR and SSR	Difference in azimuth between PSR and SSR	Time of day	Track number	Track status	Calculated ground speed	Calculated heading	Track quality sigma X	Track quality sigma Y	Track quality sigma V	Track quality sigma H	Aircraft address	Communication/ACAS capability and flight status
DI	130	130	130	130	130	140	161	170	200	200	210	210	210	210	220	230
Unit	dBm	°	dBm	NM	°	s			kt	°	NM	NM	kt	°		
Format	Int	R.3	Int	R.3	R.3	R.3	Int	Char Bin	R.2	R.4	R.2	R.2	R.2	R.2	Char Hex	Char Bin

Field Name	Aircraft identification	*Counter of Mode S MB data*	*Mode S MB data*	ACAS RA Report
DI	240	250	250	260
Unit				
Format	Char	Int	Char Hex	Char Hex

3.6.4.6 Functional description

In the light of the forthcoming PTE P2B2 development (data linking and merging function), it is opportune not to include the PTE P2B1 data export function in the EDR Convert tool. Moreover, a separate data export tool eliminates the interaction with the existing EDR convert tool currently used in PTE.

The A17, A18, A34 and A48 raw data is recorded and time stamped using the PTE EDR hardware and the EDR Serial Recording tool currently used in PTE. A separate A17, A18, A34 and A48 data format export tool with a dedicated user interface allows the user to export the raw data into the file formats defined in par. 4.2 of the SRD. All the general data export specifications (§.3.6.1 of the SRD) are relevant for the A17, A18, A34 and A48 data format export function. The following figure illustrates the A17, A18, A34 and A48 data format export function.

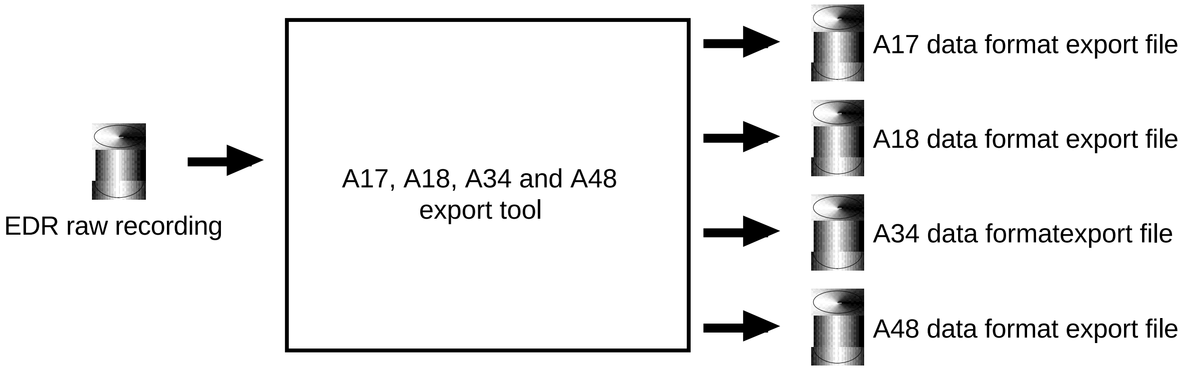

Figure 3-26: ASTERIX export tool overview

3.6.4.7 File Format S18 Data

The Data will also be copied in a DDS type data file (called xxx.S18 file) for further processing and linking under PTE P2B2. The format of this file is presented hereafter: DDS File

Size	*Format*	*Contents*	*unit*
8	Dbl	Timestamp	[s]
4	U32	ARP/ACP	
1	U8	Type	list
1	U8	Message type	
4	U32	Mode S address	
4	U32	FSPEC18 H	
2	U16	FSPEC18 L	
4	U32	Number (Packet)	
2	U16	Source	
2	U16	Destination	
		Message dependent data	

3.6.4.8 File Format S48 Data

The Data will also be copied in a DDS type data file (called xxx.S48 file) for further processing and linking under PTE P2B2. The format of this file is presented hereafter

Bytes	Type	Contents	Unit
A48 Record			
8	Dbl	Time of recording	[s]
4	U32	FSPEC48	
4	U32	Status	See 1)
4	U32	ARP/ACP	
1	U8	SAC	
1	U8	SIC	
2	U16	Target Report descriptor	
4	U32	Warning/Error	18 bits
2	U16	Rho Measured	
2	U16	Theta Measured	
2	U16	X calculated position	
2	U16	Y calculated position	
2	U16	Mode 2	
2	U16	Mode 1	
2	U16	Mode 2 code confidence	
2	U16	Mode 1 code confidence	
2	U16	Mode A	
2	U16	Mode A code confidence	
2	U16	Mode C	
4	I32	Altitude	(ft)
4	I32	Measured Height by 3D radar	(ft)
2	U16	Presence of raw Doppler speed	Boolean
1	U8	SSR plot run length	[deg]*0.44
1	U8	Nr of received SSR replies	
1	U8	Amplitude of SSR reply	[dBm]
1	U8	Primary plot run length	[deg]*0.44
1	U8	Amplitude of PSR reply	[dBm]
1	U8	Difference in range SSR-PSR	[Nm]
1	U8	Difference in Az SSR-PSR	[deg]
3	U32	Time of detection	[sec]/256
2	U16	Track nr	
2	U16	Track status	
2	U16	Calculated Ground Speed	[Nm/h]
4	U16	Calculated Heading	[deg]
4	U8	Track Quality Sigma x	[Nm]
4	U8	Track Quality Sigma y	[Nm]
4	U8	Track Quality Sigma v	[Nm/h]
4	U8	Track Quality Sigma h	[deg]
4	U32	Aircraft address	
2	U16	Com/ACAS/flight	
8	8*U8	8 BDS registers of MB data found in Cat48	
3	U24	MB index	
1	U8	Mb count	

PTE P2B2

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Abstract

As part of the Mode S development program, standard analysis tools are required to evaluate the performance of the **P**re-**O**perational **E**uropean **Mode S** (POEMS) stations being developed. It is intended that the integrated **P**OEMS **T**est **E**nvironment (PTE) will fulfil this objective. The creation of this Tool is broken into various phases - the target simulator, data recording and FAT support tool (the PTE phases P1 and P2B1), the transmitter test tool (PTE phase P2A), the data link performance assessment tool (PTE phase P2B2), the cluster simulation and testing tool (PTE phase P3), the radar site performance analysis tool (PTE phase P4) and a further element to ensure that a network or cluster of Modes S ground stations are functioning together (PTE phase P5).

Keywords

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TABLE OF CONTENTS

1. Introduction

Sophisticated radar analysis and testing capabilities are required for evaluating current and future generations of SSR systems.

As part of the Mode S development program, standard analysis tools are required to evaluate the performance of the Pre-Operational European Mode S (POEMS) stations being developed. It is intended that the POEMS Test Environment (PTE) will fulfil this objective by combining the capabilities of various test tools - the PTE -P1, P2A, P2B1, P2B2, P3, P4 and P5.

Each of these tools will be validated and accepted for use as part of the Factory Acceptance Testing (FAT) and Site Acceptance Testing (SAT) phases by the various interested parties including EUROCONTROL, National Authorities and Industry.

As well as being employed as development aid and test tools, the PTEs are also envisaged as an optimization, maintenance and fault finding tool kit for use in operational Mode S deployments and site support.

1.1 The PTE P2B2 Project

The POEMS Test Environment (PTE) is an assembly of test tools, each designed to fulfil a specific requirement. It consists of a tool to simulate targets and to export recorded data, to test the performance of the radar, its data capture and its data processing (the PTE phases P1 and P2B1) and for further analysis by other PTEs, of a transmitter test tool (PTE phase P2A), of a data link performance assessment tool (PTE phase P2B2), of the cluster simulation and test tool (PTE phase P3), of a further analysis tool (PTE phase P4) to assess mono-radar processing at the radar site and a further element to ensure that a network or cluster of Modes S ground stations are functioning together (PTE phase P5).

1.2 PTE P2B2 Components

1.2.1 Data Recording

In the first step, all required data for a data link analysis is recorded. Typically, this step requires the running of a RES scenario containing the data link events. An alternative is the recording of life data, but in most cases life data will not contain a lot of data link activity in order to allow a proper analysis of the radar performance.

This step involves the recording of at least the radar surveillance output (asterix cat 048). Preferably, the radar data link output (asterix cat 18) will also be recorded . Both these data sets are recorded by means of the RASS EDR and GPS .

A second important source of data are the Mode S (roll call) interrogations and replies. For this purpose, the RES will record all the interrogations and all its replies in a special file. Alternatively, the interrogations and replies can be recorded at video level by using the RVR.

1.2.2 Data Import

The role of the Data import is to convert data which is possibly provided in a TSF format into the internal PTE P2B2 DSS format, used for the analysis. The TSF files can be created by the PTE P2B1 tool and optionally changed by COTS spreadsheet software. After modification, the data can be re-imported using the data import feature. This import is optional since the internal format for PTE P2B2 is also directly produced by the PTE P2B1 tool. The tool will be able to create.S4SC, .A48,.A18 and .IRD files.

1.2.3 Data Conversion and Merging

Once all data is recorded, it needs to be converted into a usable format for analysis. This conversion is performed by one single tool, called the “Scenario Time Merger”. This tool was already part of previous PTE configurations (P1 and P2B1) but has been enhanced under the PTE P2B2 amendment. The tool produces a .S4SC (scenario data with UTC time stamping) .S48 (asterix cat 048), .S18 (asterix cat 18) and .IRD (Interrogations/Replies) . The data can be visualised immediately by means of the proper display tools (Inventory, GDLP-DLF Viewer, Asterix Cat48 viewer and Interrogation-Reply viewer) or can be further processed.

1.2.4 Data Linking

The merged data set (resident in a RESULT folder) can now be linked. The term linking relates to the combination of related data items in different recorded data files. A single plot return has several related data items:

One plot , or Target Reference Data (TRD) item, has one related Scenario position data field. This can be found in the S4SC file. The TRD also has one S48 record, the output of the plot by the radar. This data can be found in the S48 file.

Depending on the data link activity to the target, the TRD can also have one or more Asterix Cat 18 messages related to it. These can be found in the S18 file. Finally, each plot has one or more Interrogations and Replies related to it. This information can be found in the IRD file.

The Data Linker searches all converted data files (S4SC,S48,S18,IRD) for related data records and reconstructs a new logical file , named .TRD, which holds records of all related plot data for each target. The TRD file allows the simple loading of all related data per target . This allows simple and straight forward analysis.

The new logical data file is in fact a combination of 6 physical files (.TRD, .S48, .S18, .IRD, .pac, .BDS) , which are all stored in a single new Folder which is put under the “LINKED_DATA” three of the Campaign structure. The LINKED _DATA files , further references to as .TRD files, (although we actually mean the combination of the six files, we will only refer to the .TRD file) can be displayed in the “Data Display “ tool , or can be further processed in the Data Link Analyser.

1.2.5 Data Analysis

The .TRD file forms the basis of the data link analysis. Since the TRD data is created target based , the tool actually loads all related data target per target and calculates a number of important parameters for the data link assessment:

-Data Link Activity

-Data Link Exchange

-Data Link Delay

-Data Link Failure

-Data Link GICB Pd

-Data Link Comm C/D segment retransmission

-Data Link model B compliance

-Surveillance Re-interrogation rate

1.2.6 Data Displaying

The results of these analysis can be viewer immediately in the “Result Viewer” tool, in a number of graphs or tables, but are also included as calculated fields in the TRD data set itself. This allows the user to visualise the calculated data link fields (such as delays , activity, ..) as a function of a recorded or other calculated field in the data display tool.

This tool is derived from the PTE P1 inventory tool but allows the loading of TRD data , which has a lot more fields available than the original inventory tool. Any field in each of the related data items (Scenario data, Radar Data, Interrogation and reply data) can be visualised in relation to any other field. Sometimes this leads to 1-N relations. These are shown in a scatter diagram as N points.

The data display allows the printing of data , histogram calculations, 3D views, etc..

2. Reference Documents

Ref. 1. Radar Surveillance in En-Route Airspace And Major Terminal Areas. 006-95 EUROCONTROL. 19 May 1995.

Ref. 2. EATCHIP. POEMS User requirements for tools. Edition 1.1. SUR.ET2.ST03.3110-xx-xx. Draft. 6 May 1996.

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Ref. 26. User Manual RASS-S4 v 4.2 June 2000 Intersoft Electronics 20/6/2000

Ref. 27. Requirement specification of the PTE P2B1 Development Phase of the POEMS Test Environment PTE P2B; Edition 1.1 12/10/1999

Ref. 28. PTE P2B1 Project Plan Edition 1.0 21/2/2000

Ref. 29. PTE P2B1 System Requirement Document v 2.0 22/6/2000

Ref. 30. PTE P2B1 Architectural Design Document v 1.1 19/6/2000

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Ref. 37. PTE P2B2 System Requirement Document v 1.1 17/10/2000

Ref. 38. PTE P2B2 Architectural Design Document v 1.0 18/10/2000

Ref. 39. PTE P2B2 Test Specifications v 0.3 17/10/2000

Ref. 40. PTE P2B2 Test Report 0.1 21/10/2000

3. PTE - P2B2 Project Design

3.1 Introduction

3.1.1.1 General

In the first phase (P1) of the PTE (POEMS Test Environment) development the emphasis was put on the simulation of the environment, the recording and analysis of signals at different levels in the radar chain.

In the first part of the second stage (PTE P2A) , a POEMS transmitter test tool was created.

In the second part of the second stage (P2B1), additional simulation capabilities have been be added and all recorded result data has been made available for export into tab delimited text files.

In the third part of the second stage (P2B2) the effort will be put on the analysis of the data. This stage will allow the user to visualize and analyze all levels of the results of the POEMS performance on data link level (POEMS phase 2) , including Target report level, (Asterix Cat 48) data link communication level (Asterix Cat 18) and Interrogations and Reply data (Video level).

3.1.2 Purpose

The purpose of the PTE P1/P2 is to create a test environment by mimicking the behavior of multiple aircraft at antenna and PSR input level to simulate the future environment in which a POEMS station is to be used. Furthermore, PTE P1/2 has the task of recording all required analysis data and formatting it into the right format for further analysis. Some of this analysis can be done on the PTE P1/P2 platform itself, other must be performed on the P4 platform or using external analysis tools (e.g. spreadsheet program).

By recording the interrogations and output of the station for such a repeatable “virtual“ environment, the performance of the radar can be analyzed.

Three important parts can be distinguished :

1. The generation of test signals to simulate a specific environment
2. The recording of all important signals
3. The Analysis of all Recorded data

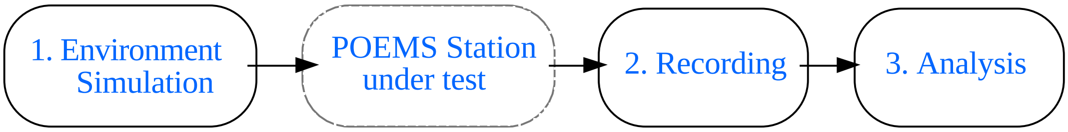


Figure 3-1: POEMS Purpose

3.1.3 Scope of PTE P2B2

The scope for the P2B2 project must be seen within the general PTE P1/P2 project.

At the end of the P2 development, the PTE P1/2 shall provide the user with the possibility of generation of a arbitrary scenario and compile this scenario into sufficient data files to feed two types of hardware devices:

The RES (or Radar Environment Simulator)
The EDR (Extended Data Recorder / Replayer)

These devices will then provide in turn the required input to the POEMS radar for it to operate under simulated conditions which are as close as possible to a future (highly loaded) real environment. For this purpose, PTE will create scenario information and provide the radar with SSR or Mode S replies, simulate Mode S protocols (among which all data link protocols) (GDLP simulation) , simulate possible outputs of a co-located or nearby PSR radar (P2B1

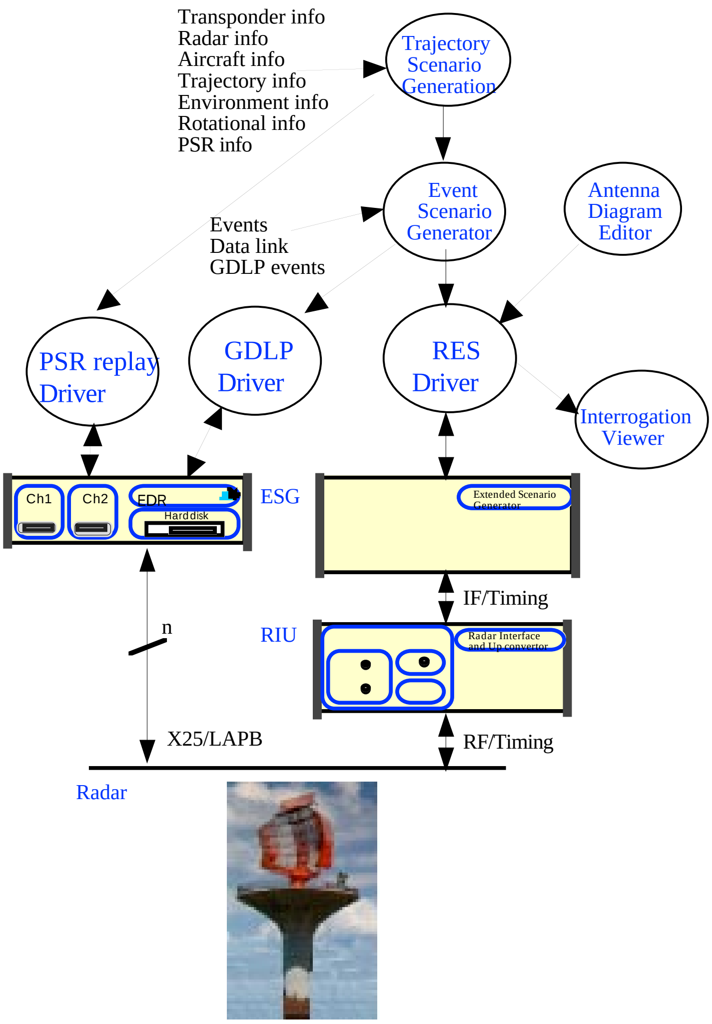


Figure 3-2: PTE Generation overview

Once the scenario is running, PTE P1 Records data at different levels:

Air level: : Interrogations send by Radar captured by RFA
Interrogations and Replies: I/RS data : Recorded by RES at generation
Video Level: Interrogations and Replies and Video Data recorded by RVR/RVI
Digitised level: No recording performed
Service level: Syncro time, Pimary input,
Network level: Asterix Cat 34,48,17 and 18

PTE P2B1 will use this data and convert it into the necessary formats such that analysis is possible.

Some important sections of the analysis are already available in PTE P1:

Pd calculation
Accuracy Calculation
Data Visualisation in numerous combinations.
Interrogation schedule analysis

PTE P2B1 added following analysis features to the list:

Sector message delay analysis

PTE P2B2 adds following analysis features to the list:

- General Analysis
- Data Link Activity Measure
- Data Link exchange Analysis
- Data Link Cancellation Analysis
- Data Link Broadcast CommA Analysis
- Data Link Pd CommB Analysis
- Data Link Comm C/D segment Retransmission Analysis
- Data Link Model B Compliance Analysis:
- Re-Interrogation Rate Calculation

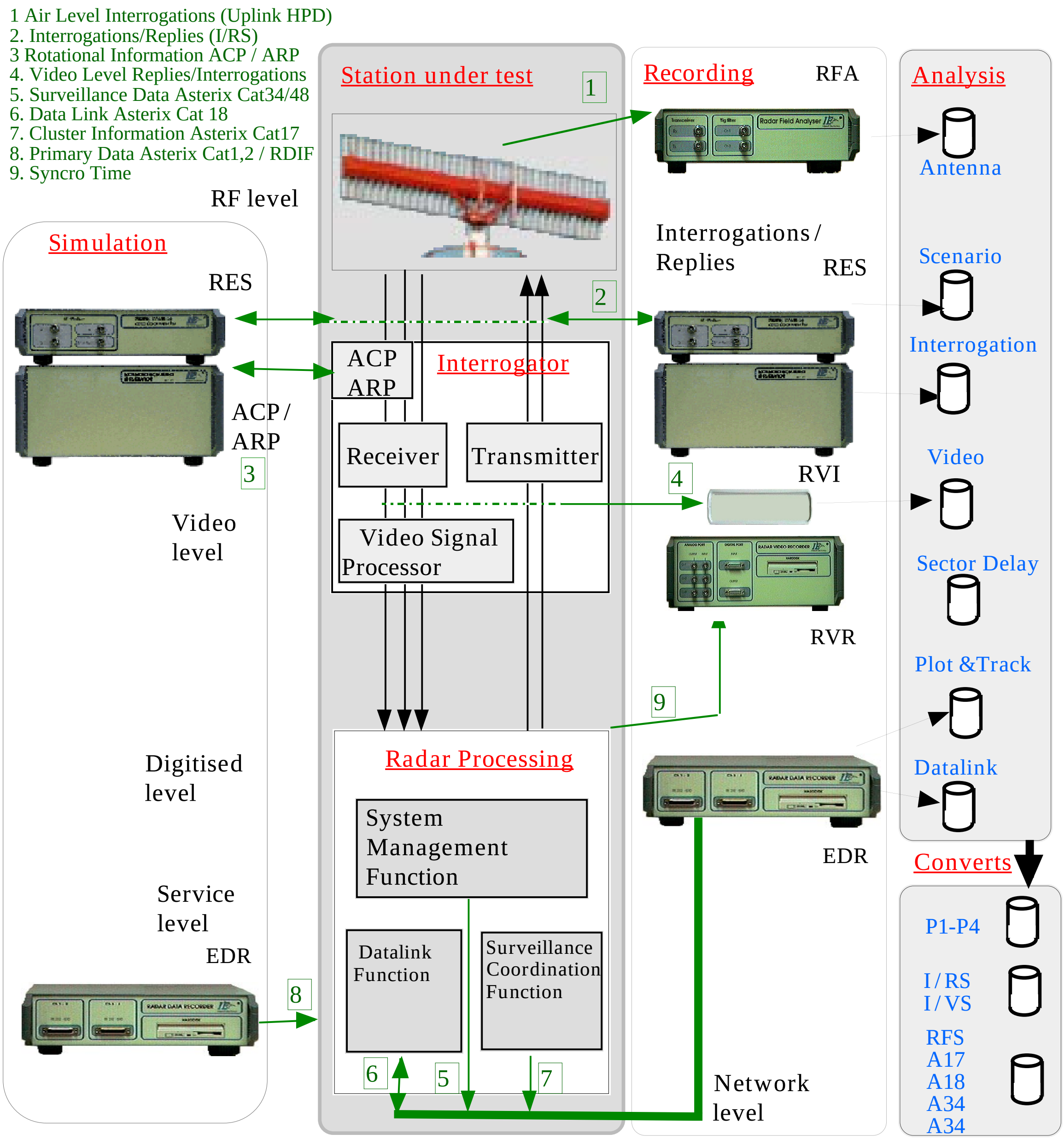


Figure 3-3: POEMS Recording Data

3.2 General Design Features

3.2.1 Related Specs

The PTE P2B2 tool provides the operator with measures of the data analysis performance of the POEMS station under test (SUT). These is based principally upon an assessment of the SUTs' outputs and other data as processed and recorded by the PTE P1 / P2B1 tool.

[PTE-SR-P2B2-CAP-0100] The PTE P2B2 tool **shall** provide off-line capabilities for data link analysis functions.

[PTE-SR-P2B2-CAP-0101] The PTE P2B2 tool **shall** be able to quantify the various performance levels for the SUT by comparison of the data output by the SUT (and recorded by the P1 / P2B1 tool) against a "reference" data set (also provided by the P1 / P2B1 tool).

[PTE-SR-P2B2-CAP-0102] The "reference" data used by the PTE P2B2 tool to evaluate the POEMS SUT performance, in case of simulated traffic, **shall** be the - RFS – R / F Scenario replay data containing the target information resulting of a scenario simulation and the - IRD – Mode S Interrogations / Replies Data recorded and generated by the RES tool running under the PTE P1 / P2B1 tool. A link shall be established from the reference data towards the recorded Asterix Cat 48 and Cat 018 data.

[PTE-SR-P2B2-CAP-0103] The "reference" data used by the PTE P2B2 tool to evaluate the POEMS SUT performance, in case of live traffic , **shall** be the – A48 Asterix Cat 048 Target report information containing the target information resulting of the recording of the POEMS station output and the - IRDV – Mode S Interrogations / Replies Data containing the Mode S interrogations produced by the station and the corresponding Mode S replies derived from the recorded video. A link shall be established from the reference data towards the recorded Asterix Cat 48 and Cat 018 data.

[PTE-SR-P2B2-CAP-0104] The PTE P2B2 tool **shall** import data as specified in the PTE P1 / P2B1 ICD (Ref. 32)

[PTE-SR-P2B2-CAP-0105] The PTE 2B2 tool **shall** include an on-line help function.

3.2.2 User Interface

The PTE P2B2 project is a Software only project. No Hardware modules are to be designed.

For the creation of the software, we will make use of LabVIEW, which is the programming language of the other PTE P1 and P2 tools. LabVIEW provides the user of the final product with a number of build in features, such as on line documentation using a floating window.

The user interface of PTE P2B will be no different from the PTE P1 design, since the same basic building functions and user interface design will be used.

3.2.3 File structure

3.2.3.1 General

The most important step in designing the PTE P2B2 tool was the correct definition of the data structure and the proof of its ability to include all required data items and allow easy , fast and correct access and filtering of the data.

In order to understand the data structure , we will start by explaining the four mayor parts of the structure:

Target Reference Data (TRD) positional and calculated result information

Target Asterix 48 Data (A48) positional information

Target Asterix 18 (A18) data link information

Target Interrogation and Reply data (IRD)

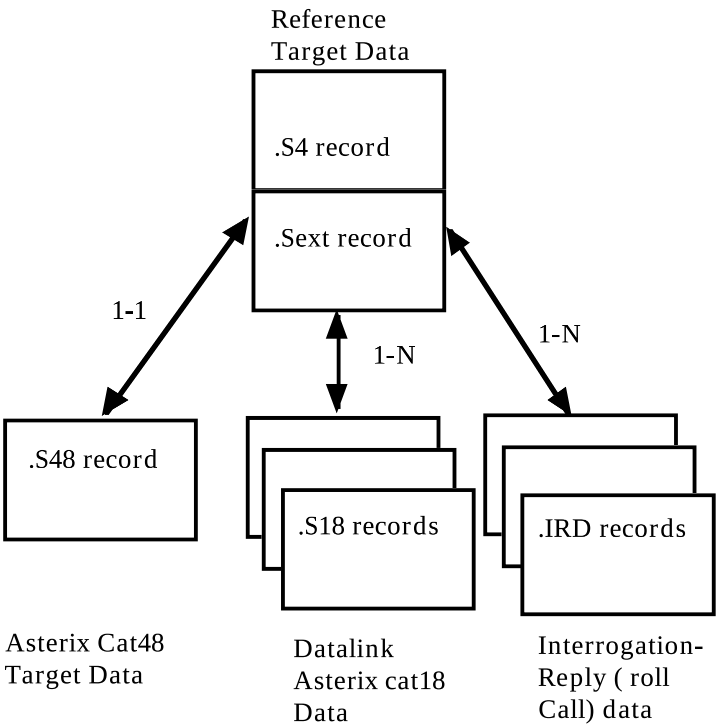


Figure 3-4: General Data structure

The TRD data has in principle one record entry per target per beam ,unless in specific cases, such as North crossings, reflections, etc.. These will not be dealt with in the PTE P2B2 analysis. (The original S4 records might contain sector messages or North messages, but they are removed by the Data Link module when creating the TRD data)

The Asterix A48 data should have a zero or one to one correlation with the TRD data; in cases where no radar data is produced (miss) or a false target is created, no link is present between TRD and A48 (0 to 1) and if radar data is found, a 1-1 link is present..

The Asterix cat 18 data should have a N to 1 relation with the TRD data, unless in cases where data link messages are programmed to non existing targets or nor target related messages have been created. These messages are not retained in the created TRD record structure.

The IRD data also has a N to 1 relation with the TRD data file, unless duplicate S address targets are present in the same beam. These cases will NOT be dealt with by PTE P2B2. All Non Roll Call IRD records and IRD records not belonging to targets in the TRD dataset will not be linked and removed by the Data link module.

3.2.3.2 File structure Simulated (SCENARIO) data

In case the data at the input of the PTE P2B2 is the result of a scenario playback, the data structure is filled as follows:

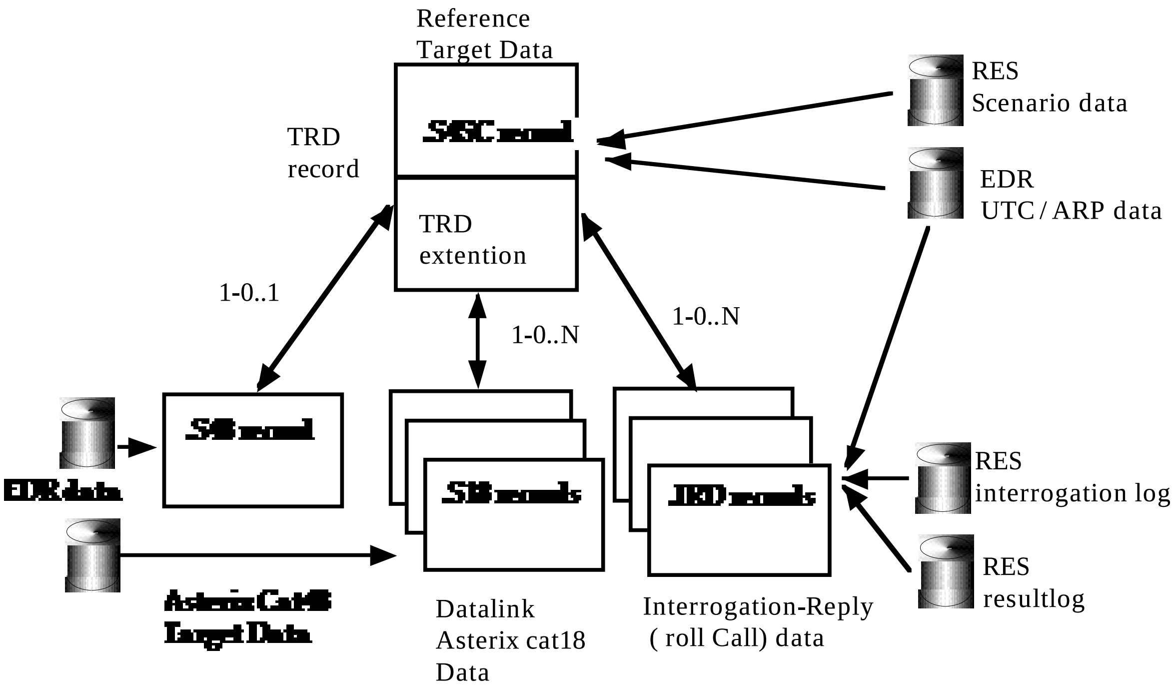


Figure 3-5: Simulated scenario data structure

In case of simulated scenario data, the “Reference Target Data” is extracted from the RES scenario and the EDR UTC time stamping information of the scenario playback session.

Simultaneously, the EDR has recorded the resulting data of the radar into a raw EDR file. The PTE P2B1 export tool has converted this data into a S48 file, containing all Asterix cat 48 data and a S18 file, containing all data link messages exchanged between the GDLP and DLF.

Finely the reference data is completed with a set of IRD (interrogation reply data) records, created by an other PTE P2B1 tool (Scenario time merger) from RES result data.

The linking between the target reference data input (S4SC data) , the S48 , S18 and IRD records into one TRD record is dealt with by the PTE P2B2 Data Linker module. Each scenario S4SC record (which contains reference target position, time etc..) will be extended by a record which contains all index pointers to the three other filesplus all additional calculated fields and counters required for the analysis section of PTE P2B2. The S4SC records combined with the extensions are put into a new file with the .TRD extension. The link between the TRD positional information and the Asterix cat 48 data is stored in a first “index48” value in TRD extension.

The link to the Cat 18 data is created by means of a “index18” value and a “counter18” . The index points to the first record in the Cat 18 file that contains cat 18 data for that TRD record (same S address, same scan) and the counter tells us how many records are stored that match the link. The S18 file is sorted by time of recording and S address, which causes all messages linked to the same TRD record so be stored sequentially one after the other.

The link to the IRD data is created by means of a “indexIRD” value and a “counter IRD” . The index points to the first record in the IRD file that contains Interrogation and reply data for that TRD record (same S address, same scan) and the counter tells us how many records are stored that match the link. The IRD file is sorted by time of recording and S address, which causes all messages linked to the same TRD record so be stored sequentially one after the other.

3.2.3.3 File structure life data recordings

For life data, we will maintain the same type of structure, only in this case the reference data is taken from the converted S4RD data. For the time being, the S48 and the TRD data will contain the same data. An improvement could be made by providing a reference from e.g. P4 reference trajectories or SASS-C multi radar trackers

As a logical extension to PTE P2B2, the TRD data set for life data could contain tracked data which was filtered and fitted , similar to the current P4 implementation.

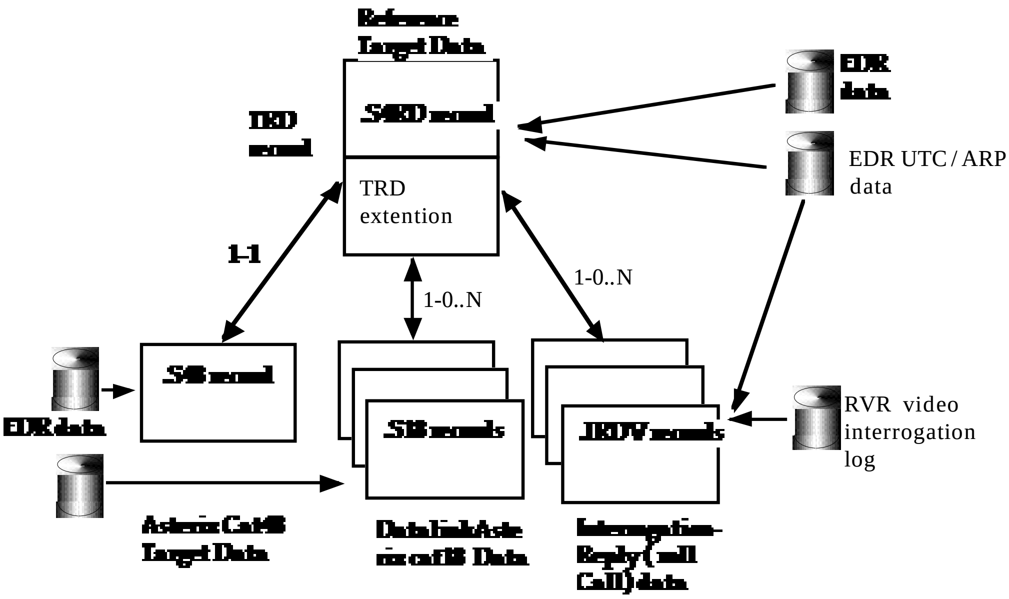


Figure 3-6: Life data structure

Simultaneously, the EDR has recorded the resulting data of the radar into a raw EDR file. The PTE P2B1 export tool has converted this data into a S48 file, containing all Asterix cat 48 data and a S18 file, containing all data link messages exchanged between the GDLP and DLF.

Finely the reference data is completed with a set of IRDV (interrogation reply data recorded at Video level) records, created by the “Analyze Pulse recording” tool.

The linking between the target reference data input (S4RD data) , the S48 , S18 and IRDV records into one TRD record is dealt with by the PTE P2B2 Data Linker module. Each P2B1 defined S4RD record (which contains target position, time etc.. derived from life traffic by the radar) will be extended by a record which contains all index pointers to the three other files plus all additional counters required for the analysis section of PTE P2B2. The S4RD records combined with the extensions are put into a new file with the .TRD extension.

The link between the TRD positional information and the Asterix cat 48 data is stored in a first “index48” value in TRD extension.

The link to the Cat 18 data is created by means of a “index18” value and a “counter18” . The index points to the first record in the Cat 18 file that contains cat 18 data for that TRD record (same S address, same scan) and the counter tells us how many records are stored that match the link. The S18 file is sorted by time of recording and S address, which causes all messages linked to the same TRD record so be stored sequentially one after the other.

The link to the IRDV data is created by means of a “indexIRD” value and a “counterIRD” . The index points to the first record in the IRDV file that contains Interrogation and reply data for that TRD record (same S address, same scan) and the counter tells us how many records are stored that match the link. The IRDV file is sorted by time of recording and S address, which causes all messages linked to the same TRD record so be stored sequentially one after the other.

3.2.3.4 File definition for TRD data

Bytes	Type	Contents	Unit
S4 Record			
8	Dbl	Time of recording (since 12:00 1/1/1904)	s
2	U16	Target ID	-
2	U16	Track number	-
4	U32	Scan number	-
2	U16	Mode 1 code	-
2	U16	Mode 2 code	-
2	U16	Mode A code	-
4	I32	Altitude	Ft
4	U32	Time of detection(Radar time)	1/256s
4	Sgl	Range	Nm
4	Sgl	Delta Range	Nm
4	Sgl	Azimuth	° (degrees)
4	Sgl	Delta Azimuth	° (degrees)
2	U16	Plot Quality	?
4	Sgl	Power	dBm
4	U32	Status	See 1)
4	Sgl	X coordinate	Nm
4	Sgl	Y coordinate	Nm
4	Sgl	Velocity	Nm/h
4	Sgl	Heading	° (degrees)
1	U8	# PSR Reflections	-
1	U8	# SSR Reflections	-
4	U32	Mode S Address	-
7	U8	MB Data	Bytes
1	U8	-	
1	U8	Comm Cap/Flight Status/ACAS	3/3/2 bits
1	U8	-	
4	Sgl	Delta Time	s
1	U8	Overlap	0-255
1	U8	Target Generator (RES)	1-4
2	U16	Transponder nr (RES)	
4	U32	3dB Beamwidth (RE)	mdeg
2	U16	Reflector nr (RES)	
2	U16	Set number (RES)	
4	U32	Asterix multi level index	bytes
4	U32	Data link Counters	See 4)
4	U32	Status2	See 2)
8	8*char	Target ID	
4	U32	Data link type	See 3)
4	U32	Index TRD	
4	U32	Index A48	
4	U32	Index A18	
4	U32	Index IRD	
1	U8	Count A48	
1	U8	Count A18	
1	U8	Count IRD	

1	U8	N1 spare
0.5	U4	UF4 count
0.5	U4	UF5 count
0.5	U4	UF20 count
0.5	U4	UF21 count
0.5	U4	UF24 UELMcount
0.5	U4	UF24 DELM count
0.5	U4	UF11 count
0.5	U4	SSR count
4	U32	Data link state
4	U32	Data link message
8	dbl	S48 Time of detection
1	U8	Re-interrogation rate Ni
1	U8	Re-interrogation rate Nei
0.5	U4	Broadcast comm B activity count
0.5	U4	GICB Activity Count
0.5	U4	AICB Activity Count
0.5	U4	ACAS RA Activity Count
1	U8	Nr of Comm A segments count
1	U8	Nr of Comm C initial or intermediate segments
1	U8	Nr of Comm C final segments count
1	U8	Nr of Comm D segments count
2	U16	Run nr
1	I8	Comm C segment retransmissions count
1	I8	Comm D segement retransmissions count
0.5	U4	Short Uplink Packets in Cat18 count
0.5	U4	Long Uplink Packets in Cat18 count
0.5	U4	Cancel Packet in Cat 18 count
0.5	U4	Uplink Packet Acqnowledge in Cat 18 count
0.5	U4	Short Downlink Packets in Cat18 count
0.5	U4	Long Downlink Packets in Cat18 count
0.5	U4	Down link Braodcast in Cat 18 count
0.5	U4	GICB extraction commands in Cat 18 count
0.5	U4	Spare
0.5	U4	Mode A code Change Failure count
0.5	U4	ACAS RA failure count
0.5	U4	AICB failure count
0.5	U4	Broadcast Comm B failure count
0.5	U4	Comm D failure count
0.5	U4	Comm A invalid sequence count
0.5	U4	Comm C failure count
4	U32	FSPEC delay values see 5)
4	sgl	delay1
4	sgl	delay2
4	sgl	delay3
4	sgl	delay4
4	sgl	delay5
4	sgl	delay6
4	sgl	delay7
4	sgl	delay8
4	U32	TRD8 spare
4	U32	TRD9 spare
4	U32	TRD10 spare
4	U16	TRD 11 spare
0.5	U4	Announcement Brcast CommB Exchange count
0.5	U4	Announcement ACAS RAExchange count
0.5	U4	Announcement AICB Exchange count
0.5	U4	Announcement Comm D Exchange count
0.5	U4	Brcast CommB Started and Non Completed Exchange count
0.5	U4	Brcast CommB Started and Completed Exchange count
0.5	U4	Brcast CommB Ongoing Exchange count
0.5	U4	Brcast CommB Completed Exchange count
0.5	U4	GICB Started and Non Completed Exchange count

0.5	U4	GICB Started and Completed Exchange count
0.5	U4	GICB Ongoing Exchange count
0.5	U4	GICB Completed Exchange count
0.5	U4	ACAS RA Started and Non Completed Exchange count
0.5	U4	ACAS RA Started and Completed Exchange count
0.5	U4	ACAS RA Ongoing Exchange count
0.5	U4	ACAS RA Completed Exchange count
0.5	U4	Comm A 1 segment Started and Non Completed Exchange count
0.5	U4	Comm A 1 segment Started and Completed Exchange count
0.5	U4	Comm A 1 segment Ongoing Exchange count
0.5	U4	Comm A 1 segment Completed Exchange count
0.5	U4	Comm A multiple segments Started and Non Completed Exchange count
0.5	U4	Comm A multiple segments Started and Completed Exchange count
0.5	U4	Comm A multiple segments Ongoing Exchange count
0.5	U4	Comm A multiple segments Completed Exchange count
0.5	U4	Comm C Started and Non Completed Exchange count
0.5	U4	Comm C Started and Completed Exchange count
0.5	U4	Comm C Ongoing Exchange count
0.5	U4	Comm C Completed Exchange count
0.5	U4	Comm D Started and Non Completed Exchange count
0.5	U4	Comm D Started and Completed Exchange count
0.5	U4	Comm D Ongoing Exchange count
0.5	U4	Comm D Completed Exchange count

Table 3-1; TRD data contents

1) Status:

bit 31 Valid A
bit 30 Valid C
bit 29 Valid 3D
bit 28 Valid 1
bit 27 Valid 2
bit 26 Valid S
bit 25 Garbled A
bit 24 Garbled C
bit 23 Garbled 3D
bit 22 Garbled 1
bit 21 Garbled 2
bit 20 Garbled S
bit 19 Track
bit 18 Plot
bit 17 PSR detect
bit 16 SSR detect
bit 15 Emergency 7500
bit 14 Radio fail 7600
bit 13 Hijack 7700
bit 12 SPI
bit 11 RA_Present (=BDS 30 data present)
bit 10 Simulated
bit 9 RFM
bit 8 MODE S Data
bit 7 Mil ident
bit 6 Mil emergency
bit 5 Reflection
bit 4 False Plot
bit 3 A code swap
bit 2 All-Call
bit 1 Roll-Call detect
bit 0 Sector Message

2) Status2

bit 24 BDS20: BDS 20 (AC ID) data present
bit 19/16 #MB data found in Asterix
bit 14: Resolution flag
bit 13: Duplicate S address
bit 12: Manual Designation flag
bit 11: Acquisition
bit 10 CNF: 0=Confirmed Track/1=Tentative Track
bit 9/8 RAD: Type of sensor : 00=Combined;01=PSR;10=SSR/S Track;11=Invalid
bit 7 DOU: Confidence (0= Normal;1=Low)
bit 6 MAH: Maneuver detection Hor sense
bit5/4CDM:Climbing/Descend Mode:00=Maintaining;01=Climbing;10=Descending;11=Invalid

bit 3 TRE: End of Track?
bit 2 GHO: Ghost track?
bit 1 SUP: Track from neighbor Node in cluster
bit 0 TCC: Type of plot coordinate transform (1=Slant range corr)

3)Data link type:

bit 31 Broadcast Comm A
bit 30 Code Change announcement
bit 29 Comm D Closeout
bit 28 Comm D Reply last segment
bit 27 Comm D Reply intermediate segment
bit 26 Comm D Extraction
bit 25 Comm D Reservation
bit 24 Comm D Announcement
bit 23 Comm C Closeout
bit 22 CommC technical acknowledge
bit 21 CommC Delivery last segment
bit 20 CommC Delivery n th segment
bit 19 Comm C Delivery 1st segment
bit 18 Comm C Reservation
bit 17 Comm A multi element Acknowledge
bit 16 Comm A multi element Tx nth element
bit 15 Comm A multi element Transmission 1st el
bit 14 Comm A 1 element Acknowledge
bit 13 Comm A 1 element Transmission
bit 12 Air Initiated Comm B Closeout
bit 11 Air Initiated Comm B Reply
bit 10 Air Initiated Comm B Extraction
bit 9 Air Initiated Comm B Reservation
bit 8 Air Initiated Comm B Announcement
bit 7 Ground Initiated CommB Reply
bit 6 Ground Initiated CommB Extraction
bit 5 Resolution Advisory Reply
bit 4 Resolution Advisory Extraction
bit 3: Resolution Advisory Announcement
bit 2 Broadcast CommB Reply
bit 1 Broadcast comm B Extraction
bit 0 Broadcast commB Announcement

4)Data link counters

Bits	Events
bit 0..1:	BcCB events
bit 1..2:	RA events
bit 3..6:	GICB events
bit 7..8:	AICB events
bit 9..10:	CA 1el events
bit 11..12:	CA m el events
bit 13..14:	CommC events
bit 15..16:	CommD events
bit 17:	Code events
bit 18:	BRCB Closeout
bit 19..20:	AICB Closeout
bit 21..22:	CA Acknowledge
bit 23..24:	CC Acknowledge
bit 25..27:	CD Closeout

5)Data link Delay FSPEC

The data link delay values are stored in 8 random usage delay fields, named delay1 through delay 8. For each of these fields, one FSPEC bit is reserved in the Delay FSPEC. If the bit in the FSPEC is 1, the next delay field is filled with the corrsponding delay value. e.g. If FSPEC is x22, this means delay1 field is filled with a Comm D delivery delay and delay2 field is filled with a Comm D duration.

Bits in FSPEC	Timers:	nr
31.	A Code Change throughput delay	(1/TRD)
30.	ACAS throughput delay	(1/ TRD)
29.	AICB throughput delay	(1/ TRD)
28.	Broadcast Comm B A18 throughput delay	(1/ TRD)
27.	Broadcast Comm B A48 throughput delay	(1/ TRD)
26/25.	Comm D throughput delay	(2/ TRD)
24/23.	COMM A throughput delay	(2/ TRD)
22/21.	Comm C throughput delay	(2/ TRD)
20/19/18/17.	GICB processing delay	(4/ TRD)
16/15.	COMM A processing delay	(2/ TRD)
14/13.	COMM C processing delay	(2/ TRD)
12.	Broadcast Comm B delivery delay	(1/ TRD)
11/10/9/8.	GICB delivery delay	(4/ TRD)
7	AICB delivery delay	(1/ TRD)
6	Comm A duration	(1/ TRD)
5/4.	Comm D delivery delay	(2/ TRD)
3/2.	Comm C duration	(2/ TRD)
1/0.	Comm D duration	(2/ TRD)

3.2.4 File definition for S48 data

Bytes	Type	Contents	Unit
A48 Record			
8	Dbl	Time of recording	[s]
4	U32	FSPEC48	
4	U32	Status	See 1)
4	U32	ARP/ACP	
1	U8	SAC	
1	U8	SIC	
2	U16	Target Report descriptor	
4	U32	Warning/Error	18 bits
2	U16	Rho Measured	
2	U16	Theta Measured	
2	U16	X calculated position	
2	U16	Y calculated position	
2	U16	Mode 2	
2	U16	Mode 1	
2	U16	Mode 2 code confidence	
2	U16	Mode 1 code confidence	
2	U16	Mode A	
2	U16	Mode A code confidence	
2	U16	Mode C	
4	I32	Altitude	(ft)
4	I32	Measured Height by 3D radar	(ft)
2	U16	Presence of raw Doppler speed	Boolean
1	U8	SSR plot run length	[deg]*0.44
1	U8	Nr of received SSR replies	
1	U8	Amplitude of SSR reply	[dBm]
1	U8	Primary plot run length	[deg]*0.44
1	U8	Amplitude of PSR reply	[dBm]
1	U8	Difference in range SSR-PSR	[Nm]
1	U8	Difference in Az SSR-PSR	[deg]
3	U32	Time of detection	[sec]/256
2	U16	Track nr	
2	U16	Track status	
2	U16	Calculated Ground Speed	[Nm/h]
4	U16	Calculated Heading	[deg]
4	U8	Track Quality Sigma x	[Nm]
4	U8	Track Quality Sigma y	[Nm]
4	U8	Track Quality Sigma v	[Nm/h]
4	U8	Track Quality Sigma h	[deg]
4	U32	Aircraft address	
2	U16	Com/ACAS/flight	
8	8*U8	8 BDS registers of MB data found in Cat48	
3	U24	MB index	
1	U8	Mb count	
4	U32	status 1 (see above)	

Table 3-2:File definition for S48 data

3.2.4.1 File definition for S18 data

This file type has a header of 32 bytes which is fixed for all message types plus a message dependant section :

Size	*Format*	*Contents*	*unit*
8	Dbl	Timestamp	[s]
4	U32	ARP/ACP	
1	U8	Type	list
1	U8	Message type	
4	U32	Mode S address	
4	U32	FSPEC18 H	
2	U16	FSPEC18 L	
4	U32	Number (Packet)	
2	U16	Source	
2	U16	Destination	
		Message dependent data; see annex A	

Table 3-3: File definition for S18 data

Furthermore, the file can contain a reference index to a second file containing the Up link and down link packets. This file has a fixed 160 byte record length and contains the packet data.

3.2.4.2 File definition for IRD data

Bytes	*Type*	*Contents*	*Unit*
8	Sgl Dbl	Range Reply Azimuth(ACP) Interrogation	µs deg
8	Dbl	UTC Time of day Int	sec
8	Dbl	Azimuth Reply (ACP)	deg
8	Dbl	Azimuth Target	deg
2	U16	Scan nr	
1	U8	Interrogation type	List
1	U8	Reply Type	list
4	U32	S address	
2	U16	ID/SSR Code	
4	Sgl	Interrogation Power	dBm
4	Sgl	Reply Power	dBm
4	Sgl	OBA Value	V
1	U8	Reply Flag	Status field
1	U8	#SSR/All Call Replies	
4	U32	Data link type(see Table 3-5)	Status field
14	14*U8	Interrogation	
14	14*U8	Reply or Code	
4	U32	Index	
4	U32	Data link transaction flags	Status field
28	7*U32	Spare IRD2..IRD8	

Table 3-4:File definition for IRD data

3.3 Data import

3.3.1 Related Specs

[PTE-SR-P2B2-CAP-0201] The PTE P2B2 tool shall be capable of off-line importing of data from the following individual sources (these interfaces are further discussed in P1 / P2B1 ICD (Ref. 32)):"RFS" – (xxx_RFS.txt file to S4SC file) the R / F Scenario replay data containing the target reference information resulting of a scenario simulation (not available for live traffic).

"IRD" (xxx_IRS.txt to .IRD file)– Mode S Interrogations / Replies data containing the Mode S interrogations produced by the station and the corresponding Mode S replies generated by the PTE P1 tool as generated by the RES in Scenario replay.

"IRDV" –(xxx_IVS.txt to .IRDV file) Mode S Interrogations / Video replies containing the Mode S interrogations produced by the station and the corresponding Mode S replies derived from the recorded video .

"A18" – (x_A18.txt to .S18 file) Asterix Cat 018 containing the Data link information (ASTERIX Cat 018 messages) sent and received by the station and recorded by the PTE P1 tool.

"A48" – (x_A48.txt to .S48 file) Asterix Cat 048 Target report information (ASTERIX Cat 048 messages) sent by the station and recorded by the PTE P1 tool.

[PTE-SR-P2B2-CAP-0202] The PTE P2B2 tool **shall** be capable of importing 1 G Byte of data from these various sources.

3.3.2 Importing functionality

The Data Import module is used to import TSF (Tab Separated File) / DSS (Internal RASS file) format data files into the Data link module. The structure of these TSF format files is described in the ICD. The Data Import module converts the TSF format files into the corresponding DSS format to be used by the Data Link module.

Notice that the TSF format is an intermediate format that is not mandatory for the Data Link process. The TSF format allows the user to view and edit the data in a spreadsheet program before importing it into the Data Link module.

In some cases, the selected TSF may not contain all datafields (or columns) . If this is the case, the user will be warned. In case the missing fields are not mandatory, the import merely skips the fields and leaves them empty. If mandatory fields (typically S address, time , date, Azimuth, Range, etc..) are not present , the import is aborted.

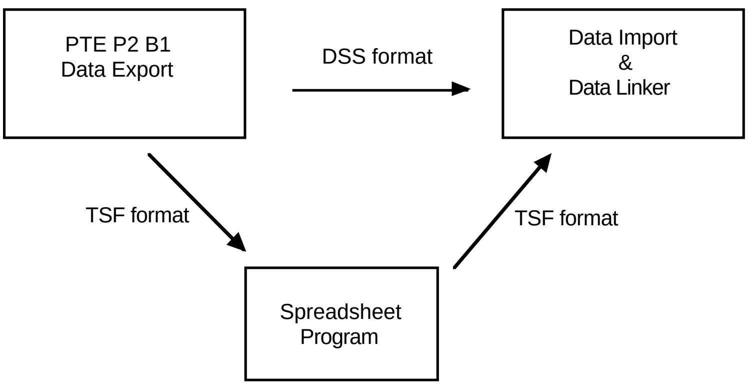
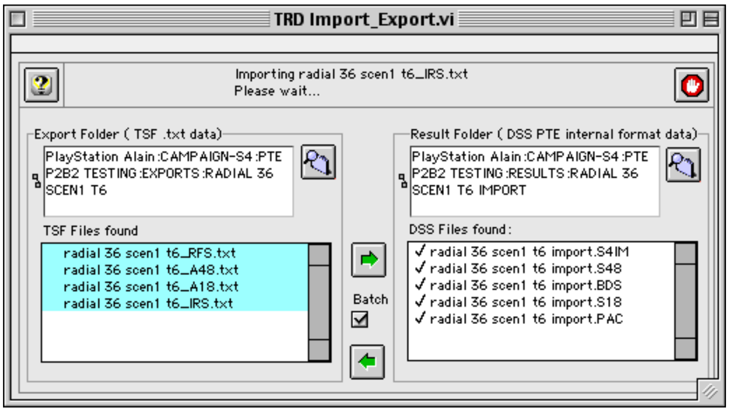
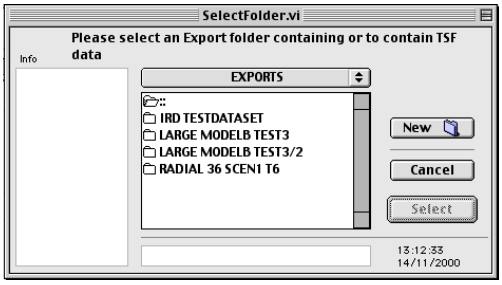


Figure 3-7: General Data import structure

The “TRD Import Export.vi” tool allows the selection of a Source folder containing one or more TSF files.

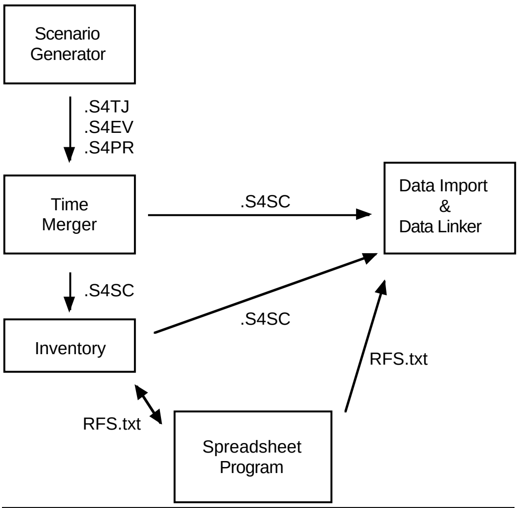




The tool automatically reads all files in the folder and presents them in a list. The user can select one or more of these files to be imported. The tool will import the RFS, A48,A18 and IRS/IVS files separately one by one.

3.3.2.1 .S4SC from RFS.txt Generation

The .S4SC format is the result of a Scenario Time Merge of a .S4TJ (Trajectory Scenario), .S4EV (Event Scenario) or .S4PR (Primary Scenario) format and an EDR ASTERIX Cat034/048 recording of the corresponding scenario. This .S4SC format can be exported towards the RFS.txt format (PTE P2B1 functionality) to be read/edited by a spreadsheet program. This export module is incorporated in the Inventory tool.



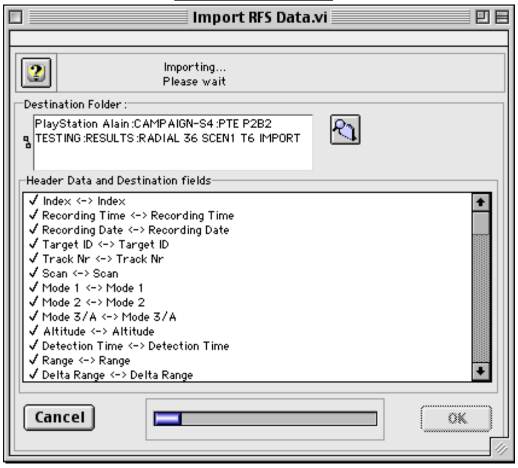
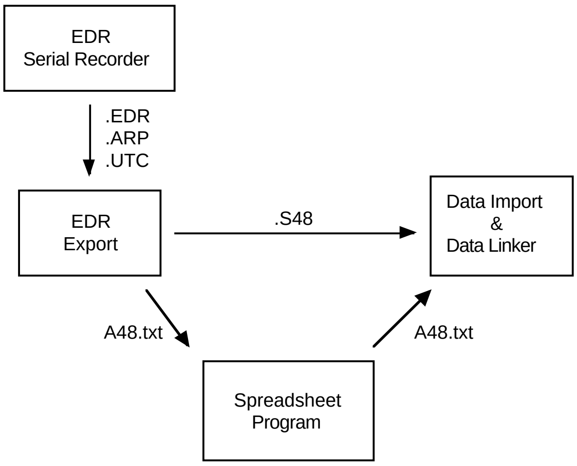


Figure 3-8: RFS Data import

3.3.2.2 .S48 from A48.txt generation

The .S48 format is the result of a DSS export of an EDR ASTERIX Cat048 recording. The EDR ASTERIX Cat048 recording can also be exported (TSF) towards the A48.txt format (PTE P2B1 functionality) to be read / edited by a spreadsheet program. This export module is incorporated in the EDR Export tool.



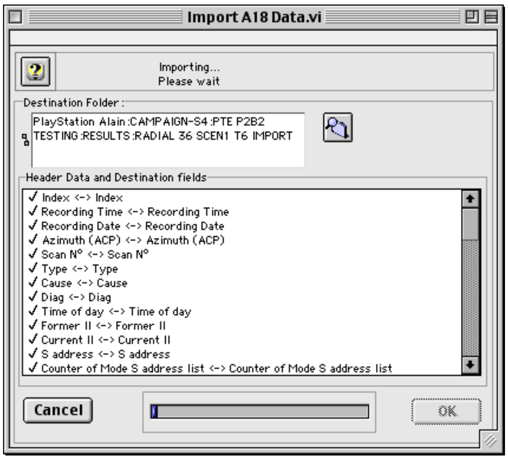


Figure 3-9: A 48 Data import

3.3.2.3 .S18 from A18.txt generation

The .S18 format is the result of a DSS export of an EDR ASTERIX Cat018 recording. The EDR ASTERIX Cat018 recording can also be exported (TSF) towards the A18.txt format (PTE P2B1 functionality) to be read / edited by a spreadsheet program. This export module is incorporated in the EDR Export tool.

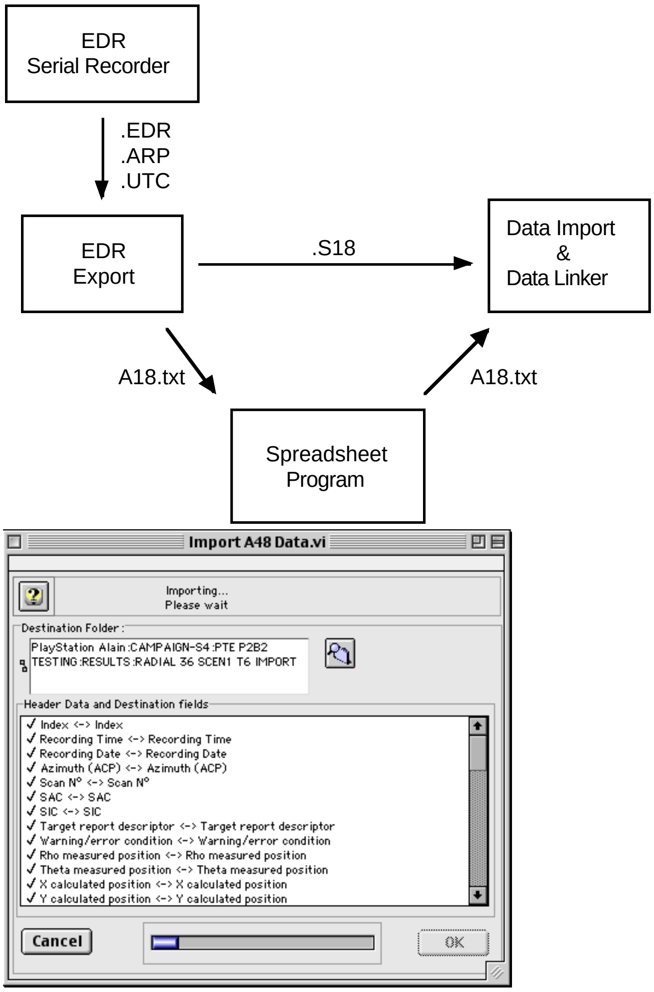
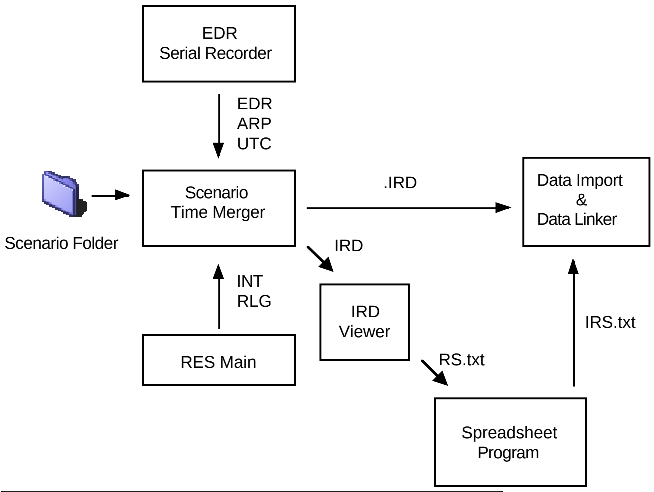


Figure 3-10: S18 Data import

3.3.2.4 .IRD from I/RS.txt generation

The .IRD format can be the result of a Scenario Time Merge of a Data link Scenario, an EDR ASTERIX Cat034/048 recording of the scenario and the corresponding Scenario Result files. This .IRD format can be exported towards the I/RS.txt format (PTE P2B1 functionality) to be read/edited by a spreadsheet program. This export module is incorporated in the IRD Viewer tool.



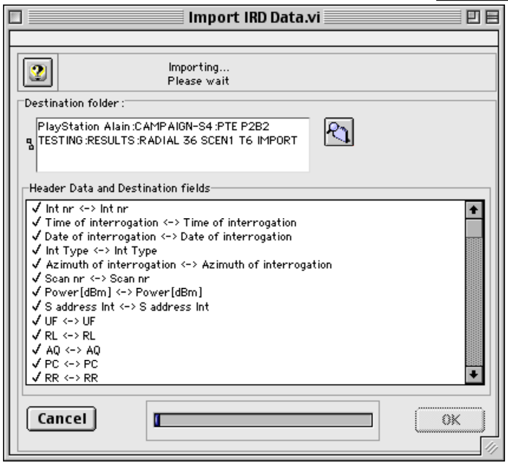
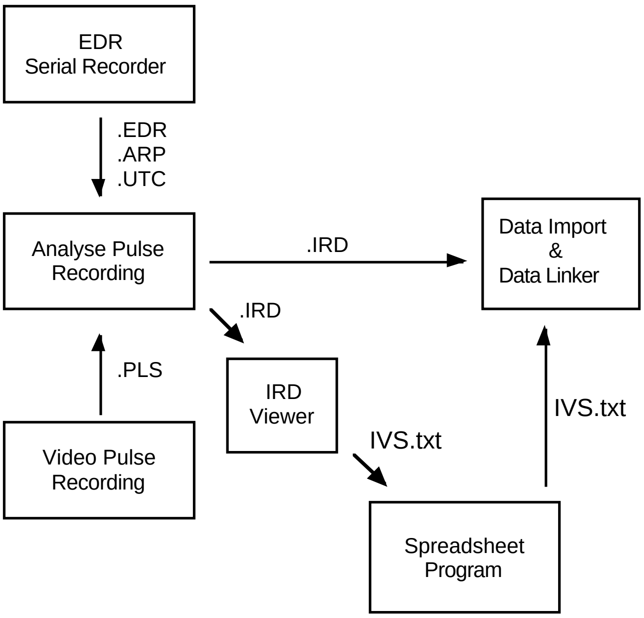


Figure 3-11: IRD Data import

3.3.2.5 .IRD from I/VS.txt generation

The .IRD format can be the result of a Pulse Recording Analysis taking into account the corresponding EDR ASTERIX Cat034/48 recording. This .IRD format can be exported towards the I/VS.txt format (PTE P2B1 functionality) to be read/edited by a spreadsheet program. This export module is incorporated in the IRD Viewer tool.



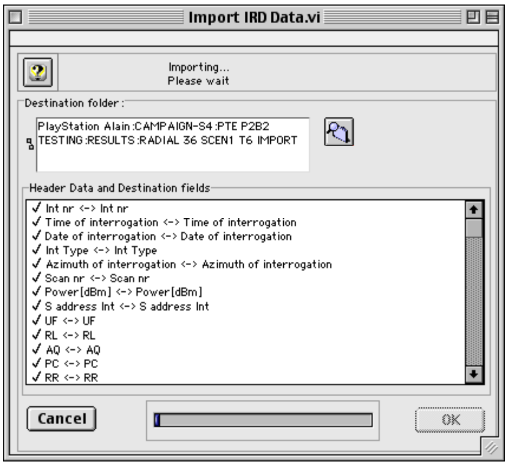


Figure 3-12; IVS data import

3.4 Data Link Module

3.4.1 Related Specs

[PTE-SR-P2B2-CAP-0301] After the individual recorded files defined above have been selected and imported, the PTE P2B2 tool **shall** be capable of “linking” this data so that all data derived from any individual target, irrespective of source file or input format, is unambiguously associated together using its Mode S address and its time. The logical data structure resulting from this linking containing all of the associated data for any particular target is discussed below.

[PTE-SR-P2B2-CAP-0302] When linking data the PTE P2B2 tool **shall** associate each processed data item either to a single logical “Target Reference Data” (TRD) record. Details of the selected structure is provided in the PTE P2B2 ADD. (Ref. 38)

[PTE-SR-P2B2-CAP-0304] For A18 data, two linking logic’s **shall** be available and based on the recording time stamping of the A18 data and on target report detection date :

Logic 1: Any cat 18 message containing a Mode S address and sent to POEMS DLF is linked to the next TRD with the same Mode S address. Any cat 18 message containing a Mode S address, coming from POEMS DLF with DI 000 equal to 22h (uplink packet acknowledge) or 42h (GICB extraction acknowledge) and with DI 001 D_Result-Cause equal to Accepted (0h) or Rejected (1h) is linked to the next TRD with the same Mode S address. Any other cat 18 message containing a Mode S address and coming from POEMS DLF is linked to the previous TRD.

Logic 2: Any cat 18 message containing a Mode S address and received or sent sent to POEMS DLF is linked to the next target reference data beam TRD".

[PTE-SR-P2B2-CAP-0305] The proposed specification of the linking algorithm resulting from the prototyping exercise **shall** be presented by the Contractor in the ADD (Ref. 38), along with the results of the testing, at the SDR.

[PTE-SR-P2B2-CAP-0306] The data linking and combination **shall** be completed in less than 10 ifor up to 50 Mb of input data, running on the minumum platform required for PTE P2B2 (Macintosh Powerbook G3 @ 350Mhz and 192 Mb internal RAM.)

[PTE-SR-P2B2-CAP-0308] A "TRD" record **shall** be characterised by, the following data-fields:

Position,
Mode S address,
Mode A Code,
Scan number,
Time.

Furthermore, the TRD record shall contain all fields currently defined in the S4 type file (see ICD P1 (Ref. 22) , All fields defined in the IRD data record (see ICD P2B, Ref. 32) and those defined in the Cat 18 data. (See ICD P2B)

Furthermore, the TRD records shall be described in the PTE P2B ICD (see ICD P2B, Ref. 32)

[PTE-SR-P2C-CAP-0309] The position of a "TRD" Data record **shall** be derived from the Scenario position in case of SCENARIO replay. The difference between Asterix and Scenario (A48-SCEN) in position is stored in two calculated fields, namely delta R and delta Az.

[PTE-SR-P2C-CAP-0310] The position of a "TRD" Data record **shall** be derived from the Asterix Cat 48 data in case of LIFE recording. The calculated fields delta R and delta Az shall be set to zero.

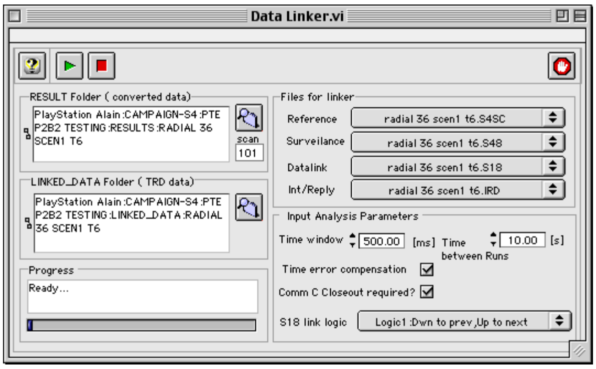
[PTE-SR-P2B2-CAP-0311] The time / (azimuth + scan number) information of a "TRD" record **shall** be derived from the Scenario time in case of SCENARIO replay. The difference between Asterix and Scenario (A48-SCEN) in time is stored in a calculated field, namely delta T.

[PTE-SR-P2C-CAP-0312] The time / (azimuth + scan number) of a "TRD" Data record **shall** be derived from the Asterix Cat 48 data in case of LIFE recording. The calculated field delta T shall be set to zero.

3.4.2 Data Link Module

3.4.2.1 User Interface

The PTE P2B2 Data Linker Module will create the TRD data structure defined in §3.2.3. depending on the type of input data, RES generated of Life recorded data, the operation will be slightly different.



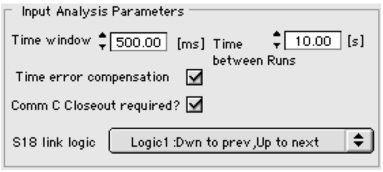
The Data link is a separate module called from the RASS-S toolbox is run after the PTE P2B1 Scenario time merger , Analyse Pulse recordings or Data convert tool.

The tool will asks the user to define a RESULT folder. In this folder, the user has to make sure a S4 type data file, an S48 type data file ,S18 type data file and an IRD type data file is present. These can be created by eigther the Scenario time merger , , Data Import module , Analyse Pulse recordings or Data convert tools.

All files related with the TRD data will be stored together in one folder in the selected Campaign folder, under the subfolder LINKED_DATA. This folder will be named the same as the result folder.

Following parameters are to be entered in the “Data Link” module:

- RESULT folder
- Time window for Linking[0.1…4,0.1s]
- Time between two runs in same scenario
- Time error compensation for delta calculation
- Comm C required or not
- Cat 18 linking mechanism[Tx next / Rx prev OR Tx,Rx next



The definition of the RESULT folder is required to define the path of the files to be linked.

The Time window for the target linking is used to define the maximum time difference between a TRD record (scenario reference position) and its corresponding S48 record. The time window is also used to define the maximum time difference between a TRD record (scenario reference position) and its corresponding interrogation and replies. (besides that, S address is used as second link parameter). The Cat 18 linking mechanism needs to be defined to know to which TRD record a certain Cat 18 message is to be linked; two definitions are available.

3.4.2.2 RES generated data (Non life recording)

For RES generated data, the Data Link tool will read the S4SC file located inside the RESULT folder. If no such file is present (even after checking for TST files), a warning message is created and shown in a dialog box. The Linking is aborted in that case.

The same applies for the S48, S18 and IRD data, but the missing of one or more of these files will not abort the linking. It will merely limit the number of present fields in the TRD file.

The Linker starts by indexing the S4SC, the S48 file, the S18 file and the IRD file file and create lists of S address, Time of detection / generation / recording and Index to original file. These lists are sorted and cut into pieces, resulting in separate sets of lists per target (or per S address). The lists are sorted towards time, because all identical S addresses will have been put in one set..

3.4.2.2.1 S 48 Linking

The Linking process starts by reading all S4 records of the first target. (S address) and all S48 records of the same S address. Each S4 record is passed through a loop and its contenst is copied in the top section of the TRD data. A matching S48 record is searched for . If a match is found and Time of GenerationS4 –Window < TOD S48 < Time of GenerationS4+window , the S48 index is written in the TRD data and the S48 record is copied into a new S48 file, inside the LINKED_DATA folder. .

3.4.2.2.2 S18 linking

Next, the S18 data is linked. For this the list of all S18 messages of the selected target (from the S4 record) is loaded in memory . Depending on the user selection of the “Cat18 linking” parameter, the messages are linked differently:

- logic 1: Cat 018 received message is linked to the previous target reference Data scan TRD. Cat 018 sent message is linked to next target reference Data scan TRD.
- logic 2Cat 018 received or sent message is linked to the next target reference data scan TRD”.

In the first option, all “unlinked” received messages in the buffer are searched against following criteria: (t18=time of recording of Cat 18 message; t ref= time of detection of reference target; P= 1 scan period.)

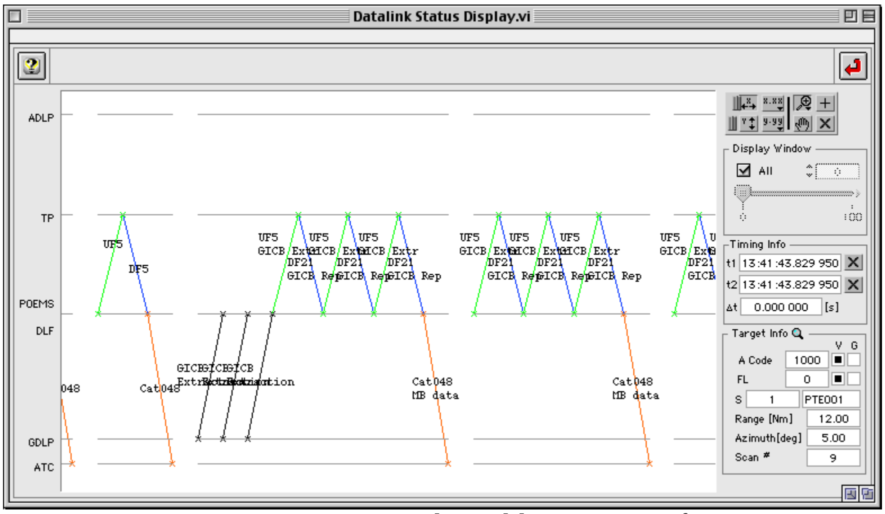
-t 18 >= tref & t18 < tref + P
AND S address 18 = S address ref

In the both options, all “unlinked” send messages and in the second option also all received messages in the buffer are searched against following criteria:

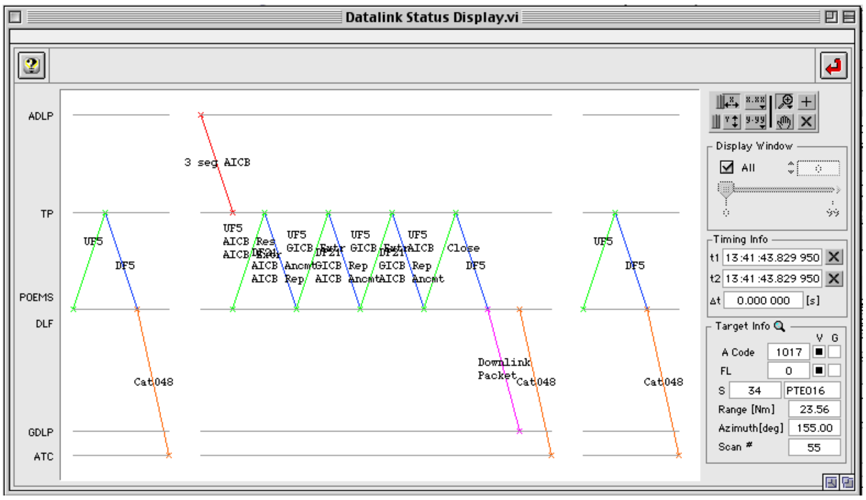
-t 18 > tref-P & t18 <= tref
AND S address 18 = S address ref

3.4.2.2.2.1 Logic 1:

The Cat 18 Uplink messages (e.g. GICB extractions, Uplink packets) are linked to the NEXT record (time S18n <= time TRDn) ;

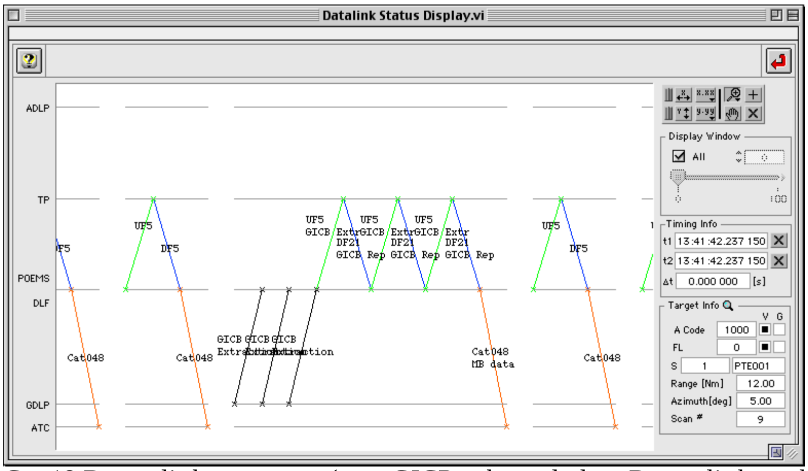


Any cat 18 message containing a Mode S address, coming from POEMS DLF with DI 000 equal to 22h (uplink packet acknowledge) or 42h (GICB extraction acknowledge) and with DI 001 D_Result-Cause equal to Accepted (0h) or Rejected (1h) is linked to the next TRD with the same Mode S address. Any other cat 18 message containing a Mode S address and coming from POEMS DLF is linked to the previous TRD. (time S18n >= time TRD).

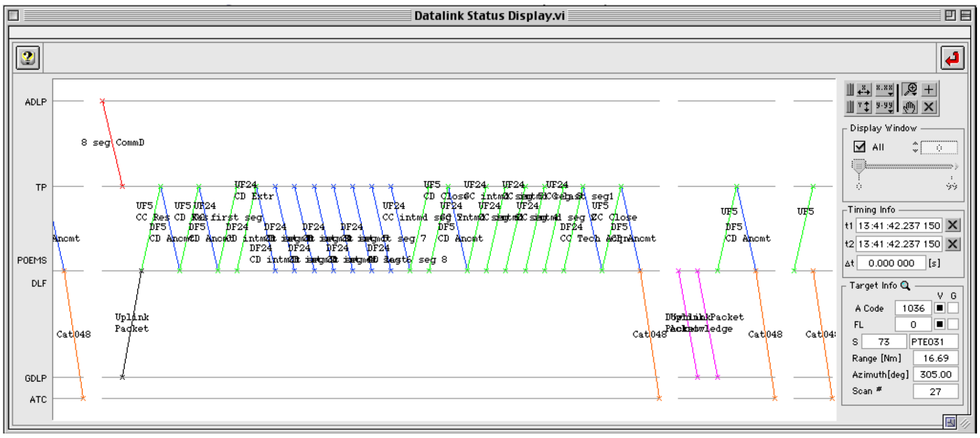


3.4.2.2.2.2 Logic 2:

The Cat 18 Uplink messages (e.g. GICB extractions, Uplink packets) are linked to the NEXT record (time S18n <= time TRDn) ;



Cat 18 Down link messages (e.g. GICB acknowledge, Down link packets) are are linked to the NEXT record (time S18n <= time TRDn).



A new record in a new S18 file (in the LINKED_DATA folder) is added with all the matching S18 records writen as one block.)

The index of the record is added to the TRD record as “index18” and the number of matching records is put in the “count 18” field. If no matches are found, the index is filled with –1. The data link counters and data link type flags in the TRD record are updated.

3.4.2.2.3 IRD Linking

Next, the IRD records are linked: The index list is searched for all IRD data that corresponds to the following criteria: (T recIRD = time of recording of Interrogation, t ref= time of detection of reference target; pbeam= time window for one beam)

Tref –pbeam < T record IRD < tref + pbeam
AND S address Int = S address reply

All matching IRD records are written as one block to a newly created IRD file (inside the LINKED-DATA folder).

The index of the record is added to the TRD record as “indexIRD” and the number of matching records is put in the “count IRD” field. If no matches are found, the index is filled with –1. Once the linking is ready for all files, the TRD record is written to file and the next record is linked.

The tool continues with all other targets in the list of S4 records..

3.4.2.3 Life Recorded data

A similar principle is used for life recordings. The S4SC file is substituted by the S4RD file and the IRD file is substituted by a IRDV file. The result is the same as with RES data, only this time a 1-1 relation exists between the S48 and TRD file, since their contents is the same.

3.5 Data filtering

3.5.1 Related Specs

[PTE-SR-P2B2-CAP-0320] After the data linking/combination), the PTE P2B2 tool **shall** enable the user to filter the imported and linked data at the level of the individual “TRD” logical data records on the basis of “parametric filters”.

[PTE-SR-P2B2-CAP-0321] The effect of the “parametric filtering” carried out by the PTE P2B2 tool **shall** be that all and only those data items associated to the “TRD” logical data items passing the filter criteria will be passed to further functions described in the following paragraphs of this document.

[PTE-SR-P2B2-CAP-0322] The PTE P2B2 tool **shall** enable the user to apply any parametric filter to the imported and linked data immediately prior to executing any of the analysis or display functions.

Remark: Once the input data is imported, linked and the TRD records are created, it is possible for the user to apply some filtering (i.e. the usual PTE-P1/P2 parametric filtering).However because of the nature of the linking and of the analysis requested (e.g. delay assessment) it will only be possible to apply filtering on Mode S address prior to request any datalink analysis facility.
Once the analysis is performed and the corresponding results are included in the TRD records it will be possible to filter the data as usual.
The corresponding warning needs to be included in the PTE-P2B2 UM.

[PTE-SR-P2B2-CAP-0323] Within PTE P1/P2, the user **shall** be able to specify a parametric filter as the logical combination of, as a minimum, 8 “OR” of 8 “AND” set of elementary filter criterion

[PTE-SR-P2B2-CAP-0324] An elementary filter criterion **shall** be composed of :

- a user selectable source field
- a user selectable data field
- a user specified arithmetic logical relation (>,>=,<,<=, =,<>) applicable on decimal, integer and flag fields
- a user specified logical relation (=,<>,Contains) applicable on string fields
- a user specified value

[PTE-SR-P2B2-CAP-0325] Data items which can be used in a PTE P2B2 filter criterion **shall** comprise (as a minimum) :

- all fields of the imported data items ;
- all characteristics or additional fields computed and logically associated to a “TRD” record by the PTE P2B2 tool .

Note : When a filter criterion is associated to a data item for which several occurrences can be present in a single “TRD”, the “TRD” will pass the filter criterion if at least one of its associated data field passes the filter criterion.

[PTE-SR-P2B2-CAP-0326] For any filter criterion whose data item is the Mode S address, the user **shall** be able to define values in either hexadecimal or binary format.

[PTE-SR-P2B2-CAP-0328] For a filter criterion whose data item is the Mode A code, the user **shall** be able to define a value in octal format.

[PTE-SR-P2B2-CAP-0329] After a filter has been applied within PTE P1/P2B2, the user **shall** be able to save (to be retrieved in a later session) the resulting filtered data set under a user specified data set name and associate a comment to this file.

[PTE-SR-P2B2-CAP-0330]] When editing a previously saved data set the user **shall** be able to display and/or print the following characteristics of the data set

date of recording,
date of saving,
filters applied,
user comment,
name of the file.

[PTE-SR-P2B2-CAP-0331]] Within PTE P1/P2B2, the user **shall** be able to define, load, modify, save (to be retrieved in a later session) and delete parametric filters.

[PTE-SR-P2B2-CAP-0332] The data filtering **shall** be completed in less than 10 for up to 50 Mb of input data. running on the minimum platform required for PTE P2B2 (Macintosh Powerbook G3 @ 350Mhz and 192 Mb internal RAM.)

3.5.2 Data Filtering Principles

3.5.2.1 General

The data filtering module allows the user to filter the imported and linked data at the level of the individual TRD logical data records on the basis of parametric filters. The effect of parametric filtering is that only those TRD logical data records passing the filter criteria are passed to further processing. The parametric filtering can be applied to the imported and linked data before executing any of the analysis or display functions. A parametric filter is a logical combination (OR, AND) of a set of elementary filter criterion. An elementary filter criterion is composed of a user selectable source field (TRD, S48, S18, IRD, CALC), a user selectable data field (this list depends on the selection of the user selectable source field), a user specified arithmetic logical relation (>, >=, <, <=, =, <>, [], <>[]) applicable to decimal, integer, list and flag fields and a user specified value. The arithmetic logical relations [] (contains) and <>[] (does not contain) are only applicable to string type fields The user is able to define, load , save, modify and delete parametric filters.

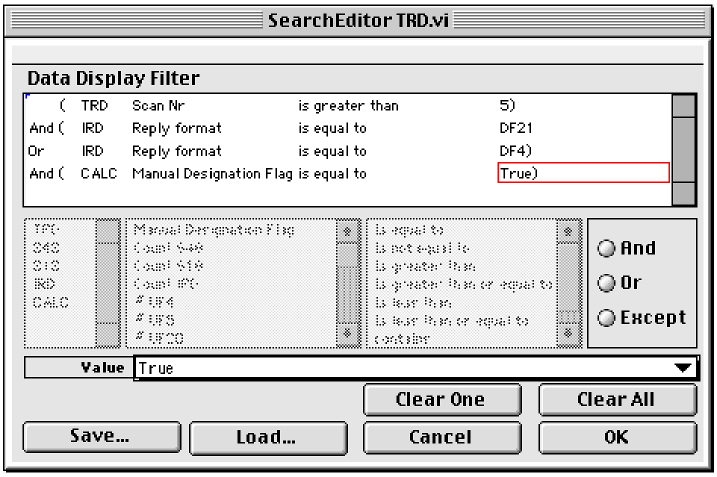


Figure 3-13: Filter example

The complete filter is a logical combination of multiple “OR” of multiple “AND” sets of elementary filter criterion. This logical combination is made clear by using brackets.

A parametric filter can be specified as the logical combination of “OR” of multiple “AND” set of elementary filter criterion. The number of logical combinations is virtually unlimited (only limited is computer memory) for both the “OR” and “AND” sets. For display purposes, “AND” sets are surrounded by brackets to allow a visual feedback of the logical combination rule between “AND and “OR”. The following figure illustrates this concept.

(	IRD	Interrogation format	is equal to	UF24
Or	IRD	Reply format	is equal to	DF24)
And (	TRD	Fractional Scan	is greater than	5.000000
Or	CALC	Linked S18	is greater than	2)

3.5.2.2 Sources for Filtering

The following user selectable sources are available:

- .TRD, .S18, .S48, .IRD

This selection defines which user selectable data fields are presented to the user. Each of the user selectable sources has a matching set of user selectable data fields. This makes the total number of user selectable data fields more manageable and long selection lists are avoided.

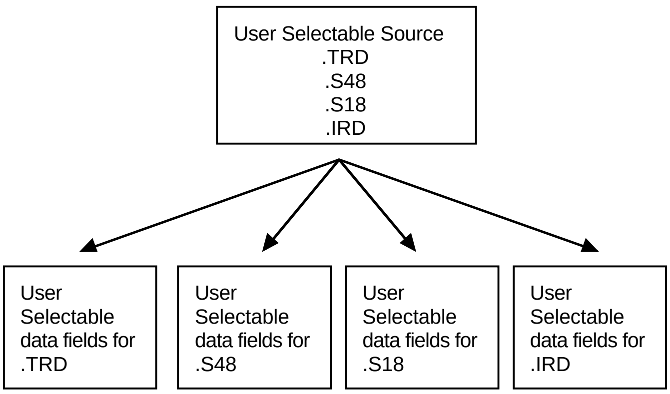


Figure 3-14: TRD structure filtering

The result of a parametric filter is a new .TRD file that is a subset of the original .TRD file. The corresponding .S18, S48 and .IRD files remain the same. This is necessary to keep the reverse links from the .S48, .S18 or .IRD file to .TRD file intact. It also avoids to have multiple copies of large files present on the disk. The following figure illustrates the corresponding file structure.

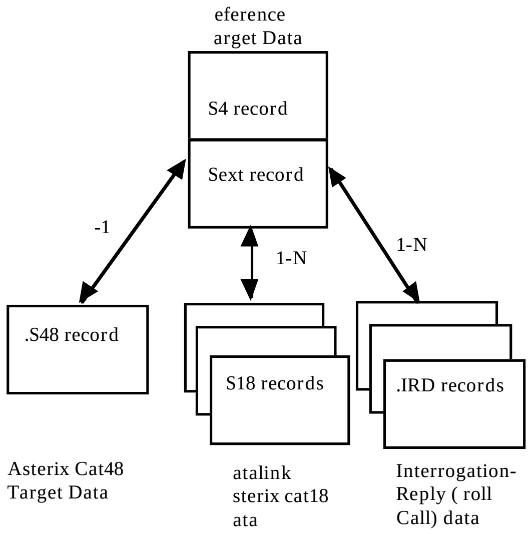


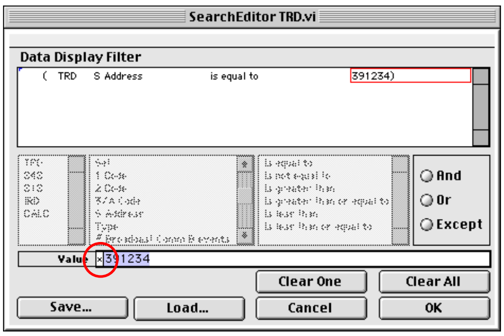
Figure 3-15: File structure TRD

A disadvantage of this filtering algorithm is the fact that a specific search in the .S48, .S18 or .IRD file will take longer because these files stay intact even after parametric filtering. To overcome this, data fields from the .S48, .S18 or .IRD files that are used often can be transferred into the .TRD file. The number of fields that can be transferred to the .TRD file is limited by the .TRD record size. This transfer procedure will speed up the filter and search process. Because the .IRD file is rebuild according to the parametric filter and the .S48, .S18 or .IRD files need not to be consulted any more to acquire the necessary data.

All the PTE P1 features of the filter module will remain. This means that the loading, saving and editing of parametric filters is done with a similar user interface as for PTE P1.

3.5.2.3 Hexadecimal data items in filter

For any filter criterion whose data item is the Mode S address, the user is able to define values in hexadecimal.



Whenever a data item containing a Mode S Address is chosen, the value-input field is marked with an X as an indication that the value to inputted has to in Hex and only Hex.

The following Mode S Address data items can be chosen;

TRD: Mode S Address

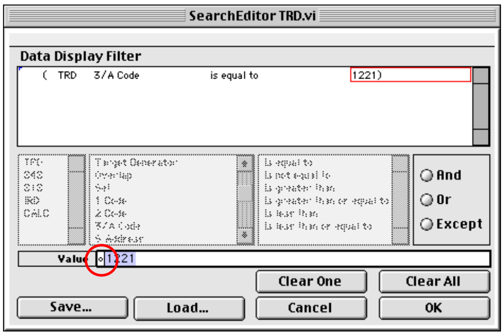
S48: Mode S Address (I048/220)

S18: Mode S Address (I018/005), Mode S Address list (I018/006)

IRD: Mode S Address

3.5.2.4 Octal data items in filter

For a filter criterion whose data item is the Mode A code, the user is able to define a value in octal format.



Whenever a data item containing a Mode A Code is chosen, the value-input field is marked with an O as an indication that the value to inputted has to in octal and only octal.

The following Mode A Code data items can be chosen;

TRD: Mode A Code

S48: Mode A Code (I048/070)

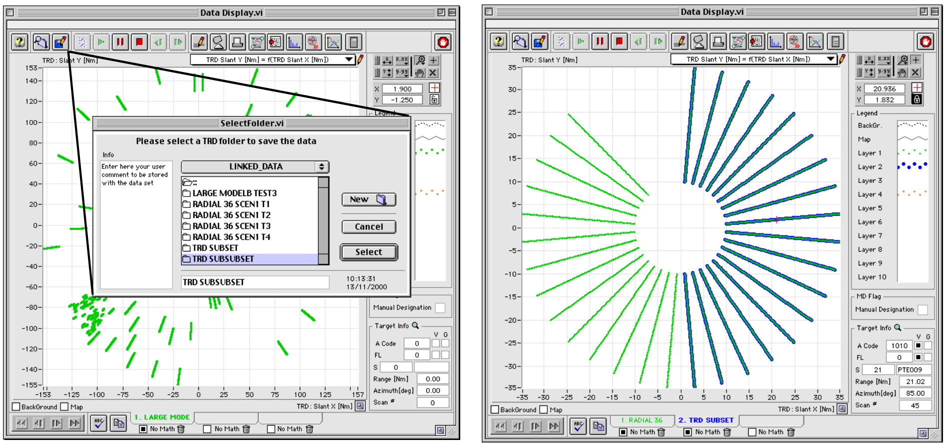
S18: Mode A Code (I018/032)

IRD: Mode A Code

FIL10 will be demonstrated and verified during FAT.

3.5.2.5 Filter Usage

After a filter has been applied within PTE P1/P2B2, the user is able to save (to be retrieved in a later session) the resulting filtered data set under a user specified data set name and associate a comment to this file. This saving procedure can be done using the PTE P2B2 Data Display tool. The PTE P2B2 Data Display tool allows the user to load a data set applying a parametric filter and display this data set. The save sub set function can be executed by clicking the  button in the Data Display tool It takes into account the pan and zoom boundaries of the chosen display to define the data subset to be saved. A user comment can be associated with the data sub set (see FIL 12)

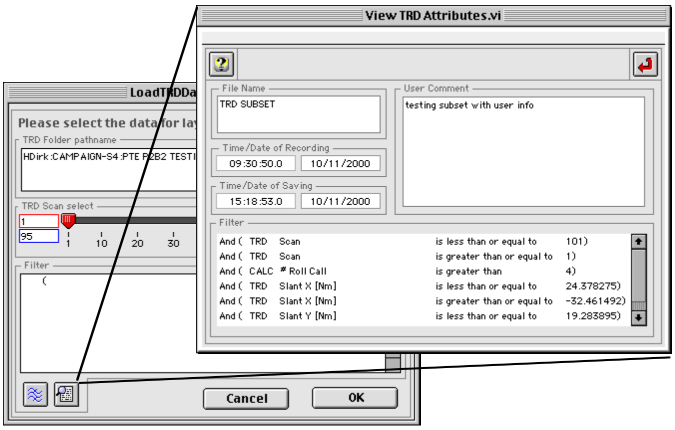


The right figure is a representation using the Data Display tool of the original data set (green) and the saved sub set (blue), containing only those records with an azimuth smaller that 180 degrees.

3.5.2.6 Filter storage

When loading a previously saved data set, the user is able to display the date of recording, the date of saving, the filters applied, the user comment and the name of the file by clicking the  (View Attributes) button in the load data dialog box.

The user is able to define, load, modify, save (to be retrieved in a later session) and delete parametric filters.



3.6 Computation of Additional fields

3.6.1 Related Specs

[PTE-SR-P2B2-CAP-0350] After the data linking process has been completed, the PTE P2B2 tool **shall** automatically derive the following information (where available from the imported data) and logically associate it as additional fields within each individual “TRD” level logical data item.

- Type (Mode S only, Mode S & SSR) , contained in Status flags
- the number of interrogations categorised by Mode S UF (4, 5, 20, 21, 24), derived from the imported IRD (simulated traffic) or IRDV (live traffic) information.

- the number and types of data-link requests as derived from the "A18" imported data
- the numbers of data-link exchanges (Broadcast Comm-B, GICB (BDS >= 4,0), AICB, ACAS Resolution Advisory extraction, Comm-A, Comm-C, Comm-D) as derived from the imported IRD (simulated traffic) or IRDV (live traffic) information.
- manual designation flag field (set to 0 by default)
- duplicate Mode S address flag as derived from the "RFS" imported data (simulated traffic).
- Data link type flags (one bit per type of data link found in IRD data), see for detailed list ICD P2B (Ref. 32)
- Delta Range, azimuth and time , calculated as reference value (TRD) – radar data (S48_).

[PTE-SR-P2B2-CAP-0351] The computation of additional data-fields **shall** be completed in less than 10 minutes for up to 50 Mb of input data. running on the minimum platform required for PTE P2B2 (Macintosh Powerbook G3 @ 350Mhz and 192 Mb internal RAM.)

3.6.2 Calculated Fields

The Data Link tool links four different sources of data into one "virtual" data set (containing up to 6 separate files). While performing this linking, the tool already includes a number of calculated fields in the data set. (in the TRD extended section of the record, see ADD for details.). The calculated fields can be visualized from the data Display (a field for the X,Y or Z scale) and can be queried to get the detailed values using the "TRD Info" window.

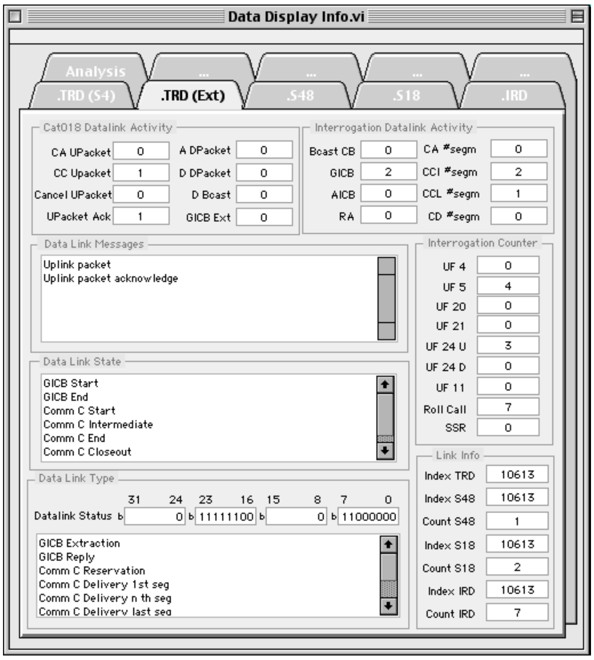


Figure 3-16: Data Display Info showing calculated fields

The Data Link module will add a number of calculated fields to the TRD data. These fields are the following:

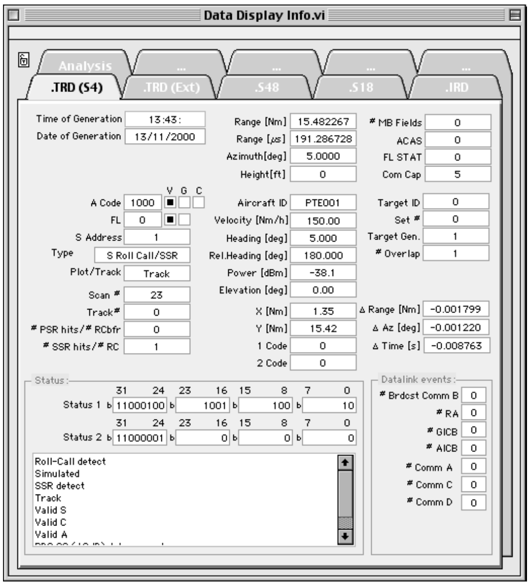
-Target Type (Mode S only, Mode S &SSR, SSR only) : This field can only be determined from the scenario file. (Not for life data) .
–Interrogation counters: 8 counters are updated to reflect the number of interrogations of each type (UF4,5,20,21,UELM UF24,DELM UF24) are linked to the TRD record.

–Data link ActivityCounters: 12 Counters are updated to count the data link activity on the targets: The counters can be updated by the scenario file (in case of scenario reply) or by using the IRD and Cat18 data.
-Data link type flags: 32 flag fields that indicate which type of data link actions (as found in the IRD data) are linked to the current record of the TRD.
–Data link message flags: 25 flags indicating which type of cat 18 messages are linked to the current record in the file and which type of data link data is present in the Cat48 data.
–Data link status field: 24 bits (3 bits per data link type) are updated to reflect the status of a data link transaction.
–Manual designation flag: this field can be set or reset from the data-display. Beware: the data set must be resaved for this purpose!
–Duplicate S address flag : This flag is derived from the scenario data.
–Re interrogation rate: The re-interrogation rate as defined in the PTE P2B2 ECP "Assessment of the Roll Call Re-interrogation Rate Whithin PTE P2B2"
-The calculated fields delta azimuth, delta range and delta time are calculated by the linking tool.

3.6.2.1 Target Type

The linking tool adds a "Type" field to the TRD record, denoting the Target type. (ModeS only, Mode S & SSR). The Type field is encoded in the "Status" field of the TRD record.

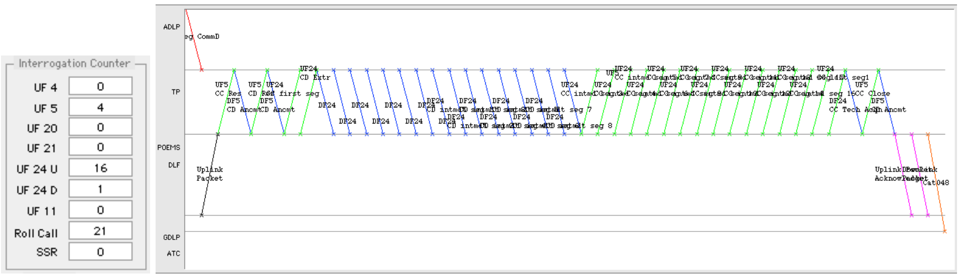
The type field can be visualized using the data display info query.



3.6.2.2 Interrogation counters

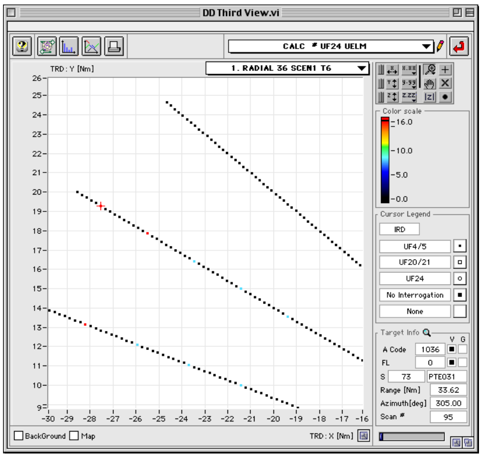
The linking tool adds 8 count fields denoting the number of interrogations cataloged by UF code field to the TRD . The counters will count UF4,UF5,UF20,UF21,UF24U,UF24D and UF11 or SSR (if available in IRD data).

These count fields can be visualised using the data display Info window:



The values are verified using the Data Display Status display.

The data can also be used as a X,Y or Z axis of the data display:



3.6.2.3 Data link Activity Counters from Cat 18

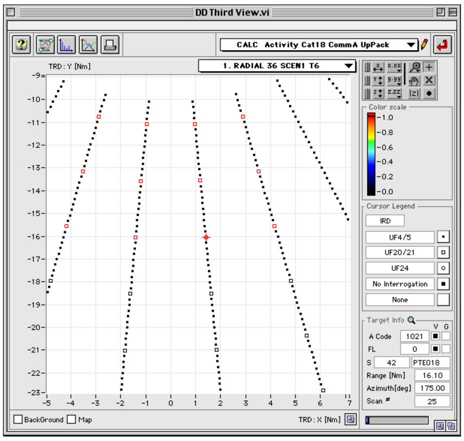
The data link counters are updated by the Data Link module while linking the data and count the following fields:

Cat 18 derived exchanges:

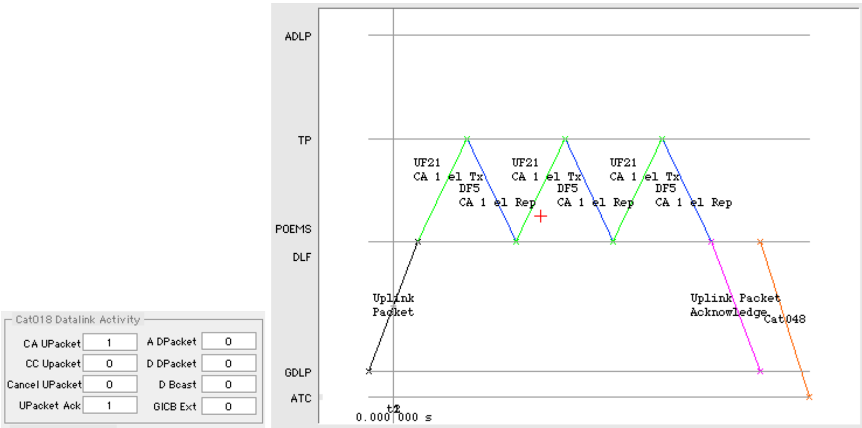
-# Comm A Packets (Uplink packets with # bytes <= 27)
-# Comm C Packets (Uplink packets with # bytes >27)
-# Uplink Packet Acknowledge
-# AICB Downlink Packets (Downlink packets with # bytes <= 27)
-# AICB Downlink Packets (Downlink packets with # bytes > 27) |
-# Uplink broadcast
-# Downlink broadcast

The linking tool adds 8 count fields denoting the number of data link transaction derived from the Asterix Cat 18 data to the TRD . The counters count the CA short Uplink packets, CC Long Uplink packet, Cancel Uplink Packet, Uplink Packet Acknowledge, AICB down link Packet, Comm D Down link Packet, Down link Broadcast and GICB extract commands.

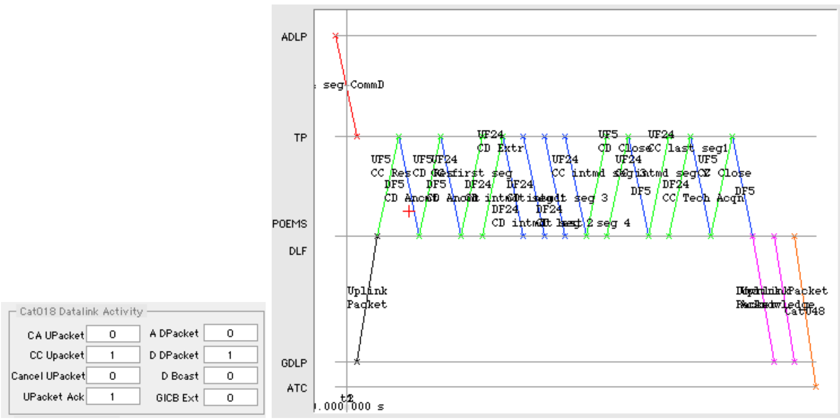
This data is counted in the calculated fields and can be visualized in the data display info field or as a X,Y or Z axis of the Data Display.



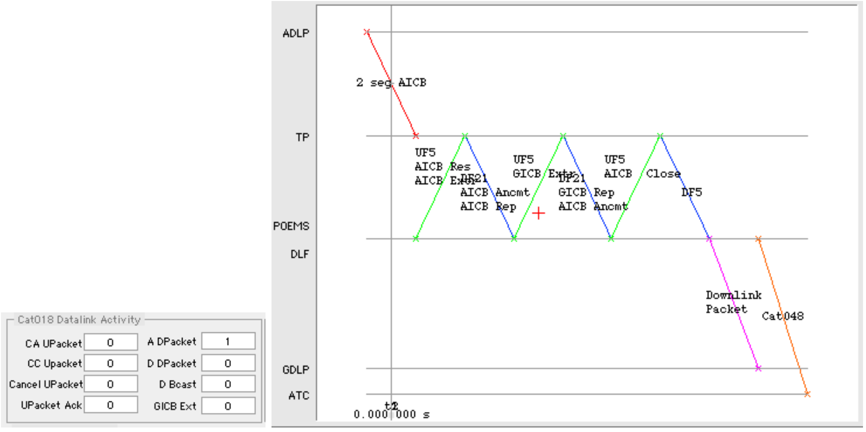
3.6.2.3.1 CA short Uplink packets, Uplink Packet Acknowledge



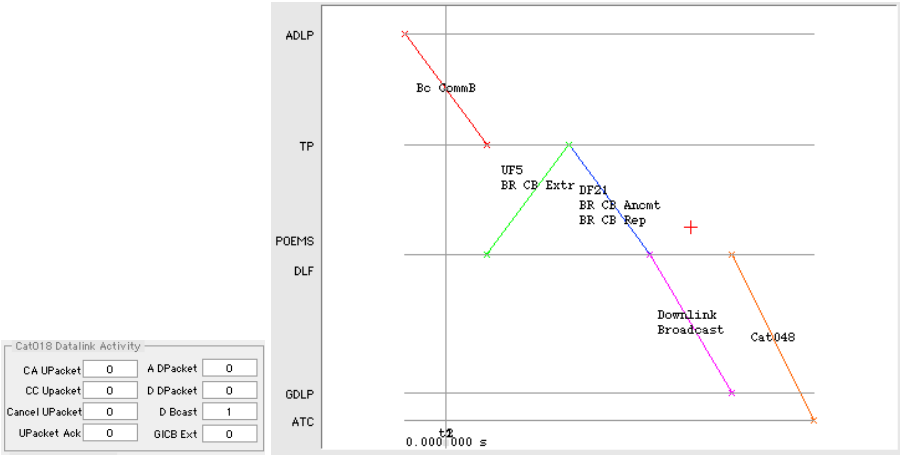
3.6.2.3.2 CC Long Uplink packet, Uplink Packet Acknowledge, Comm D Down link Packet



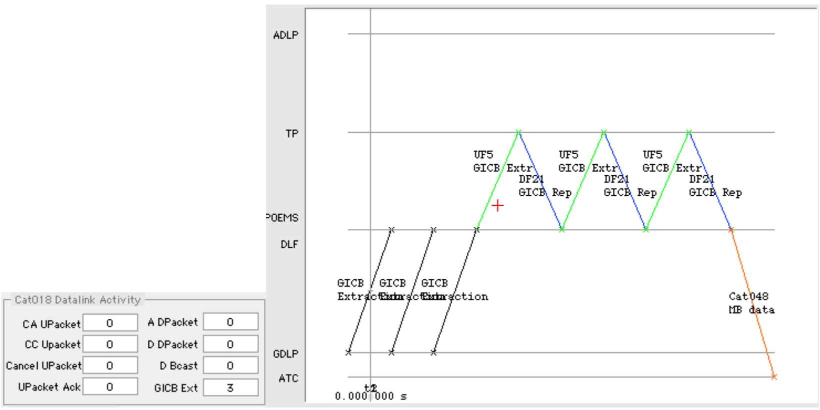
3.6.2.3.3 AICB down link Packet



3.6.2.3.4 Down link Broadcast



3.6.2.3.5 GICB extract commands



3.6.2.4 Data link Activity Counters from Interrogation /Replies

IRD derived exchanges:

-# Broadcast Comm B exchanges (count data link type **bit 2 Broadcast CommB Reply)**
-# GICB (BDS >=40) (count data link type **bit 7 Ground Initiated CommB Reply)**
-# AICB (Count data link type **bit 11 Air Initiated Comm B Reply)**

-# Res Advisory (Count data link type **bit 5 Resolution Advisory Reply)**
-# Comm A exchanges (# segments) (Count data link type **bit 13 Comm A 1 element Transmission OR bit 15 Comm A multi element Transmission 1^{st} el OR bit 16 Comm A multi element Tx n^{th} element)**
-# Comm C initial / intermediate exchanges (# segments) (Count data link type **bit 19 Comm C Delivery 1^{st} segment OR bit 20 CommC Delivery n th segment)**
-# Comm C final exchanges (# segments) (Count data link type **bit 21 CommC Delivery last segment)**
-# Comm D exchanges (# segments) (Count data link type **bit 27 Comm D Reply intermediate segment OR bit 28 Comm D Reply last segment)**

All these counters can be viewed and put in graphs by means of the data-display module.

3.6.2.5 Data link type flags

In order to simplify the data link analysis later the IRD records already have a "Data link type" field present in the data record. This data link type field is filled with bits the are the result of a set of tests on the Interrogation-reply pair. This is a PTE P2B1 feature and is performed by the tool that creates the IRD data (Scenario time merger and Analyze Pulse recordings tool.) The bits are used in the data link analysis section to simplify the analysis. The data link tool (see above) creates a similar field in the TRD data (data link type) . This field is an OR function of all IRD records that have been linked to the TRD record.

The table below shows the way the bits are determined. (a comma sign means an or condition, an & symbol means an AND condition: e.g.: Reply; DF=4,5,20,21 & DR=4,5 means "A Reply with (DF = 4 OR DF=5 OR DF=20 OR DF=21) AND (DR=4 OR 1 0 DR=5) . "

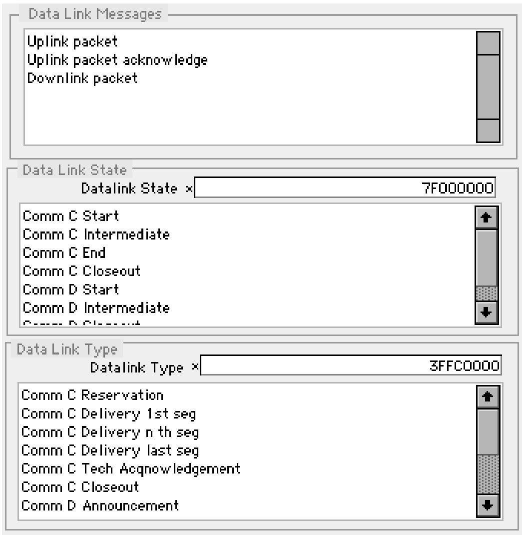
Data link type bit / flag	Condition for setting of flag
bit 0 Broadcast commB Announcement	Reply; DF=4,5,20,21 & DR=4,5
bit 1 Broadcast comm B Extraction	Int; UF=4,5,20,21 &(RR=16 &DI=0,1,2) OR (RR=16 & DI=3,7 & RRS=0) & DR=4,5
bit 2 Broadcast CommB Reply	Reply DF 20,21 to Int; UF=4,5,20,21 &(RR=16 &DI=0,1,2) OR (RR=16 & DI=3,7 & RRS=0)
bit 3: Resolution Advisory Announcement	Reply; DF=4,5,20,21 & DR=2,3,6,7
bit 4 Resolution Advisory Extraction	Int; UF=4,5,20,21 &(RR=19 &DI=0,1,2) OR (RR=19 & DI=3,7 & RRS=0)
bit 5 Resolution Advisory Reply	Reply DF 20,21 to Int; UF=4,5,20,21 &(RR=19 &DI=0,1,2) OR (RR=19 & DI=3,7 & RRS=0)
bit 6 Ground Initiated CommB Extraction	Int; UF=4,5,20,21 &(RR>19 & RR<32 &DI=0,1,2) OR (RR>19 & RR,<32 & DI=3,7 & RRS=0)
bit 7 Ground Initiated CommB Reply	Reply DF 20,21 to Int; UF=4,5,20,21 &(RR>19 & RR<32 &DI=0,1,2) OR (RR>19 & RR,<32 & DI=3,7 & RRS=0)
bit 8 Air Initiated Comm B Announcement	Reply; DF=4,5,20,21 & DR=1
bit 9 Air Initiated Comm B Reservation	Int; UF=4,5,20,21 & DI=1 & MBS=1
bit 10 Air Initiated Comm B Extraction	Int; UF=4,5,20,21 &(RR=16 &DI=0,1,2) OR (RR=16 & DI=3,7 & RRS=0) & DR=1
bit 11 Air Initiated Comm B Reply	Reply DF 20,21 & DR=1 to Int; UF=4,5,20,21 &(RR=16 &DI=0,1,2) OR (RR=16 & DI=3,7 & RRS=0)
bit 12 Air Initiated Comm B Closeout	UF=4,5,20,21 & PC=4 OR (DI=1 & MBS=2)
bit 13 Comm A 1 element Transmission	UF=20,21 & DI = 1,7 & TMS=0
bit 14 Comm A 1 element Acknowledge	Reply DF 4,5,20,21 to UF=20,21 & DI = 1,7 & TMS=0
bit 15 Comm A multi element Transmission 1^{st} el	UF=20,21 & DI = 1,7 & TMS=1
bit 16 Comm A multi element Tx n^{th} element	UF=20,21 & DI = 1,7 & TMS=2,3,4,5,6

bit 17 Comm A multi element Acknowledge	Reply DF 4,5,20,21 to UF=20,21 & DI = 1,7 & TMS=2,3,4,5,6
bit 18 Comm C Reservation	Int; UF=4,5,20,21 & DI=1 & MES=1,5
bit 19 Comm C Delivery 1st segment	UF=24 & RC=0
bit 20 CommC Delivery n th segment	UF=24 & RC=1
bit 21 CommC Delivery last segment	UF=24 & RC=2
bit 22 CommC technical acqnowledge	Reply DF=24 & KE=1 to UF=24 & RC=2
bit 23 Comm C Closeout	UF=4,5,20,21 & PC=5 OR (DI=1 & MES=2,6,7)
bit 24 Comm D Announcement	Reply; DF=4,5,20,21 & DR>=16
bit 25 Comm D Reservation	Int; UF=4,5,20,21 & DI=1 & MES=3,6
bit 26 Comm D Extraction	UF=24 & RC=3
bit 27 Comm D Reply intermediate segment	Reply DF=24 & KE=0 &RC≠0 to UF=24 & RC=3
bit 28 Comm D Reply last segment	Reply DF=24 & KE=0 &RC=0 to UF=24 & RC=3
bit 29 Comm D Closeout	UF=4,5,20,21 & PC=6 OR (DI=1 & MES=4,5,7)
bit 30 Code Change announcement	DF=4,5,20,21 & FS=2,3,4
bit 31 Broadcast Comm A	UF =20,21 & AA=FFFFFF

Table 3-5: Data link type definitions

The data type flags are used as primary source for data link exchange analysis in the analysis tools, so the correct implementation of these flags is required for the correct implementation of all the data link exchange counters. Once these are proven correct, the calculated bits are also verified.

The data bits can be verified using the Data Display info display, or by using them as flags for cursor types in the third view of the data display tool.



3.6.2.6 Data link message flags

In a similar way the Data link messages (Asterix Cat 18) that are linked to the TRD are flagged in the “Data link message” field in each TRD record. If a certain data link message is linked to a TRD record, the corresponding bit is set. (multiple messages of the same type will not be distinguishable in this way)

In a similar way, the presence of data link data in the linked Cat 48 data will be flagged: Bits 24 through 27 are used for this purpose. The presence of these fields is determined by looking at the S48 FSPEC48 field. A code changes are also monitored by comparison of the S48 Acode with the previous A code.

The table below shows the way the bits are determined.

Data link message bit	Condition for setting of flag
bit 0 Associate Request	Cat018/000=x00
bit 1 Associate response	Cat018/000=x01
bit 2 Release request	Cat018/000=X02
bit 3 Release response	Cat018/000=X03
bit 4 Abort request	Cat018/000=X04
bit 5 Keep alive	Cat018/000=X05
bit 6 Aircraft report	Cat018/000=X10
bit 7 Aircraft command	Cat018/000=X11
bit 8 II code Change	Cat018/000=X12
bit 9 Uplink Packet	Cat018/000=X20
bit 10 Cancel uplink Packet	Cat018/000=X21
bit 11 Uplink Packet acknowledge	Cat018/000=X22
bit 12 Downlink Packet	Cat018/000=X23
bit 13 Data Xon	Cat018/000=X26
bit 14 Data Xoff	Cat018/000=X27
bit 15 Uplink broadcast	Cat018/000=X30
bit 16 Cancel Uplink Broadcast	Cat018/000=X31
bit 17 Uplink Broadcast Acknowledge	Cat018/000=X32
bit 18 Downlink Broadcast	Cat018/000=X34
Bit 19 GICB_Extraction	Cat018/000=X40
Bit 20 Cancel GICB Extraction	Cat018/000=X41
Bit 21 GICB_Extraction_Acknowlegde	Cat018/000=X42
Bit 22 GICB responce	Cat018/000=X43
Bit 23 A Code Swap	A code changed in Cat48
Bit 24 ACAS	ACAS Res Advisory present in Cat 48
Bit 25 AI	Aircraft Identification found in Cat 48
Bit 26 BDS10	BDS 10 data found in Cat 48
Bit 27 BDS20	BDS 20 data found in Cat 48
Bit 28	BDS 40 data found in Cat 48
Bit29	BDS 50 data found in Cat 48
Bit30	BDS 60 data found in Cat 48
Bit31	other BDS data found in Cat 48

Table 3-6: Data link message field in TRD

The data link message flags are used as primary source for data link exchange analysis in the analysis tools, so the correct implementation of these flags is required for the correct implementation of all the data link exchange and delay counters. Once these are proven correct, the calculated bits are also verified.

The data bits can be verified using the Data Display info display, or by using them as flags for cursor types in the third view of the data display tool.

3.6.2.7 Data link state flags

From the IRD data and the data link state in the previous scan of the same target, the new data link state can be determined according to the timing and state diagrams hereafter. The "data link state" field in the TRD reflects the state at the end of the current beam dwell.

Each of the eight types of data link can be in "start" (or announced) , "intermediate"(or ongoing) or "end" (completed) state. Two exceptions exist:: GICB has no intermediate status and the Comm C has two "end " states and therefore a fourth state bit : Technical acknowledge and closeout. Each state is reflected in a bit. Using these bits, the data link analyzer tool can count the number of targets in a specific state per scan.

The table below shows the way the bits are determined.

TRD Data link state flag	Condition of data link state flag in IRD to initiate state in TRD
bit 0 Broadcast Comm B Start	bit 0 Broadcast commB Announcement
bit 1 Broadcast Comm B Intermediate	bit 1 Broadcast comm B Extraction
bit 2 Broadcast Comm B End	bit 2 Broadcast CommB Reply
bit 3 Resolution Advisory Start	bit 3: Resolution Advisory Announcement
bit 4 Resolution Advisory Intermediate	bit 4 Resolution Advisory Extraction
bit 5 Resolution Advisory End	bit 5 Resolution Advisory Reply
bit 6 Ground Initiated CommB Start	bit 6 Ground Initiated CommB Extraction
bit 7 Ground Initiated CommB End	bit 7 Ground Initiated CommB Reply
bit 8 Air Initiated CommB Start	bit 8 Air Initiated Comm B Announcement
bit 9 Air Initiated CommB Intermediate	bit 9 Air Initiated Comm B Reservation OR bit 10 Air Initiated Comm B Extraction
Bit 10: Not used	
bit 11 Air Initiated CommB End	bit 12 Air Initiated Comm B Closeout
bit 12 CommA 1 sgmt start	bit 13 Comm A 1 element Transmission
bit 13 Not used	
bit 14 CommA 1 sgmt end	bit 14 Comm A 1 element Acknowledge
bit 15 CommA m sgmt start	bit 15 Comm A multi element Transmission 1st el
bit 16 CommA m sgmt intermediate	bit 16 Comm A multi element Tx nth element
bit 17 CommA m sgmt end	Last bit 17 Comm A multi element Acknowledge
bit 18 Comm C start	bit 18 Comm C Reservation
bit 19 Comm C intermediate	bit 19 Comm C Delivery 1st segment
bit 20 Not Used	
bit 21 Not Used	
bit 22 Comm C End Technical Ackn	bit 22 CommC technical acknowledge
bit 23 Comm C End Closeout	bit 23 Comm C Closeout
bit 24 CommD Start	bit 24 Comm D Announcement
bit 25 Comm D Intermediate	bit 25 Comm D Reservation OR bit 26 Comm D Extraction
bit 26 Not Used	
bit 27 Not Used	
bit 28 Not Used	
bit 29 Comm D end	bit 29 Comm D Closeout
bit 30 Not Used	
bit 31 Not Used	

Table 3-7: Data link status fields in TRD.

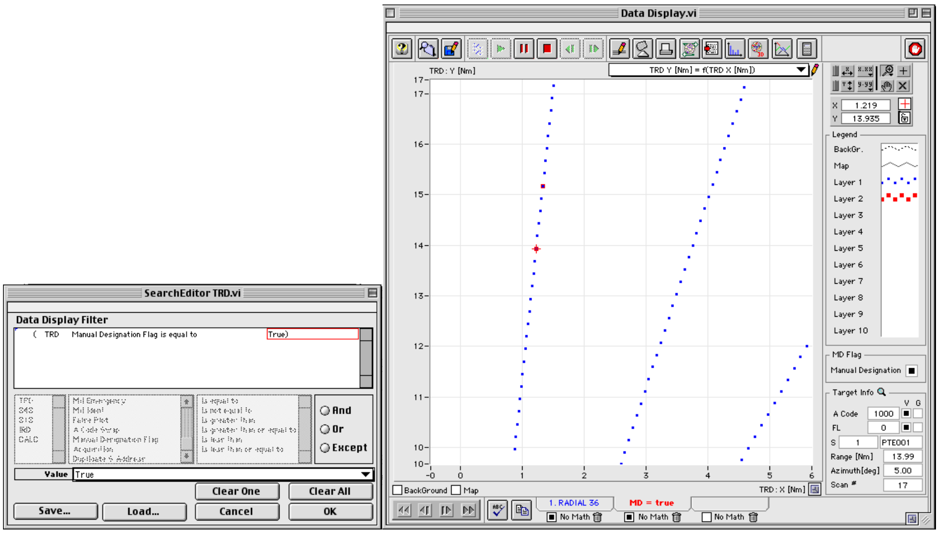
The data state flags are used as primary source for data link exchange analysis in the analysis tools, so the correct implementation of these flags is required for the correct implementation of all the data link exchange and delay counters. Once these are proven correct, the calculated bits are also verified.

The data bits can be verified using the Data Display info display, or by using them as flags for cursor types in the third view of the data display tool.

3.6.2.8 Manual Designation Flag

The Data Display allows the setting and resetting of the manual designation flag.

The manual designation flag is set or reset using the data display tool. The flag is written in the original file and can be used afterwards as filter.



3.7 Data Analysis

3.7.1 General statistical analysisRelated Specs

[PTE-SR-P2B2-CAP-0410] In response to a user command, the PTE P2B2 tool **shall** carry out a general statistical analysis on the “TRD” records specified by the user defined filtering (including the no filter option).

[PTE-SR-P2B2-CAP-0411] The PTE P2B2 general statistical analysis **shall** be based on any user specified numeric / flag field associated to the structure of the imported data from the choice of:

all fields and sub-fields of the imported data items with the exception of sub-fields of the MB data

all characteristics or additional fields computed and logically associated to a “TRD” record by the PTE P2B2 tool.

[PTE-SR-P2B2-CAP-0412] The PTE P2B2 general statistical analysis **shall** calculate and display descriptive statistics (sample size; minimum, maximum, mean and rms. values; standard deviation around the mean) for the population of the user specified numeric field type associated to the structure of the imported data.

[PTE-SR-P2B2-CAP-0413] The PTE P2B2 general statistical analysis **shall** count (sample size, number of flagged records) for the population of the user specified flag field type associated to the structure of the imported data.

[PTE-SR-P2B2-CAP-0414] The PTE P2B2 general statistical analysis **shall** display in a histogram form the number of “TRD” records for which the value of the selected field falls in a specified interval.

3.7.1.2 General Analysis

The General Statistical Analysis (histogram , counting , etc..) is performed from the Data Display. The analysis itself is identical to the analysis that was defined in the “histogram” function , present in the PTE P2B1 tool. The histogram function allows the counting and histogram function on any of the three (X,Y or Z) scales of the data display. The histogram function itself has not changed since B1, so the use of this type of function needs to be concentrated on demonstrating the correlation between the data shown in the data display and that presented in the histogram. Once this relation has been proven, a number of analysis results can be verified.

This general statistical analysis allows the user to select ±500 different imported or calculated fields for a general XY or X-Y-Z (color coded) graph. Once the graph is drawn on the screen, the user can zoom in on a section of the data and create a histogram of the section. The histogram also provides the general statistical values (sample size; minimum, maximum, mean and rms. values; standard deviation around the mean) .

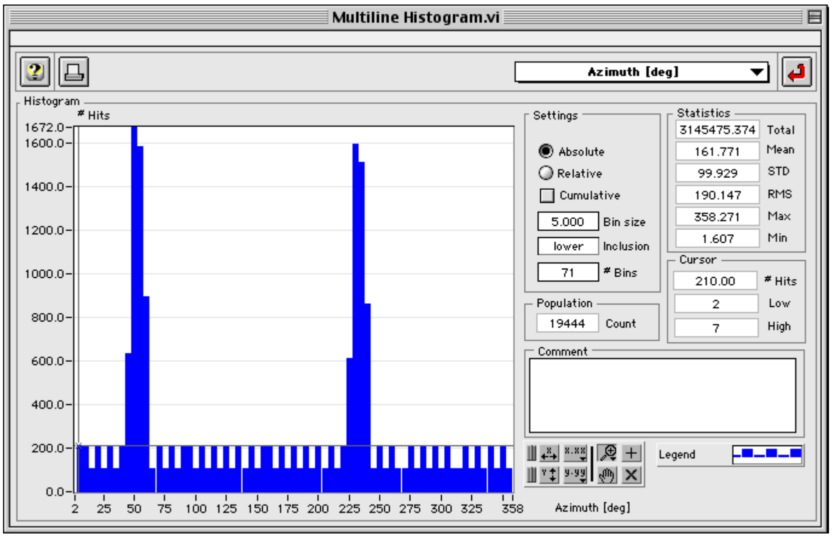


Figure 3-17: Histogram

The General statistical Analysis is based on any user specified numeric / flag field of the TRD data structure, all fields and sub-fields of the imported data items with the exception of sub-fields of the MB data, all characteristics or additional fields computed and logically associated to a “TRD” record by the PTE P2B2 tool.

The general analysis can be performed on any of the three selected axis of the data display. These can consist of any field, sub field or calculated field as found in the TRD data.

The PTE P2B2 general statistical analysis calculates and displays descriptive statistics (sample size; minimum, maximum, mean and rms. values; standard deviation around the mean) for the population of the user specified numeric field of the TRD data structure.

The histogram function of the Data Display presents the user with population, minimum value, maximum value, mean, RMS, STD, for the selected population.

The PTE P2B2 general statistical analysis counts (sample size, number of flagged records) for the population of the user specified flag field type associated of the TRD data structure.

The general analysis can count user specified flags by selecting a specific filter for this flag.

The PTE P2B2 general statistical analysis displays in a histogram form the number of “TRD” records for which the value of the selected field falls in a specified interval.

The histogram function in the data display implicitly creates a histogram graph.

3.7.2 Data Link Analyzer tool

The Data Link analyzer tool will comply to the main part of the analysis specifications. It will perform the following analysis:

- Data Link Activity
- Data Link Exchange
- Data Link Delay
- Data Link Cancellation
- Data Link Pd Comm B Analysis
- Data Link Comm C / Comm D segment retransmission analysis
- Data Link model B compliance Analysis

These analysis are run on a complete TRD data set, but the tool allows the user to exclude a number of targets using a filter on S address.

The Data link Analyzer tool also adds some additional calculated fields to the TRD records:

- Data Link Exchange
- Data Link Cancellation counters
- Data Link Delay counters

The Data Link Analyzer tool will parse the complete TRD data set and will create a "RESULT" file inside the TRD folder. This result file contains all analysis results per target. The Result Viewer tool, to be called from the data analyzer, can be used to visualize the results per target or per scan.

3.7.3 Data-link Activity Measure

3.7.3.1 Related Specs

[PTE-SR-P2B2-CAP-0420 In response to a user command, the PTE P2B2 tool **shall** carry out a data-link performance analysis on the "TRD" records specified by the user defined filtering (including the no filter option).

[PTE-SR-P2B2-CAP-0421] The PTE P2B2 data-link performance analysis **shall** assess (from the Mode S Interrogation / Reply information – IRD (simulated traffic) or IRDV (live traffic) information) the instantaneous data link activity derived from interrogations by computing the following information per radar scans:

A) number of extracted COMM-B
B) number of transmitted COMM-A segments
C) number of transmitted initial or intermediate COMM-C segments
D) number of transmitted final COMM-C segments
E) number of requested COMM-D (derived from the content of the interrogation)
F) the sum of the numbers above (this data only provide an indication of the data link activity for the scan, it does not have a physical meaning)

§	Event to be counted
0A	Interrogation UF 4, 5, 20 or 21 with 16 <= RR <= 31 to request a Comm-B
0B	Interrogation UF 20 or 21 (Comm-A)
0C	Interrogation UF 24 with RC = 0 or 1 (initial or intermediate Comm-C segment)
0D	Interrogation UF 24 with RC = 2 (final Comm-C segment)
0E	After the reservation of a down link ELM POEMS sends an interrogation UF 24 RC = 3, within the MC field the SRS sub-field indicates the number of requested Comm-D's

[PTE-SR-P2B2-CAP-0422] In addition, it **shall** calculate and display statistics (sample size; minimum, maximum, mean values; standard deviation around the mean, plus minimum, mean and population of non zero values) on these counters for all the scan.

[PTE-SR-P2B2-CAP-0423] The result of the above analysis **shall** be available:

in a tabular display (one row per scan) form for all the targets included in the data set.
in a line chart display form, using a specific colour/symbol for each target/type, scan nr on x-axis.

3.7.3.2 Implementation

The Data link Activity measure determines the data link Activity using 5 different counters:

- *A) number of extracted COMM-B*

- *B) number of transmitted COMM-A segments*

- *C) number of transmitted initial or intermediate COMM-C segments*

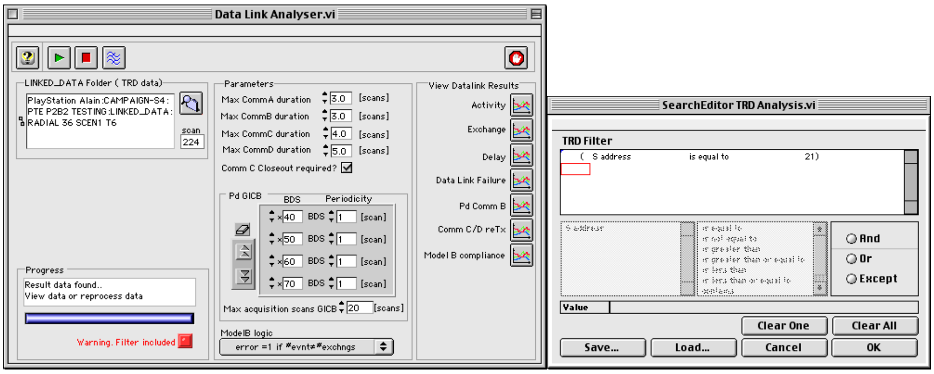
- *D) number of transmitted final COMM-C segments*

- *E) number of requested COMM-D (derived from the content of the interrogation)*

-F) the sum of the numbers above (this data only provide an indication of the data link activity for the radar beam, it does not have a physical meaning)

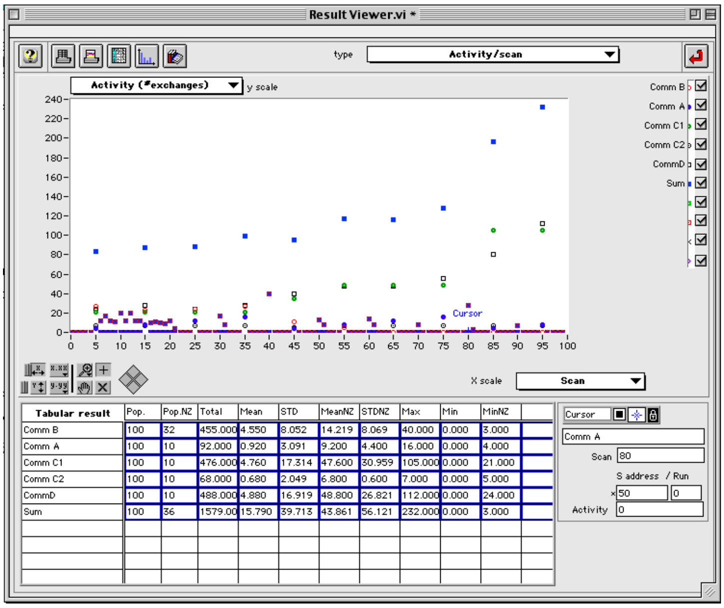
Almost the same counters are already available as a calculated field in the TRD records (as calculated by the data linker). Therefore the data link activity analysis uses these calculated fields as a source to calculate the data per target and per scan.

The Data link Activity Analysis can be performed by the user in response to a click on the start button of the "Data Link Analyzer" tool. The tool allows the definition of a filter on S address or no filter.



The data is extracted and presented in the Data link Result Viewer window:

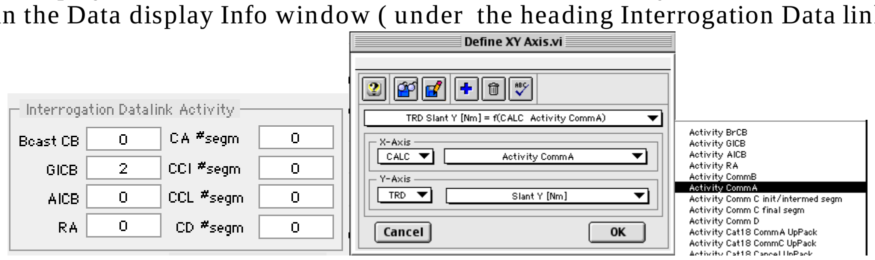
The result is available:
- in a tabular display (one row per radar scan) form for all the targets included in the data set.
- in a line chart display form, using a specific colour/symbol for each target/type, scan number on x-axis.



The tool calculates and displays statistics (sample size; minimum, maximum, mean values; standard deviation around the mean) on these counters for all the radar scans.

The tool includes the result of these activity analysis in the calculated fields of each individual TRD record. These results can be visualized in the data display as a selected X Y or Z scale value.

The Data Display has these values in its X,Y,or Z definitions. They can also be shown directly in the Data display Info window (under the heading Interrogation Data link Activity)



3.7.4 Data link Exchange Analysis

3.7.4.1 Related Specs

PTE-SR-P2B2-CAP-0430] The PTE P2B2 data-link performance analysis **shall** calculate (from the Mode S interrogation / reply information – IRD (simulated traffic) or IRDV (live traffic) information) the number of data-link exchanges during each beam dwell (i.e. for a single target reference point “TRD”) per target and per radar beam classified according to the following definitions :

remark1) the"Announced" status is only applicable to Air Initiated data link transactions (i.e.broadcast Comm B, AICB, ACAS RA and Comm D). The start of a transaction,either uplink or down link, is then defined by the first interrogationperformed by the station and forming part of the transaction (reservation ingeneral)

remark2): it should be noted that in case of down link transaction it can start in the same beam where it is announced

Exchange classification	A	S-C	S-NC	O	C
a) Broadcast Comm-B[1]	Y	Y	Y	Y	Y
b) GICB (BDS >= 4,0)		Y	Y	Y	Y
c) AICB	Y	Y	Y	Y	Y
d) Comm-A (single-segment)[1]		Y	Y	Y	Y
e) ACAS RA extraction[1]	Y	Y	Y	Y	Y
f) Comm-A (multi-segment)		Y	Y	Y	Y
g) Comm-C (UELM)		Y	Y	Y	Y
h) Comm-D (DELM)	Y	Y	Y	Y	Y

The definitions of the abbreviations for exchange classification used in the table are

A : the exchange was announced during the beam dwell
S-C : the exchange was started and completed during the beam dwell
S-NC : the exchange was started but not completed during the beam dwell
O : the exchange was ongoing (neither started nor completed) during the beam dwell
C: the exchange was completed during the beam dwell (but not started).
a Y in any column of the table indicates that an individual counter for that exchange classification is required.

The definitions of the above exchanges are:

Broadcast Comm-B: between the corresponding announcement and reply corresponding to the Comm-B.
GICB (BDS >= 4,0) : between the interrogation requesting the BDS and the reply containing the BDS
AICB: between the corresponding reservation and close-out.
Comm-A single-segment : between the single segment/interrogation and the reply to the single segment/interrogation
ACAS RA: between the corresponding announcement/reply and reply corresponding to the BDS 3,0.
Comm-A multi-segment : between the first segment/interrogation and the reply to the last segment/interrogation
Comm-C (UELM): between the corresponding reservation/interrogation and close-out/interrogation (default).
Comm-C (UELM): between the corresponding reservation and technical acknowledge reply (alternative selectable by the operator).
Comm-D (DELM): between the corresponding announcement/reply and close-out/interrogation.

3.7.4.1.1 Broadcast Comm-B

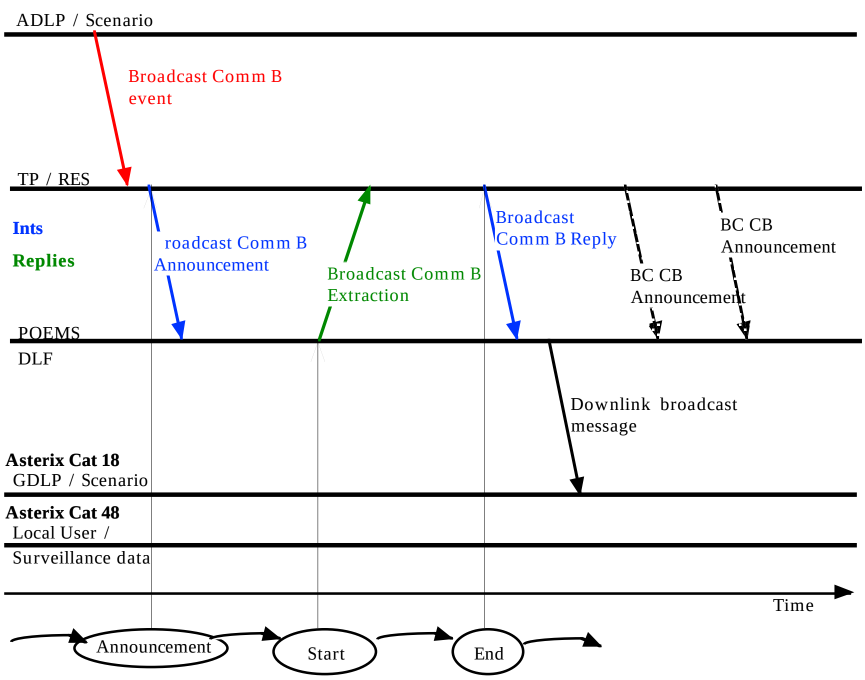


Figure 3-18: Broadcast Comm-B state

3.7.4.1.2 GICB (BDS >= 4,0)

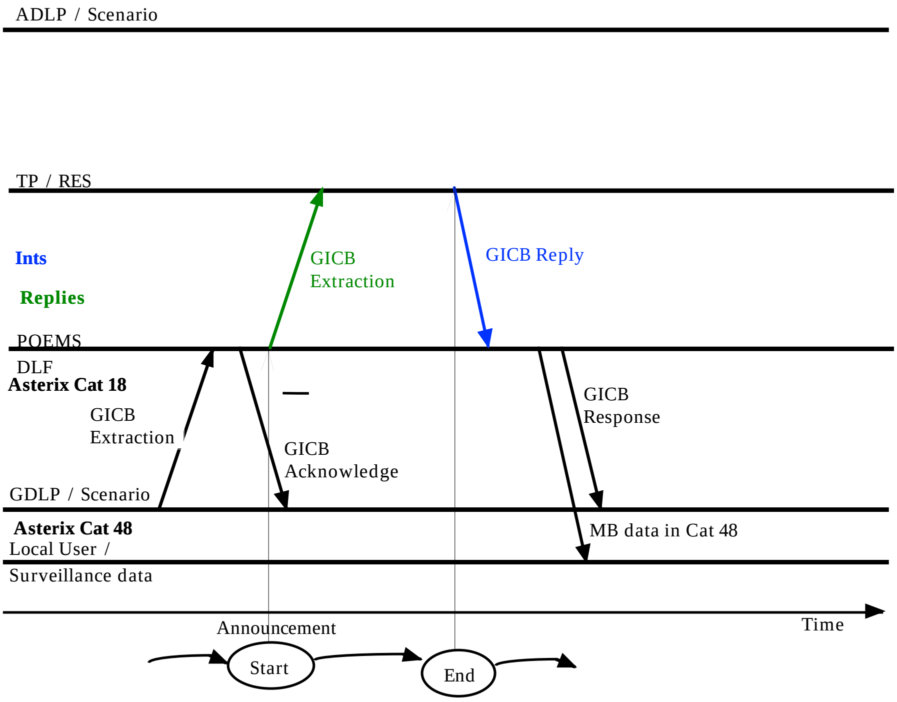


Figure 3-19:GICB states

3.7.4.1.3 AICB

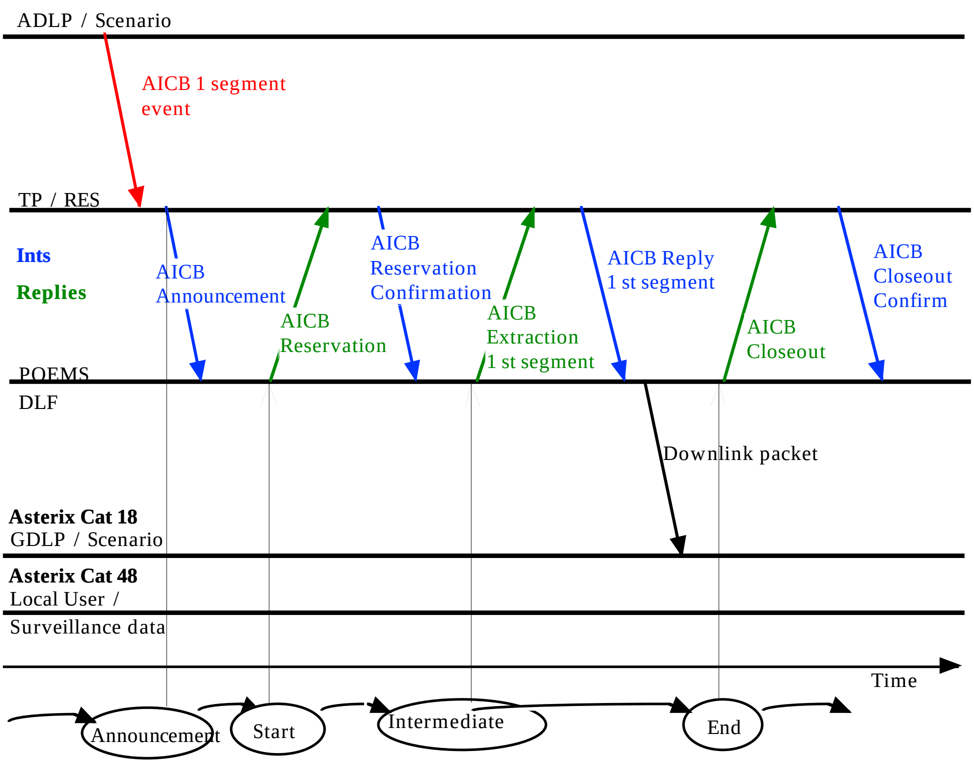


Figure 3-20:AICB 1 segment states

3.7.4.1.4 AICB multi element

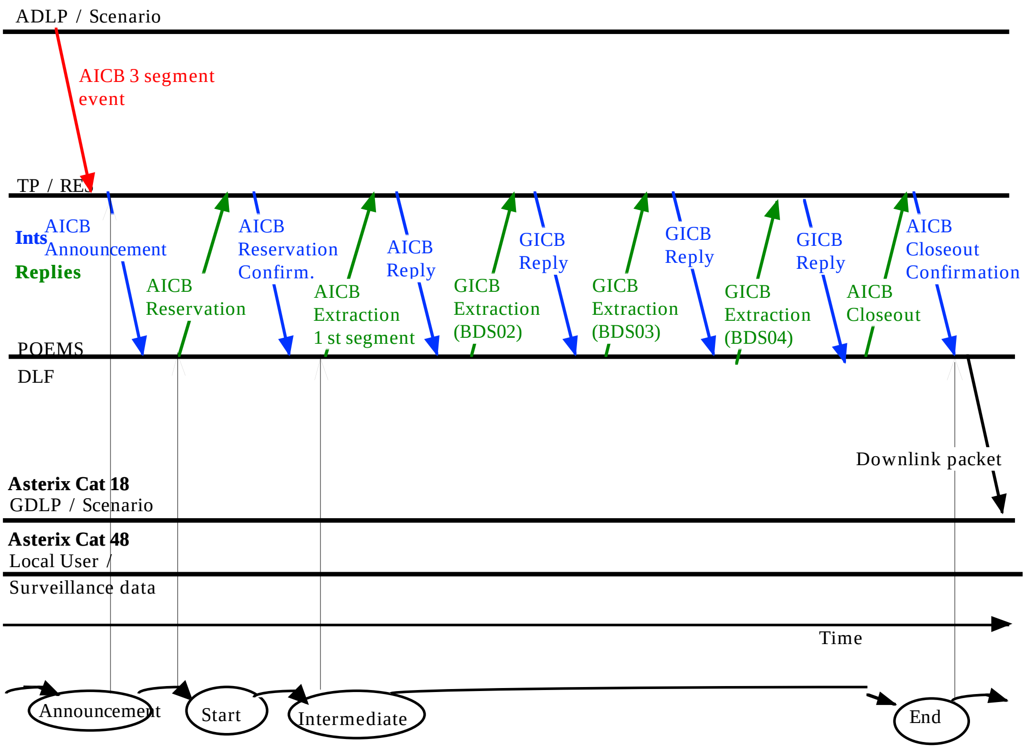


Figure 3-21:AICB multi element states

3.7.4.1.5 Comm-A (single-segment)

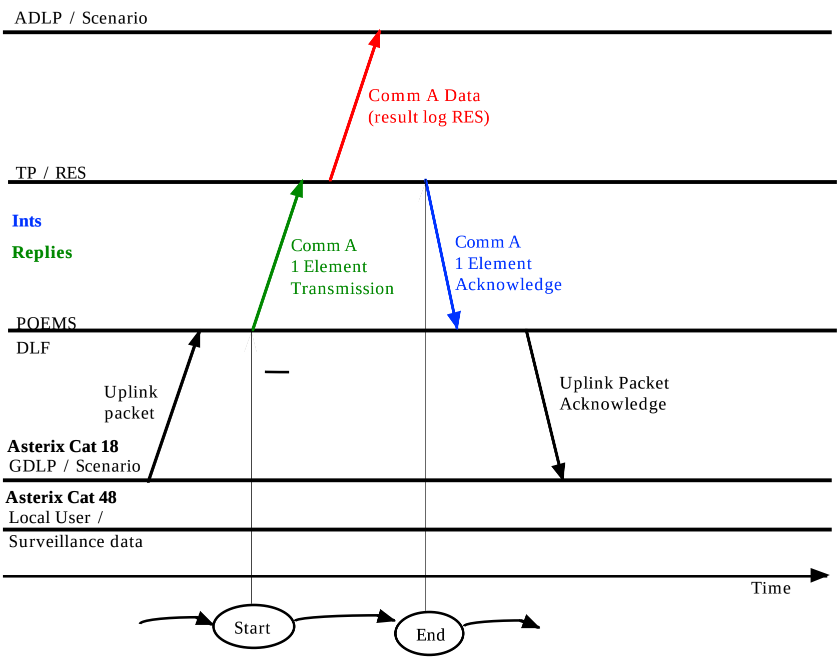


Figure 3-22: Comm A single segment states

3.7.4.1.6 ACAS RA extraction

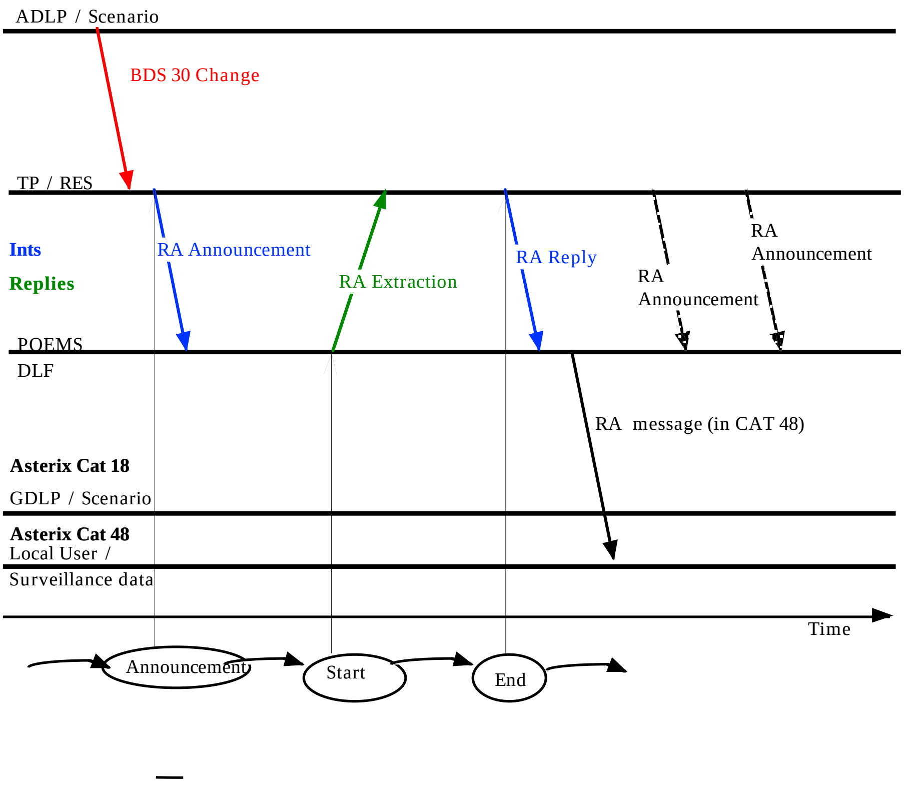


Figure 3-23: ACAS Resolution advisory States

3.7.4.1.7 Comm-A (multi-segment)

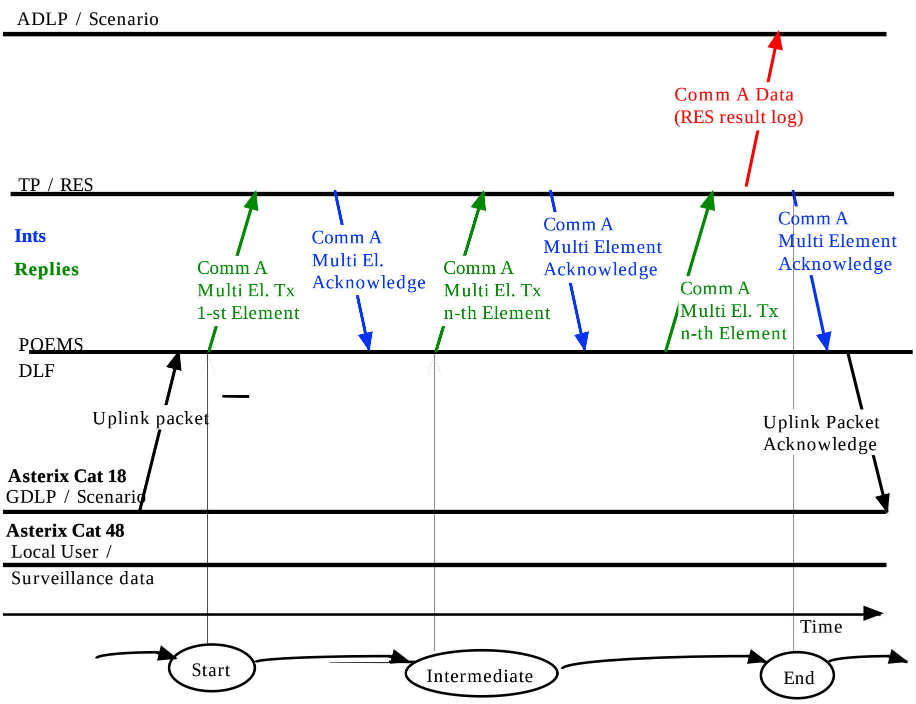


Figure 3-24: Comm A Multi segment states

3.7.4.1.8 Comm-C (UELM)

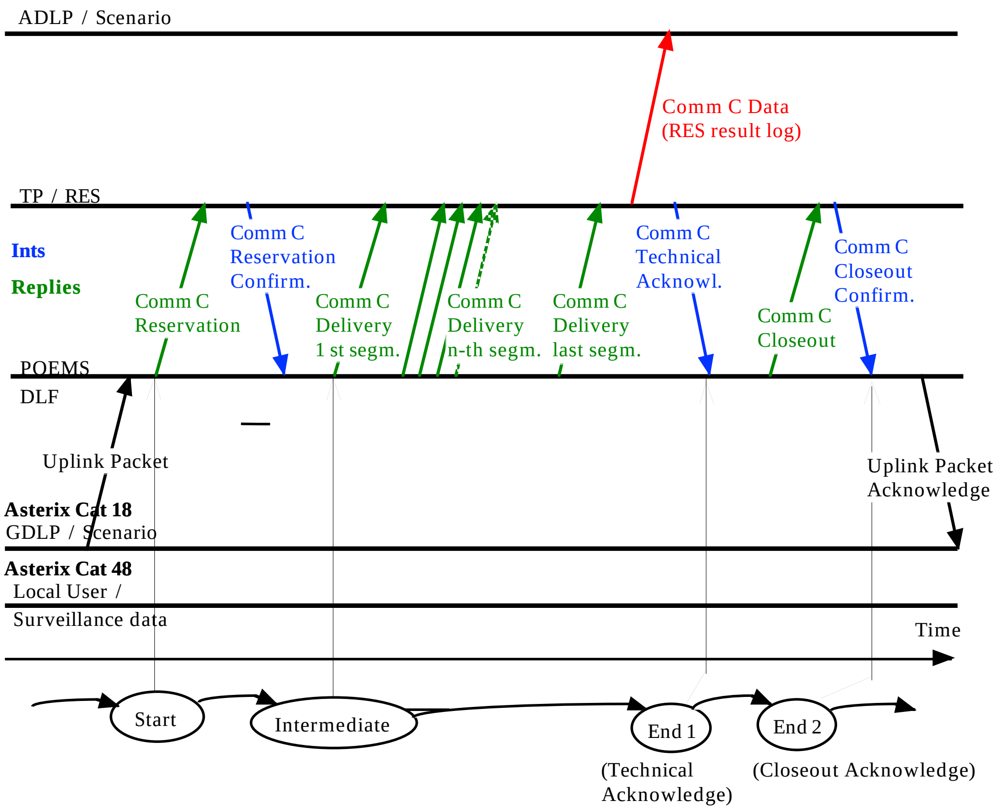


Figure 3-25: Comm C states

3.7.4.1.9 Comm-D (DELM)

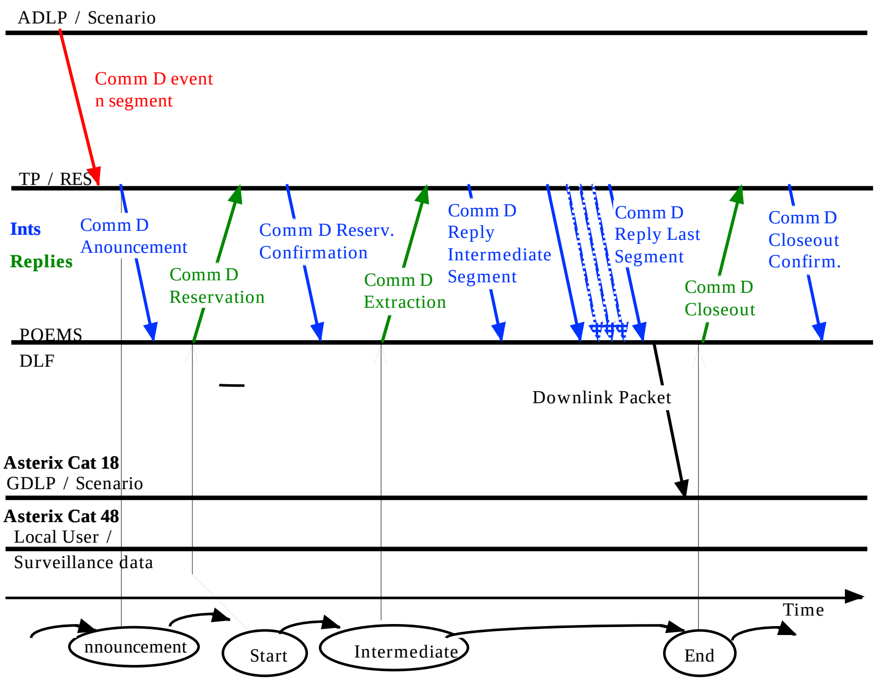


Figure 3-26: Comm D states

Exchange type	Announcement	Start	Intermediate	Completion
a)Data link Exchange Analysis of broadcast Comm B	Reply DF 4, 5, 20, 21 DR = 4 or 5 (announcement)	Interrogation UF 4, 5, 20 or 21 with RR = 16 and (DI = 0, 1, 2 or (DI = 3, 7 and RRS = 0)) to request a Comm-B announced by a broadcast Comm-B	next identical interrogation(s) with or without reply	Reply DF 20, 21 corresponding to the broadcast Comm-B
b) Data link Exchange Analysis of GICB extraction	NA	Interrogation UF 4, 5, 20 or 21 with 20 <= RR < =31 RR and RRS define the BDS registers to be extracted (Comm-B request)	next identical interrogation(s) with or without reply	Reply DF 20, 21 corresponding to the requested Comm-B (BDS)
c) Data link Exchange Analysis of AICB	Reply DF 4, 5, 20, 21 DR = 1 (announcement)	Interrogations UF 4, 5, 20 or 21 with RR = 16, and if DI = 3, 7 then RRS = 0 [extraction 1st segment] Replies DF 20, 21 DR = 1 (Comm-B)	Interrogations UF 4, 5, 20 or 21 with RR = 16 and DI = 3, 7 ans RRS = 2,3 or 4) Replies DF 20, 21 DR = 1 (Comm-B)	Reply toclose oit Interrogation UF 4, 5, 20 or 21 with (PC = 4 non selective) or (DI = 1 and MBS = 2 multi-site) (close-out acknowledge)
d)Data Link Exchange analysis of Coimm A single segment	NA	Interrogation UF 20, 21 DI = 1 or 7 and LAS (3 last bits of TMS) = 0 (Comm-A single segment)	NA	Reply to Comm A interrogation
e) Data Link Exchange analysis ofACAS RA extraction	Reply DF 4, 5, 20, 21 with DR = 2, 3, 6 or 7 (announcement)	Interrogation UF 20 or 21 with RR = 19, and if DI = 3, 7 then RRS = 0 (request of BDS 3,0)	next identical nterrogation(s with or without reply	Reply DF 20, 21 corresponding to the requested Comm-B (BDS 3,0)
f)Data Link exchange analysis of Comm A multi element	NA	Interrogation UF 20, 21 DI = 1 or 7 and LAS (3 last bits of TMS) = 1 (first segment)	Interrogation UF20,21 DI=1 or 7 and LAS = 2,3,4,6	Reply to the last interrogation of one of the following sequences of Comm-A's (after elimination of duplicates) : LAS = 5 LAS = 2, 6 LAS = 6, 2 LAS = 2, 3, 4 LAS = 3, 2, 4 LAS = 2, 4, 3 LAS = 3, 4, 2 LAS = 4, 2, 3 LAS = 4, 3, 2
g)Data Link exchange analysis of Comm C	NA	Interrogation UF 4, 5, 20, 21 DI = 1 MES = 1 or 5 (reservation)	Interrogation UF 24 RC = 0, 1 or 2 (Comm-C)	Reply DF 24 KE = 1 (technical acknowledgement by transponder) or Reply to closeout Interrogation UF 4, 5, 20, 21 with (DI = 1 and MES = 2, 6, 7 multi-site) or (PC =5 non selective) (default)
h)Data Link exchange analysis of Comm D	Reply DF 4, 5, 20, 21 16 <= DR <= 31 (announcement) Number of segments = DR - 15	Interrogation UF 4, 5, 20 or 21 with DI = 1, MES = 3 or 6 (reservation if multi-site)	interrogation UF 24 RC = 3 (indicating the number of segments to be down-linked NS) Reply DF 24 KE= 0 1 <= ND <= NS (Comm-D)	Interrogation UF 4, 5, 20, 21 with (DI = 1 and MES = 4, 5 or 7 multi-site) or (PC = 6 non selective) (close-out)

Remark 3: Concerning the failure of datalink transaction, it is agreed that when a datalink transaction is considered failed (cf. conditions detailed in requirement PTE-SR-P2B2-CAP-0460 and in § 3.4.6 of the SRD) it shall also be considered closed. This

should be clearly stated in the user manual and in the on-line help associated to the input of the number of scans after which a transaction is "failed".

[PTE-SR-P2B2-CAP-0431] In addition, it **shall** calculate and display statistics (sample size ; minimum, maximum, mean values ; standard deviation around the mean , plus minimum, mean and population of non zero values) of these counters for all the beams.

[PTE-SR-P2B2-CAP-0432] it **shall** also calculate and display the percentage of exchanges, which were started and completed in one beam.

[PTE-SR-P2B2-CAP-0433 The result of the above analysis shall be available:

in a tabular display (one row per radar beam) form for all the targets included in the data set of for some (maximum number TBD during design according to size limitation) user selected targets and for all the types of data-link

in a line chart display form, using a specific colour / symbol for each target / type, beam number on x-axis.

Inserted as calculated fields in the resulting TRD dataset

3.7.4.2 Data Link Exchange Measure

The Data link Exchange measure determines the data link Exchange using 36 different counters:

For all Down link exchanges,(Broadcast Comm B, Air Initiated Comm B , Resolution Advisories and Down link Comm D) a counter is kept for the number of Announced, Started and Completed in one beam dwell, Started and not Completed in one beam dwell, Ongoing and Completed but not started in one beam dwell exchanges.

For all Uplink exchanges, (Ground Initiated Comm B, Comm A single segments, Comm A multi segments, Comm C Uplink packets) a counter is kept for the number of Started and Completed in one beam dwell, Started and not Completed in one beam dwell, Ongoing and Completed but not started in one beam dwell exchanges.

All these counters are inserted as extra calculated fields in the TRD (4 bits per counter!) by the data link analysis tool.

The result can be viewed summed per scan or per target in the result viewer, or can be viewed individually per target using the data display.

The Data link Exchange Analysis can be performed by the user in response to a click on the start button of the "Data Link Analyzer" tool. The tool allows the definition of a filter on S address or no filter.

The PTE P2B2 data-link performance analysis calculates from the linked TRD data the number of data-link exchanges during each beam per target and per radar scan classified according to the definitions.

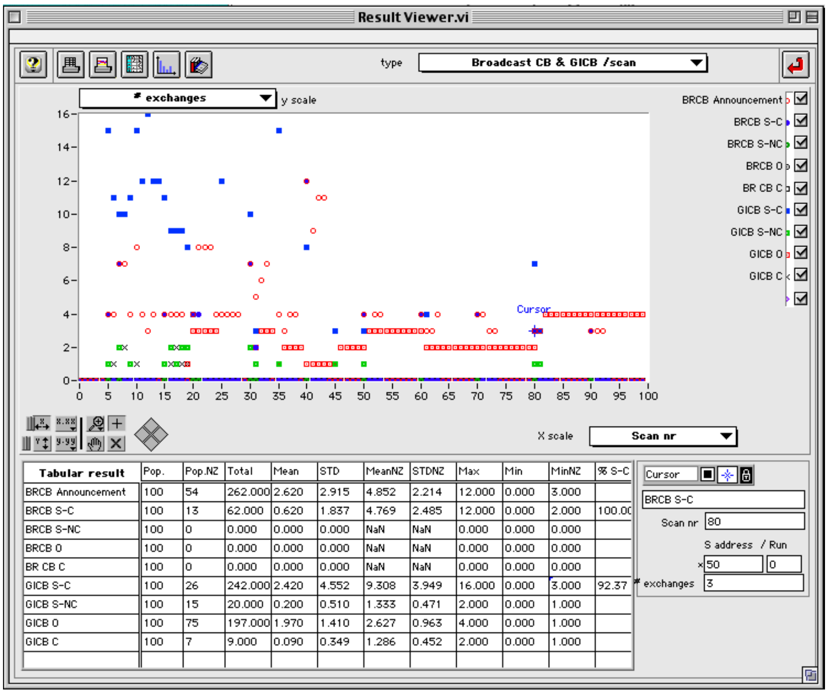
The result of the analysis is available:

- *in a tabular display (one row per radar scan) form for all the targets included in the data set.*

- *in a line chart display form, using a specific colour/symbol for each target/type, scan number on x-axis.*

The results of these tests are added in a separate test sheet , to be found in annex of this report. Examples of each data link exchange shall be produced during FAT.

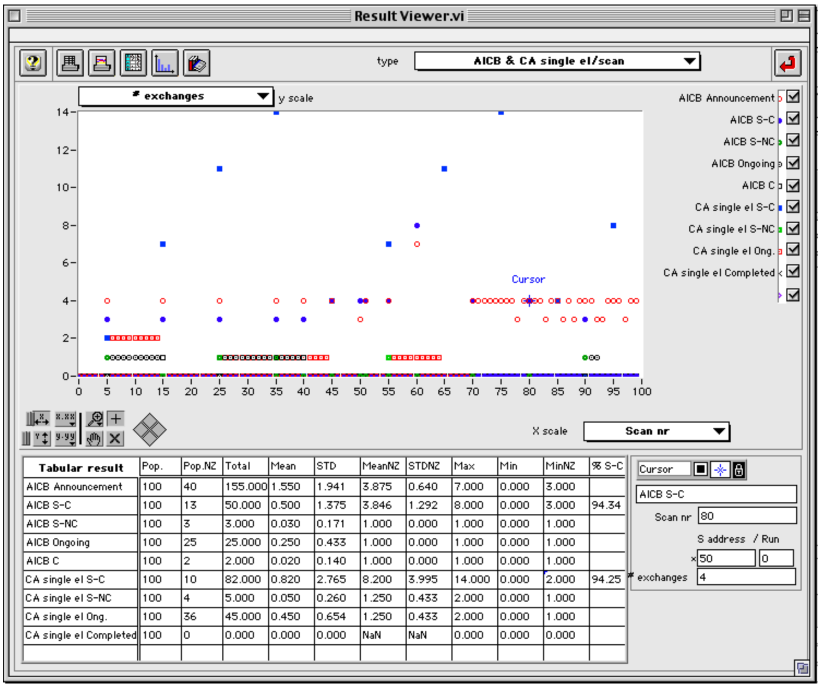
The tool calculates and displays the percentage of exchanged that were started and completed in one scan.

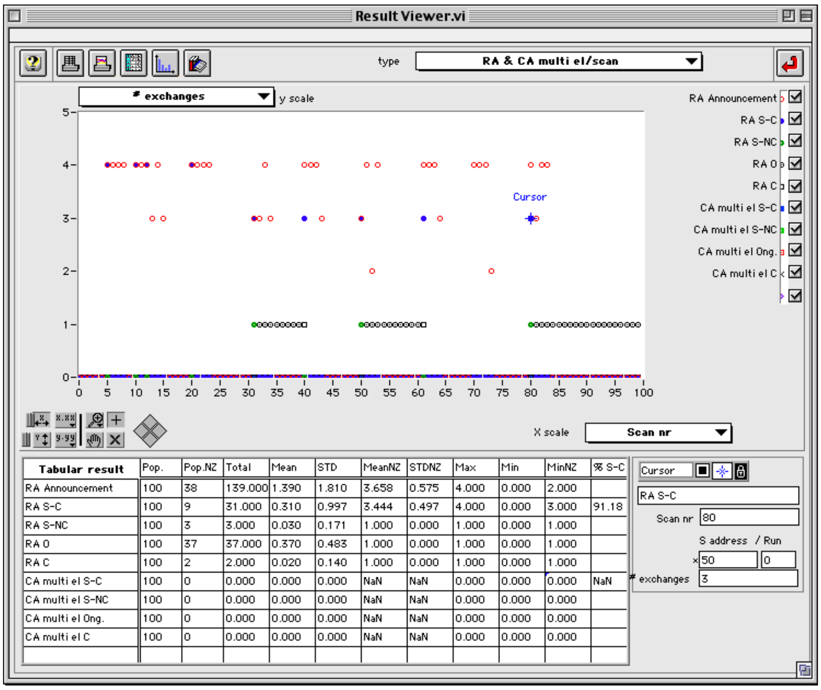


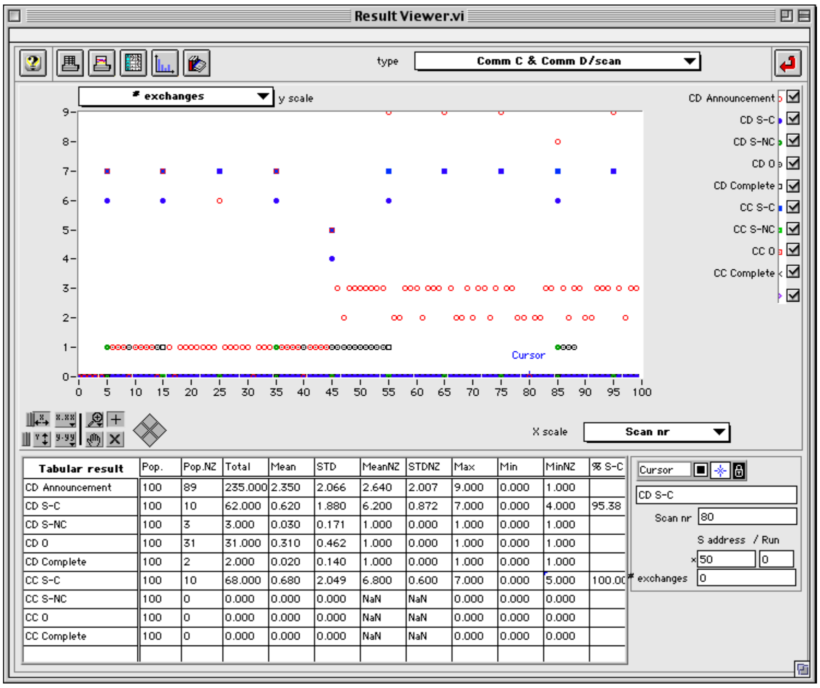
The percentage is calculated and displayed for each of the 8 possible data link exchanges in the tabular table of the “Result Viewer”. Two out of 8 possible Data link exchanges are shown in the same graphs.

The tool calculates and displays statistics (sample size; minimum, maximum, mean values; standard deviation around the mean) on these counters for all the radar scans.

Statistics on the counters can be found in the tabular result section of the Result viewer.

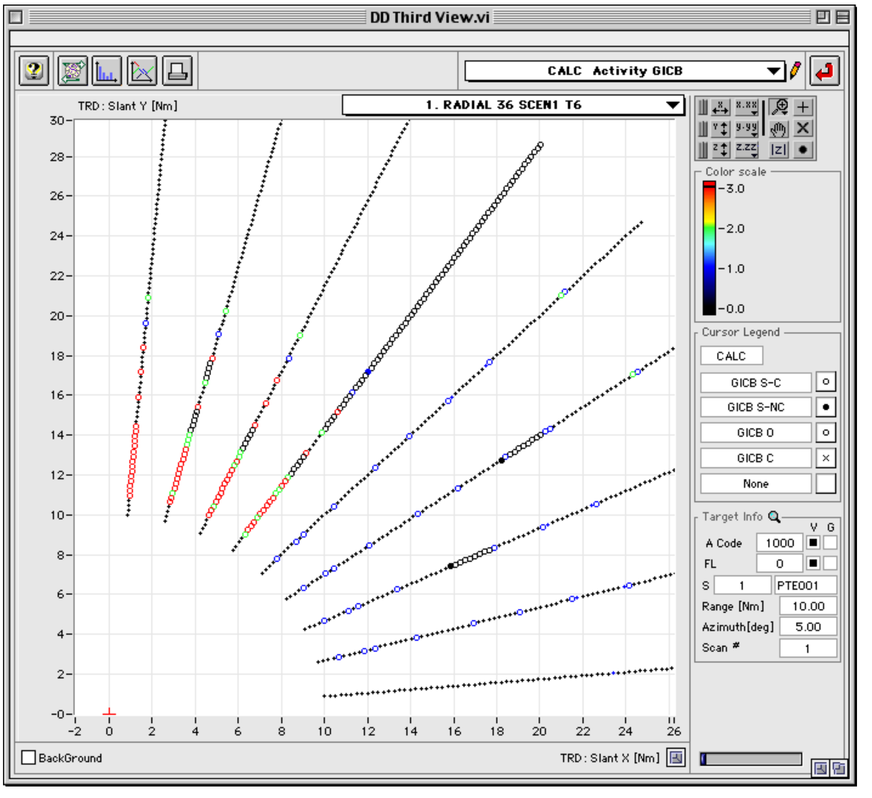






The tool includes the result of these exchange analysis in the calculated fields of each individual TRD record. These results can be visualized in the data display as a selected X Y or Z scale value.

The result of these counters can also be visualized in the data display tool. Therefor the user has the ability to select any of the 36 possible counters as a X, Y or Z scale in the data display.


DD Third View.vi
CALC Activity GICB
TRD : Slant Y [Nm]
1. RADIAL 36 SCEN1 T6
Color scale
Cursor Legend
CALC
GICB S-C
GICB S-NC
GICB O
GICB C
None
Target Info
A Code 1000
FL 0
S 1 PTE001
Range [Nm] 10.00
Azimuth[deg] 5.00
Scan # 1
BackGround
TRD : Slant X [Nm]

3.7.5 Data Link Delay Analysis

The Data link delay analysis determines the data link delay or duration for 17 different types of delay definition.

In most cases, the delays are determined between the occurrence of an event (e.g. Code change, Com D announcement, Uplink packet, and the execution of that event.

The delay analysis uses a buffer of 10 timers for each type of delay so that complex staggered or piled data link exchanges can be analyzed. The timer is filled with the "start" time of the exchange (or the start condition for that type of delay value) and its value is read back when the "end" situation of the delay condition is reached.

The definition of the delay allows for the inclusion of multiple identical delays (e.g. GICB processing delay) per TRD record. The results of the delays are presented in two ways:

- 1) The result can be viewed summed per scan or per target in the result viewer, or
- 2) can be viewed individually per target using the data display. In this case, the total number of delay values per TRD record is limited to eight. (e.g. 4 GICB processing delays and 1 Comm A duration delay.

The Data link Delay Analysis can be performed by the user in response to a click on the start button of the "Data Link Analyzer" tool. The tool allows the definition of a filter on S address or no filter.

The data link delay analysis will be used to determine a number of delays between the announcement of a certain event (data link or other) and presentation of the result of this event to the "outside world" by the radar.

The delay is calculated in seconds (resolution 1µs) and in scans / degrees. For this purpose, all events are time-stamped and "azimuth-stamped.

Following delays are determined: (also showing the index for result and STATE data):

- Code Change throughput delay
- ACAS throughput delay
- AICB throughput delay
- Broadcast Comm B data link throughput delay
- Broadcast Comm B surveillance throughput delay
- Comm D throughput delay
- COMM A throughput delay
- Comm C throughput delay
- GICB processing delay
- COMM A processing delay
- COMM C processing delay
- Broadcast Comm B delivery delay
- GICB delivery delay
- AICB delivery delay
- Comm D delivery delay
- Comm C duration
- Comm D duration
- Comm A duration

For this purpose, the above defined STATE array is used again. For each of the relative events defined in the delay calculation (e.g. Code Change announcement and Cat 48 Code change) , a time value is stored in the T(i) field of the STATE array while the data is being processed. A difference is made between a **Start** and **end** event. When a **start** event is encountered, the time of the event is stored in the T(i) variable (where i is used to differentiate between the different analysis) . When an **end** event is encountered, the delay is calculated by subtracting the time of the **start** event from the time of the **end** event. The same is done with the ARP / ACP value.

Each time a delay is calculated, the value is added to a result array (one array per delay definition). This result is an array of a cluster of an array of a cluster with two values: time (the time of the **end** event) and the delay itself (in seconds). The first index is used to select the analysis (index 0..16) , the second is used to store the different resulting delays.

3.7.5.1 Throughput delays

3.7.5.1.1 Related Specs

[PTE-SR-P2B2-CAP-0440] The PTE P2B2 data-link performance analysis **shall** separately calculate (from the Mode S Interrogation / Reply information - IRD (simulated traffic) or IRDV (live traffic) information - and ASTERIX Cat 018 and 048 message data - A18 & A48) the delay (in seconds with a granularity of 0,01 s, and in number of scans and degrees - e.g. 1 scan and 12° - with a granularity of 1°) that the following types of data-link exchanges took to complete:

a) announcement of a Mode A code change and the actual change in the Mode A code reported in an ASTERIX Cat 048 target report for that target (IRD (simulated traffic) or IRDV (live traffic – only) information - A48)
b) announcement of an ACAS RA and its output through an ASTERIX Cat 048 message for that target (IRD (simulated traffic) or IRDV (live traffic only) information - A48)
c) announcement of an AICB and its output through an ASTERIX Cat 018 message for that target (IRD (simulated traffic) or IRDV (live traffic only) information - A18)
d) announcement of a broadcast Comm-B and its output through an ASTERIX Cat 018 message for that target (IRD (simulated traffic) or IRDV (live traffic only) information - A18)
e) announcement of a broadcast Comm-B (BDS 10 or 20) and its output through an ASTERIX Cat 048 message for that target (IRD (simulated traffic) or IRDV (live traffic only) information - A48)
f) announcement of a Comm-D and its output through an ASTERIX Cat 018 message for that target (IRD (simulated traffic) or IRDV (live traffic only) information - A18)
g) transmission of the first segment of a multi-segment COMM-A by the station and the reply to the last segment by PTE P2B2 (IRD (simulated traffic) or IRDV (live traffic only) information)
h) transmission of a COMM-C reservation by the station and transmission of a Cat 018 message acknowledging the transaction (IRD (simulated traffic) or IRDV (live traffic only) information – A18)

§	Delay type	Start	End
0a	A code change throughput delay	Reply DF 4, 5, 20, 21 with FS =2, 3 or 4 (announcement)	Next Cat 048 message with DI070 (Mode A code) different as from the start time.
0b	ACAS RA throughput delay	Reply DF 4, 5, 20, 21 with DR = 2, 3, 6 or 7 (announcement)	Next Cat 048 with DI260 (BDS 3,0) present
0c	AICB throughput delay	Reply DF 4, 5, 20, 21 DR = 1 (announcement)	Next Cat 018 with DI000 = 23h (down link packet) sent by POEMS including the down linked short packet

§	Delay type	Start	End
0d	Broadcast Comm B throughput delay (cat 18)	Reply DF 4, 5, 20, 21 DR = 4 or 5 (announcement)	Next Cat 018 message with DI000 = 34h (down link broadcast) sent by POEMS including the down linked short packet
0e	Broadcast Comm B throughput delay (cat 48	Reply DF 4, 5, 20, 21 DR = 4 or 5 (announcement)	Next Cat 048 with DI250 (BDS 1,0) present or DI240 (BDS 2, 0) present
0f	Comm D throughput delay	Reply DF 4, 5, 20, 21 with 16 <= DR <= 31 (announcement)	Cat 018 with DI000 = 23h is sent by POEMS including the down linked long packet
0g	Comm A throughput delay	Interrogation UF 20, 21 DI = 1 or 7 and LAS (3 last bits of TMS) = 1 (first segment of a Comm-A multi-segment)	Next Cat 018 with DI000 = 22h (up-link packet acknowledge) with DI001 Cause = 3h
0h	Comm C throughput delay	Interrogation DF 4, 5, 20, 21 DI = 1 MES = 1 or 5 (reservation)	Next Cat 018 with DI000 = 22h (up-link packet acknowledge) with DI001 Cause = 3h

[PTE-SR-P2B2-CAP-0441] The result of the above analysis **shall** be available in an histogram display form (x-axis delays/types, y-axis number of corresponding exchanges).

[PTE-SR-P2B2-CAP-0442] In addition, it **shall** calculate and display statistics (sample size ; minimum, maximum, mean values ; standard deviation around the mean, plus minimum, mean and population of non zero values) on these delays.

3.7.5.1.2 ACode Change throughput delay

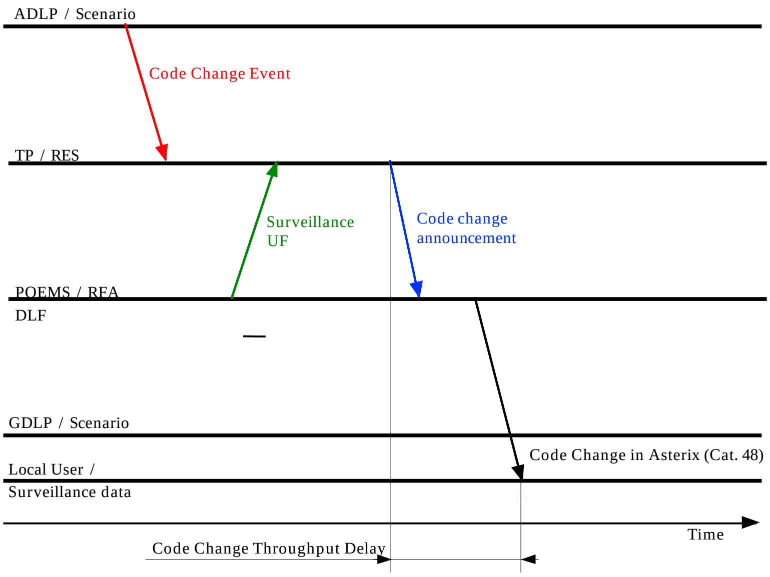
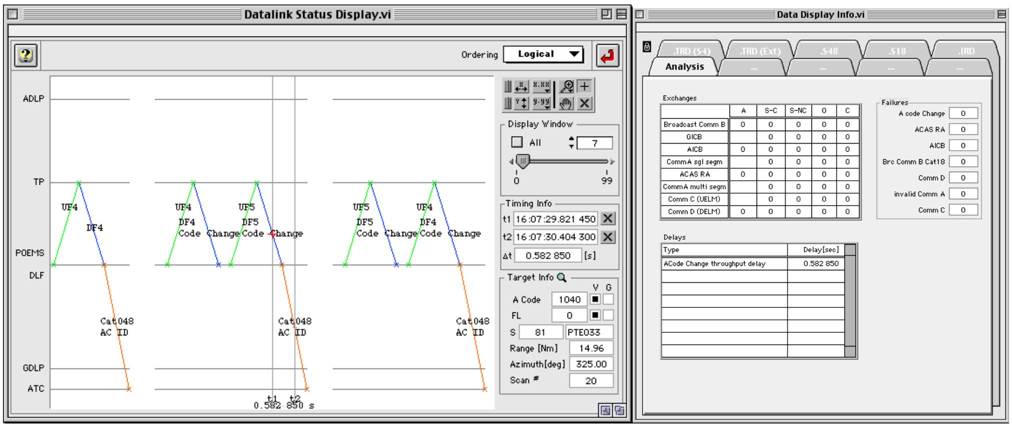


Figure 3-27: Code Change Throughput delay

The announcement of Mode A code change is found in the IRD data (data link type ; bit 30) . All IRD records of the TRD are parsed; if the bit30 is set, the time of reply of the IRD record and Azimuth/Scan of reply is copied into the T(1) field of STATE variable.

The Mode A code change is determined by checking **Bit 23 A Code Swap** in the TRD "data link message" field If a code change is detected (bit 23 is set) , T(1) is subtracted from time of detection of the linked S48 record and put in DELAY(1) field of the result array.

The PTE P2B2 data-link A code change throughput delay analysis calculates from the linked TRD data the delay that the announcement of a Mode A code change and the actual change in the Mode A code reported in an ASTERIX Cat 048 target report for that target took to complete:



The delay is measured by the data link analysis tool. The result is shown in the data link display info field.

3.7.5.1.3 ACAS throughput delay

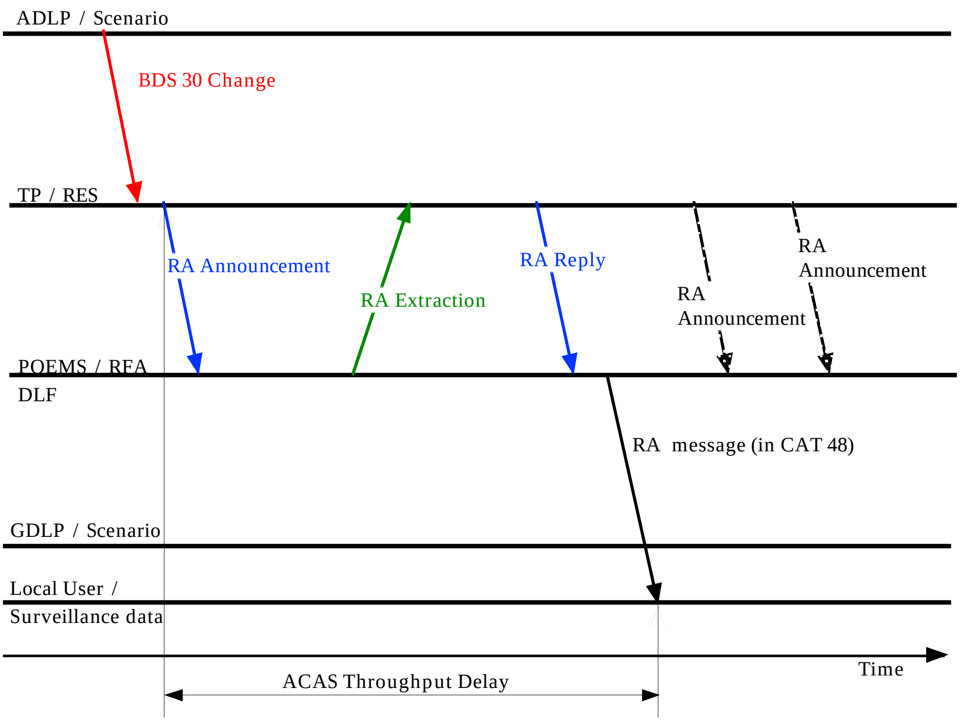


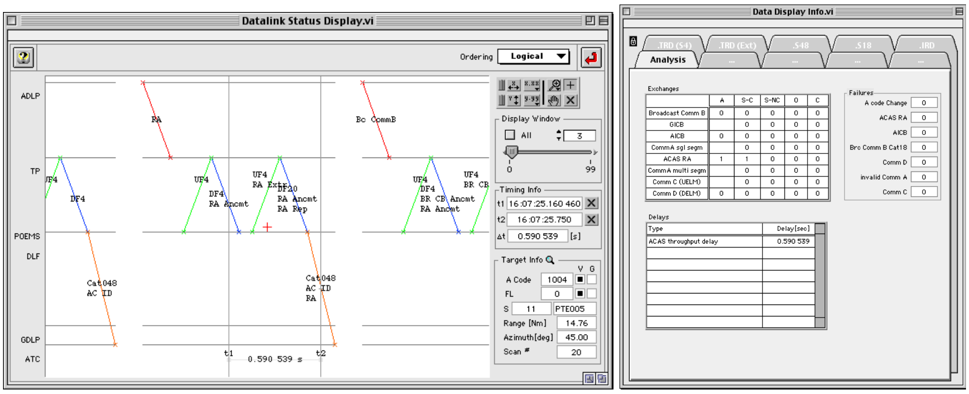
Figure 3-28: ACAS throughput delay

The announcement of the ACAS RA is found in the IRD data (data link type ; bit 3) . All IRD records of the TRD are parsed; if the bit3 is set, the time of reply of the IRD record is copied into the T(2) field of STATE variable.

The output of the ACAS message through the Asterix Cat 48 is detected during data linking by verifying the FSPEC field of the S48 record value (by reading the S48 record linked by the "index48" field in the TRD data). If bit 7 (FRN 22, DI048/260) of the FSPEC48 field is set , the corresponding **Bit 24 ACAS** in the TRD "data link message" field will be set. Therefore we will only monitor this bit to determine the delay.

If **Bit 24 ACAS** is set, the T(2) value is subtracted from time of detection of the S48 record (found in the TRD) and put in the DELAY(2) field of the result array.

The PTE P2B2 data-link ACAS throughput delay analysis calculates from the linked TRD data the delay between the announcement of an ACAS RA and its output through an ASTERIX Cat 048 message for that target:



The ACAS throughput delay is correctly measured between the first announcement of the ACAS and its throughput through the Cat 48. All Consecutive extractions are not measured until a new RA is announced.

3.7.5.1.4 AICB throughput delay

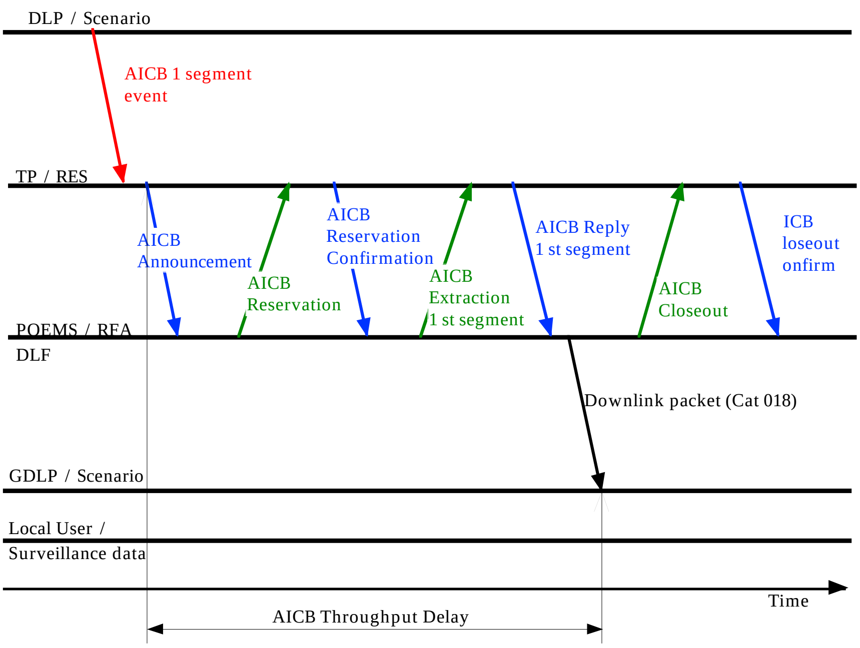
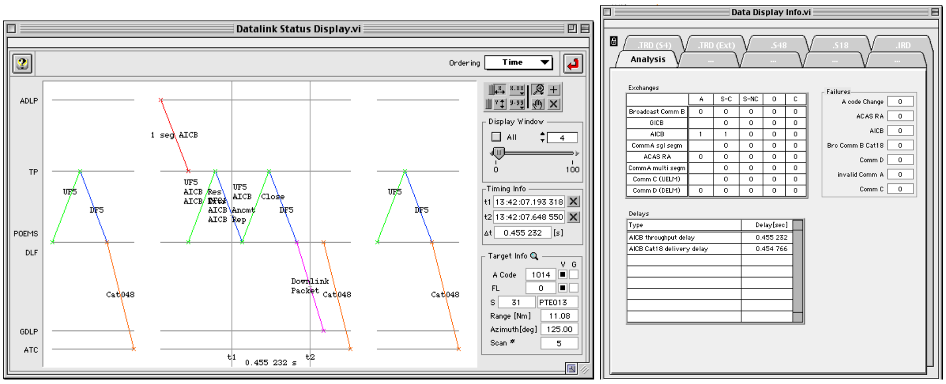


Figure 3-29: AICB throughput delay

The announcement of the AICB is found in the IRD data (data link type ; bit 8) . All IRD records of the TRD are parsed; if the bit 8 is set, the time of reply of the IRD record is copied into the T(3) field of the STATE variable.

The output of the AICB message through the Asterix Cat 18 is detected by verifying the corresponding **bit 12 Downlink Packet** in the TRD “data link message” field. If the bit is set, the S18 records linked to the TRD are parsed one by one using the TRD “Index18” field until the downlink packet command is located. T(3) is subtracted from the time of recording of the packet and its result is put in DELAY(3) field of the result array.

The PTE P2B2 data-link AICB Throughput delay analysis calculates from the linked TRD data the delay that the announcement of an AICB and its output through an ASTERIX Cat 018 message for that target took to complete:



The AICB throughput delay is correctly measured between the first announcement of the ACAS and its throughput through a Cat 18 message. All consecutive extractions are not measured until a new AICB is announced.

3.7.5.1.5 Broadcast Comm B data link Throughput delay

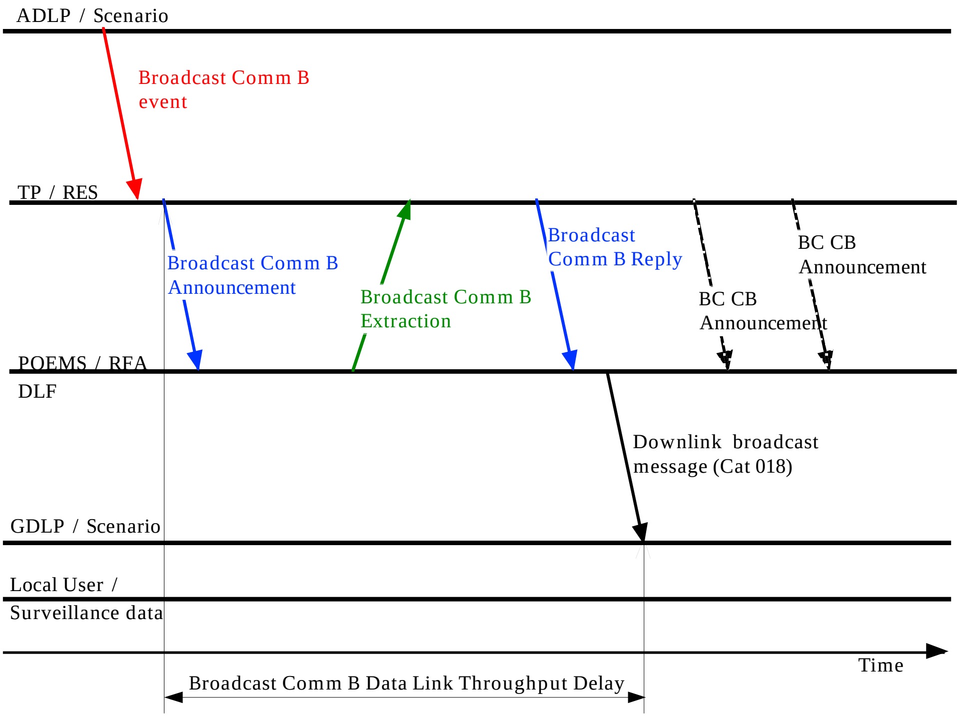
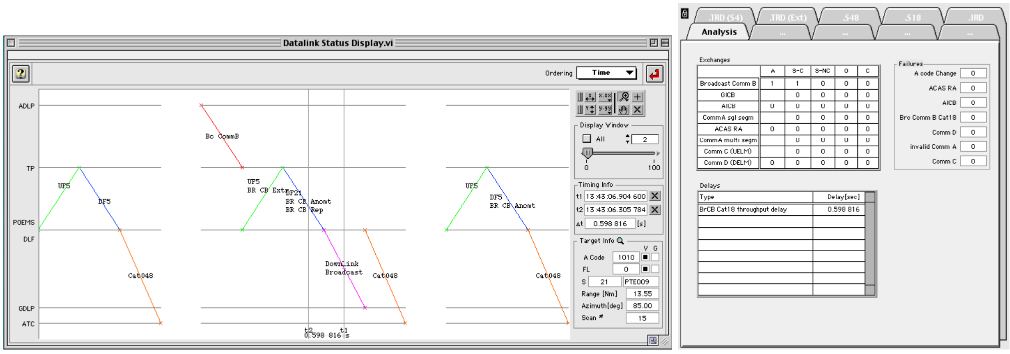


Figure 3-30: Broadcast Comm B data link Throughput delay

The announcement of the broadcast Comm-B is found in the IRD data (data link type ; bit 0) . All IRD records of the TRD are parsed; if the bit 0 is set, the time of reply of the IRD record is copied into T(4) field of the STATE variable.

The output of the BCCB message through the Asterix Cat 18 is detected by verifying the corresponding **bit 18 Downlink Broadcast** in the TRD "data link message" field. If the bit is set, the S18 records linked to the TRD are parsed one by one using the TRD "Index18" field until the downlink Broadcast command is located. T(4) is subtracted from the time of recording of the packet and its result is put in DELAY(4) field of the result array.

The PTE P2B2 data-link Broadcast Comm B Cat 18 throughput delay analysis calculates from the linked TRD data the delay that the announcement of a broadcast Comm-B and its output through an ASTERIX Cat 018 message for that target took to complete:



The BrCCommB throughput delay is correctly measured between the first announcement of the BrCCommB and its throughput through the Cat 18. All Consecutive extractions are not measured until a new BrCCommB is announced.

3.7.5.1.6 Broadcast Comm B Surveillance Throughput delay

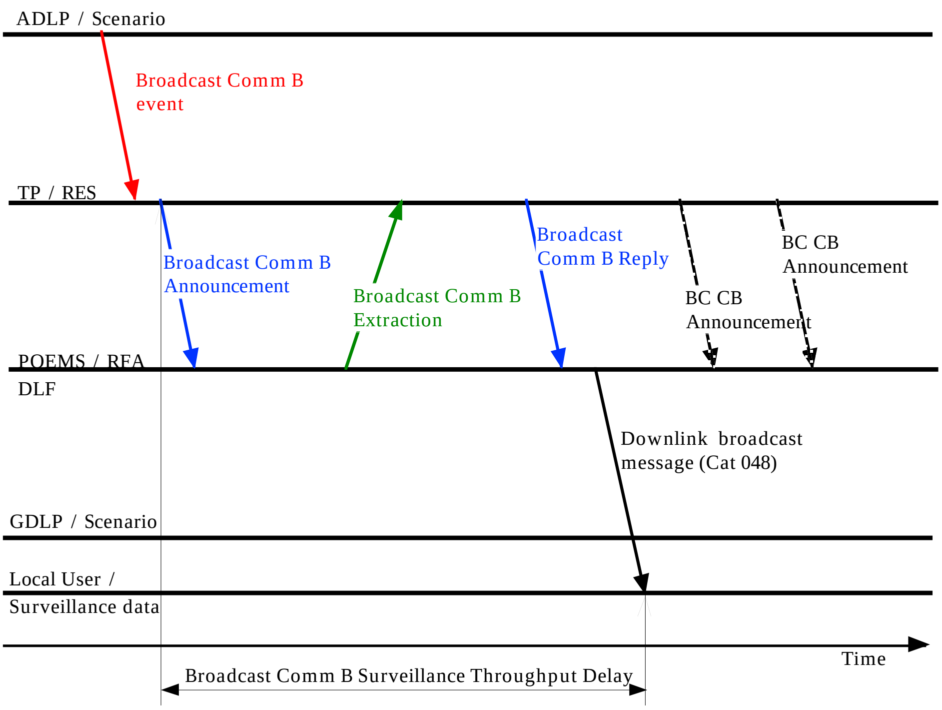


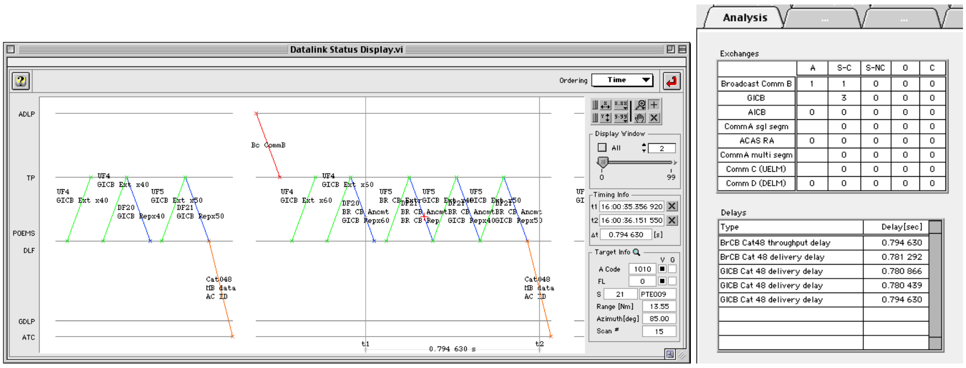
Figure 3-31; Broadcast Comm B Surveillance Throughput delay

The announcement of the broadcast Comm-B is found in the IRD data (data link type ; bit 0) . All IRD records of the TRD are parsed; if the bit 0 is set, the time of reply of the IRD record is copied into T(5) field of the STATE variable.(same action as above).

The output of the BCCB message through the Asterix Cat 48 is detected during data linking by verifying the presence of MB data with BDS 10 or 20 (by reading the S48 record linked by the "index48" field in the TRD data and then further by reading the MB data linked to the S48 record). If BDS 10 or 20 data is found , the corresponding **Bit 26 BDS10 or Bit 27 BDS20** in the TRD "data link message" field will be set. Therefore we will only monitor this bit to determine the delay.

If **Bit 26 or Bit 27** is set, the T(5) value is subtracted from time of detection of the S48 record (found in the TRD) and put in the DELAY(5) field of the result array.

The PTE P2B2 data-link Broadcast Comm B Cat 48 throughput delay analysis calculates from the linked TRD data the delay that the announcement of a broadcast Comm-B (BDS 10 or 20) and its output through an ASTERIX Cat 048 message for that target took to complete:



The BrCCommB throughput delay is correctly measured between the first announcement of the BrCCommB and its throughput through the Cat 48. All Consecutive extractions are not measured until a new BrCCommB is announced.

3.7.5.1.7 Comm D throughput delay

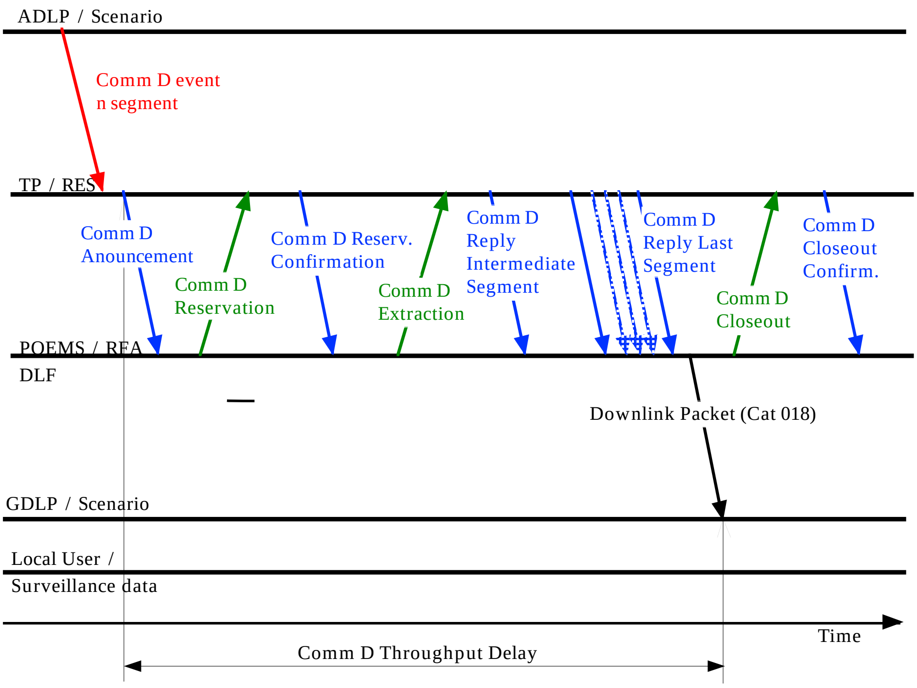
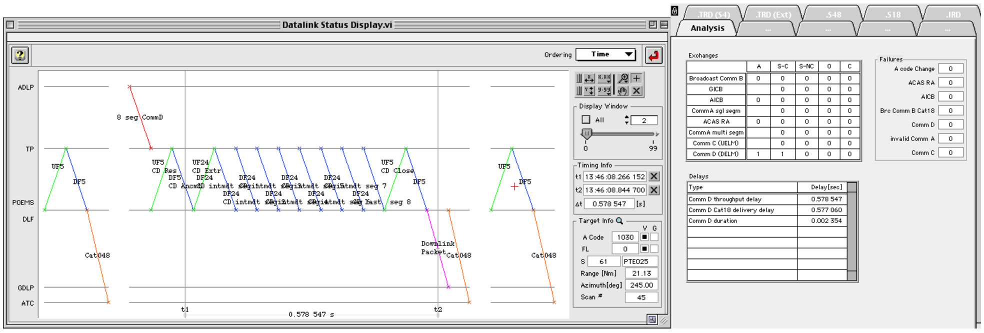


Figure 3-32: Comm D throughput delay

The announcement of the Comm-D is found in the IRD data (data link type ; bit 24) . All IRD records of the TRD are parsed; if the bit 24 is set, the time of reply of the IRD record is copied into T(6) field of the STATE variable.

The output of the Downlink Packet message through the Asterix Cat 18 is detected by verifying the corresponding **bit 12 Downlink packet** in the TRD “data link message” field. If the bit is set, the S18 records linked to the TRD are parsed one by one using the TRD "Index18" field until a downlink Broadcast command with PACKET_LENGTH > 27 is located. The T(6) is subtracted from the time of recording of the Cat18 command and its result is put in the DELAY(6) field of the result array.

The PTE P2B2 data-link Comm D Throughput delay analysis calculates from the linked TRD data the delay that the announcement of a Comm-D and its output through an ASTERIX Cat 018 message for that target took to complete:



The Comm D throughput delay is correctly measured between the first announcement of the Comm D and its throughput through a Cat 18 message. All consecutive extractions are not measured until a new Comm D is announced.

3.7.5.1.8 COMM A thoughput delay

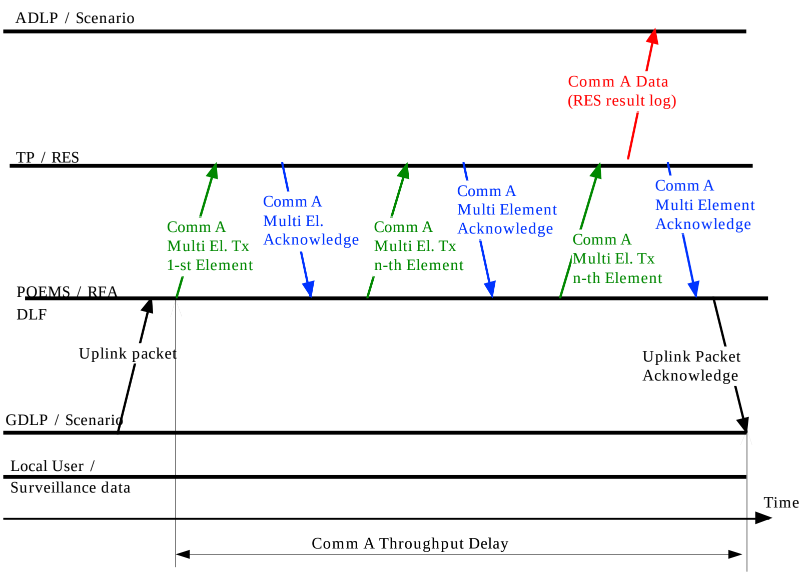
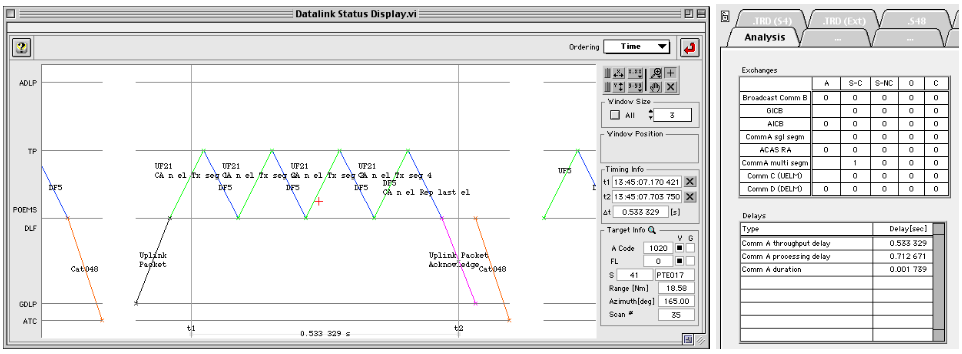


Figure 3-33 COMM A troughput

The transmission of the first segment of a multi-segment COMM-A is found in the IRD data (data link type ; bit 15) . All IRD records of the TRD are parsed; if the bit 15 is set, the time of interrogation of the IRD record is copied into T(7) field of the STATE variable.

The reply to the last segment of the Comm A is found in the IRD data (data link type ; bit 17) . All IRD records of the TRD are parsed; if the bit 17 is set, the LAS field is used to check the segment number. A list is updated in the COMMA_LAS fields in the STATE array each time a segment is detected. This list reflects the sequence of the segments. Each time a LAS=1 is encountered, the list is cleared. The last segment is found if the list includes one of the following sequences: 1,5 ; 1,2,6; 1,6,2 ; 1,2,3,4 ;1,3,2,4; 1,2,4,3; 1,3,4,2 ; 1,4,2,3 ; 1,4,3,2. If the last segment is found, the T(7) field is subtracted from the time of detection of the last segment reply command and its result is put in the DELAY(7) field of the result array..

The PTE P2B2 data-link Comm A throughput delay analysis calculates from the linked TRD data the delay between the transmission of the first segment of the Comm A and the reception of the Cat 18 Uplink Packet Acknowledge with Cause set to 3x:



The Comm A throughput delay is correctly measured between the first transmission of 1st segment of the Comm A and the output of a Cat 18 message Uplink Packet acknowledge.

3.7.5.1.9 COMM C throughput delay

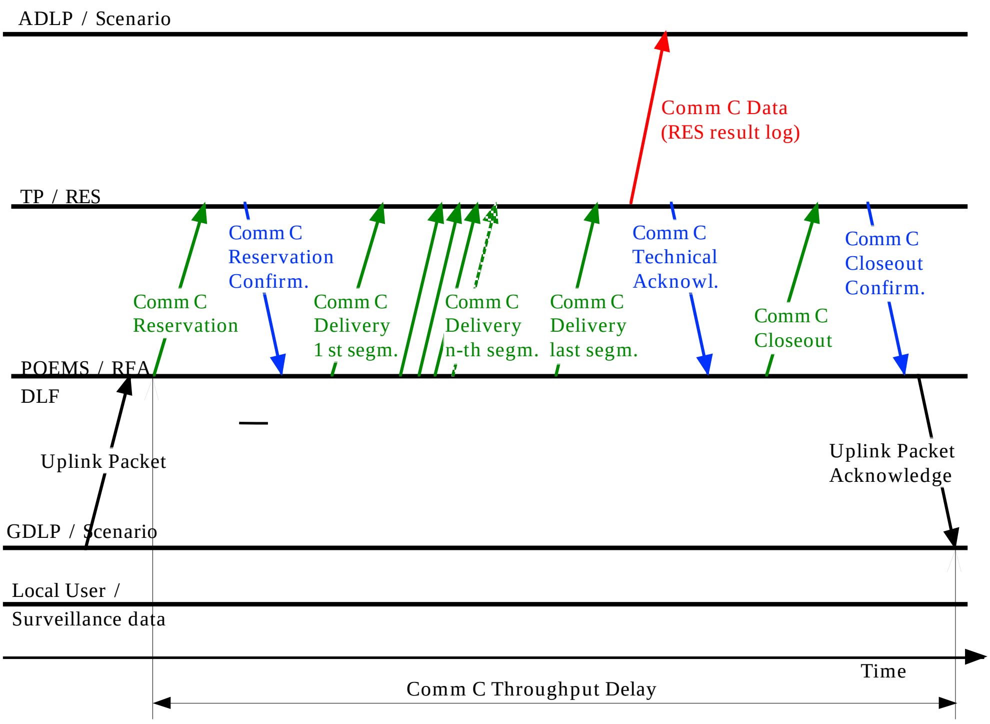
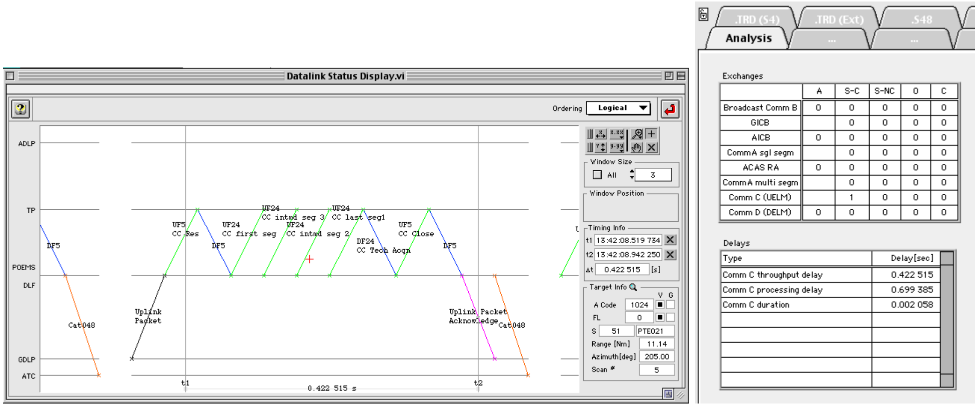


Figure 3-34: COMM C throughput delay

The reservation of the Comm-C is found in the IRD data (data link type ; bit 18) . All IRD records of the TRD are parsed; if the bit 18 is set, the time of reply of the IRD record is copied into the T(8) field of the STATE variable.

The output of the Uplink Packet Acknowledge message through the Asterix Cat 18 is detected by verifying the corresponding **bit 17 Uplink Packet Acknowledge** in the TRD “data link message” field. If the bit is set, the S18 records linked to the TRD are parsed one by one using the TRD “Index18” field until a Uplink Packet Acknowledge command with is located. The T(8) is subtracted from the time of recording of the Cat18 command and its result is put in the DELAY(8) field of the result array.

The PTE P2B2 data-link Comm C Throughput delay analysis calculates from the linked TRD data the delay that the transmission of a COMM-C reservation by the station and transmission of a Cat 018 message acknowledging the transaction took to complete:



The Comm C throughput delay is correctly measured between the <u>first</u> transmission of a reservation of the Comm C and the output of a Cat 18 message Uplink Packet acknowledge.

3.7.5.2 Processing Delay

3.7.5.2.1 Related Specs

[PTE-SR-P2B2-CAP-0443] The PTE P2B2 data-link performance analysis **shall** separately calculate (from the ASTERIX Cat 018 message - A18 – and Mode S Interrogation / Reply information – IRD (simulated traffic) or IRDV (live traffic) information), individually and for all data-link exchange types, the delay (in seconds with a granularity of 0,01 s, and in number of scans and degrees - e.g. 1 scan and 12° - with a granularity of 1°) that the first up-link component of the following types of data-link exchange were delayed :

a) GICB (BDS >= 4,0)
b) Comm-A
c) Comm-C

Note: The definition of “delay” in the previous requirement is the difference between the time of reception of the ASTERIX Cat 018 message (i.e. time stamping of the corresponding message) requesting the data-link exchange by the POEMS SUT and the time stamping of the interrogation performed by the POEMS SUT corresponding to the first component of the exchange.

§	Delay type	Start	End
0a	GICB processing delay	Cat 018 with DI000 = 40h (GICB extraction) is received by POEMS	Interrogation UF 4, 5, 20 or 21 with 17 <= RR <= 31 RR and RRS define the BDS registers to be extracted which must correspond to the BDS specified in the Cat 018
0b	Comm-Aprocessing delay	Cat 018 with DI000 = 20h (up-link packet) is received by POEMS including a short packet	Interrogation UF 20 or 21 (Comm-A)
0c	Comm-Cprocessing delay	Cat 018 with DI000 = 20h (up-link packet) is received by POEMS including a long packet	Interrogation UF 4, 5, 20, 21 DI = 1 MES = 1 or 5

[PTE-SR-P2B2-CAP-0444] The result of the above analysis **shall** be available in an histogram display form (x-axis delays/types, y-axis number of corresponding exchanges).

[PTE-SR-P2B2-CAP-0445] In addition, it **shall** calculate and display statistics (sample size; minimum, maximum, mean. values; standard deviation around the mean, plus minimum, mean and population of non zero values) on these delays.

3.7.5.2.2 GICB processing delay

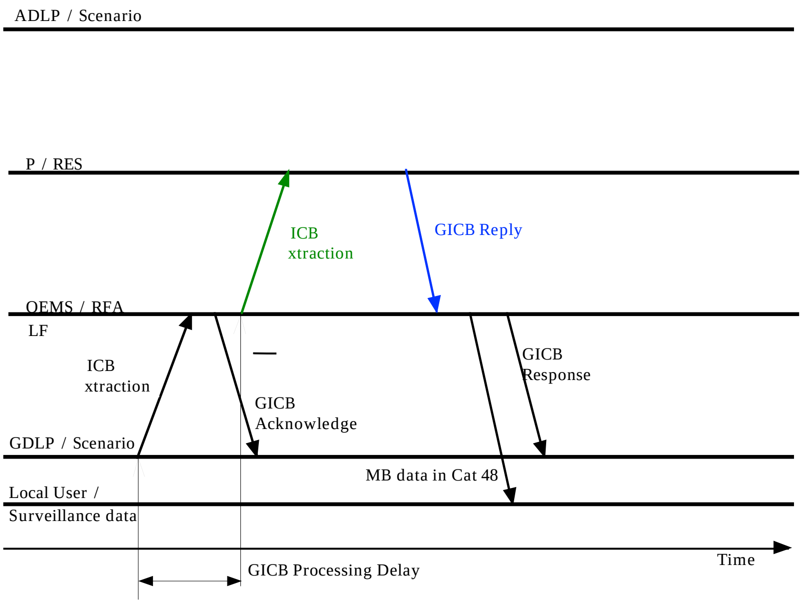
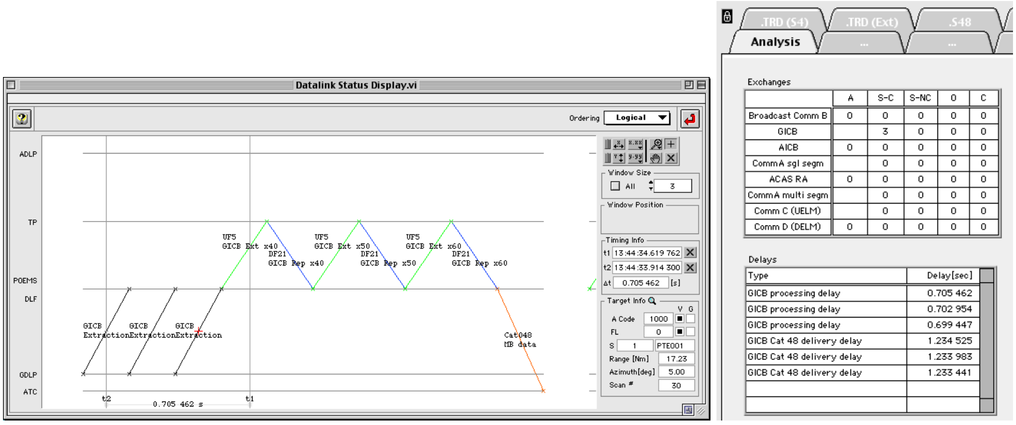


Figure 3-35: GICB processing delay

The output of the GICB Extract command message through the Asterix Cat 18 is detected by verifying the corresponding **Bit 19 GICB_Extraction** in the TRD "data link message" field. If the bit is set, the S18 records linked to the TRD are parsed one by one using the TRD "Index18" field until a GICB Extract command is located. The time of recording of the command is copied into the T(9) field of the STATE array.

The transmission of the GICB extract interrogation is found in the IRD data (data link type ; bit 6) . All IRD records of the TRD are parsed; if the bit 6 is set, the T(9) field is subtracted from the time of interrogation of the IRD record and its result is put in the DELAY(9) field of the result array.

The PTE P2B2 data-link GICB Processing delay analysis calculates from the linked TRD data the delay that the that the first up-link component of GICB (BDS >= 4,0) data-link exchange were delayed.



The GICB processing delay is correctly generated from the time difference between the Cat 18 Uplink Packet and the extraction interrogation.

3.7.5.2.3 COMM A processing delay

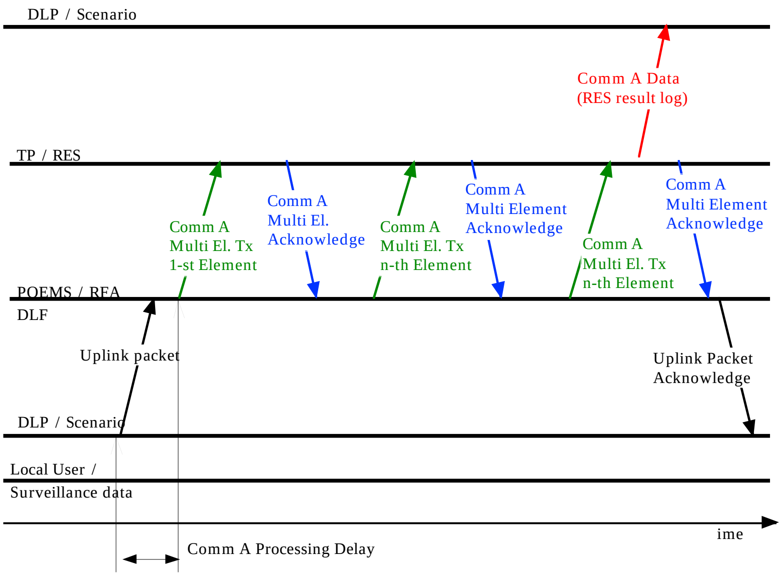
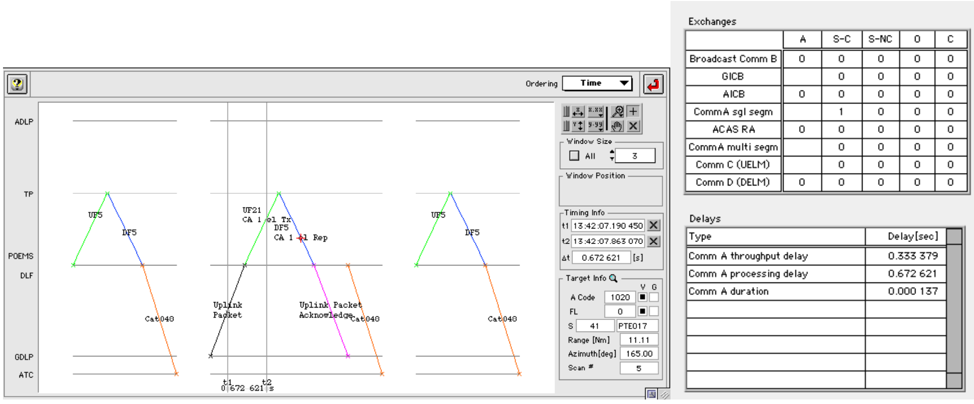


Figure 3-36: COMM A processing delay

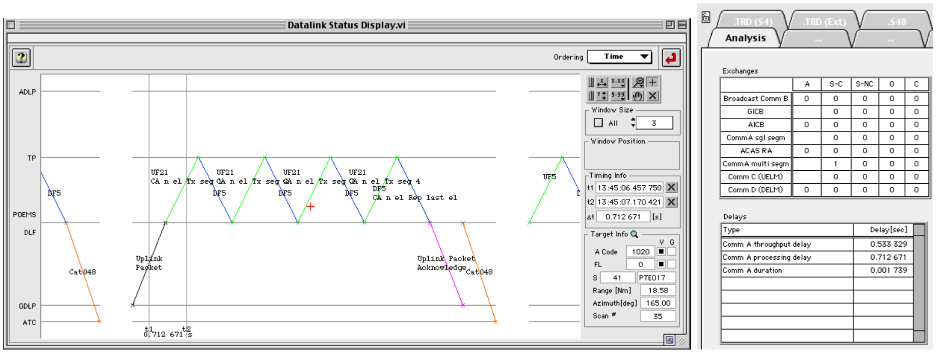
The output of the Short Uplink_packet command message through the Asterix Cat 18 is detected by verifying the corresponding **bit 9 Uplink Packet** in the TRD “data link message” field. If the bit is set, the S18 records linked to the TRD are parsed one by one using the TRD “Index18” field until a Short Uplink_packet command is located. The time of recording of the command is copied into the T(10) field of the STATE array.

The transmission of the first CommA interrogation is found in the IRD data (data link type ; bit 15) . All IRD records of the TRD are parsed; if the bit 15 is set, the T(10) field is subtracted from the time of interrogation of the IRD record and its result is put in the DELAY(10) field of the result array.

The PTE P2B2 data-link Comm A Processing delay analysis calculates from the linked TRD data the delay that the that the first up-link component of the Comm-A data-link exchange were delayed



The Comm A processing delay is correctly measured between the Cat 18 Uplink packet and the 1st segment of the Comm A. The test is repeated for multi segment Comm A:



3.7.5.2.4 COMM C processing delay

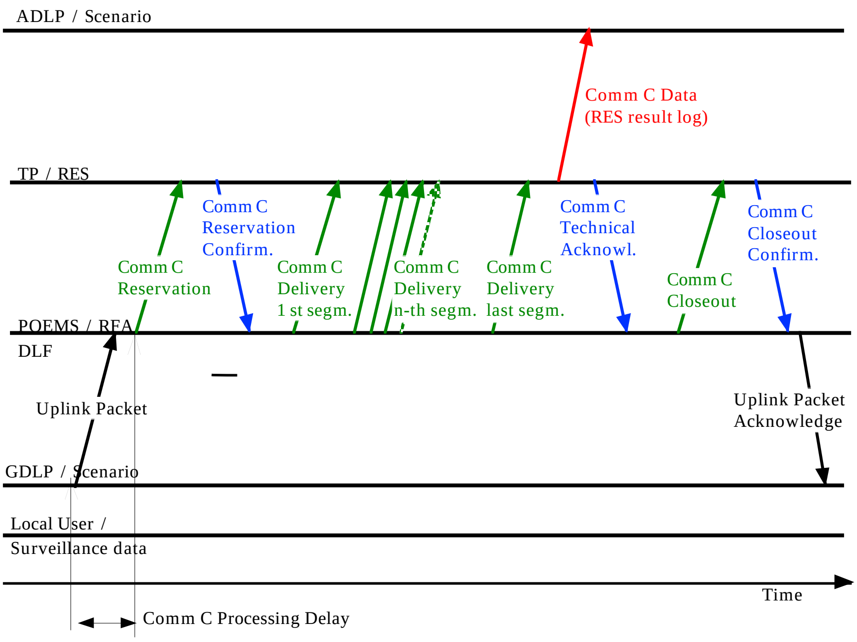


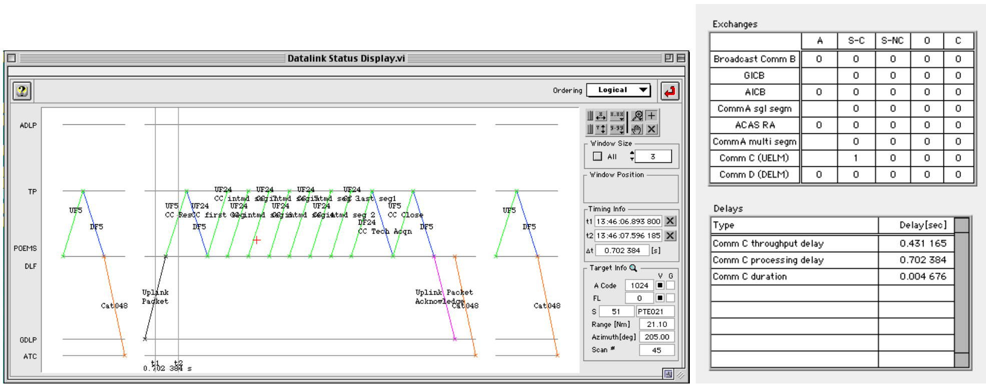
Figure 3-37: COMM C processing delay

The output of the Long Uplink_packet command message through the Asterix Cat 18 is detected by verifying the corresponding **bit 9 Uplink Packet** in the TRD "data link message" field. If the bit is set, the S18 records linked to the TRD are parsed one by one using the TRD "Index18" field until a Long Uplink_packet command is located.

The time of recording of the command is copied into the T(11) field of the STATE array.

The transmission of the CommC reservation interrogation is found in the IRD data (data link type ; bit 18) . All IRD records of the TRD are parsed; if the bit 18 is set, the T(11) field is subtracted from the time of interrogation of the IRD record and its result is put in the DELAY(11) field of the result array.

The PTE P2B2 data-link Comm C processing delay analysis calculates from the linked TRD data the delay that the first up-link component of the Comm-C data-link exchange were delayed.



The Comm C processing delay is correctly measured between the Cat 18 message (Uplink Packet) and the reservation interrogation of the Comm C.

3.7.5.3 Delivery Delays

3.7.5.3.1 Related Specs

[PTE-SR-P2B2-CAP-0446] The PTE P2B2 data-link performance analysis **shall** separately calculate (from the and Mode S Interrogation / Reply information – IRD (simulated traffic) or IRDV (live traffic) information - and the ASTERIX message data - A18 or A48), individually and for all data-link exchange types, the delay (in seconds with a granularity of 0,01 s, and in number of scans and degrees - e.g. 1 scan and 12° - with a granularity of 1°) between the end of a down-link exchange (time stamping of the reply of last segment of last frame) and the output of the relevant ASTERIX Cat 018/048 message (time stamping of the corresponding message) for the following data-link exchanges types :

a) broadcast Comm-B (A48)
b) GICB (BDS >= 4,0) (A48)
c) AICB (A18)
d) Comm-D (A18)

§	Event to be counted	Start	End
0a	Broadcast Com mB delivery delay	Reply DF 20, 21 corresponding to the previous broadcast Comm-B	Cat 048 with DI250 containing BDS 1,0 or with DI240 present (BDS 2,0)
0b	GICB Delivery Delay	Reply DF 20, 21 corresponding to the requested BDS in Interrogation UF 4, 5, 20 or 21 with 17 <= RR < =31 RR and RRS define the BDS registers to be extracted	Cat 048 with DI250 containing the requested BDS

§	Event to be counted	Start	End
0c	AICB delivery delay	Reply DF 4, 5, 20, 21 corresponding to the Comm-B close out interrogation : UF 4, 5, 20 or 21 with (PC = 4 non selective) or (DI = 1 and MBS = 2 multi-site)	Cat 018 with DI000 = 23h (down-link packet) is sent by POEMS including a short packet
0d	Comm D delivery delay	Reply DF 24 corresponding to the last Comm-D segment after successful transmission of all other segments	Cat 018 with DI000 = 23h (down-link packet) is sent by POEMS including a long packet

[PTE-SR-P2B2-CAP-0447] The result of the above analysis **shall** be available in a histogram display form (x-axis delays/types, y-axis number of corresponding exchanges).

[PTE-SR-P2B2-CAP-0448] In addition, it **shall** calculate and display statistics (sample size ; minimum, maximum, mean values ; standard deviation around the mean, plus minimum, mean and population of non zero values) on these delays.

3.7.5.3.2 Broadcast Comm B delivery delay

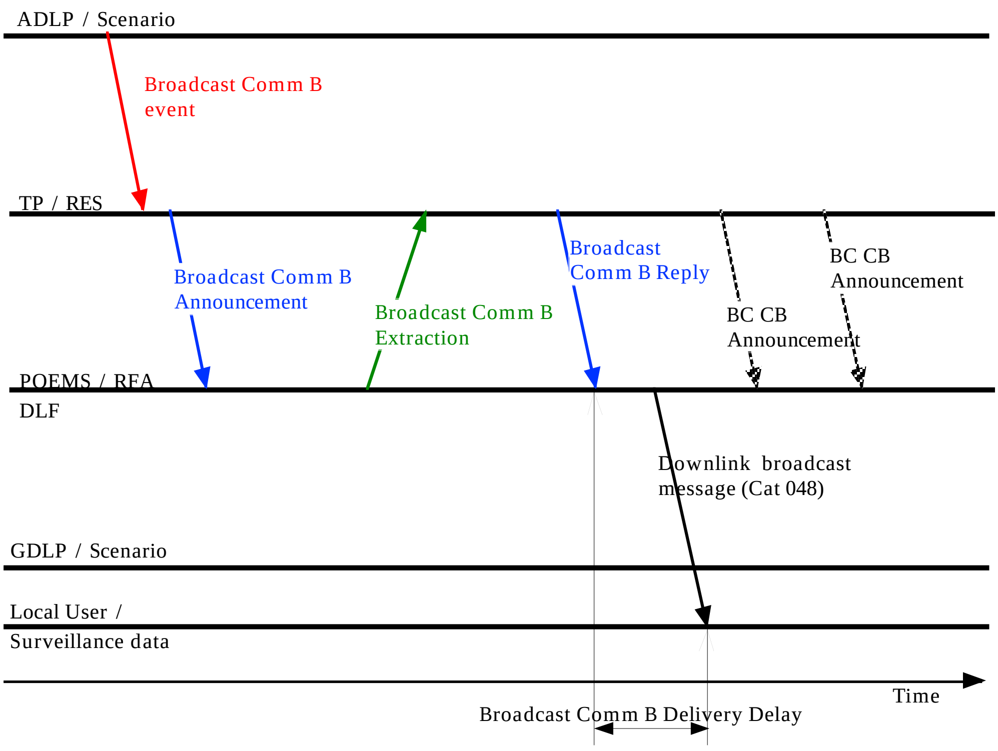


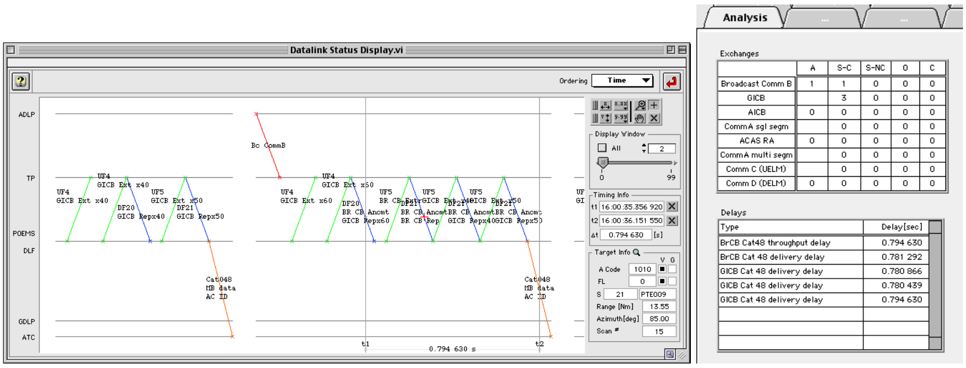
Figure 3-38: Broadcast Comm B delivery delay

The Reply to the broadcast Comm-B is found in the IRD data (data link type ; bit 2) . All IRD records of the TRD are parsed; if the bit 2 is set, the time of reply of the IRD record is copied into T(12) field of the STATE variable.(same action as above).

The output of the BCCB message through the Asterix Cat 48 is detected during data linking by verifying the presence of MB data with BDS 10 or 20 (by reading the S48 record linked by the "index48" field in the TRD data and then further by reading the MB data linked to the S48 record). If BDS 10 or 20 data is found , the corresponding **Bit 26 BDS10 or Bit 27 BDS20** in the TRD "data link message" field will be set. Therefore we will only monitor this bit to determine the delay.

If **Bit 26 or Bit 27** is set, the T(12) value is subtracted from time of detection of the S48 record (found in the TRD) and put in the DELAY(12) field of the result array.

The PTE P2B2 data-lin kBroadcast Comm B delivery delay analysis calculates from the linked TRD data the delay between the end of the down-link transaction and the output of the relevant ASTERIX Cat 048 message for broadcast Comm-B



The BrCCommB delivery delay is correctly measured between the reply to extraction of the BrCCommB and its output through the Cat 48. All extraction with correct Cat 48 data are measured.

3.7.5.3.2.1 GICB delivery delay

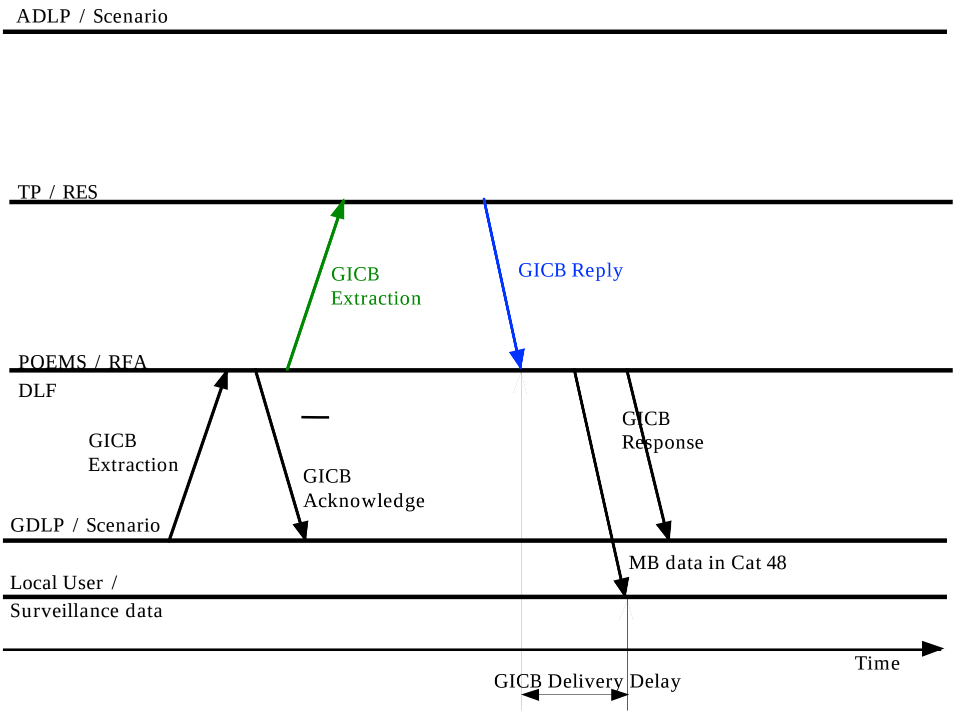


Figure 3-39: GICB delivery delay

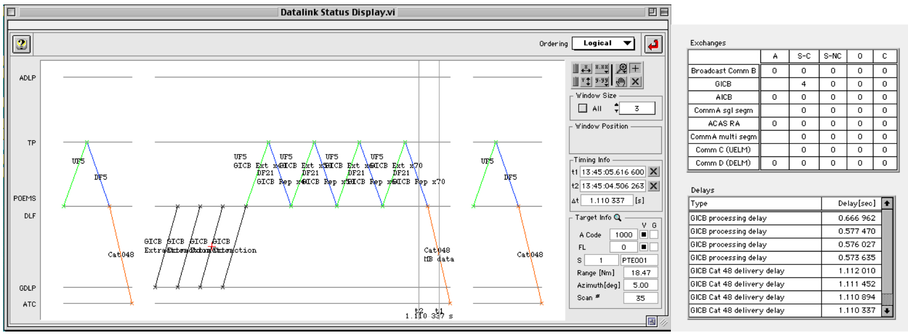
The GICB reply is found in the IRD data (data link type ; bit 7) . All IRD records of the TRD are parsed; if the bit 7 is set, the time of reply of the IRD record is copied into T(13) field of the STATE variable.(same action as above). The contents of the GICB reply is also copied into the MB field of the STATE variable.

The output of the GICB message through the Asterix Cat 48 is detected during data linking by verifying the presence of MB data with BDS 40,50,60 or others (by reading the S48 record linked by the “index48” field in the TRD data and then further by reading the MB data linked to the S48 record). If BDS 40 ,50 or 60 data is found(the most commonly used BDSes for this type of testing) , the corresponding **Bit 28 BDS40 Bit 29 BDS50 or Bit 30 BDS60** in the TRD “data link message” field will be set. If other BDS data is also present, Bit 31 other BDS will be set .

To simplify the analysis, the output of the GICB will therefore monitored in a first instance by looking only at the TRD Data link message field bits 28 through 31. If bit 31 is set, the corresponding S48 record needs to be read. The S48 record contains the BDS headers (first byte of MB data). If BDS 40,50 or 60 is used, the bits in the TRD are sufficient to detect the presence of the GICB message.

If **Bits 28 through 31** is set, the T(13) value is subtracted from time of detection of the S48 record (found in the TRD) and put in the DELAY(13) field of the result array.

The PTE P2B2 data-link GICB delivery delay analysis calculates from the linked TRD data the delay between the end of the down-link transaction and the output of the relevant ASTERIX Cat 048 message for GICB (BDS >= 4,0)



The GICB delivery delay is correctly determined from the time between the reply to the GICB extraction interrogation and the time of detection of the Cat 48 message containing the GICB data.

3.7.5.3.3 AICB delivery delay

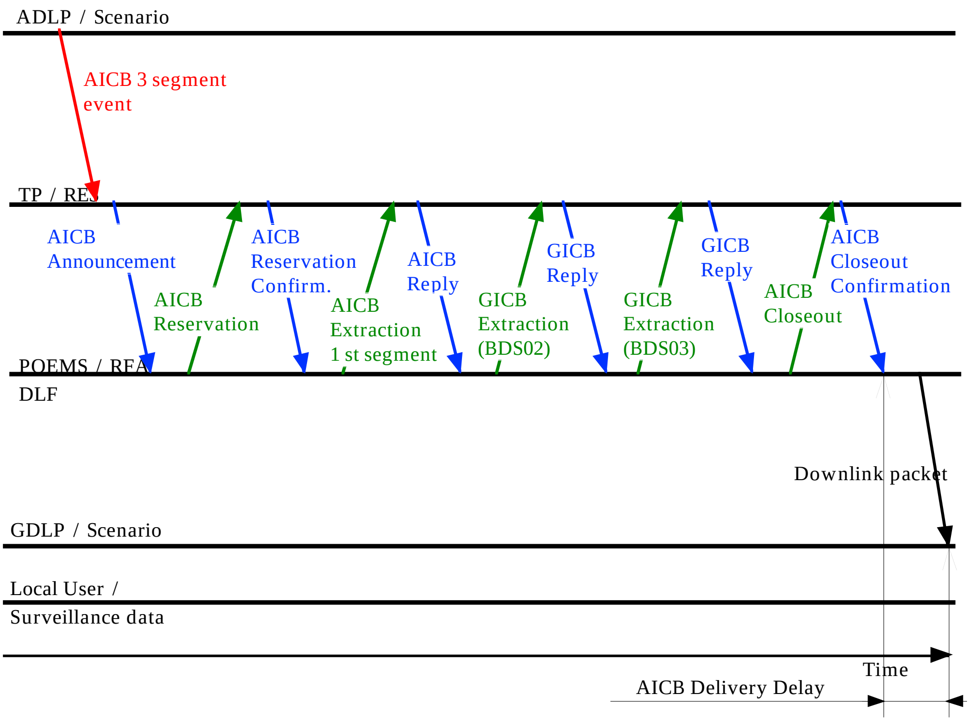
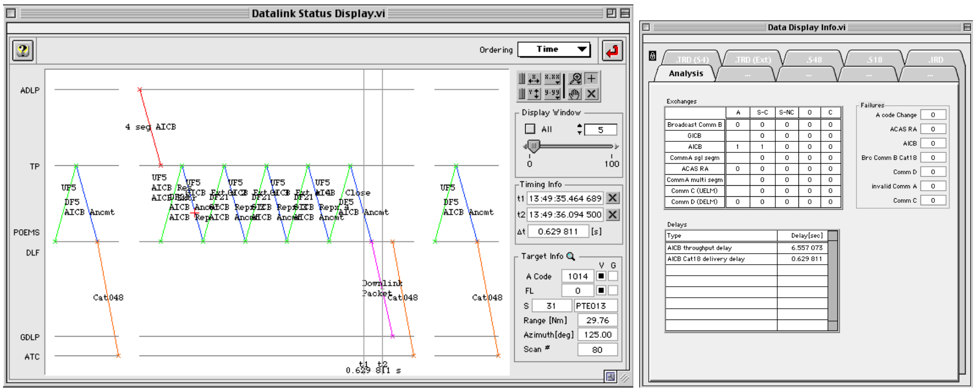


Figure 3-40: AICB delivery delay

The AICB Closeout confirmation is found in the IRD data (data link type ; bit 12) . All IRD records of the TRD are parsed; if the bit 12 is set AND a Reply is present in the IRD record, the time of reply of the IRD record is copied into the T(14) field of the STATE variable.

The output of the AICB message through the Asterix Cat 18 is detected by verifying the corresponding **bit 12 Downlink Packet** in the TRD "data link message" field. If the bit is set, the S18 records linked to the TRD are parsed one by one using the TRD "Index18" field until the downlink packet command is located. T(14) is subtracted from the time of recording of the packet and its result is put in DELAY(14) field of the result array.

The PTE P2B2 data-link delay analysis calculates from the linked TRD data the delay between the end of the down-link transaction and the output of the relevant ASTERIX Cat 018 message for AICB



The AICB delivery delay is correctly measured between the closeout of the AICB of the ACAS and its throughput through a Cat 18 message.

3.7.5.3.4 Comm D delivery delay

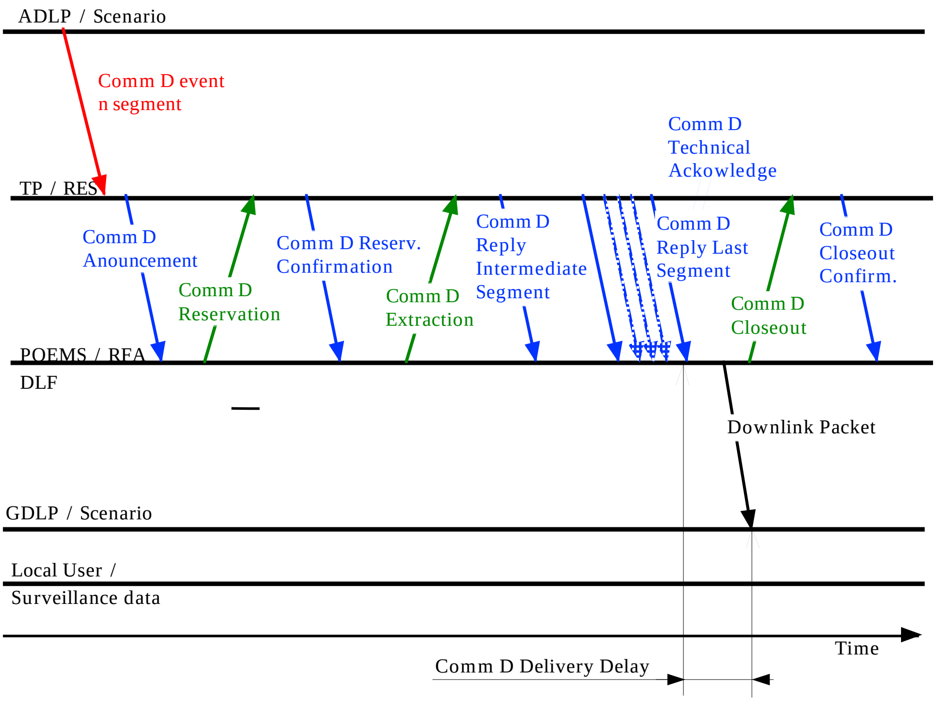
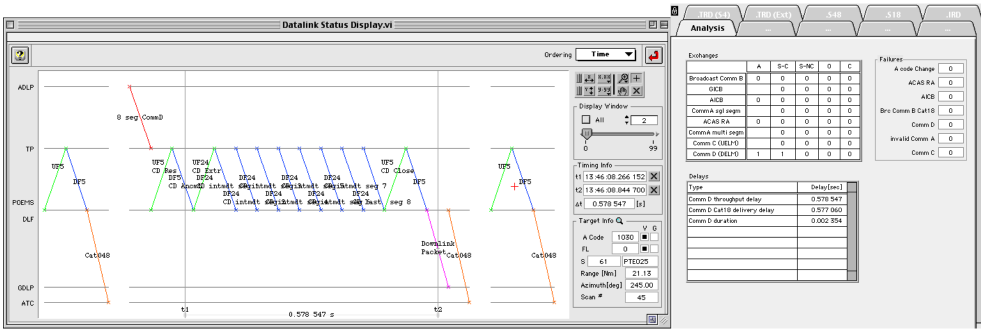


Figure 3-41: Comm D delivery delay

Comm D Technical acknowledge (or reply last segment) is found in the IRD data (data link type ; bit 28) . All IRD records of the TRD are parsed; if the bit 28 is set, the time of reply of the IRD record is copied into T(15) field of the STATE variable.

The output of the Downlink Packet message through the Asterix Cat 18 is detected by verifying the corresponding **bit 12 Downlink packet** in the TRD "data link message" field. If the bit is set, the S18 records linked to the TRD are parsed one by one using the TRD "Index18" field until adownlink Broadcast command with PACKET_LENGTH > 27 is located. The T(15) is subtracted from the time of recording of the Cat18 command and its result is put in the DELAY(15) field of the result array.

The PTE P2B2 data-link delay analysis calculates from the linked TRD data the delay between the end of the down-link transaction and the output of the relevant ASTERIX Cat 018 message for Comm-D



The Comm D delivery delay is correctly measured between the delivery of the Comm D last segment of the Comm D and its output through a Cat 18 message.

3.7.5.4 Data link Duration

3.7.5.4.1 Related Specs

[PTE-SR-P2B2-CAP-0449] The PTE P2B2 data-link performance analysis **shall** separately calculate (from the and Mode S Interrogation / Reply information – IRD (simulated traffic) or IRDV (live traffic) information), the duration (in seconds with a granularity of 0,01 s, and in number of scans and degrees - e.g. 1 scan and 12° - with a granularity of 1°), globally for all targets, of Comm A, Comm-C and Comm-D exchanges. The definition of the duration of a Comm A , Comm-C or Comm-D exchange is the time delay between the relevant reservation and close-out interrogations performed by the POEMS SUT (based on time stamping of the interrogations). relevant reservation and the technical acqnowledge reply provided by the transponder.

§	Delay type	Start	End
a)	Comm C duration	Interrogation UF 4, 5, 20, 21 DI = 1 MES = 1 or 5 (up-link ELM reservation)	Reply to UF24 & KE=1 (Technical acqnowledge Transponder) or Reply to Interrogation UF 4, 5, 20, 21 with (DI = 1 MES = 2, 6 or 7 multi-site) or (PC = 5 non selective) (up-link ELM close-out)
b)	Comm D duration	Interrogation UF 4, 5, 20, 21 DI = 1 MES = 3 or 6 (down-link ELM reservation)	Reply to Interrogation UF 4, 5, 20, 21 with (DI = 1 MES = 4, 5 or 7 multi-site) or (PC = 6 non selective) (down-link ELM close-out)

§	Delay type	Start	End
c)	Comm A duration	Interrogation UF 20, 21 DI = 1 or 7 and LAS (3 last bits of TMS) = 1 (first segment of a Comm-A multi-segment)	Reply to the last segment if the sequence of previous Comm-A / reply is one of the following (after elimination of duplicates) : LAS = 5 LAS = 2, 6 LAS = 6, 2 LAS = 2, 3, 4 LAS = 3, 2, 4 LAS = 2, 4, 3 LAS = 3, 4, 2 LAS = 4, 2, 3 LAS = 4, 3, 2

[PTE-SR-P2B2-CAP-0450] The result of the above analysis shall be available:

in an histogram display form (x-axis duration of the exchange, y-axis number of corresponding exchange).

Inserted as calculated fields in the resulting TRD dataset. The total number of delay result fields shall be limited to 8 per TRD. Maximum 4 identical delays (e.g GICB processing delays) shall be contained in one TRD record.

3.7.5.4.2 Comm C Duration

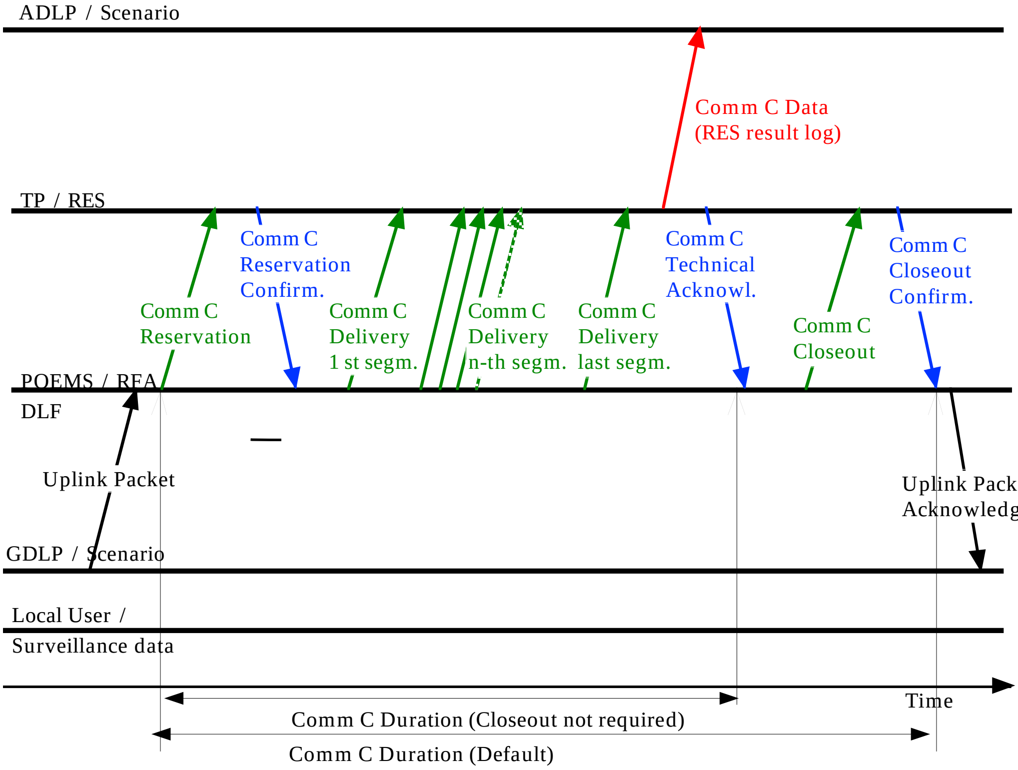


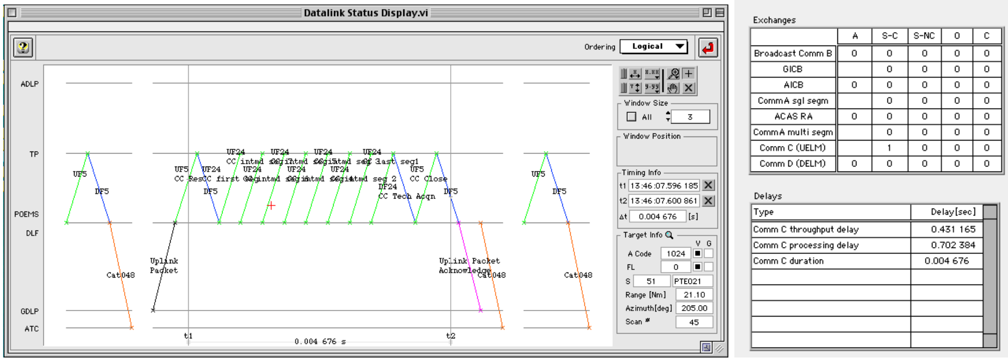
Figure 3-42: Comm C Duration

The transmission of the CommC reservation interrogation is found in the IRD data (data link type ; bit 18) . All IRD records of the TRD are parsed; if the bit 18 is set, the time of interrogation of the IRD record is copied into T(16) field of the STATE variable.

The Reception of the CommC closeout confirmation reply is found in the IRD data (data link type ; bit 23) . All IRD records of the TRD are parsed; if the bit 23 is set

AND the IRD record contains a reply, the T(16) field is subtracted from the time of reply of the IRD record and its result is put in the DELAY(16) field of the result array.

The PTE P2B2 data-link Comm C duration analysis calculates from the linked TRD data the duration globally for all targets, of Comm-C exchanges. The definition of the duration of a Comm-C exchange is the time delay between the relevant reservation and close-out interrogations performed by the POEMS SUT .



The Comm C duration is correctly measured as the delay between the reservation interrogation of the Comm C and the reply to the Comm C closeout. The delay can be viewed in the result viewer or the Data Display. The values can be summarized in the result viewer.

3.7.5.4.3 Comm D duration

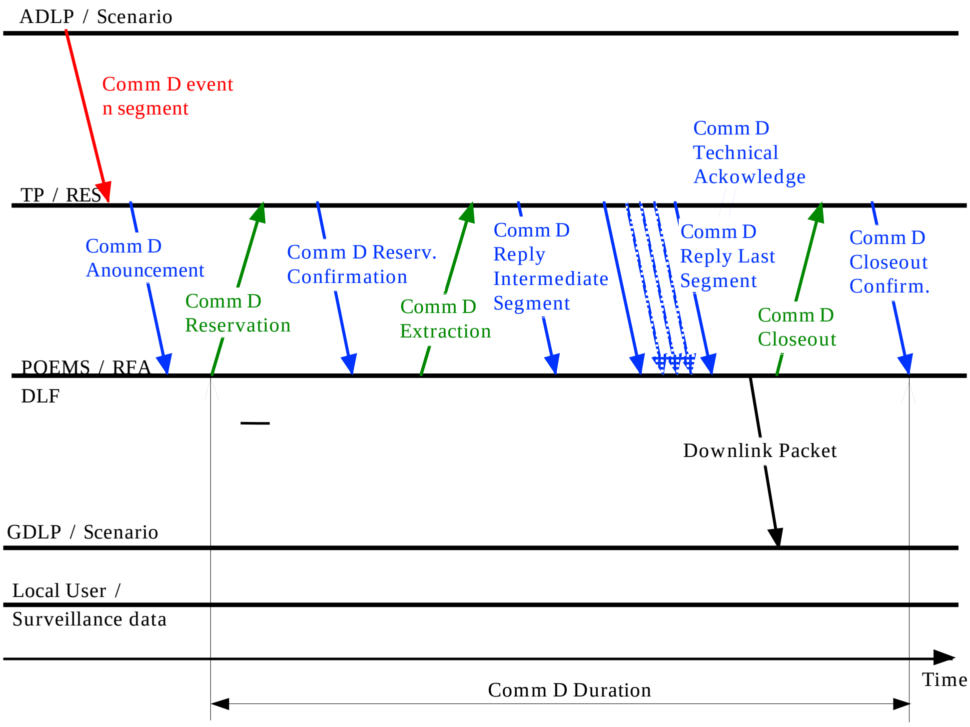


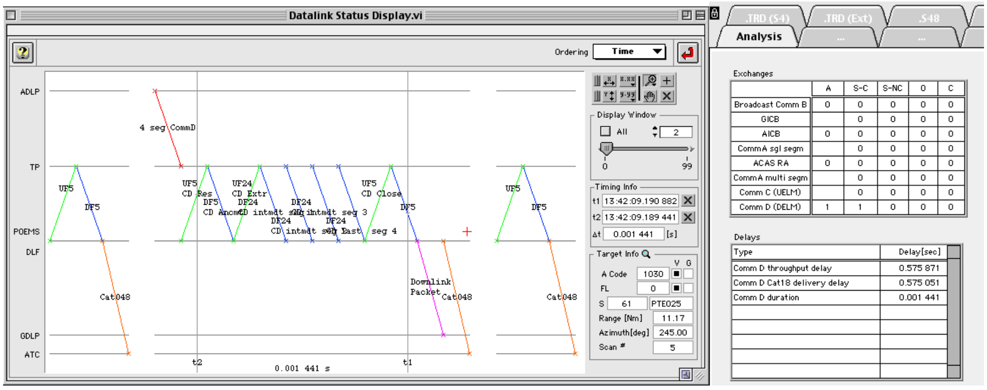
Figure 3-43:Comm D duration

The transmission of the CommD reservation interrogation is found in the IRD data (data link type ; bit 25) . All IRD records of the TRD are parsed; if the bit 25 is set, the time of interrogation of the IRD record is copied into T(17) field of the STATE variable.

The Reception of the CommD closeout confirmation reply is found in the IRD data (data link type ; bit 29) . All IRD records of the TRD are parsed; if the bit 29 is set

AND the IRD record contains a reply, the T(17) field is subtracted from the time of reply of the IRD record and its result is put in the DELAY(17) field of the result array.

The PTE P2B2 data-link delay analysis calculates from the linked TRD data the duration globally for all targets, of Comm-D exchanges. The definition of the duration of a Comm-D exchange is the time delay between the relevant reservation and close-out interrogations performed by the POEMS SUT .



The Comm D duration is correctly measured between the reservation interrogation of the Comm D and the reply to the closeout interrogation for the Comm D. The delay can be viewed in the result viewer or the Data Display. The values can be summarized in the result viewer.

3.7.5.4.4 Comm A duration

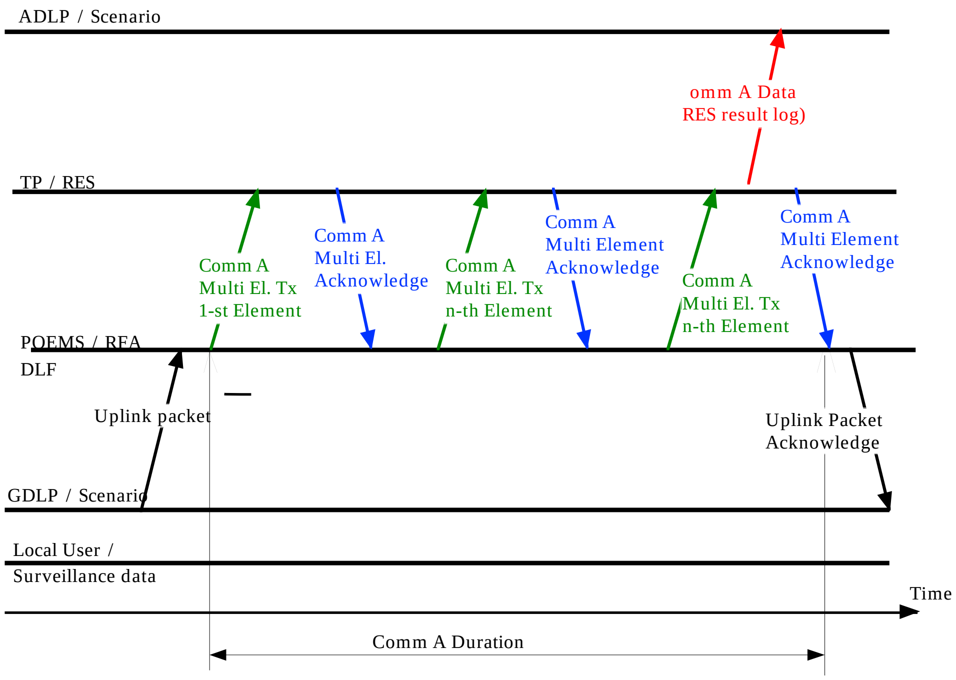
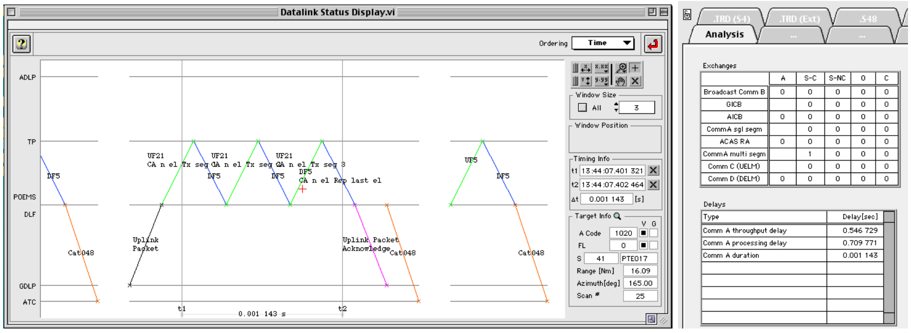


Figure 3-44: Comm A duration

The PTE P2B2 data-link delay analysis calculates from the linked TRD data the duration of the transmission of the first segment of a multi-segment COMM-A by the station and the reply to the last segment by PTE P2B2 took to complete:



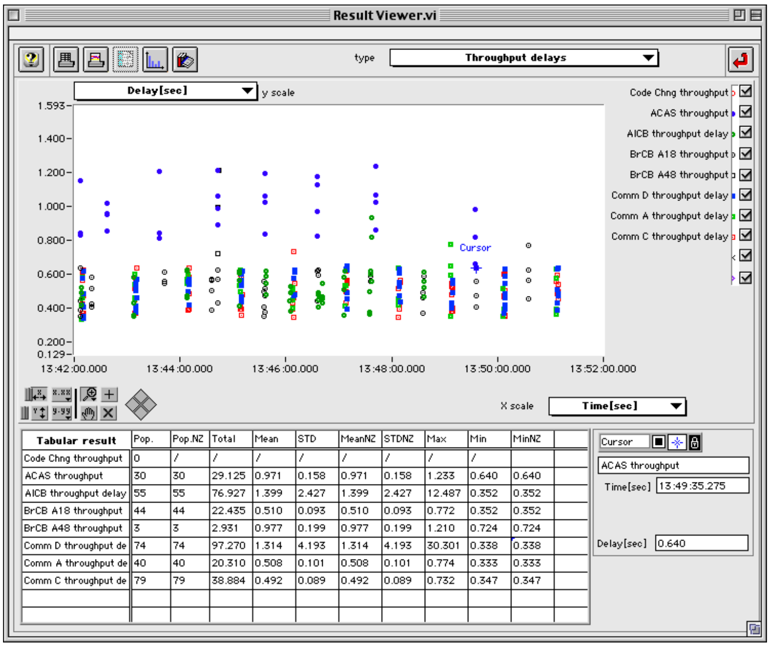
The Comm A duration is correctly measured between the First segment transmission and the reply to the last segment transmission.

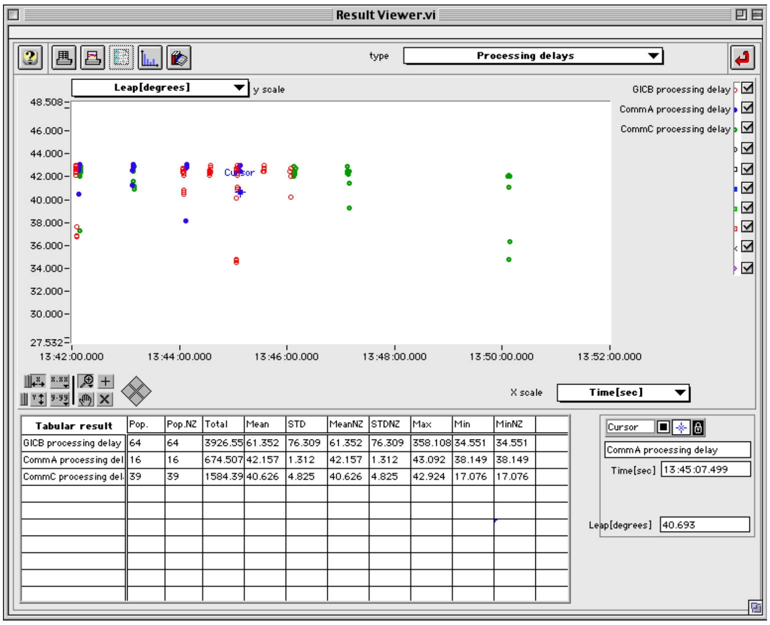
The delay can be viewed in the result viewer or the Data Display. The values can be summarized in the result viewer.

3.7.5.5 Data link Delay Result representation

The tool allows the display of the delay or duration in seconds with a granularity of 0,01 s, and in number of scans and degrees - e.g. 1 scan and 12° - with a granularity of 1°

The delay values can be shown in two possible ways: In the result viewer or in the data display (and linked Data Display Info window). Only the first of the two allows the selection between delay in seconds and degrees. The second tool only shows the data in seconds.





The tool includes the result of these delay analysis in the calculated fields of each individual TRD record. These results can be visualized in the data display as a selected X Y or Z scale value. Maximum 8 different or similar delays are to be included in one TRD record.

The values shown above are all shown by means of the data display.

The tool calculates and displays statistics (sample size; minimum, maximum, mean values; standard deviation around the mean) on these delays for all the radar scans.

This data is also available in a tabular format:

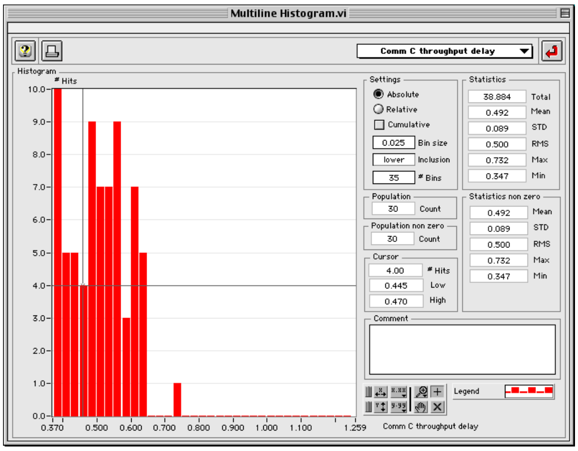
Tabular result	Pop.	Pop.NZ	Total	Mean	STD	MeanNZ	STDNZ	Max	Min	MinNZ
Code Chng throughput	0	/	/	/	/	/	/	/	/	
ACAS throughput	30	30	29.125	0.971	0.158	0.971	0.158	1.233	0.640	0.640
AICB throughput delay	55	55	76.927	1.399	2.427	1.399	2.427	12.487	0.352	0.352
BrCB A18 throughput	44	44	22.435	0.510	0.093	0.510	0.093	0.772	0.352	0.352
BrCB A48 throughput	3	3	2.931	0.977	0.199	0.977	0.199	1.210	0.724	0.724
Comm D throughput de	74	74	97.270	1.314	4.193	1.314	4.193	30.301	0.338	0.338
Comm A throughput de	40	40	20.310	0.508	0.101	0.508	0.101	0.774	0.333	0.333
Comm C throughput de	79	79	38.884	0.492	0.089	0.492	0.089	0.732	0.347	0.347

The result of the above analysis is available:

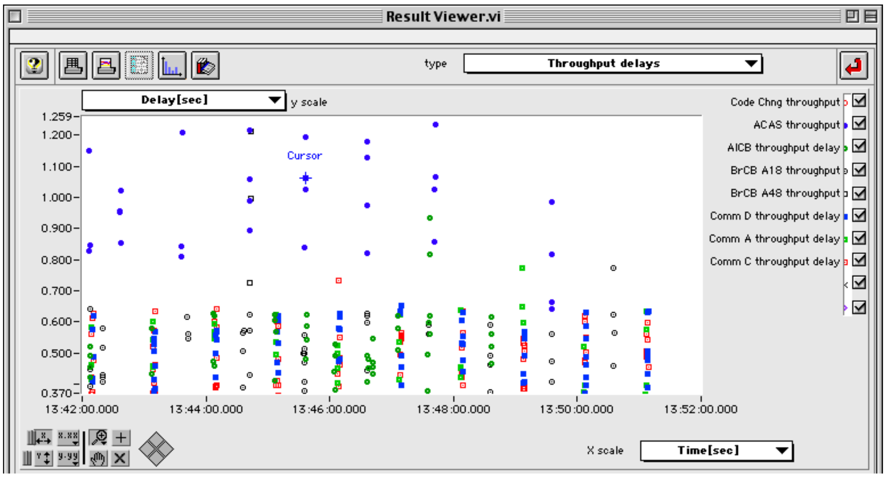
- in a histogram representing the distribution of the delays around their mean value. form (x-axis delays/types, y-axis number of corresponding exchanges).

-in a line chart display form, using a specific colour/symbol for each target/type, time or scan nr on x axis, delay value on y axis. .

The statistical data can be derived by means of the “histogram” function called from the result viewer.



The delays can also be viewed in a scatter diagram. (a line chart has no value in this case):



3.7.6 Data Link Failure Analysis

3.7.6.1 General

The Data link failure analysis determines the data link failures for 7 different exchanges.

The failure of a certain data link transaction is detected when the end state of the exchange (in most cases the reporting of the result through Asterix Cat 18 or 48 has not occurred within a certain amount of time (defined as a number of scans) or not at all.

The failures are detected per target by verifying the start timers (as entered by the delay analysis) against the maximum delay defined by the user of the analyzer software. Following typical maximums are foreseen:

A transaction shall be considered as a failure if it is not completed within the time delays given below, from the moment when the first interrogation concerning it is transmitted.:

Comm A (1 to 4 segments) : N1=3 scans (typical)
Comm B & A code(1 to 4 segments) :N2=3 scans (typical)
Comm C (2 to 16 segments) :N3=4 scans (typical)
Comm D (1 to 16 segments) : N4=5 scans (typical)

1) The result can be viewed summed per scan or per target in the result viewer, or

2) can be viewed individually per target using the data display. The counter is 4 bits per failure counter, so a maximum value of 15 is used. This is not a problem.

3.7.6.2 Related Specs

[PTE-SR-P2B2-CAP-0460] The PTE P2B2 data-link performance analysis **shall** separately count (from the Mode S Interrogation / Reply information - IRD (simulated traffic) or IRDV (live traffic) information - and ASTERIX Cat 018 and 048 message data - A18 & A48) the number of the following types of data-link exchanges which were failed

a) announcement of a Mode A code change without any change in the Mode A code reported in an ASTERIX Cat 048 target report for that target during the N1 (user selectable value) scans following the announcement (IRD (simulated traffic) or IRDV (live traffic) information - A48)

b) announcement of an ACAS RA without any output through an ASTERIX Cat 048 message for that target during the N2 (user selectable value) scans following the announcement (IRD (simulated traffic) or IRDV (live traffic) information - A48)

c) announcement of an AICB without any output through an ASTERIX Cat 018 message for that target during the N2 (user selectable value) scans following the announcement (IRD (simulated traffic) or IRDV (live traffic) information - A18)

d) announcement of a broadcast Comm-B without any output through an ASTERIX Cat 018 message for that target during the N2 (user selectable value) scans following the announcement (IRD (simulated traffic) or IRDV (live traffic) information - A18)

e) announcement of a Comm-D without any output through an ASTERIX Cat 018 message for that target during the N4 (user selectable value) scans following the announcement (IRD (simulated traffic) or IRDV (live traffic) information - A18)

f) invalid sequence of multi-segment Comm-A interrogations (IRD (simulated traffic) or IRDV (live traffic) information)

g) transmission of a COMM-C reservation by the station without transmission of the close-out acknowledgement or technical acqnowledge (Defined by user) reply provided by the transponder.by PTE P2B2 (IRD (simulated traffic) or IRDV (live traffic) information) during the N3 (user selectable value) scans following the reservation.

§	Failure type	Start	End
a)	Mode A code change failure	Reply DF 4, 5, 20, 21 with FS =2, 3 or 4	No new DI070 in Cat48 within N0 scans
b)	ACAS RA failure	Reply DF 4, 5, 20, 21 with DR = 2, 3, 6 or 7	No Cat 48 with DI260 within N2 scans
c)	AICB failure	Reply DF 4, 5, 20, 21 DR = 1	No Cat 018 with DI000 = 23h sent by POEMS within N2 scans
d)	broadcast Comm-B failure	Reply DF 4, 5, 20, 21 DR = 4 or 5	No Cat 018 message with DI000 = 34h has been sent by POEMS whithin N2 scans
e)	Comm-D failure	Reply DF 4, 5, 20, 21 with 16 <= DR <= 31 (announcement)	No Cat 018 message with DI000 = 23h has been sent by POEMS in the N4 scans following the announcement

§	Failure type	Start	End
f)	invalid sequence of multi-segment Comm-A	Interrogation UF 20, 21 DI = 1 or 7 and LAS (3 last bits of TMS) = 1	Invalid Sequence of Comm-A's found: (sequence is **not** one of the following (after elimination of duplicates) : LAS = 5 LAS = 2, 6 LAS = 6, 2 LAS = 2, 3, 4 LAS = 3, 2, 4 LAS = 2, 4, 3 LAS = 3, 4, 2 LAS = 4, 2, 3 LAS = 4, 3, 2 or No reply to last segment
g)	Com C failure	Interrogation UF 4, 5, 20, 21 DI = 1 MES = 1 or 5 (reservation)	No reply to comm C closeout or technical acqnowledgement within N3 scans.

[PTE-SR-P2B2-CAP-0461] The result of the above analysis **shall** be available in a histogram display form (x-axis types, y-axis number of corresponding exchanges).

3.7.6.3 Implementation

The data link cancellation analysis will count for a given TRD dataset the number of data link exchanges that were canceled. All of these cancellation analysis will need a maximum timeout value in seconds [1..100,0.1,18] or scan numbers. This value is entered in the Data link Analysis HMI. If the timeout is entered in scans, the value is recalculated towards time using the calculated (constant) rotation speed .
Following cancellation exchanges will be counted:

- a)Mode A change loss
- b) ACAS RA loss
- c) AICB loss
- d)Broadcast Comm B loss
- e)Comm D loss
- f) Comm A invalid sequence
- g) Comm C

The result of the Cancellation analysis is put in the CANCEL(i) result array.

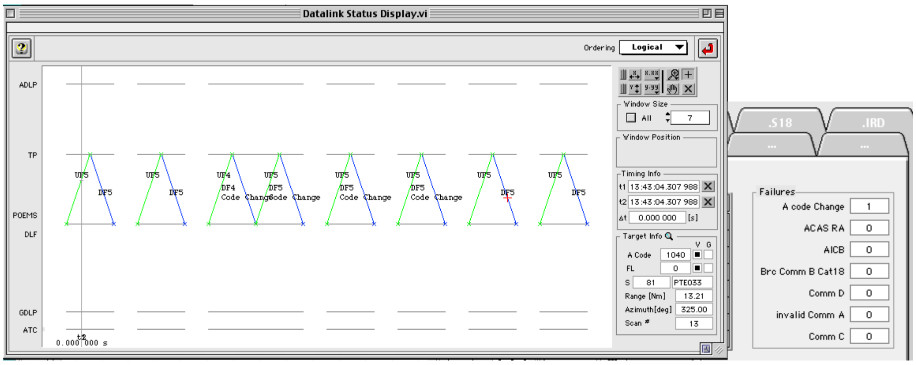
For this purpose, the above defined STATE array is used again. For each of the relative events defined in the cancellation analysis (e.g. Code Change announcement not found in Cat 48) , a time value is stored in the T(i) field of the STATE array while the data is being processed. This defines a **Start**. When a **start** event is encountered, the time of the event is stored in the T(i) variable (where i is used to differentiate between the different analysis) . When an **end** event is NOT encountered within a certain timeout, the exchange is counted as CANCELED and the CANCEL(i) array is incremented.

The result is presented in a graph showing the number of cancellations in the Y scale and the type in the X scale. The same data can also be transferred to a TSF (Tab separated File) for analysis by spreadsheet programs.

3.7.6.3.1 A code Change failure

The PTE P2B2 data-link failure analysis calculates from the linked TRD data the number of announced Mode A code changes without the actual change in the Mode A code reported in an ASTERIX Cat 048 target report for that target during the N2 scans following the announcement.

The counting of the Mode A change loss is performed simultaneously with the Code Change Throughput delay (see § 3.7.5.1.2). If the difference between the T(1) and the time of detection of the linked S48 records becomes larger than the TIMEOUT parameter, a Cancellation is counted in the CANCEL(1) result array.

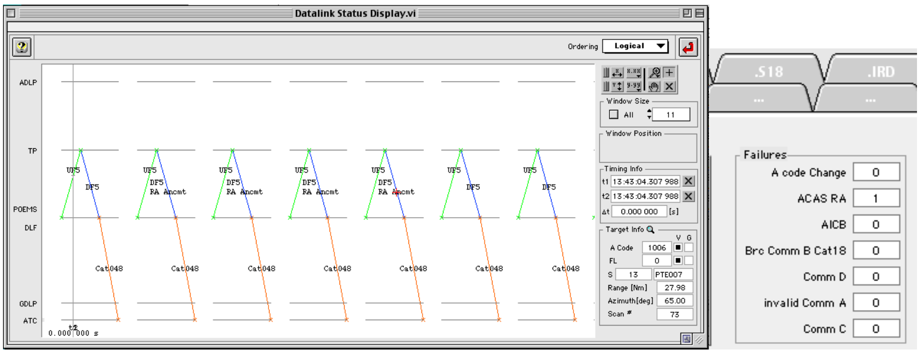


3.7.6.3.2 ACAS RA failure

The PTE P2B2 data-link failure analysis calculates from the linked TRD data

the number of announced ACAS RA without the actual output through an ASTERIX Cat 048 message for that target during the N2 scans following the announcement.

The counting of the ACAS RA loss is performed simultaneously with the ACAS Throughput delay (see §3.7.5.1.3). If the difference between the T(2) and the time of detection of the linked S48 records which does NOT contain a RA field becomes larger than the TIMEOUT parameter, a Cancellation is counted in the CANCEL(2) result array.

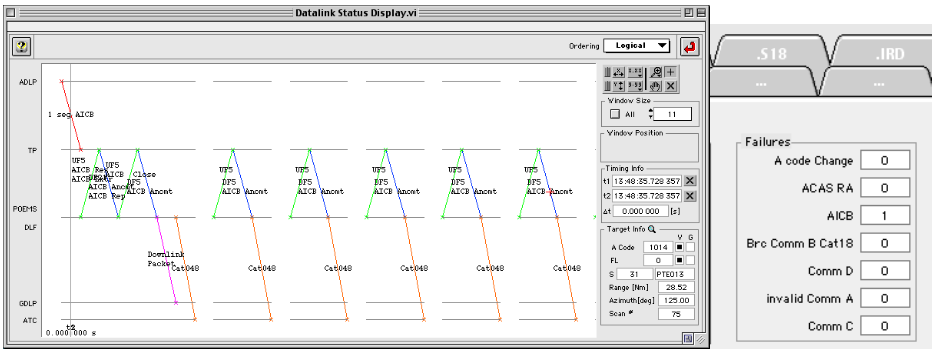


In this case the RA was not extracted by the interrogator; This caused a failure after 4 scans.

3.7.6.3.3 AICB failure

The PTE P2B2 data-link failure analysis calculates from the linked TRD data the number of announced AICBs without any output through an ASTERIX Cat 018 message for that target during the N2 scans following the announcement.

The counting of the AICB loss is performed simultaneously with the AICB Throughput delay (see §3.7.5.1.4). If the difference between the T(3) and the time of detection of the last linked S18 record in the TRD which does NOT contain a short down-link packet message becomes larger than the TIMEOUT parameter, a Cancellation is counted in the CANCEL(3) result array.

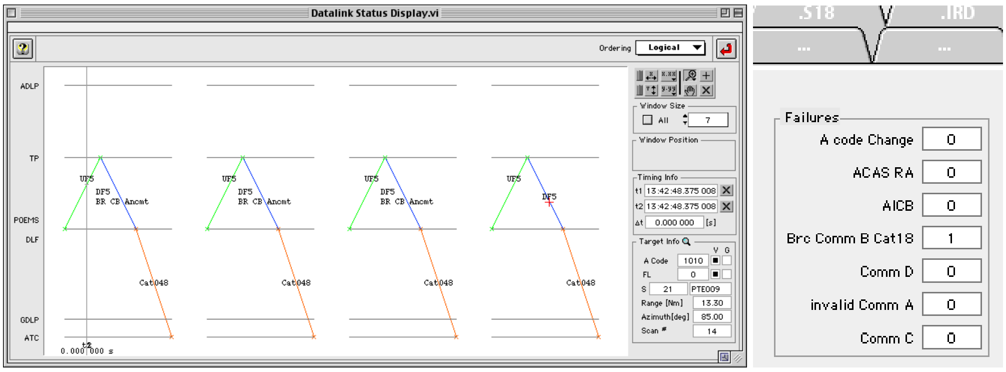


This case was tested with a directed AICB (to II 1) using a non selective protocol. (II 0). This caused the AICB not to be closed (the interrogator closes the AICB using II 0; this is not allowed since the AICB is reserved for II1). This action causes a AICB failure after 4 scans.

3.7.6.3.4 Broadcast Comm B failure

The PTE P2B2 data-link failure analysis calculates from the linked TRD data the number of announced broadcast Comm-B without any output through an ASTERIX Cat 018 message for that target during the N2 scans following the announcement.

The counting of the Broadcast Comm B loss is performed simultaneously with the BCCB Throughput delay (see §3.7.5.1.5). If the difference between the T(4) and the time of detection of the last linked S18 record in the TRD which does NOT contain a down-link broadcast message becomes larger than the TIMEOUT parameter, a Cancellation is counted in the CANCEL(4) result array.

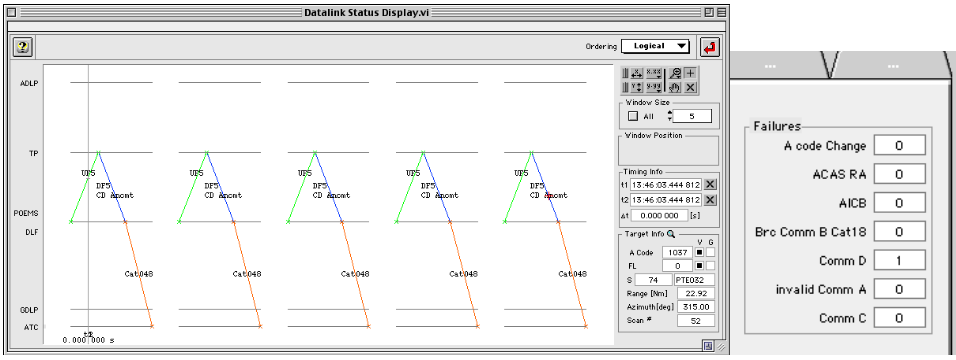


This case was tested using a Broadcast Comm B which was not extracted by the radar. The failure was detected by the analysis software and counted.

3.7.6.3.5 Comm D failure

The PTE P2B2 data-link failure analysis calculates from the linked TRD data the number of announced CommD- without any output through an ASTERIX Cat 018 message for that target during the N4 scans following the announcement

The counting of the Comm D loss is performed simultaneously with the Comm D Throughput delay (see §0). If the difference between the T(6) and the time of detection of the last linked S18 record in the TRD which does NOT contain a long down-link packet message becomes larger than the TIMEOUT parameter, a Cancellation is counted in the CANCEL(5) result array.

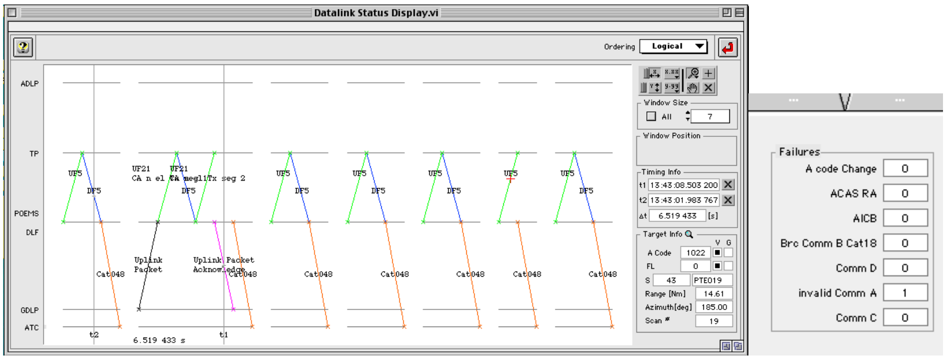


This was tested by using a Comm D which was not extracted by the radar. As can be seen above, after N4 scans the Comm D is still not extracted. The failure is declared after N4+1 scans.

3.7.6.3.6 Comm A failure

The PTE P2B2 data-link failure analysis calculates from the linked TRD data the number of invalid sequences of multi-segment Comm-A interrogations.

The determination of the Comm A Invalid sequence is performed simultaneously with the Comm A duration analysis (see § **Error! Reference source not found.**) . A list of Comm A segments is updated in the COMMA_LAS fields in the STATE array each time a segment is detected during the . Comm A duration analysis. This list reflects the sequence of the segments. Each time a LAS=1 is encountered, the list is cleared. The last segment is found if the list includes one of the following sequences: 1,5 ; 1,2,6; 1,6,2 ; 1,2,3,4 ;1,3,2,4; 1,2,4,3; 1,3,4,2 ; 1,4,2,3 ; 1,4,3,2. If the list contains an invalid sequence (or if the last segment was not detected yet and a new LAS=1 interrogation is send) , the CANCEL(6) counter is incremented.

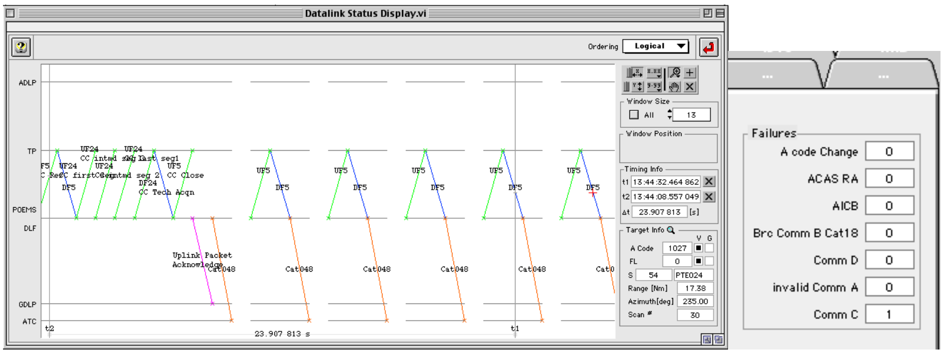


In this example the reply to the Comm A second segment was never received. (Normally, the radar would be required to re-interrogate the Comm A completely, but this was not done in this case.). Therefore a Comm A failure was detected 4 scans after the Comm A.

3.7.6.3.7 Comm C failure

The PTE P2B2 data-link failure analysis calculates from the linked TRD data the number of transmissions of a COMM-C reservation the station without transmission of the close-out acknowledgement by PTE P2B2 during the N3 scans following the reservation.

The counting of the COMM-C cancellation is performed simultaneously with the COMM C Throughput delay (see §3.7.5.1.9). If the difference between the T(8) and the time of detection of the last linked IRD record in the TRD which does NOT contain a Comm C closeout acknowledge becomes larger than the TIMEOUT parameter, a Cancellation is counted in the CANCEL(7) result array.



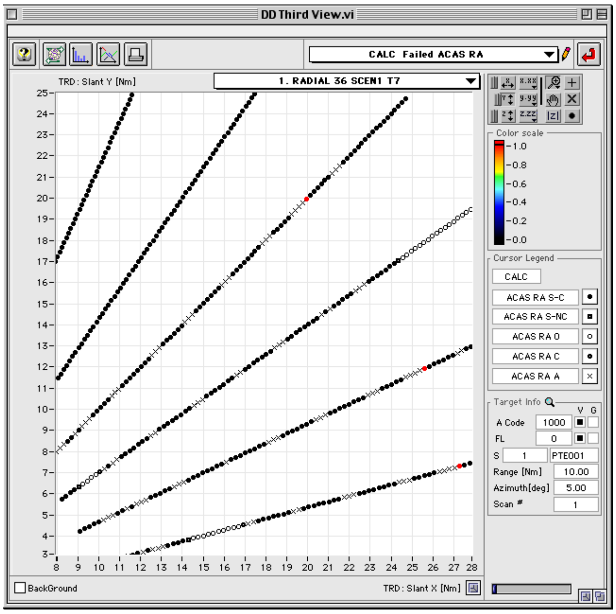
In this example, no Comm C closeout reply was detected. A comm C failure is declared after 4 scans.

3.7.6.3.8 Results

The tool includes the result of the failure analysis in the calculated fields of each individual TRD record. These results can be visualized in the data display as a selected X Y or Z scale value .

The data shown above is taken from the calculated TRD fields.

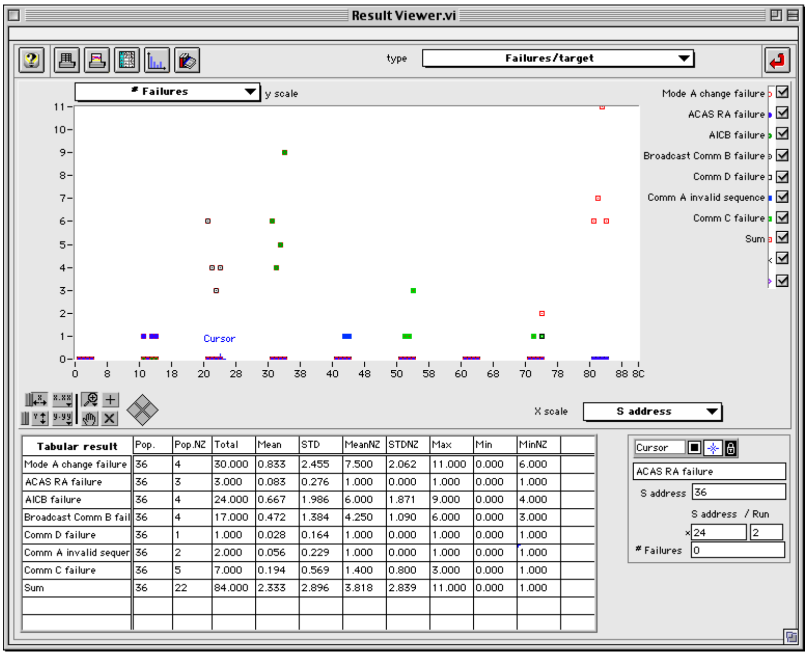
In the example below, the # of failed ACAS RA data was put as the z (color) axis. Cursors are defined to show the different states of the the ACAS data link event.



The tool calculates and displays statistics (sample size; minimum, maximum, mean values; standard deviation around the mean) on these counters for all the radar scans.

The data link result viewer allows us to view the number of cancelations in a scatter graph (# of failures versus scan nr, S address or Run nr);

A general counting of all failures is performed and shown in the table underneath the graph.



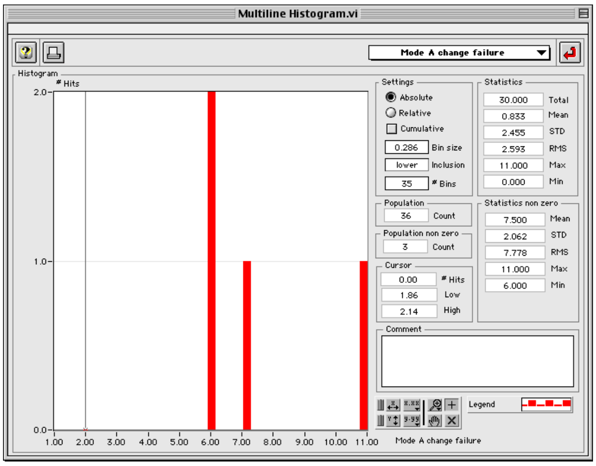
The result of the analysis is available:

- in a histogram representing the distribution of the failure counters around their mean value. form (x-axis delays/types, y-axis number of corresponding exchanges).

- in a line chart display form, using a specific colour/symbol for each target/type, time or scan nr on x axis, counter value on y axis. .

The result data can also be shown in a histogram by calling the histogram function from the result viewer of data display.

The line chart has no value in this case since the all points are not related. A scatter diagram is a better solution.



3.7.7 Data Link Broadcast Comm A Analysis

3.7.7.1 Interrogation-Reply Analyzer tool

A last analysis is incorporated in the “Interrogation Reply Analyzer”. This tool was already tested under the PTE P2B1 contract, but was enhanced with an extra analysis feature.:

Data Link Broadcast Comm A Analysis

This is because the Broadcast Comm A interrogations are not linked specifically to a target TRD record, but are separate interrogations not aimed at a specific target. This last analysis requires the user to load the original IRD or IRDV data file and perform the analysis.

3.7.7.2 Related Specs

[PTE-SR-P2B2-CAP-0470] The PTE P2B2 data-link performance analysis **shall** calculate (from the and Mode S Interrogation / Reply information – IRD (simulated traffic) or IRDV (live traffic) information), individually for each broadcast Comm-A and globally for all broadcast Comm-As, the number of broadcast Comm-A interrogations per fraction of scan (selectable between 1/32 and 1 scan). The definition of an individual broadcast Comm-A, for the purposes of this requirement, is all Comm-A interrogations with identical content .

Activuty	Event to be counted
Broadcast Comm A	Interrogation UF 20, 21 corresponding to Mode S address = ‘FFFFFF’ hex (broadcast Comm-A)

[PTE-SR-P2B2-CAP-0471] The result of the above analysis **shall** be available

in a tabular display (one row per radar scan fraction) form.
in a line chart display form, scan fraction number on x-axis.

3.7.7.3 Implementation

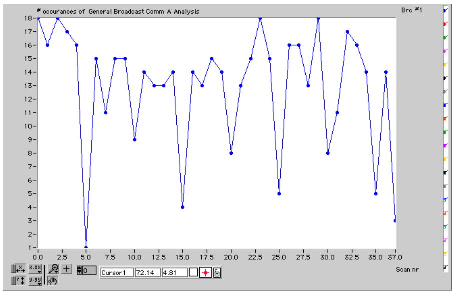
The Data link Broadcast Comm A analysis can be performed by the user in response to a click on the button of the “Interrogation-reply” tool. The Data link Broadcast Comm A analysis window automatically appears and the data loaded into the Interrogation-reply Analyzer tool (including the selected filter) is processed according to the settings of the Data link Broadcast Comm A analysis tool

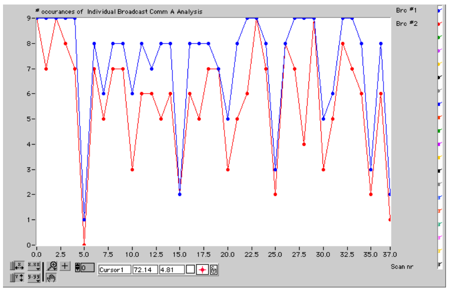
The PTE P2B2 Data link Broadcast Comm A analysis calculates individually for each broadcast Comm-A and globally for all broadcast Comm-As, the number of broadcast Comm-A interrogations per fraction of scan (selectable between 1/32 and 1 scan). The definition of an individual broadcast Comm-A, for the purposes of this requirement, is all Comm-A interrogations with identical content.

The scan fraction can be entered from 1/32 of a scan up to 32/32 of a scan. The analysis is automatically redone and the results are redrawn when the scan fraction is changed.

The type of analysis (general or individual) can be selected from the Analysis Types list. The analysis is automatically redone and the results are redrawn when the analysis type is changed.

The result of the Data link Broadcast Comm A Analysis is displayed as a line chart. When "general analysis" is selected, there is one line representing all broadcast comm A data link events counted per fraction of a scan, with the scan fraction number on the x-axis. When "individual analysis" is selected, there is one line for each broadcast comm A data link with a different contents.





The line chart can be converted into a tabular display by clicking the button. There is a column per individual broadcast comm A data link and one row per radar

3.7.8 Data Link Pd Comm B Analysis

3.7.8.1 General

The Data link Probability of Ground Initiated Comm B analysis determines the probability of correct GICB extraction per target. For this purpose, the number of different extracted GICB s found in the Asterix Cat 48 is compared to the number of requested GICB s. The later parameter is calculated using the assumed start and end scan nr of the GICB extraction and a user inputted GICB update rate(in scans) . A maximum GICB acquisition time (or scan nrs) is taken into account.

The Pd is only calculated for those trajectories where a specific GICB is extracted at least 1 time.

3.7.8.2 Related Specs

[PTE-SR-P2B2-CAP-0472] The PTE P2B2 data-link performance analysis **shall** calculate (from the ASTERIX Cat 048 message) individually for each target the probability of successful Comm-B delivery through Cat 048. This probability is defined as the ratio of the number of ASTERIX Cat 048 messages containing the user selected BDS in the "Mode S MB data" data item of Cat 048 compared to number of beam dwells during which the MB field was requested . This number **shall** be calculated as follows: $(t_{end} - t_{start}) / T_{GICB}$,

T_{end} is the time of the last TRD of that target and t_{start} is the minimum of the time of the first TRD of that target containing an interrogation requesting that BDS and the time of the first cat 048 for that target supplemented by a user defined maximum delay. *This delay is determined from a user input number of scans (**Max acquisition scans GICB**) recalculated towards time using calculated rotation speed.*

T_{GICB} is the ordered periodicity of Comm-B BDS extraction (input by the user). The parameters is only calculated for targets with at least 1 GICB extraction found for that track.

[PTE-SR-P2B2-CAP-0473] The result of the above analysis shall be available:

in a tabular display (one row per target) form.

[PTE-SR-P2B2-CAP-0474] The PTE P2B2 data-link performance analysis **shall** calculate and display statistics (sample size; minimum, maximum, mean. values;

standard deviation around the mean , plus minimum, mean and population of non zero values) of the probability of successful Comm-B delivery through Cat 048 for all targets of the data set.

3.7.8.3 Implementation

The Data Link Pd CommB Analysis shall calculate the probability of successful Comm B delivery through Cat 48 data.

For this purpose the software will determine the PdCommB

For this purpose, two numbers must be determined individually for each target:
-The number of times a specific BDS registers data was present in the Cat 48 data
–The number of times the BDS was requested.

The first number can easily be determined by counting per individual TRD record the number of times a BDS data is present. For this purpose, the most common BDS registers are already included in the “data link message” field of the TRD record by the data link tool. (bits 26,27,28,29,30). These bits show the presence of BDS 10,20,40,50 and 60 data in the Cat 48 data. Bit 31 is used to identify “other” BDS registers.

If this bit is set, the S48 field must be read and verified for BDS contents. Since the S48 data is limited to 8 different MB fields, only 8 counters are updated. A counter is updated per BDS register and per target. Therefore the counter array is as follows:

While parsing the TRD data, an array of counters is updated. Each time a new target is encountered, a record in the counter array is added and its start time is recorded in the “t start”variable in the counter array. Every encountered TRD record will update the counter array. If the target is found in the array (it was already started) , the t end value is updated and the BDS counters are updated. If the target can not be found, a new record will be added to the counter array.

At the end of the operation , 8 Pd values can be as follows:

Pd = Count value / [(t end – t start)/BDS update rate]

(t start is the mimimum of two numbers: a user input value (maximum GICB acquisition time) and the time of detection of the first GICB extraction of that BDS.

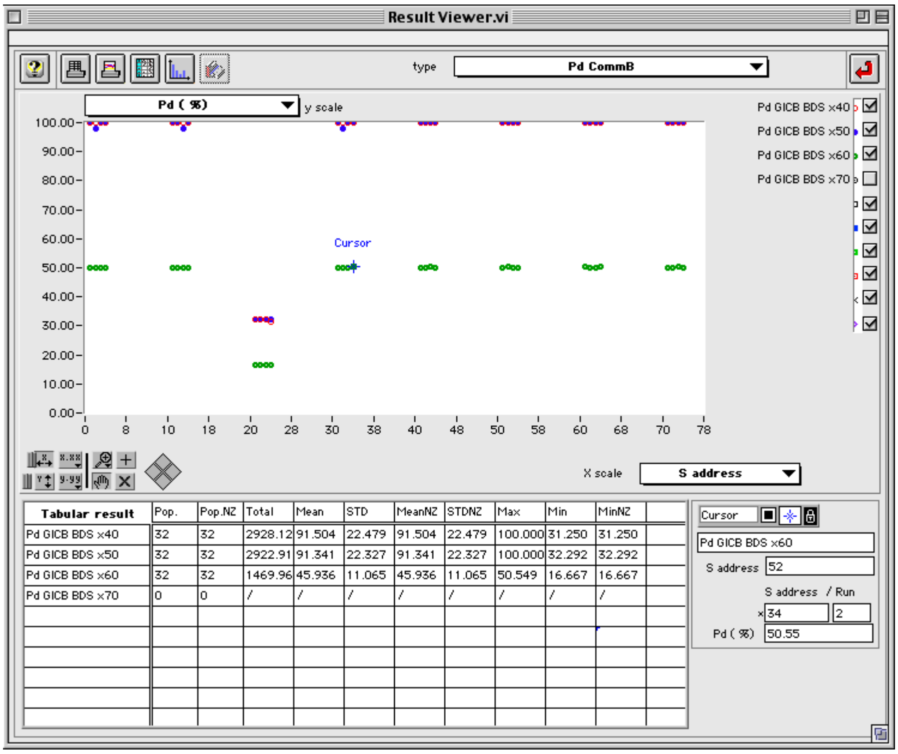
For this purpose, the user must include the BDS update rate for each of the 8 registers prior to starting the analysis in a user input field.

The Data link GICB PdAnalysis can be performed by the user in response to a click on the start button of the "Data Link Analyzer" tool. The tool allows the definition of a filter on S address or no filter.

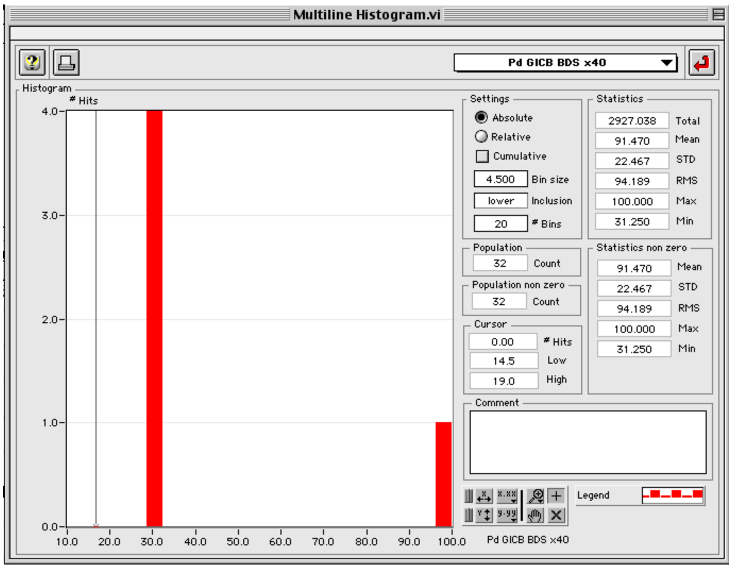
The PTE P2B2 data-link performance analysis calculates individually for each target the probability of successful Comm-B delivery through Cat 048.

The parameters is only calculated for targets with at least 1 GICB extraction found for that track.

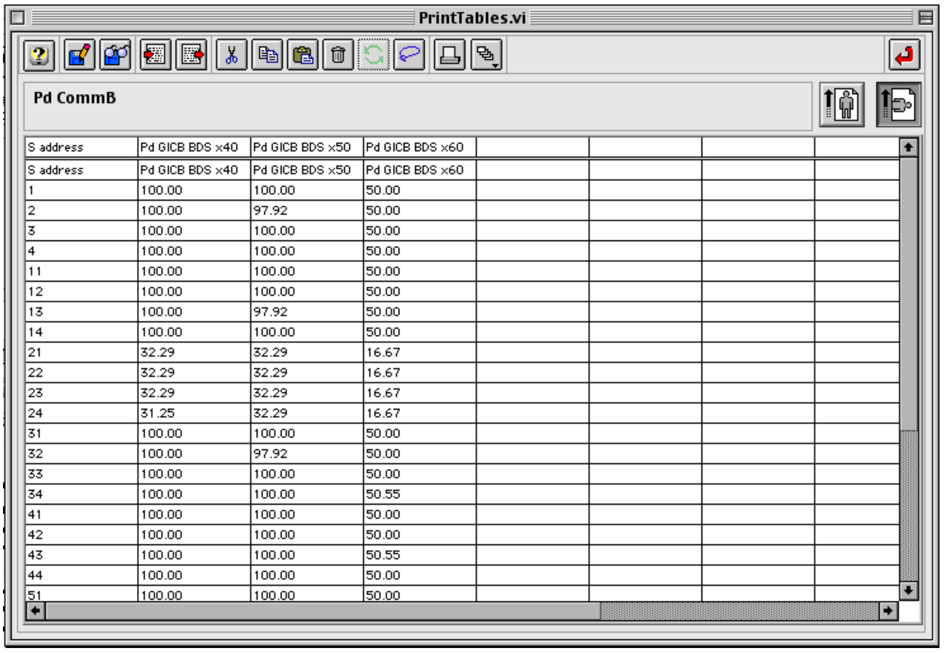
The PTE P2B2 data-link performance analysis calculates and displays statistics (sample size; minimum, maximum, mean values; standard deviation around the mean) of the probability of successful Comm-B delivery through Cat 048 for all targets of the data set.



The result of the analysis is available in a histogram representing the distribution of the Pd values.



The result of the analysis is available in a tabular display (one row per target) form.



S address	Pd GICB BDS x40	Pd GICB BDS x50	Pd GICB BDS x60
S address	Pd GICB BDS x40	Pd GICB BDS x50	Pd GICB BDS x60
1	100.00	100.00	50.00
2	100.00	97.92	50.00
3	100.00	100.00	50.00
4	100.00	100.00	50.00
11	100.00	100.00	50.00
12	100.00	100.00	50.00
13	100.00	97.92	50.00
14	100.00	100.00	50.00
21	32.29	32.29	16.67
22	32.29	32.29	16.67
23	32.29	32.29	16.67
24	31.25	32.29	16.67
31	100.00	100.00	50.00
32	100.00	97.92	50.00
33	100.00	100.00	50.00
34	100.00	100.00	50.55
41	100.00	100.00	50.00
42	100.00	100.00	50.00
43	100.00	100.00	50.55
44	100.00	100.00	50.00
51	100.00	100.00	50.00

The result of the analysis is available in a line chart display form, using a specific color/symbol for each target/type, target nr or S address nr on x axis, Pd value on y axis. .

3.7.9 Data Link Com C/D Segment Retransmission Analysis

3.7.9.1 General

The Data link comm C segment retransmission analysis is based on the calculation of the difference between the number of programmed Comm C segments and the real number transmitted by the radar.

The Data link comm D segment retransmission analysis is based on the calculation of the difference between the number of announced Comm D segments and the real number of replies send by the target.

The difference between the two numbers is added to the TRD data in the calculated fields. (If multiple exchanges are present on one TRD record, the data is added).

The Data link Comm C and Comm D segment retransmission Analysis will determine the number of segments that have been retransmitted in a Comm C or Comm D transaction. For this purpose, two counters per transaction are maintained:
-Number of requested segments (in first interrogation or Comm D reservation reply)
–Number of transmitted segments between reservation and closeout of the same transaction.

For this purpose, Four additional fields have been added to the STATE variable:

-COMMC_REQ: number of requested segments
–COMMC_SEND: number of send segments
-COMMD_REQ: number of requested segments
–COMMD_SEND: number of send segments

Each time a closeout is detected, the two parameters are subtracted and put in the COMMC_RETRANS or COMMD_RETRANS result arrays. These arrays are arrays of a cluster of a time value and a count value. The time value is the time of closeout of the data link.

3.7.9.2 Related Specs

Type	Event to be counted
Com C retransmission	Difference between the number of transmitted Comm-C's before close-out and the number of Comm-C's specified in the first Comm-C
Comm D retransmission	Difference between the number of generated Comm-D's and the number of Comm-D's specified in the reservation

[PTE-SR-P2B2-CAP-0480] The PTE P2B2 data-link performance analysis **shall** separately calculate (from the Mode S Interrogation / Reply information – IRD (simulated traffic) or IRDV (live traffic) information), individually for Comm-C and Comm-D exchanges, the number of segment re-transmissions.

[PTE-SR-P2B2-CAP-0481] The result of the above analysis shall be available:

in a histogram display form (x-axis number of segment retransmissions, y-axis r of corresponding exchanges).

[PTE-SR-P2B2-CAP-0482] The PTE P2B2 data-link performance analysis **shall** calculate and display statistics (sample size; minimum, maximum, mean. values; standard deviation around the mean, plus minimum, mean and population of non zero values) on the number of segment re-transmissions during Comm-C and Comm-D exchanges.

3.7.9.3 Implementation

3.7.9.3.1 Comm C Segment Retransmission

the number of segments that have been retransmitted between a COMM-C reservation by the station and reception of Comm C Closeout confirmation Reply.

The transmission of the CommC 1st segment interrogation is found in the IRD data (data link type ; bit 19) . All IRD records of the TRD are parsed; if the bit 19 is set, the number of segments(found in the NC field+1) of the IRD record is copied into COMMC_REQ field of the STATE variable. The COMMC_SEND parameter is set to 1.

The transmission of the CommC intermediate segments interrogation is found in the IRD data (data link type ; bit 20 or 21) . All IRD records of the TRD are parsed; if the bit 20 or 21 is set, the COMMC_SEND parameter of the STATE variable is incremented by 1.

The Reception of the CommC closeout confirmation reply is found in the IRD data (data link type ; bit 23) . All IRD records of the TRD are parsed; if the bit 23 is set AND the IRD record contains a reply, the COMMC_REQ field is subtracted from the COMMC_SEND field and its result is put in the COMMC_RETRANS result array along with the time of detection of the closeout reply

The Data link CommC and CommD Analysis can be performed by the user in response to a click on the start button of the "Data Link Analyzer" tool. The tool allows the definition of a filter on S address or no filter.

The PTE P2B2 data-link performance analysis calculates individually for Comm-C exchanges the number of segment re-transmissions.

3.7.9.3.2 Comm D Segment Retransmission

The number of segments that have been retransmitted between a COMM-D reservation by the station and reception of Comm D Closeout confirmation Reply.

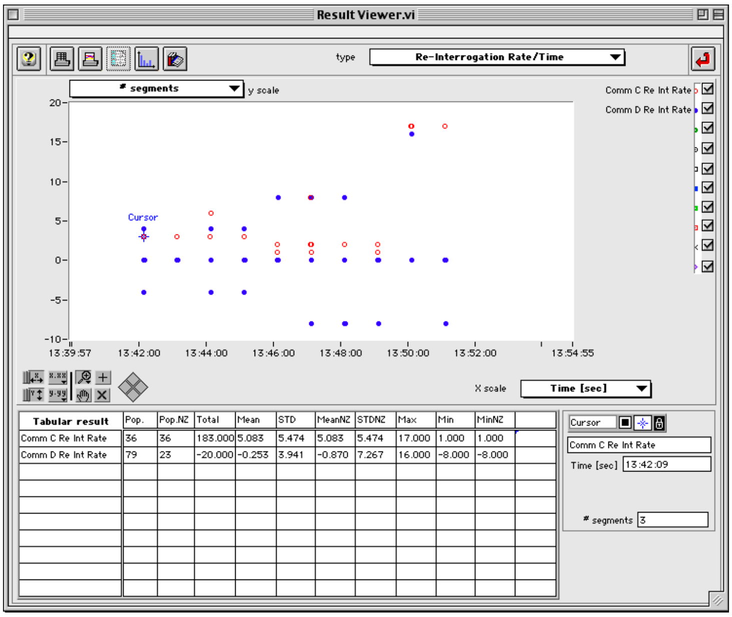
The reservation of the CommD interrogation is found in the IRD data (data link type ; bit 25) . All IRD records of the TRD are parsed; if the bit 25 is set AND a reply is found in the corresponding IRD record, the number of segments (found in the DR subfield-15) of the IRD record is copied into COMMD_REQ field of the STATE variable. The COMMD_SEND parameter is set to 1.

The reception of the CommD intermediate segments interrogation is found in the IRD data (data link type ; bit 27 or 28) . All IRD records of the TRD are parsed; if the bit 27 or 28 is set, the COMMD_SEND parameter of the STATE variable is incremented by 1.

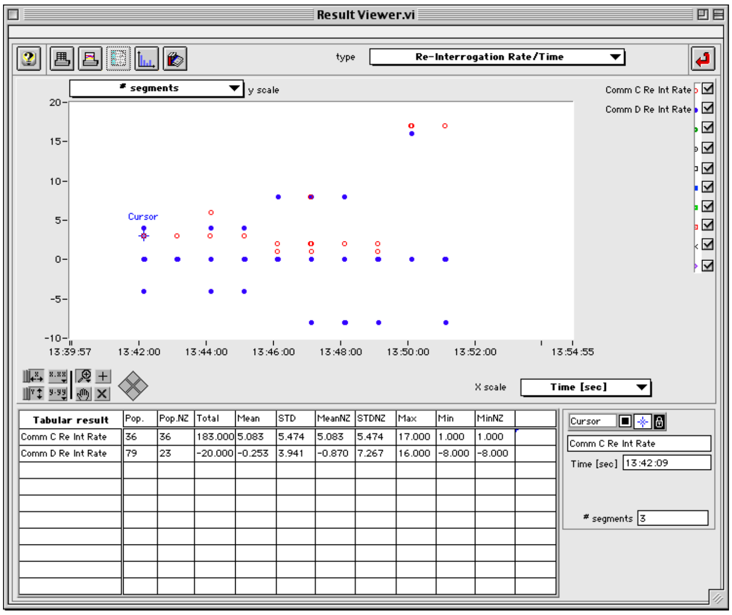
The Reception of the CommD closeout confirmation reply is found in the IRD data (data link type ; bit 29) . All IRD records of the TRD are parsed; if the bit 29 is set AND the IRD record contains a reply, the COMMD_REQ field is subtracted from the COMMD_SEND field and its result is put in the COMMD_RETRANS result array along with the time of detection of the closeout reply

The PTE P2B2 data-link performance analysis calculates individually for Comm-D exchanges the number of segment re-transmissions

3.7.9.3.3 Results.



The requirement has been met by using the “data link result Viewer.” This tool allows us to see the number of segment retransmissions per target or generally in time per transaction. The later allows to make statistics per target or per transaction.

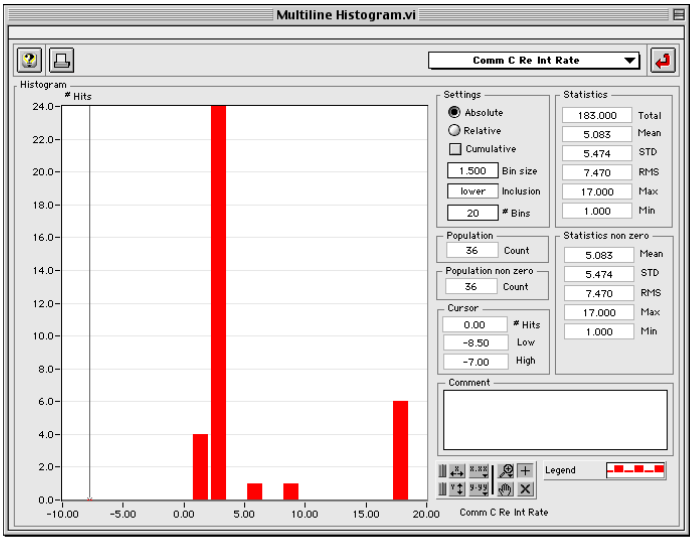


The PTE P2B2 data-link performance analysis calculates and display statistics (sample size; minimum, maximum, mean. values; standard deviation around the mean) on the number of segment re-transmissions during Comm-C and Comm-D exchanges

The result of the above analysis is available:

- in a histogram display form (x-axis number of segment retransmissions, y-axis r of corresponding exchanges).

- in a line chart display form, using a specific colour/symbol for each target/type, target nr or S address nr on x axis, # segments on y axis. ..



3.7.10 Data link model B compliance Analysis

3.7.10.1 General

The data link Model B compliance analysis verifies whether the scenario complies to the programmed Model B model. The original spec of PTE B2 requires the input of the criteria of the model B scenario. This has proven to be not required, since the Model B scenario can only be generated by means of the PTE tool itself (no life data will ever comply to the model B). Therefore it is sufficient that the Model B can be defined at compilation using the existing PTE P2B1 tools, and that this information is correctly passed to the analysis tool.

For this , three types of data link exchanges must be verified:

- -GICB extractions
- -Comm C
- -Comm D

For the model B compliance analysis, the analysis tool must verify whether all Comm C and CommD exchanges are completed within a predefined number of scans (in most cases 1) and that a user defined number of GICB s are extracted.

The data link model B compliance status shall be equal to the percentage of successful run within a scenario.

a run shall be declared successful if:

- all the data link transactions (Comm. C and Comm. D) are completed(reservation to close-out) in less than the maximum duration (in scan number, default 1) specified by the user;
- a user defined percentage (default 100) of the requested GICB extractions have been performed each scan on all the targets (in the peak sector(s) and in the background) during the run.

3.7.10.2 Related Specs

[PTE-SR-P2B2-CAP-490] The PTE-P2B2 Data link model B compliance status calculation shall provide a facility to the operator to input the characteristics of the data link model B scenario to be analyzed (more details on the structure and characteristics of data link model B scenarios can be found in Doc.

Alternatively, the scenario information can be embedded in the scenario file provided by the PTE P2B1 tool.

mode of operation: multi-site / non selective
GICB background rate GB (0..5,1)
Scan number of the start of GICB request SB (1..10,1)
Number of peak sequence in the scan (1..2,1)
Number of peak sector in the sequence (1..2,1)
Azimuth position of the first peak sector
Scan number of the first peak sector sequence PS (1..20,1) > SB
Peak sequence duration in scan numbers P (1..20,1)
Number of data-link events defined for the sequence
Number of repetition of the peak sequence(s)
Period of repetition of the peak sequence(s)
Characteristics of successive data-link events:
Scan number SG (0..20,1) during the peak at which a GICB rate GP (0..5,1) is requested
For selected aircraft, scan number SC (0..20,1) during the peak at which an UELM of NC (1..16,1) segments is requested
For selected aircraft, scan number SD (0..20,1) during the peak at which a DELM of ND (1..16,1) segments is announced

[PTE-SR-P2B2-CAP-0491] The PTE-P2B2 Data link model B compliance status calculation shall calculate for a whole scenario (without any filter applied) the following percentages of success of the data link exchanges performed during the scenario run: The data link model B compliance status shall be equal to the percentage of successful run within a complete scenario.

GICB (BDS >= 4,0)

Comm-C
Comm-D
Global (GICB + Comm-C + Comm-D) (= model B compliance status)

A run shall be declared successful if :

all the data link transactions (Comm. C and Comm. D) are succesful.
GICB extractions has been succesful

[PTE-P2B2-CAP-0492] The PTE-P2B2 tool shall declare GICB extraction successful for the runif the number of extracted GICB (started and completed in 1 beam) during the run is above or equal to the user defined percentage (default 100) times the number of targets (in the peak(s) and in the background) times the number of scans of the run. Because the targets are not moving there is always exactly one rendez-vous (beam / target) per scan.

[PTE-P2B2-CAP-0493] The PTE-P2B2 tool shall declare a Comm-C successful if started (reservation) and completed (close-out) in less than a user defined number of beams N3 (1..20,1). completed(reservation to close-out) in less than the maximum duration N3 (1..20,1). (in beam number, default 1) specified by the user;

[PTE-P2B2-CAP-0494] The PTE-P2B2 tool shall declare a Comm-D successful if completed(reservation to close-out) in less than the maximum duration N4 (1..20,1). (in beam number, default 1) specified by the user; started (announced) and completed (close-out) in less than a user defined number of beambeams N4(1..20,1).

[PTE-SR-P2B2-CAP-0495] The result of the above analysis shall be available:

in 9 line graphs (x-axis run nr or target nr or S address, y- axis nr of exchanges, programmed events and errors for all three types :).
In a tabular display representing the percentages of successful runs of GICB, Comm C and CommD.

[PTE-SR-P2B2-CAP-0496] The PTE P2B2 data-link performance analysis **shall** calculate and display statistics (sample size; minimum, maximum, mean. values; standard deviation around the mean, plus minimum, mean and population of non zero values) on the number of GICB events, GICB exchanges, GICB errors, Comm C exchanges, Comm C events, Comm C failures, comm D exchanges, Comm D events and Comm D failures. The analysis shall also provide the ratio between the number of exchanges and the number of events plus the ratio between the number of errors and the number of events for all runs.

3.7.10.3 Data Link Model B Compliance Analysis:

The data link model B compliance analysis will be used to calculate the percentages of successful data link transaction on GICB, Comm C and Comm D scenarios, as generated by PTE P2B1. The Model B scenario is generated by the PTE P2B1 tool (event scenario generator). This tool already provides the user to input all the parameters required for automatic Model B generation. From these parameters (see SRD, ADD and Manual PTE P2B1) the tool will generate all required RES data for RF playback and GDPL stream data for Asterix Cat18 generation of data link commands.

Furthermore, the tool will generate an S4EV file (further to be translated into a S4SC and a TRD file) containing a file representation of all target records generated by the tool. Each target report has a number of “event” counters present in the data (see table in §3.2.3.4) . These counters contain the number of GICB extractions, Comm C and Comm D event programmed for every target in that scan.

By comparing the value in these counters with the real values , found in the IRD data, we can determine the percentages of success of the data link actions.

If the values of the counters are not present (e.g. the data is imported from an RFS file) , the user still has the option of defining the data link model himself by using the same definition window as used in PTE P2B1 data link model B definition

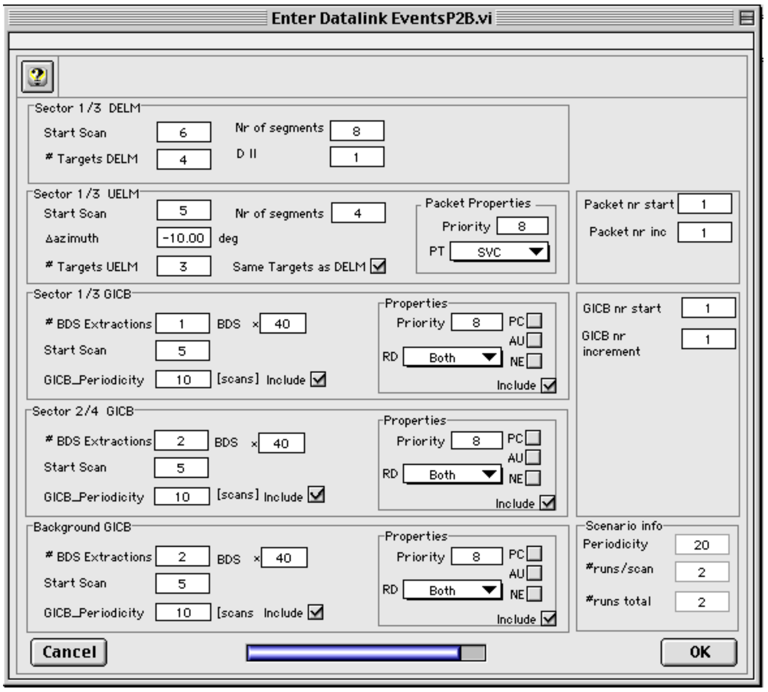


Figure 3-45: Datalink Model B definition

In that case, the data link counters are calculated prior to the analysis.

3.7.10.3.1 GICB Model B compliance

The GICB model B compliance test is performed by parsing through the TRD records one by one. If the data link counter field (bit 3..6:GICB events) shows a number of GICB events > 0, the IRD data for that scan is parsed. In that case the GICB EVENT field in the STATE variable is incremented with [1 / number of GICB extractions programmed ♦]. The transmission of a GICB extract interrogation is found in the IRD data (data link type ; bit 6), so is its reply (bit 7). All IRD records of the TRD are parsed; if the bit 6 and 7 are set, a counter is incremented. When all IRD records of the target and scan have been parsed, the resulting GICB count value is compared with the programmed value (as found in the TRD data link counter field) . If the two counters are not identical, the GICB COUNT field in the STATE variable is incremented by [1 / the difference between the two values♦] for that target.

At the end of the analysis, this GICB COUNT field is filled with the number of unsuccessful GICB extractions. and the GICB EVENT field is filled with the number of requested GICB extractions. The two values are divided to result in a percentage of successful GICB extraction for that target. All values of GICB COUNT GICB EVENT are added for all targets to determine a value for the complete scenario.

% of unsuccessful GICB Model B exchanges=
(GICB COUNT) / (GICB EVENT) *100%

3.7.10.3.2 Comm C Model B compliance

The Comm C model B compliance test is performed by parsing through the TRD records one by one. If the data link counter field (bit 13..14:CommC events) shows a number of Comm C events > 0, the IRD data for that scan is parsed. In that case the COMMC EVENT field in the STATE variable is incremented with [1 / number of Comm Cs programmed ♦] and the time of detection of the TRD record is put in the

♦ The selection between these two options is determined by the user and results in a different result.

T(18) variable of the STATE variable of that target. The transmission of a Comm C reservation and closeout interrogation can be found in the IRD data (data link type ; bit 18 and 23. All IRD records of the TRD are parsed; if the bit 23 is set, the time of that IRD record is compared with the value of T(18). If the difference is < the user defined maximum value (to be entered prior to analysis) , the Comm C exchange is counted as successful and the COMMC CLOSE value in the STATE variable is incremented. This action can span several scans.

When the time of the parsed IRD records of the target becomes larger than T(18)+Comm C timeout, the resulting COMMC CLOSE value is compared with the programmed value (as found in COMMC EVENT) . If the two counters are not identical, the COMMC COUNT field in the STATE variable is incremented by [1 / the difference between the two values♦] for that target.

At the end of the analysis, this COMMC COUNT field is filled with the number of unsuccessful COMMC extractions. and the COMMC EVENT field is filled with the number of requested COMMC exchanges. The two values are divided to result in a percentage of unsuccessful COMMC exchange for that target. All values of COMMC COUNT and COMMC EVENT are added for all targets to determine a value for the complete scenario.

% of unsuccessful COMM C Model B exchanges=
(COMMC COUNT) / (COMMC EVENT) *100%

3.7.10.3.3 Comm D Model B compliance

The Comm D model B compliance test is performed by parsing through the TRD records one by one. If the data link counter field (bit 15..16:CommD events) shows a number of Comm D events > 0, the IRD data for that scan is parsed. In that case the COMMD EVENT field in the STATE variable is incremented with [1/ number of Comm Ds programmed ♦] and the time of detection of the TRD record is put in the T(19) variable of the STATE variable of that target. The transmission of a Comm D reservation and closeout interrogation can be found in the IRD data (data link type ; bit 25 and 29). All IRD records of the TRD are parsed; if the bit 29 is set, the time of that IRD record is compared with the value of T(19). If the difference is < the user defined maximum value (to be entered prior to analysis) , the Comm D exchange is counted as successful and the COMMD CLOSE value in the STATE variable is incremented. This action can span several scans.

When the time of the parsed IRD records of the target becomes larger than T(18)+Comm D timeout, the resulting COMMD CLOSE value is compared with the programmed value (as found in COMMD EVENT) . If the two counters are not identical, the COMMD COUNT field in the STATE variable is incremented by [1 / the difference between the two values♦] for that target.

At the end of the analysis, this COMMD COUNT field is filled with the number of unsuccessful COMMD extractions. and the COMMD EVENT field is filled with the number of requested COMMD exchanges. The two values are divided to result in a percentage of successful COMMD exchange for that target. All values of COMMD COUNT and COMMD EVENT are added for all targets to determine a value for the complete scenario.

% of unsuccessful COMM D Model B exchanges=
(COMMD COUNT) / (COMMD EVENT) *100%

♦ The selection between these two options is determined by the user and results in a different result.

3.7.10.3.4 Global Model B compliance figure

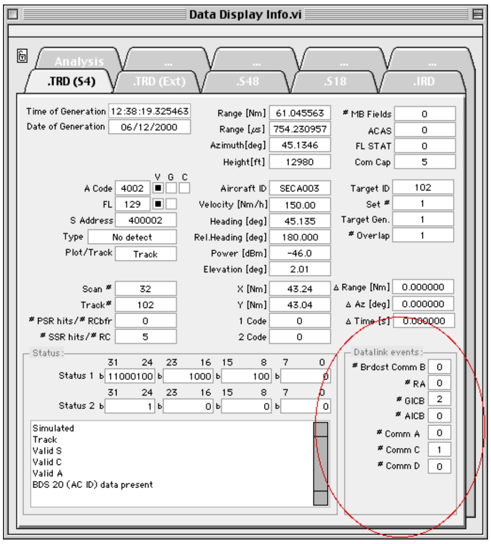
The values of the 3 other analysis are averaged into a new general figure:

Global % of unsuccessful Model B exchanges=
(GICB COUNT / GICB EVENT +COMMC COUNT / COMMC EVENT +COMMD COUNT / COMMD EVENT) 100%

3.7.10.4 Implementation

The Data link Model B Compliance Analysis can be performed by the user in response to a click on the start button of the "Data Link Analyzer" tool. The tool allows the definition of a filter on S address or no filter.

The Model B Compliance Analysis correctly uses the information required for the analysis provided by the B1 scenario generator. This information mainly concerns the number of programmed (or requested) GICB,Comm C and Comm D exchanges. This information is available as "event" counters in the generated S4SC and TRD data.



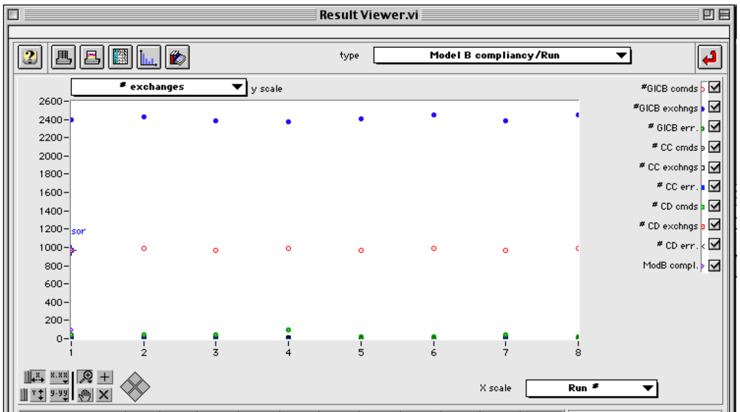
The PTE-P2B2 Data link model B compliance status calculation calculates for a whole scenario (without any filter applied) the following percentages of success of the data link exchanges performed during the scenario run : The data link model B compliance status shall be equal to the percentage of successful run within a complete scenario.

- GICB (BDS >= 4,0)

- Comm-C

- Comm-D

- Global (GICB + Comm-C + Comm-D) (= model B compliance status)



Tabular result	Pop.	Pop.NZ	Total	Mean	STD	MeanNZ	STDNZ	Max	Min	MinNZ	% Succe
#GICB comds	8	8	7828.00	978.500	9.500	978.500	9.500	988.000	969.000	969.000	100.00
#GICB exchngs	8	8	19276.0	2409.50	25.710	2409.50	25.710	2447.00	2377.00	2377.00	
# GICB err.	8	8	332.000	41.500	21.260	41.500	21.260	93.000	23.000	23.000	
# CC cmds	8	8	60.000	7.500	0.500	7.500	0.500	8.000	7.000	7.000	12.50
# CC exchngs	8	8	41.000	5.125	0.781	5.125	0.781	7.000	4.000	4.000	
# CC err.	8	7	19.000	2.375	0.992	2.714	0.452	3.000	0.000	2.000	
# CD cmds	8	8	64.000	8.000	0.000	8.000	0.000	8.000	8.000	8.000	12.50
# CD exchngs	8	8	53.000	6.625	0.857	6.625	0.857	8.000	5.000	5.000	
# CD err.	8	7	11.000	1.375	0.857	1.571	0.728	3.000	0.000	1.000	
ModB compl.	8	1	100.000	12.500	33.072	100.000	0.000	100.000	0.000	100.000	12.50

A run is declared successful if :

-*all the data link transactions (Comm. C and Comm. D) are successful.*

- *GICB extractions has been successful*

Model B compliancy/Run

Run #	#GICB comds	#GICB exchngs	# GICB err.	# CC cmds	# CC exchngs	# CC err.	# CD cmds	# CD exchngs	# CD err.	ModB compl.
Run #	#GICB comds	#GICB exchngs	# GICB err.	# CC cmds	# CC exchngs	# CC err.	# CD cmds	# CD exchngs	# CD err.	ModB compl.
1	969	2392	40	7	7	0	8	8	0	100
2	988	2428	42	8	5	3	8	6	2	0
3	969	2390	42	7	4	3	8	7	1	0
4	988	2377	93	8	5	3	8	6	2	0
5	969	2408	24	7	5	2	8	7	1	0
6	988	2447	23	8	5	3	8	5	3	0
7	969	2388	44	7	5	2	8	7	1	0
8	988	2446	24	8	5	3	8	7	1	0

This is verified by means of the tabular display of a simulated Model B playback. The example above shows individually, per run, the number of GICB commands in that run. (If multiple GICB extractions are required per beam dwell, this is considered as ONE command). It also shows the number of real GICB extraction interrogations (In this example each command equals 3 extractions), and the number of GICB errors. A GICb error is considered 1 if not all requested GICBs in that beam are exchanged. From this, a general percentage G is calculated. (G(%) = (1-(# GICB errors / # GICB commands))*100 %. If this percentage is greater or equal to a minimum threshold (default set to 100) , the run is considered succesful for GICB.

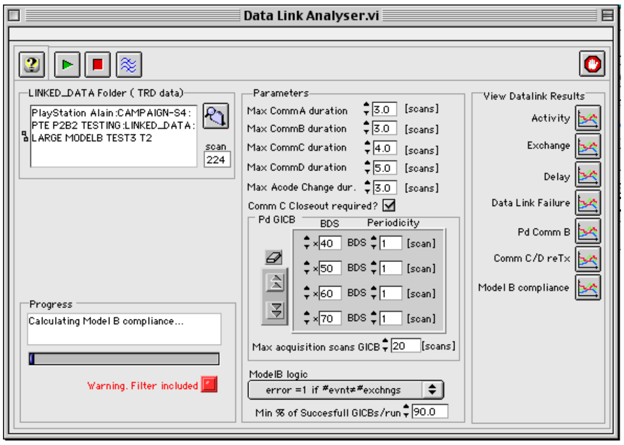
For Comm C and Comm D all exchanges are taken into account. If a Run contains one exchange which is not correctly closed out within a timeout value, the Run is considered unsuccesful for that data link type.

A general "Model B figure of compliance" <u>per Run</u> is calculated by logical ANDing the three requirements. This means that if one of the three is not compliant (GICb rate < threshold, or any Comm C or any Comm D error in the run, a 0 % is attributed. In case all three conditions are met, the figure is set to 100.

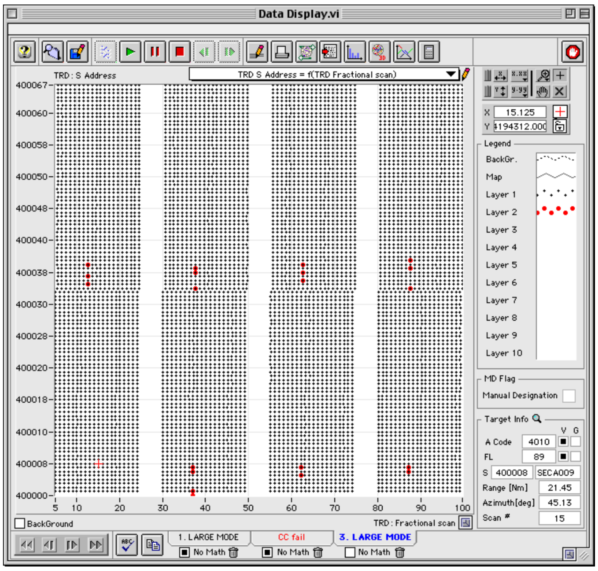
At the end, all figures for each run is added and averaged. This results in one general "Model B compliance " number.

The PTE-P2B2 tool declares GICB extraction successful for the run if depending on the target and the scan number the number of extracted GICB (started and completed in the scan) a user defined percentage (default 100) of the requested GICB extractions have been performed each scan on all the targets (in the peak sector(s) and in the background) during the run.

The user can enter the percentage of requested GICB in the parameter list of the data link analysis tool.



The PTE-P2B2 tool declares a Comm-C successful if completed(reservation to close-out) in less than the maximum duration N3 (1..20,1). (in scan number, default 1) specified by the user;



As the screenshot above illustrates, the data link model B scenario used in this example has seven Runs with at least on Comm C failure and one Run with no failure. (This is also the result as shown in table DLAN 93.) This caused the general Model B compliance figure to be 12.5 %.

The PTE-P2B2 tool declares a Comm-D successful if completed(reservation to close-out) in less than the maximum duration N4 (1..20,1). (in scan number, default 1) specified by the user;

The result of the above analysis is available:

- in a tabular display representing the percentages of successful runs for GICB, Comm C, Comm D and complete compliance status.

Model B compliancy/Run

	Pop.	Pop.NZ	Total	Mean	STD	MeanNZ	STDNZ	Max	Min	MinNZ	% Succes
#GICB comds	8	8	7828.000	978.500	9.500	978.500	9.500	988.000	969.000	969.000	100.00
#GICB exchng	8	8	19276.000	2409.500	25.710	2409.500	25.710	2447.000	2377.000	2377.000	
# GICB err.	8	8	332.000	41.500	21.260	41.500	21.260	93.000	23.000	23.000	
# CC cmds	8	8	60.000	7.500	0.500	7.500	0.500	8.000	7.000	7.000	12.50
# CC exchngs	8	8	41.000	5.125	0.781	5.125	0.781	7.000	4.000	4.000	
# CC err.	8	7	19.000	2.375	0.992	2.714	0.452	3.000	0.000	2.000	
# CD cmds	8	8	64.000	8.000	0.000	8.000	0.000	8.000	8.000	8.000	12.50
# CD exchngs	8	8	53.000	6.625	0.857	6.625	0.857	8.000	5.000	5.000	
# CD err.	8	7	11.000	1.375	0.857	1.571	0.728	3.000	0.000	1.000	
ModB compl.	8	1	100.000	12.500	33.072	100.000	0.000	100.000	0.000	100.000	12.50

- in a line chart display form, using a specific color/symbol for each type (# GICB, Comm C or Comm D programmed events, exchanges and failures counted (9 graphs in total) : target nr , run nr or S address on x axis, number of exchanges/ events/ failures on y axis.

3.7.11 Re-Interrogation Rate Calculation

3.7.11.1 Introduction

3.7.11.1.1 Background

In the context of POEMS evaluation the Mode S detection performance of the POEMS ground stations will be measured by means of the performance parameter ‘Probability of Detection’. However to minimise the RF pollution, this probability of detection shall be achieved by minimising the number of Roll Call interrogations, while extracting from the aircraft all the requested information.

The performance parameter that indicates how well the radar succeeded in minimising this number of roll call interrogations is the roll call re-interrogation rate.

The radar can perform more interrogations than expected because of the following reasons:

- - the reply was received to early in the beam, where the accuracy is not sufficient
- - the interrogation was sent before the beam was eliciting the target
- - no reply was sent by the transponder
- - the reply could not be successfully decoded due to garbling by fruit

3.7.11.1.2 Definition

The Roll Call re-interrogation rate R_R is defined as the ratio between the number of Roll Call interrogations actually performed N_I and the number of expected Roll Call interrogations N_{EI}.

$$R_R = \frac{N_I}{N_{EI}}$$

The aim of this document is to explain the method of assessment of the Roll Cal re-interrogation rate and to specify the corresponding ECP to be included in PTE P2B2 as an additional off-line analysis facility.

3.7.11.1.3 TRD data structure

The analysis starts from the TRD data structure as defined in P2B2. The TRD data structure consists of all target reports and the links to the corresponding interrogations. Each TRD record contains one Mode S target report, and all the links to the roll call interrogations corresponding to that target in that beam dwell (scan).

The P2B2 software allows parametric filtering and display of all the parameters defined. The re-interrogation rate amendment will add a number of fields to this data structure. These fields can be used in the parametric filter and display.

3.7.11.1.4 Assumptions

The tool will be used in the context of CEVAP evaluation. Because the evaluation is restricted to Elementary and Enhanced Surveillance, a very complex tool can be avoided by making a number of assumptions:

The calculation is only based on surveillance interrogations: UF4, UF5, including GICB extractions[2]

The TRD records that contain links to AICB, broadcast Comm-B, Comm-A, Comm-C and Comm-D interrogations are flagged, so they can be excluded from the automatic overall calculations and be investigated separately.

The exclusion of these data link transactions will not have a large impact on the CEVAP evaluations and when they appear they will be known.

3.7.11.1.5 Results

In the method described, for each individual target report the following figures will be calculated:

- The number of performed roll call re-interrogations N_I
- The number of expected roll-call interrogations N_{EI}
- The difference between performed and expected: $\Delta N = N_I - N_{EI}$

These calculations will form the basis for the following output of results:

- The overall roll call re-interrogation rate: $R_{Rtot} = \frac{\Sigma N_I}{\Sigma N_{EI}}$
- The roll call re-interrogation rate for a selected set of target reports (parametric filtering)
- The roll call re-interrogation rate per scan, which will consist of a graph with on the horizontal axis the scan number and on the vertical the re-interrogation rate
- The roll call re-interrogation rate per range window, as a sliding window result (window size and step size are user defined). The result will consist of a graph with on the horizontal axis the range and on the vertical axis the re-interrogation rate
- The display of all target reports in the inventory display, the targets with $\Delta N > 0$ will be displayed in a different color. This will allow investigation when re-interrogation happens, because the target reports can not only be display on a polar display, but 'any to any', e.g. heading against range.

[2] BDS 0,0; 0,2; 0,3; 0,4 are excluded, as they are part of the data link AICB and broadcast Comm-B

3.7.11.2 Method of assessment of roll call re-interrogation rate

The method is based on the roll call interrogations performed on one given target during one beam dwell, and its associated target report (ASTERIX CAT048). The association between roll call interrogations and target reports is already performed by PTE P2B2, resulting in the TRD data structure.

3.7.11.2.1 Calculations

To calculate the roll call re-interrogation rate, for each TRD record (target report) three values have to be calculated and associated:

- N_I : The total number of interrogations performed
- N_{EI} : The number of expected roll call interrogations

Additionally, for each target report the following information is stored:

- $\Delta N = N_I - N_{EI}$

A set of data link information flags as indicated in the table below

Flag	*Condition*
Comm-A	UF=20 OR UF=21
AICB reservation	RR=16 & DI=1 & MBS=1
AICB intermediate segment	RR=16 & DI=7 & RRS ≥2
AICB close-out	(DI=1 & MBS=2) OR (DI=0,1 or 7 & PC=4)
Comm-B broadcast	RR=16 & (DI =0 OR (DI=1 & MBS=0) OR (DI=7 & RRS=0))
Comm-C reservation	DI=1 & (MES=1 or 5)
Comm-C segment	UF=24 & (RC=0,1 or 2)
Comm-C close-out	(DI=1 & MES=2, 6 or 7) OR (DI=0,1 or 7 & PC=5)
Comm-D reservation	DI=1 & (MES=3 or 6)
Comm-D close-out	(DI=1 & MES=4, 5 or 7) OR (DI=0,1 or 7 & PC=6)
Comm-D transaction request	UF=24 with RC=3
Datalink transaction	True if one of the above flags is true

The calculation of N_I is straight forward. It consists of counting the number of UF4, UF5 roll call interrogations associated to the target report.

The calculation of N_{EI} is more complicated. It consists of two steps:

- Estimating which transactions were taking place
- Calculating the minimum number of interrogations required to perform these transactions

To estimate the different transactions the following steps have to be taken for each target report:

1. Count the total number of different GICB extractions N_{GICB} using UF4 and UF5 interrogations
2. If a UF5 interrogation is present, determine if a mode A code extraction was expected. This is the case when:
   - It is the first target report of this mode S address in the file[3], or
   - The previous target report was indicated as a miss[4], or
   - A mode A code change happened. This is when the mode A code of this target report differs from the A-code of the previous target report, or
   - The mode A code is 7500, 7600, 7700

The minimum number of interrogations expected for this TRD can then be calculated as follows:

IF ModeAExpected = true THEN N_{EI} = max (2,N_{GICB}) ELSE N_{EI} = max (1, N_{GICB})

For display purposes also $\Delta N = N_I - N_{EI}$ is calculated

3.7.11.2.2 Calculation and display of results

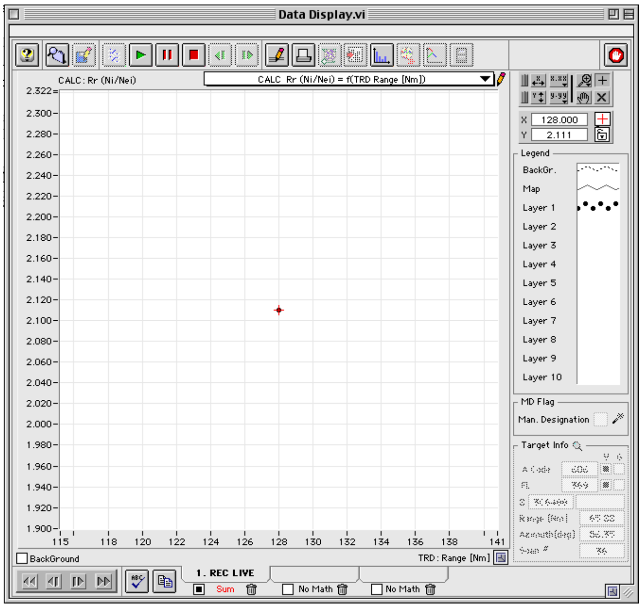
To calculate and display the results, first a filter is applied that filters out all target reports that contain data link transactions, using the Data link Transaction flag.

Overall re-interrogation rate

To calculate the overall re-interrogation, apply the following formula:

$$R_{Rtot} = \frac{\Sigma N_I}{\Sigma N_{EI}}$$

The data display should show one dot in the center. Put the cursor on this dot to determine the overall re-interrogation Rate.



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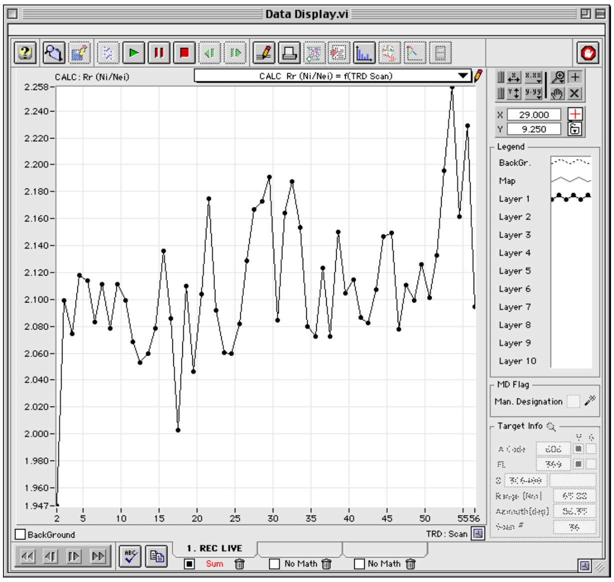
3 Extraction of mode A is expected at track initiation
4 For safety reasons, because a mode A code change announcement could have been missed

Re-interrogation rate per scan

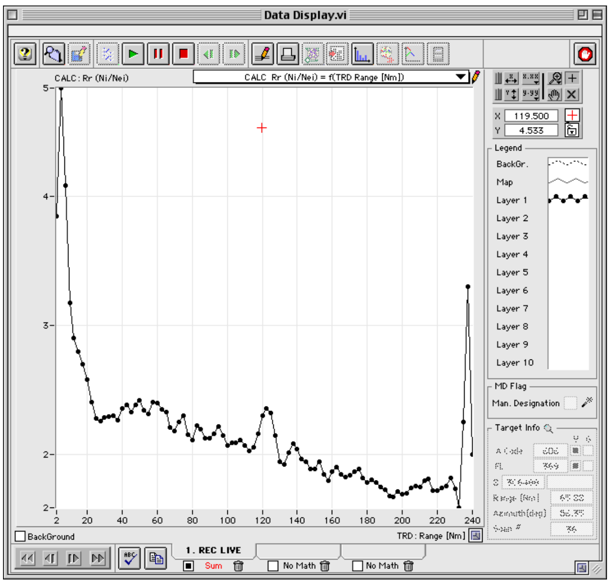
To calculate the re-interrogation rate per scan, apply the formula defined for the overall re-interrogation rate, for the target reports of that scan



Re-interrogation rate per range window

To calculate the re-interrogation rate per range window, the following two parameters must be defined by the user: WindowSize (0..256, 1NM) and StepSize (0..256, 1NM)

Then the re-interrogation rate is calculated according to the formula above for all target reports within the range window, the window is shifted by StepSize, until 256 NM is reached. All values for re-interrogation rate are displayed in a graph.



Example : WindowSize = 5 NM and StepSize is 2.5 NM

The re-interrogation rate is calculated and displayed for the following range intervals: 0-5, 2.5-7.5, 10-15, …

3.8 Display and output capabilities of “TRD” records

3.8.1 General

The Data Display tool is an investigation tool based on the PTE P2B1 Inventory tool. It has a similar look and feel as the PTE P2B1 Inventory tool. Any one who is familiar with the PTEP2B1 Inventory tool will have no problems operating the PTE P2B2 Data Display tool.

The Data Display tool is capable of displaying up to ten different user specified data sets in the same display. These data sets are differentiated using a distinctive symbology and coloring. All fields of the imported data items and all characteristics or additional fields computed and logically associated to a “TRD” record can be presented using a specific display representation.

Only those TRD records passing the Data Filtering Module are presented in the Data Display tool. The Data Display tool allows to save subsets of the original data and to export subsets of the original data using a Tab Separated File format.

3.8.2 Related Specs

3.8.2.1 General Display

[PTE-SR-P2B2-CAP-0600] The PTE P2B2 tool **shall** be able to show multiple displays on screen. The general PTE P2B2 layout **shall** consist of the following screens:

-Inventory screen showing position or time information on reference and Asterix data.
Interrogation reply screen showing interrogations and replies
Digital Display Info window
Protocol viewer

[PTE-SR-P2B2-CAP-0601] The PTE P2B2 tool **shall** enable the user to select either a geographical or a tabular display of those “TRD” records passing all of the relevant user specified filters (including the characteristics of the file (site, scan period, number of records, types of merged data, comment) and the additional data items added by the tool). **[PTE-SR-P2B2-CAP-0602]** As a user selectable feature, for displays depicting individual logical “TRD” data items (e.g. the map display), the PTE P2B2 tool **shall** use distinctive symbology and colouring to differentiate between (as a minimum) eight user specified sub-sets of the data in the same display.

[PTE-SR-P2B2-CAP-0603] The assignment of the precise symbol and colour mapping to user specified data sub-sets within the PTE P2B2 tool displays **shall** be a user selectable feature. **[PTE-SR-P2B2-CAP-0604]** On user command, when displaying multiple sub-sets of the data differentiated by symbol and colour, the PTE P2B2 tool **shall** create a “legend” feature showing the mapping between data sub-sets and colour and symbol used.

[PTE-SR-P2B2-CAP-0605] In displays depicting individual logical “TRD” data items (e.g. the map display), the PTE P2B2 tool **shall** enable the user to manually designate an individual logical “TRD” data items using the pointing device and, as a consequence, set that logical “TRD” data item’s manual designation flag to “true”.

3.8.2.2 Geographical Display of "TRD" records

[PTE-SR-P2B2-CAP-0610] In displays depicting the geographic positions of logical "TRD" records, the PTE P2B2 tool **shall** enable the user to zoom in / out and pan the display.

[PTE-SR-P2B2-CAP-0611] In displays depicting the geographic positions of logical "TRD" records (e.g. the map display), the PTE P2B2 tool **shall** enable the user to manually designate that multiple representations of the same of logical "TRD" data items are shown simultaneously.

[PTE-SR-P2B2-CAP-0612] When the user selects to display multiple representations of the same logical "TRD" data items the PTE P2B2 tool **shall** separately calculate the display co-ordinates for each representation of the same logical "TRD" data items from the user specified position source for each set of representations where the options available are:

reference trajectory position
ASTERIX Cat 048 position
interrogation recording position with the range derived from (as a user selectable option) either ASTERIX Cat 048 or data record position
ASTERIX Cat 018 position

[PTE-SR-P2B2-CAP-0613] In geographical displays, the PTE P2B2 tool default display co-ordinate system **shall** be Cartesian.

[PTE-SR-P2B2-CAP-0614] When any geographical display is created, the PTE P2B2 tool **shall** automatically scale the axes so that all data contained within the display are represented on screen.

[PTE-SR-P2B2-CAP-0615] Within the PTE P2B2 the user **shall** be able to manually set the axes scales for a graphical display.

[PTE-SR-P2B2-CAP-0616] When a geographical display is created the PTEP2B2 tool **shall** automatically include in the display appropriate default axis labels and a title.

[PTE-SR-P2B2-CAP-0617] On user command, the PTE P2B2 tool **shall** create a geographical display showing the geographical position of the individual logical "TRD" data items and POEMS SUT and simulated PSR radar positions in Rho, theta.

[PTE-SR-P2B2-CAP-0618] In a geographical display, the PTE P2B2 tool **shall** enable the user to toggle on / off display of polar gridlines centered on POEMS station position.

[PTE-SR-P2B2-CAP-0619] In a geographical display, the PTE P2B2 tool **shall** enable the user to select whether the individual logical "TRD" data items associated to the same logical Target N data item are depicted joined in sequence or unconnected.

[PTE-SR-P2B2-CAP-0620] In a geographical display showing multiple representations of individual logical "TRD" data items (e.g. scenario position, reply positions, Cat 048 position, etc.), the PTE P2B2 tool **shall** enable the user to select whether each set (e.g. scenario position, replies positions, Cat 048 position, etc.) of positional representations of the same logical "TRD" data items associated to the same logical Target N data item are shown joined in sequence or unconnected.

[PTE-SR-P2B2-CAP-0621] In a geographical display, the PTE P2B2 tool **shall** enable a replay mode in which the logical "TRD" data items are displayed sequentially in time order.

[PTE-SR-P2B2-CAP-0622] In a geographical display, the PTE P2B2 tool **shall** enable the user to specify whether during replay mode the logical "TRD" data items accumulate on the display or whether they are removed after a specified number of beams.

[PTE-SR-P2B2-CAP-0623] In a geographical display, the PTE P2B2 tool **shall** enable the user to specify the number of scans, from the range 1 to 10, for which the logical “TRD” data items are retained on the screen during replay mode.

[PTE-SR-P2B2-CAP-0624] In a geographical display, the PTE P2B2 tool **shall** enable the user to start, stop, pause, step backward and step forward the replay mode.

3.8.2.3 Tabular display of “TRD” records

[PTE-SR-P2B2-CAP-0630] On user command, the PTE P2B2 tool **shall** create a tabular display depicting in text the values of a number (up to a maximum 10) of user selected logical “TRD” data item associated fields (including additional data and flags generated by the PTE P2B2 tool) (in columns) per logical “TRD” data item (in rows).

[PTE-SR-P2B2-CAP-0631] When the user selects to display the “TRD” records in a tabular form, options within the PTE P2B2 tool display creation dialogue **shall** enable the user to select which fields of the data are to be displayed (from a selection of all available).

[PTE-SR-P2B2-CAP-0632] In tabular display depicting the logical “TRD” records, the PTE P2B2 tool **shall** enable to scroll (up / down) the table.

[PTE-SR-P2B2-CAP-0633] On user command, the PTE P2B2 tool **shall** sort the tabular display rows using any user specified logical “TRD” data item associated field shown within the tabular display as the sort key.

3.8.2.4 Export and printing of results

[PTE-SR-P2B2-CAP-0640] On user command, the PTE P2B2 tool **shall** export to an external file to be further interpreted and exploited by Excel, with a user specified file name, the content of the tabular display formatted as a tab delimited ASCII text file where the sequence of rows and columns mirrors that in the tabular display.

[PTE-SR-P2B2-CAP-0641] On user command, the PTE P2B2 tool **shall** print any user specified display to a color printer.

[PTE-SR-P2B2-CAP-0642] On user command, the PTE P2B2 tool **shall** save a copy of any user specified display as an external Postscript formatted file under a user specified filename.

3.8.2.5 Display of analysis results

[PTE-SR-P2B2-CAP-0700] The PTE P2B2 tool **shall** enable the user to specify interval ranges as the x-values in the histogram.

[PTE-SR-P2B2-ITF-0800] The Interface Control Document, which is to be produced after contract award in conjunction with the EUROCONTROL Agency, shall provide a description of the functional and physical boundaries of the equipment and shall consist of text supported by block diagrams, tables and other schematics as necessary

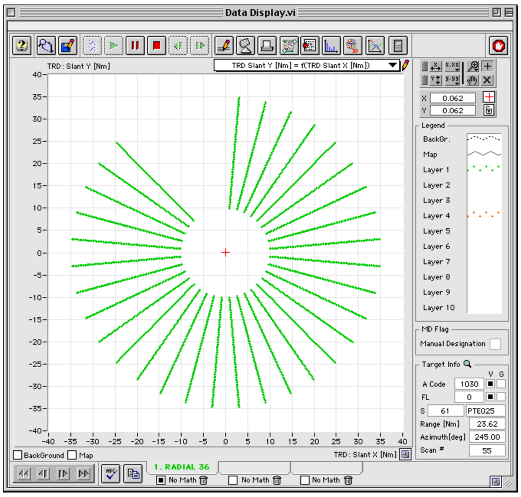
[PTE-SR-P2B2-ITF-0801] Other interfaces, such as those discussed below, shall also be described within the ICD. The ICD produced under the PTE P2B1 contract (Ref. 32) is to be used as a guidance for data import

3.8.3 Implementation

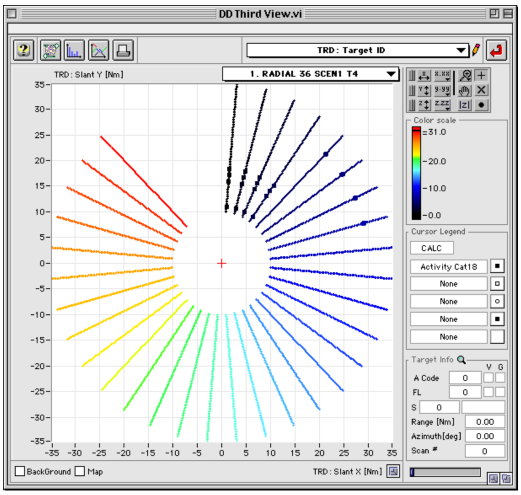
3.8.3.1 Display

The Data Display tool is able to show multiple displays on screen. The general Data Display layout can consist of the following screens: a 2D inventory screen showing whatever information is selected in a XY display type, a 3D color display adding a third color axis to the XY display, a Histogram window, a Data Display Info window and a Datalink State window. Multi level linking from the Data Display tool to the Protocol Viewer tool and the Reference Extractor tool are available.

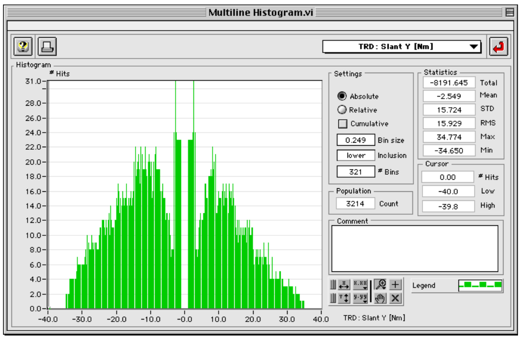
The main HMI of the Data Display tool is an inventory type screen displaying the data set chosen by the user.



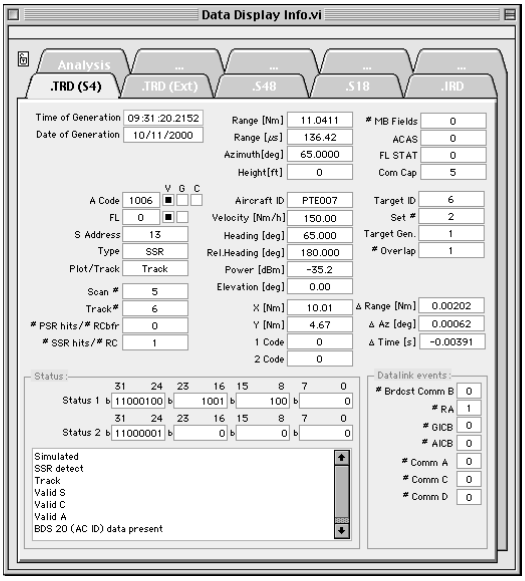
By clicking the button the 3D color display can be evoked. This window allows to add a third color axis to the YX type display of the Data Display tool.



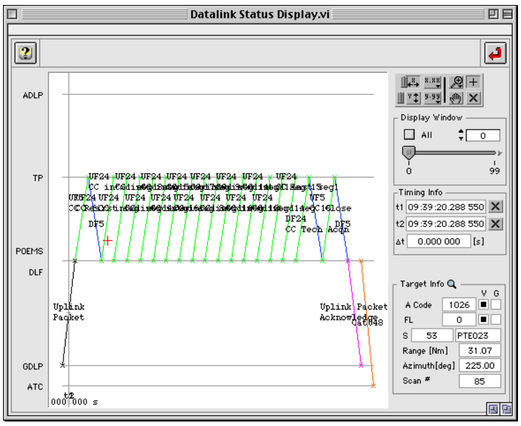
By clicking the button the Histogram display can be evoked. This window display a histogram of the selected data set in the Data Display tool.



From this main HMI the Data Display Info window can be evoked by clicking the button in the lower right corner of the window. The Data Display Info window displays all available information of the “TRD” selected by the pointing device in the Data Display. The relevant information is spread over six separate tabs, each grouping specific information of the selected “TRD”.

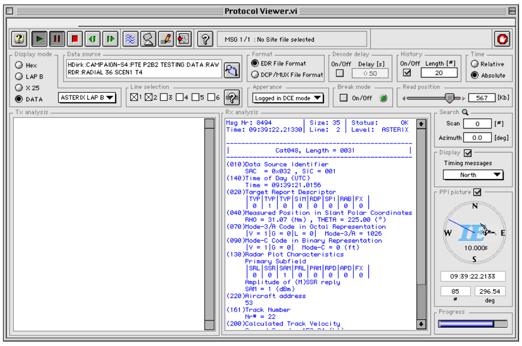


Also from the main Data Display HMI, the Datalink State window can be evoked by clicking the button in the top row buttons of the Data Display tool HMI. The Datalink State window displays a graphical summary of all the information linked to the “TRD” selected by the pointing device in the Data Display tool

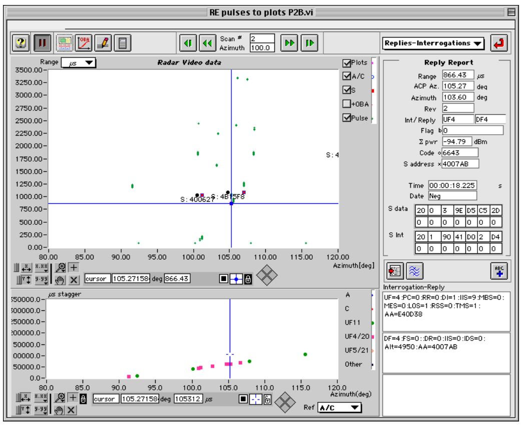


By selecting to corresponding link, the Protocol Viewer tool or the Reference Extractor tool can be linked to the “TRD” selected by the pointing device in the Data Display tool.

The Protocol Viewer tool will display the relevant Digital recording information associated with the selected “TRD”



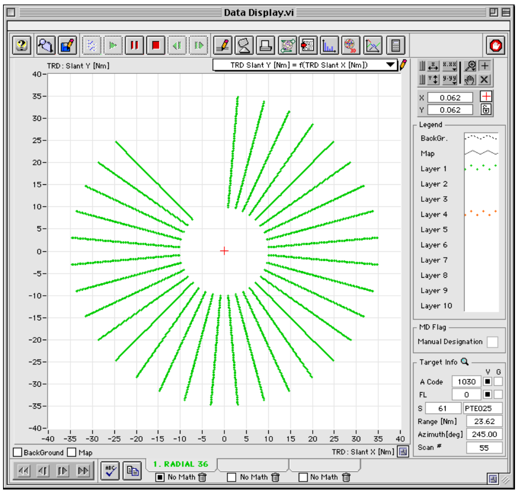
The Reference Extractor tool will display the relevant Video recording information associated with the selected “TRD”.



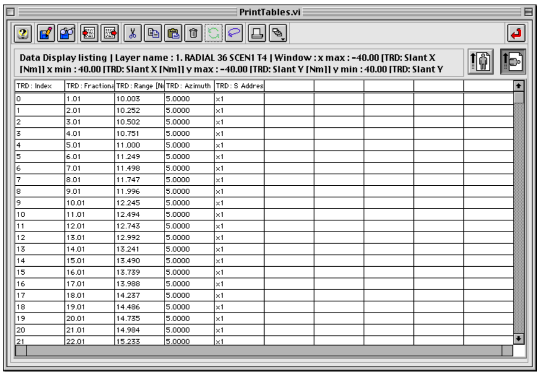
DIS1 will be demonstrated and verified during FAT.

3.8.3.2 Geographical Displaying

The Data Display tool enables the user to select either a geographical or a tabular display of those “TRD” records passing the all of the relevant user specified filters. The “TRD” records are filtered during the loading process and then automatically displayed in a user specified geographical display.



To evoke the Tabular display, the user has to click the  button in the top row buttons of the Data Display tool HMI. After specifying the column contents, a tabular display window is shown containing the requested information. The source of the information shown in the tabular display corresponds to that of the geographical display taking into account the pan and zoom boundaries of the geographical display.


PrintTables.vi

Data Display listing | Layer name : 1. RADIAL 36 SCEN1 T4 | Window : x max : -40.00 [TRD: Slant X [Nm]] x min : 40.00 [TRD: Slant X [Nm]] y max : -40.00 [TRD: Slant Y [Nm]] y min : 40.00 [TRD: Slant Y

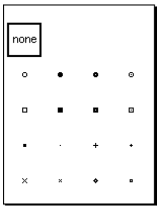
TRD : Index	TRD : Fractiona	TRD : Range [N	TRD : Azimuth	TRD : S Addres
0	1.01	10.003	5.0000	x1
1	2.01	10.252	5.0000	x1
2	3.01	10.502	5.0000	x1
3	4.01	10.751	5.0000	x1
4	5.01	11.000	5.0000	x1
5	6.01	11.249	5.0000	x1
6	7.01	11.498	5.0000	x1
7	8.01	11.747	5.0000	x1
8	9.01	11.996	5.0000	x1
9	10.01	12.245	5.0000	x1
10	11.01	12.494	5.0000	x1
11	12.01	12.743	5.0000	x1
12	13.01	12.992	5.0000	x1
13	14.01	13.241	5.0000	x1
14	15.01	13.490	5.0000	x1
15	16.01	13.739	5.0000	x1
16	17.01	13.988	5.0000	x1
17	18.01	14.237	5.0000	x1
18	19.01	14.486	5.0000	x1
19	20.01	14.735	5.0000	x1
20	21.01	14.984	5.0000	x1
21	22.01	15.233	5.0000	x1

DIS2 will be demonstrated and verified during FAT.

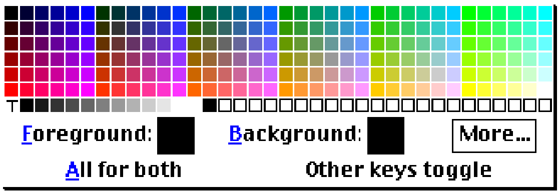
3.8.3.3 Symbology

As a user selectable feature, for displays depicting individual logical “TRD” data items (e.g. the map display), the Data Display tool uses distinctive symbology and coloring to differentiate between (as a minimum) eight user specified sub-sets of the data in the same display. In fact, the user can define up to ten sub sets in the same display. For each sub set a distinctive symbol and color can be chosen to differentiate between the subsets.

The following 16 symbols are available:



The following 216 predefined colors are available:



DIS3 will be demonstrated and verified during FAT.

3.8.3.4 Data Subsets

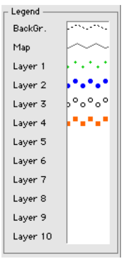
The assignment of the precise symbol and color mapping to user specified data sub-sets within the Data Display tool displays is a user selectable feature. The following rules are applied for the assignment of the Data Display preferences (including symbol and color):

The last known preference settings are automatically used except if a new campaign is started

A new campaign always starts with the factory default preferences.
At all time specific user defined preferences can be loaded and saved
DIS4 will be demonstrated and verified during FAT.

3.8.3.5 Legends

At all times, when displaying multiple sub-sets of the data differentiated by symbol and color, the Data Display tool creates a “legend” feature showing the mapping between data sub-sets and color and symbol used at the right hand side of the HMI.

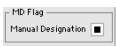


DIS5 will be demonstrated and verified during FAT.

3.8.3.6 Manual Designation Flag

In displays depicting individual logical “TRD” data items (e.g. the map display), the Data Display tool enables the user to manually designate an individual logical “TRD” data items using the pointing device and, as a consequence, set that logical “TRD” data item’s manual designation flag to “true”. At all times, when an individual logical “TRD” data item is selected using the pointing device, its Manual Designation Flag (on / off) contents is displayed in the Data Display HMI.

Off: 

On: 

At all times, the contents of the Manual Designation Flag of an individual logical “TRD” data item which is selected using the pointing device, can be changed. The dataset is immediately updated with the new contents of the Manual Designation Flag for the an individual logical “TRD” data item which is selected using the pointing device. There is no extra manipulation needed to save this information.

DIS6 will be demonstrated and verified during FAT.

3.8.3.7 Zoom Functions

In displays depicting the geographic positions of logical "TRD" records, the Data Display tool enables the user to zoom in / out and pan the display. These are standard LabVIEW functions . The Data Display tool is compliant with the specifications stated above.

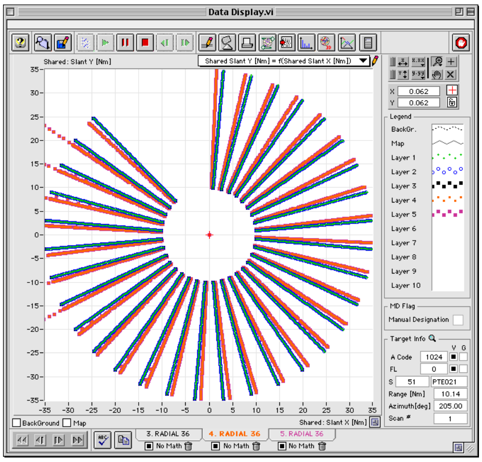
3.8.3.8 Geographical Position Axis

In displays depicting the geographic positions of logical "TRD" records (e.g. the map display), the Data Display tool enables the user to manually designate that multiple representations of the same of logical "TRD" data items are shown simultaneously. This is accomplished by loading the same data set in multiple layers (one layer for each representation of the same of logical "TRD" data item) and then assigning a specific representation to each of these layers. This assignment can be done in the Data Display preferences window. For each layer there is a choice between the following representations of the same of logical "TRD" data item: TRD (scenario), S48 (Radar Data) S18 (Data Link), IRD Int (interrogation) and IRD rep (reply). If now a so called "shared" axis type is selected by the user, each layer will get the value for the same of logical "TRD" data item from its designated source (TRD, S48, S18, IRD Int, IRD Rep).

For the moment the following "Shared" axis types can be selected:

Slant X
Slant Y
Range
Azimuth

The following figure illustrates a Shared:SlantX/Shared:SlantY type display with in layer 1: TRD (scenario = green), layer 2: S48 (radar data = blue), layer 3: S18 (data link = black), layer 4: IRD Int (interrogation = orange) and in layer 5: IRD rep (Reply = purple).



3.8.3.9 Cartesian Coordinates

In geographical displays, the Data Display tool default display co-ordinate system is Cartesian. In fact, any geographical display can be put as default by selecting it as a first element in the geographical display selection list and then saving this list as default geographical display selection list.

3.8.3.10 Axis Scaling

When any geographical display is created, the Data Display tool automatically scales the axes so that all data contained within the display are represented on screen. In fact, whenever a new data set is loaded into the Data Display tool, the axes are automatically scaled so that all data contained within the display are represented on screen. From that moment on, the Data Display tool remembers the axes scale settings belonging to a particular display (including that latest zoom and pan) and reuses these settings each time that particular display type is chosen.

3.8.3.11 Manual Setting of axis

Within the Data Display tool the user is able to manually set the axes scales for a graphical display. These are standard LabVIEW functions that were already present in the PTE P1 software. Therefore, we can conclude that the Data Display tool is compliant with the specifications stated above.

3.8.3.12 Default Axis

When a geographical display is created the Data Display tool automatically includes in the display appropriate default axis labels and a title. The axis labels are predefined and automatically adjusted to whatever choice of the display type. For example, if the range item from the S48 file is chosen then the axis label will be:

"S48: Range [Nm]".

A title is automatically presented (corresponding to the chosen display type) but can be manually changed at any time. For example, an azimuth from the TRD file on the X-axis and a range from the S48 file on the Y-axis would result in:

"S48: Range [Nm] = f(TRD: Azimuth [deg]).

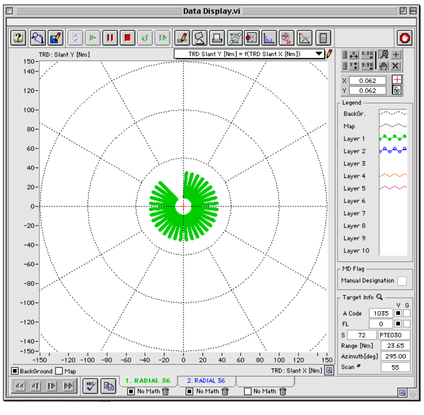
At any time the this title can be changed to:

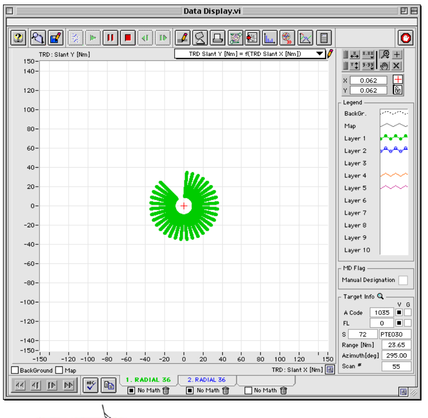
"Whatever the user wants"

DIS13 will be demonstrated and verified during FAT.

3.8.3.13 Polar Gridlines

In a geographical display, the Data Display tool enables the user to toggle on / off display of polar gridlines centered on the POEMS station by clicking the Background button in the Data Display HMI. The data Display tool toggles between polar gridlines centered on the POEMS station and a rectangular mesh of gridlines. One of both is always present. The following two figures illustrate both modes

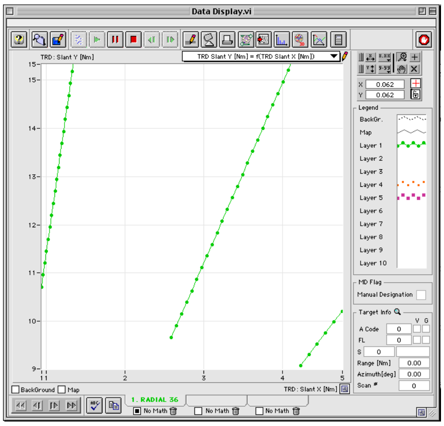




DIS14 will be demonstrated and verified during FAT.

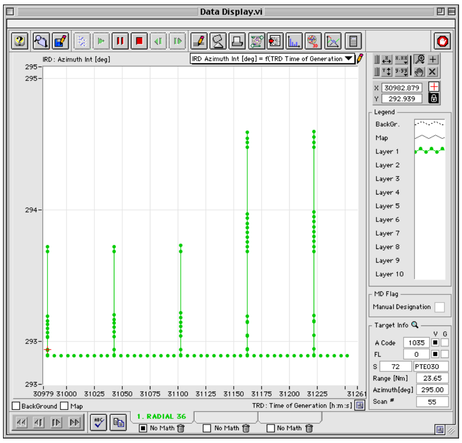
3.8.3.14 Lines Joined

In a geographical display, the Data Display tool enables the user to select whether the individual logical “TRD” data items associated to the same logical “Target N” data item are depicted joined in sequence or unconnected. This can be accomplished by selecting “Track”(connected) or “None” (unconnected) in the connection mode selector in the preferences window. This selection can be made for each layer individually. The following figure illustrates this “Track” connect mode.



3.8.3.15 Multiple Representations

In a geographical display showing multiple representations of individual logical “TRD” data items (e.g. scenario position, reply positions, Cat 048 position, etc.), the Data Display tool enables the user to select whether each set (e.g. scenario position, replies positions, Cat 048 position, etc.) of positional representations of the same logical “TRD” data items associated to the same logical “Target N” data item are shown joined in sequence or unconnected. . This can be accomplished by selecting “Target”(connected) or “None” (unconnected) in the connection mode selector in the preferences window. This selection can be made for each layer individually. The following figure illustrates this “Target” connect mode.



3.8.3.16 Replay Mode

In a geographical display, the Data Display tool enables a replay mode in which the logical “TRD” data items are displayed sequentially in time order. The tool enables the user to specify whether during replay mode the logical “TRD” data items accumulate on the display or whether they are removed after a specified number of scans. The user can specify the number of scans, from the range 1 to 10, for which the logical “TRD” data items are retained on the screen during replay mode. The Data Display tool enables the user to start, stop, pause, step backward and step forward the replay mode. All these features were already present in the PTE P1 Inventory software. The Data Display tool completely inherited this functionality from the PTE P1 Inventory tool including the HMI. In fact, there is no difference between the PTE P1 Inventory tool and PTE P2B2 data Display tool when it comes to replay mode.

The first thing to do is to switch the corresponding layer from static to dynamic, together with the start scan, the history length, the step size and the replay speed. All these values are entered in the preferences window. Each layer can have its own individual dynamic mode parameter settings. From that moment on the dynamic behaviour can be controlled with the following buttons from the top row button in the Data Display HMI:

Play , Pause, Stop, Step backward and Step forward

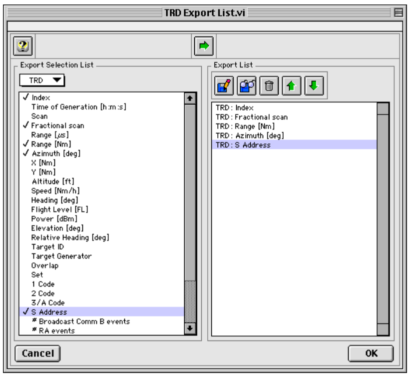
These buttons act on all layers that are in dynamic mode.

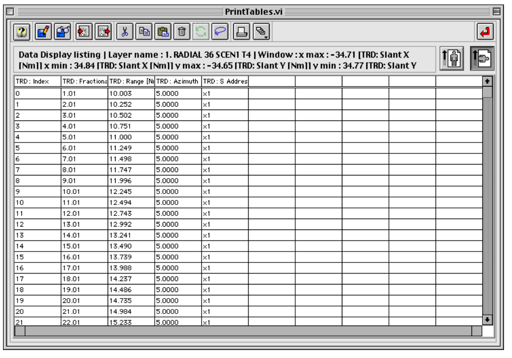
DIS17/18/19/20 will be demonstrated and verified during FAT.

3.8.3.17 Tabular Display

On user command, the Data Display tool creates a tabular display depicting in text the values of a number (up to a maximum 10) of user selected logical “TRD” data item associated fields (including additional data and flags generated by the PTE P2B2 tool) (in columns) per logical “TRD” data item (in rows). When the user selects to display the “TRD” records in a tabular form, options within the Data Display tool display creation dialogue enables the user to select which fields of the data are to be displayed (from a selection of all available).

This can be accomplished by clicking the button the in the Data Display HMI. An export selection window is shown that allows the user to select which fields of the data are to be displayed in a tabular form. At the left side of the window there is a list with all the available items that can be selected. There is such a list for each type of “TRD” sub file: TRD, S48, S18, IRD, CALC. By simply double clicking an item, it is transferred to the right side of the window and consequentially will be displayed in the tabular display. By clicking the OK button, the tabular display is created. The following two figures illustrate the selection window and the tabular display window.



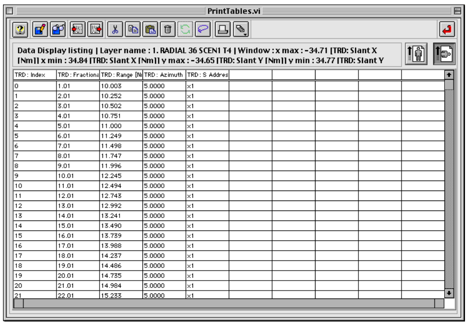
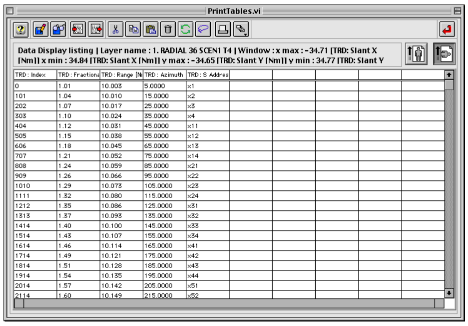


In tabular display depicting the logical “TRD” records, the Data Display tool enables to scroll (up / down) the table with the scroll bars at the right side of the tabular display window. Accordingly, in tabular display depicting the logical “TRD” records, the Data Display tool enables to scroll (left / right) the table with the scroll bars at the bottom side of the tabular display window

DIS20 / 21 / 22 will be demonstrated and verified during FAT.

3.8.3.18 Tabular Display Sort

On user command, the Data Display tool sorts the tabular display rows using any user specified logical “TRD” data item associated field shown within the tabular display as the sort key. This can be accomplished by selecting a logical “TRD” data item associated field with the  button in the top row of the tabular display HMI. This selector contains a list with the respective header of each column. By selecting one of the headers, the table is sorted in ascending order according to this column. The following two figures illustrate the sorting by column procedure. The firsttable is sorted by index (first column), the second figure is sorted by range (fourth column).

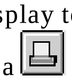
DIS23will be demonstrated and verified during FAT.

3.8.3.19 TRD Data Export

On user command, the Data Display tool exports to an external file to be further interpreted and exploited by Excel, with a user specified file name, the content of the tabular display formatted as a tab delimited ASCII text file where the sequence of rows and columns mirrors that in the tabular display. This feature was already present in the PTE P1 tabular display and is not changed for the PTE P2B2 software. Therefore, we can conclude that the PTE P2B2 tabular display is compliant with this requirement.

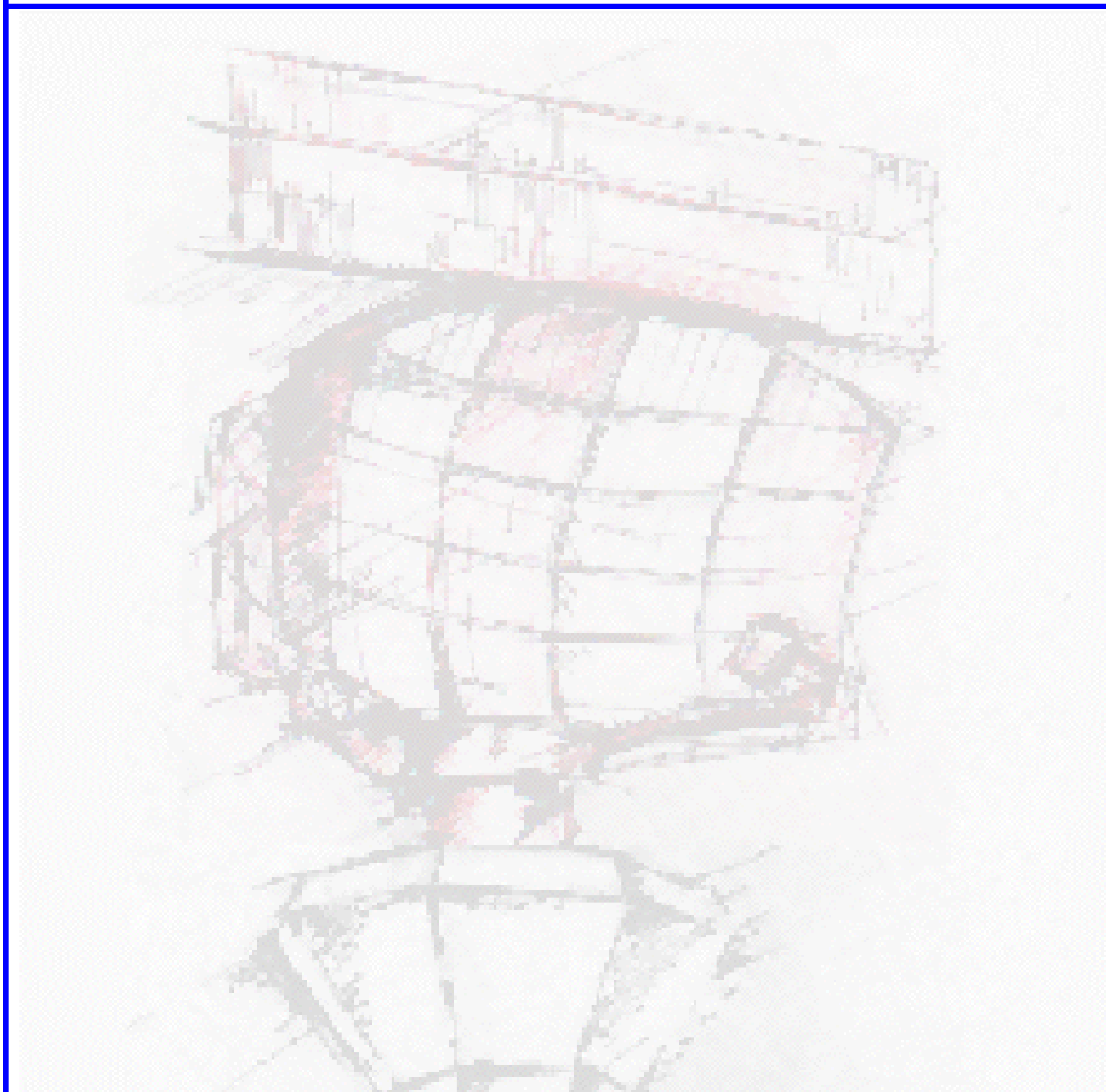
DIS24 will be demonstrated and verified during FAT.

3.8.3.20 Data Printout

On user command, the Data Display tool prints any user specified display to a color printer. Every window that has a  button in the HMI can be printed to any kind of printer. For all the other windows a screen / window dump can be used.

DIS25 will be demonstrated and verified during FAT.

PTE P1-P2-P5



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Abstract

As part of the Mode S development program, standard analysis tools are required to evaluate the performance of the **P**re-**O**perational **E**uropean **M**ode **S** (POEMS) stations being developed. It is intended that the integrated **P**OEMS **T**est **E**nvironment (PTE) will fulfil this objective. The creation of this Tool is broken into various phases - the target simulator, data recording and FAT support tool (the PTE phases P1 and P2B1), the transmitter test tool (PTE phase P2A), the data link performance assessment tool (PTE phase P2B2), the cluster simulation and testing tool (PTE phase P3), the radar site performance analysis tool (PTE phase P4) and a further element to ensure that a cluster of POEMS ground stations are inter operable (PTE phase P5).

Keywords

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EXECUTIVE SUMMARY

As part of the Mode S development program, standard analysis tools are required to evaluate the performance of the Pre-Operational European Mode S (POEMS) stations being developed. It is intended that the POEMS Test Environment (PTE) will fulfil this objective by combining the capabilities of various test tools - the PTE -P1, P2A, P2B1, P2B2, P3, P4 and P5.

Intersoft Electronics was honoured with the development of phases P1, P2A,P2B1, P2B2 and P5.

PTE-P5 is currently only foreseen to be used during the Common EVAluation Project of the POEMS stations (CEVAP) to prove the concept of data sharing between clustered ground stations

1. Introduction

Sophisticated radar analysis and testing capabilities are required for evaluating current and future generations of SSR systems.

As part of the Mode S development program, test and analysis tools are required to evaluate the performance of the Pre-Operational European Mode S (POEMS) stations being developed. It is intended that the POEMS Test Environment (PTE) will fulfil this objective by combining the capabilities of different tools - the PTE - P1, P2A, P2B1, P2B2, P3, P4 and P5.

PTE-P5 is currently only foreseen to be used during the Common EVAluation Project of the POEMS stations (CEVAP) to prove the concept of data sharing between clustered ground stations. It has been accepted by the Agency and informally validated as fit for purpose in the course of its usage during the cluster test phase of the POEMS CEVAP.

As well as being employed as development aids, acceptance test tools and evaluation test tools, the PTEs could potentially be used as an optimisation, maintenance and fault finding tool kit for use in operational Mode S deployments and site support.

1.1. The PTE P5 Project

The PTE - P5 stage contains the development that enables the inter-operability testing and analysis of an integrated POEMS radar cluster in live environment and functioning in distributed mode.

This testing can not be seen as an automated process, but rather on intuitive and interactive process between specialist user and the cluster environment. The testing shall require huge amounts of data to be gathered at each node of the cluster under test. After data acquisition, the data can be processed and analysed.

The processed data can be analysed “manually”, by using extensive data visualisation tools, or automatically, by using calculation tools which asses the performance parameters of the cluster. The P5 tool will not be able to provide the user with one and unique performance figure. The complexity of the environment of a POEMS cluster is such that it requires a lot of specialist input to determine a final judgement on the cluster performance.

1.2. General Overview of P5 system

The PTE P5 tool is a logical extension to the existing PET P1-P2 tool and has been developed using the same look and feel. The tool uses LabVIEW v4.1. as development platform.

The P5 tool consists of the following sub modules:

- Recording of data
- Processing of data
- Linking of data on sensor level
- Centralisation of data
- Linking of data on cluster level
- Analysis and Calculation of Calculated fields and Flags
- Data Visualisation

2. Reference Documents

2.1. EC documents

EC. 1. User Requirement Document for the support of the cluster test phase of POEMS CEVAP SUR/PTE5/ST04/1250/001 Edition 1.2 dated 22/09/2000.

EC. 2. EATCHIP. Pre-Operational European Mode-S Functional Specification. Eurocontrol SUR-ET2-ST03.3110-SPC-01-00. Edition 2.0.

EC. 3. EATCHIP. Intersite Co-ordination ICD for POEMS Eurocontrol SUR-ET2-ST03.3110-SPC-02-00 Edition 1.9 dated 3 June 98.

EC. 4. Radar Sensor Performance Analysis. Eurocontrol, SUR.ET01.ST03.1000-STD-01, Edition 0.1, June 1997 Working Draft.

EC. 5. POEMS Document for ASTERIX Category 017 Transmission of Mode S Surveillance Co-ordination Function Messages Ref. SUR.ET2.ST03.3111-SPC-02-00 Ed 0.5 February 1999 Proposed Issue.

EC. 6. POEMS Document for ASTERIX Category 018 (Part 6) Transmission of Mode S Datalink Function Messages Ref. SUR.ET2.ST03.3112-SPC-02-00 Ed 1.5 March 1999 Proposed Issue.

EC. 7. POEMS Document for Radar Data Exchange Part 2b Transmission of Monoradar Service Messages Ref. SUR.ET2.ST03.3116-SPC-02b-01 Ed 1.3 16 March 1999 Proposed Issue.

EC. 8. POEMS Document for Radar Data Exchange Part 4 Transmission of Monoradar Target Reports Ref. SUR.ET2.ST03.3115-SPC-04-01 Ed 1.3 12 March 1999 Proposed Issue.

EC. 9. Coverage Map Interface Control Document for POEMS stations, Ref. SUR-ET2-ST03.3113-SPC-01.00, version 1.11 15 March 1999.

EC. 11. PTE-P2B Interface Control Document, Ref. TBD Edition 2.0 Dated 10/07/2000.

EC. 12. PTE-P4 Software User Manual, Ref. AOA089D012-1.3 Dated 26/04/2000

EC.13. POEMS Test Environment Phase 3 - User Manual, Ref. DERA/LSB1(ATC)/P3/DEL/WP7/UM/1.1 Dated August 2000

EC. 14. PTE-P1/P2 User Manuals :

a. RASS-S4 User Manual Volume 1 - Introduction and Technical Specifications Version 4.3.3 Dated Oct 2001

b. RASS-S4 User Manual Volume 2 Antenna Diagram Measurement Version 4.3.3 Dated Oct 2001

c. RASS-S4 User Manual Volume 3 Video Recordings and Analysis Version 4.3.3 Dated Oct 2001

d. RASS-S4 User Manual Volume 4 Data Recordings and Analysis Version 4.3.3 Dated Oct 2001

e. RASS-S4 User Manual Volume 5 Radar Environment Simulator Version 4.3.3 Dated Oct 2001

f. RASS-S4 User Manual Volume 6 RF Test Set and Special Tools Version 4.3.3 Dated Oct 2001

g. PTE-P2A User Manual Volume 7 TTT User Manual Version 4.3.3 Dated Oct 2001

EC. 15. SES - Architectural Design Document for POEMS SMGET, Ref. DOC0631 Issue B Dated 30/05/2000

EC. 16. SES – User Manual for POEMS SMGET, Ref. ?????

EC. 17. Project Requirement Specification For the Development of the POEMS Test Environment Phase 5 (PTE P5 Tool). PTE/SPE/001 Edition 1.0 Dated 13/10/2000 Released Issue

EC. 18. NMP Stability Assessment Issue CLARIFICATION; Ref SUR/POEMS.TSC.RII/NE007 ; Version 0.3; dated 7/02/2000

EC. 19. NNCOP Issue CLARIFICATION; Ref SUR/POEMS.TSC.RII/NE008; Version 0.1; dated 7/02/2000

2.2. ICAO documents

IC. 1. ICAO Annex 10, Aeronautical Communications. Volume IV, First Edition July 1995 and including up to Amendment 71.

IC. 2. ICAO Annex 10, Aeronautical Communications. Volume III, First Edition July 1995 and including up to Amendment 71.

IC. 3. Manual on Mode S Specific Services ICAO document 9688-AN/952 First edition, 1997.

IC. 4. Manual on testing of radio navigation aids Vol. III (Testing of Radar Surveillance System) ICAO document 8071.

IC. 5. Manual of the Secondary Surveillance Radar (SSR) Systems ICAO Document 9684 Second Edition 1998.

2.3. Additional Intersoft Documents

Ref. 1. PTE P1/P2 Interface Control Document Version 2.2 Intersoft Electronics dated 21/04/99.

Ref. 2. User Manual RASS-S4 v 4.2 June 2000 Intersoft Electronics 20/6/2000

Ref. 3. PTE P2B1 Project Plan Edition 1.0 21/2/2000

Ref. 4. PTE P2B1 System Requirement Document v 2.0 22/6/2000

Ref. 5. PTE P2B1 Architectural Design Document v 1.1 19/6/2000

Ref. 6. PTE P1 Architectural Document Version 4.1 Intersoft Electronics dated 14/04/1999.

Ref. 7. PTE P2B Interface Control Document Second Edition Version 2.1 Intersoft Electronics dated 20/08/00. (Replaces Ref. 22)

Ref. 8. PTE P2B1 Test Plan v 1.0 Dated 9/5/2000

Ref. 9. PTE P2B1 Test Specifications v 1.0 Dated 2/6/2000

Ref. 10. PTE P2B1 Test Report v 0.16 Dated 19/6/2000

Ref. 11. PTE P2B2 Project Plan Edition v1.0 02/5/2000

Ref. 12. PTE P2B2 System Requirement Document v 1.1 17/10/2000

Ref. 13. PTE P2B2 Architectural Design Document v 1.0 18/10/2000

Ref. 14. PTE P2B2 Test Specifications v 0.3 17/10/2000

Ref. 15. PTE P2B2 Test Report 0.1 21/10/2000

2.4. Abbreviations and acronyms

See Annex A - List of abbreviations and acronyms applicable to the PTE projects.

2.5. Definitions

The definitions below are to be read in conjunction with document EC. 3 where the Track Acquisition and Support Protocol (TASP) is specified.

- A track acquisition procedure (TAP) is an actual implementation of TASP between two POEMS stations in the case of the acquisition through co-ordination of a specific Mode S target.
- A track support procedure (TSP) is an actual implementation of TASP between two POEMS stations in the case of the support through co-ordination of a specific Mode S target.
- A TAP from station B to station A is expected when station B outputs, without the support of station A, a category 048 target report a Mode S target located in the overlapping coverage of A and B whereas the previous target report reported by B for the same Mode S address was not located in the overlapping coverage of A and B.
- A TAP procedure is expected from station A to station B for target T (i.e. A will send cat 17 track data for target T to station B) if T is currently detected by A, is in the overlapping coverage of A and B as seen by A andthe Mode S address of target T is not present either in the NNCOP message or the NNCOP reply message sent by B to A.
- A TAP from station B to station A is initiated if station B sends a track data message (category 017) to A whereas A has not requested previously support (through track data request category 017 message) for that Mode S target.
- A TAP from station B to station A is completed if station A sends a cancellation of track data message (category 017) to B or when station B sends a track data stop message (category 017) to A.
- A TAP from station B to station A is successful if it was expected, if it has been initiated and if it has been completed by station A by sending a cancellation of track data message (category 017) to B.
- The duration of a successful TAP of target T from station B to station A is defined as the difference between the time of output by station A of a cancellation of track data message for target T and the time of output of the first track data message for target T sent by station B to station A.
- A TSP from station B to station A is expected if a Mode S target which is located in the common overlapping coverage of A and B is reported by A, for the first time, through a target report which was not being updated with a Mode S measured position.
- A TSP from station B to station A is initiated if A sends a track data request message (category 017) to station B for a Mode S target located in the overlapping area of A and B.
- A TSP from station B to station A is completed if station A sends a cancellation of track data message (category 017) to B or when station B sends a track data stop message (category 017) to A.
- A TSP is successful from station B to station A if it was expected, if it has been initiated and if it has been completed by station A sending a cancellation of track data message (category 017) to B.
- The duration of a successful TSP of target T from station B to station A is defined as the difference between the time of output by station A of a cancellation of track data message for target T and the time of output of the first track data request message for target T sent by station A to station B.
- A map mismatch occurs when the overlapping area between two stations is not identical in both station coverage maps (see Figure 1 below)

- The cluster acquisition delay of target T by station A is defined as the difference between the time of detection (DI 140) of the first target report showing a Mode S Roll-Call detection for target T output by A and the time of detection (DI 140) of the first target report for target T output by any other or one particular station of the cluster showing that target T is in the coverage of A.
- The station re-acquisition delay of target T by station A is defined as the difference between the time of detection (DI 140) of the first target report showing a Mode S Roll-Call detection for target T output by A after a period of misses and the time of detection (DI 140) of the first target report for target T showing a miss output by station A.
- The Track Data Request reaction delay of target T by station A is defined as the difference between the time of detection (DI 140) of the first target report for target T showing a miss output by station A and the time of output of the first track data request message for target T sent by station A to station B.
- The Track Data Cancellation reaction delay for TAP s of target T by station A is defined as the time of detection (DI 140) of the first target report showing a Mode S Roll-Call detection for target T output by station A and the time of output of the track data cancellation message for target T sent by station A to station B.
- The Track Data Cancellation reaction delay for TSP s of target T by station A is defined as the time of detection (DI 140) of the first target report showing a Mode S Roll-Call detection for target T after a period of misses output by station A and the time of output of the track data cancellation message for target T sent by station A to station B.

Note : The definitions of the cluster acquisition and re-acquisition delays are independent of the cluster mode, either central or distributed.

3. PTE – P5 Project Design

3.1. Introduction

3.1.1. General

In the first phase (P1) of the PTE (POEMS Test Environment) development the emphasis was put on the simulation of the environment, the recording and analysis of signals at different levels in the radar chain.

In the first part of the second stage (PTE P2A), a POEMS transmitter test tool was created.

In the second part of the second stage (P2B1), additional simulation capabilities have been be added and all recorded result data has been made available for export into tab delimited text files and internal format structures (DSS files) allowing detailed analysis in the next stage..

In the third part of the second stage (P2B2) an effort was made on the analysis of data link related data. This stage allowed the user to visualize and analyze all levels of the results of the POEMS performance on data link level (POEMS phase 2), including Target report level, (ASTERIX Cat 48) data link communication level (Asterix Cat 18) and Interrogations and Reply data (Video level).

The P5 stage will add the same functionality, but on the cluster level, hereby integrating all data recorded in the cluster (on multiple stations) into one huge data set and allowing detailed analysis of the actions going on in the cluster. P5 will no longer rely on simulated data, but will emphasis on recorded data in a life environment.

3.1.2. Purpose

The purpose of the PTE P5 is to evaluate the performance of a cluster in distributed mode by recording data at all entry points of the cluster, there be it surveillance data, SCF data and interrogation data of the radar towards the targets.

After centralization of this data, a general analysis can be made by means of the P5 tool.

3.1.3. System Concepts

The idea behind the Intersoft Electronics' implementation of P5 is one of maximum re-use of existing hardware and software, developed under previous PTE contracts.

The P1 system are currently installed in six different locations, and can as such be used to record all required data for P5. The P5 system requires three sources of data:

Asterix Cat 48, Asterix Cat 17 and Interrogation (Roll Call) data.

All this data can be collected using two different devices: The PTE P1 EDR and the PTE P1 RES. Alternatively, the RES can be swapped for the PTE P1 RFTS. (NOT the SASS-S RFTS, since it does not have the required hardware modifications performed under PTE). The recorded data can be centralized using several possible media (CD-RW, ftp, E-mail, etc..) and can then be further processed using one central P5 System . This P5 system shall be a High performance Macintosh G4 workstation with 21" screen.

The figure hereunder shows how these devices are distributed over the different stations. This only provides one possible setup, since other setups are also possible.

E.g. are setups where no interrogations are recorded at one or more sites, or where no Cat 17 of one or more sites is available. In each of these cases, PTE P5 will perform the possible analysis and shall exclude the analysis requiring the missing data.

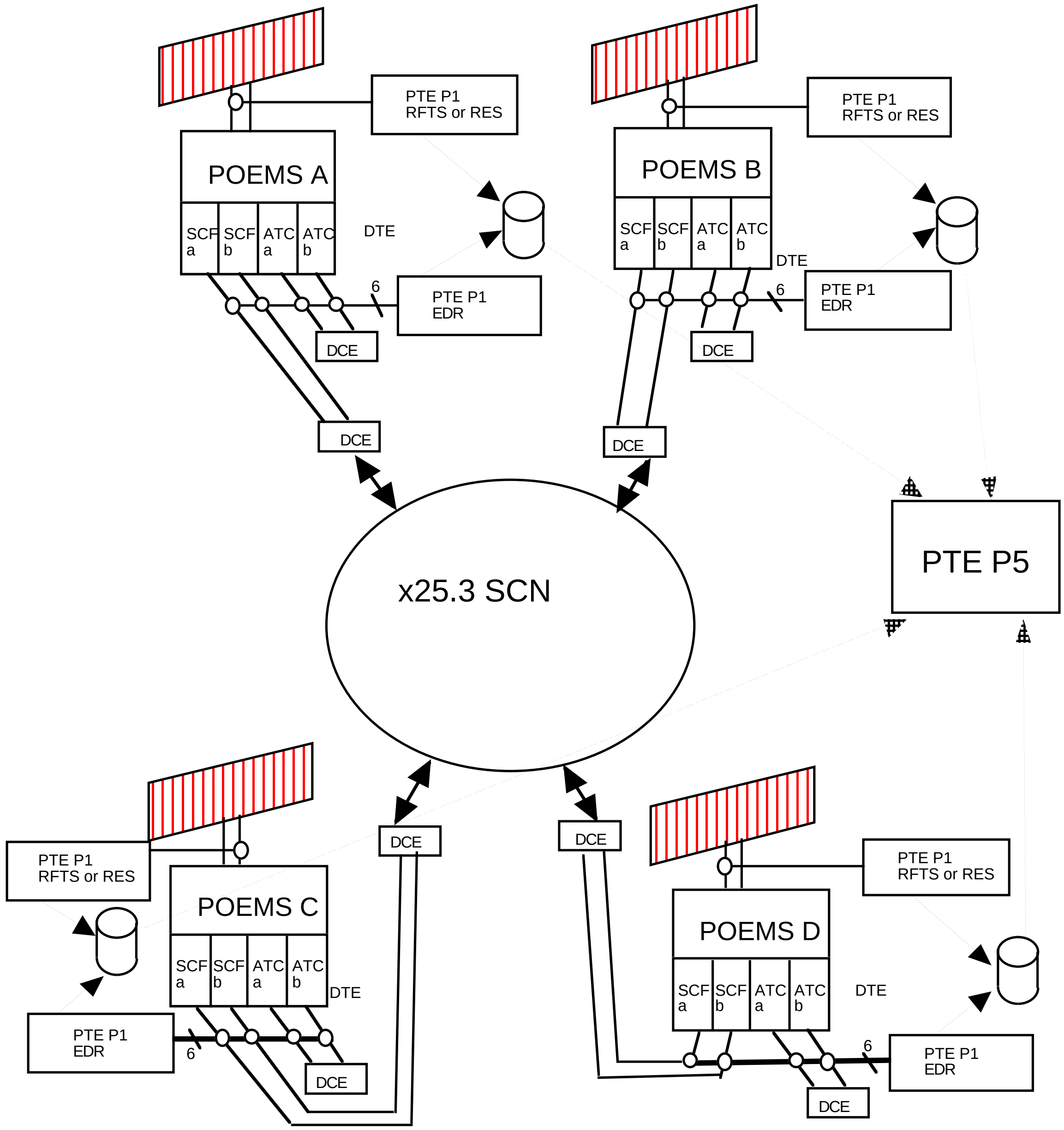

Figure 3-1: Setup for Central P5 system

3.2. File structure

3.2.1. General

The most important step in designing the PTE P5 tool was the correct definition of the data structure and the proof of its ability to include all required data items and allow easy, fast and correct access and filtering of data.

The data used for analysis in PTE P5 is file based. This means that we do not directly use relational database tools to access the data, but create our own mechanisms of linking the data.

In order to understand the data structure, we will start by explaining the five mayor parts of the structure:

- Target Reference Data for P5 (TRD5) positional information
- Target Asterix cat 48 Data (S48) positional information
- SCN Asterix cat 17 (S17) data link information
- Target Interrogation and Reply data (IRD)
- SCF Analysis result File

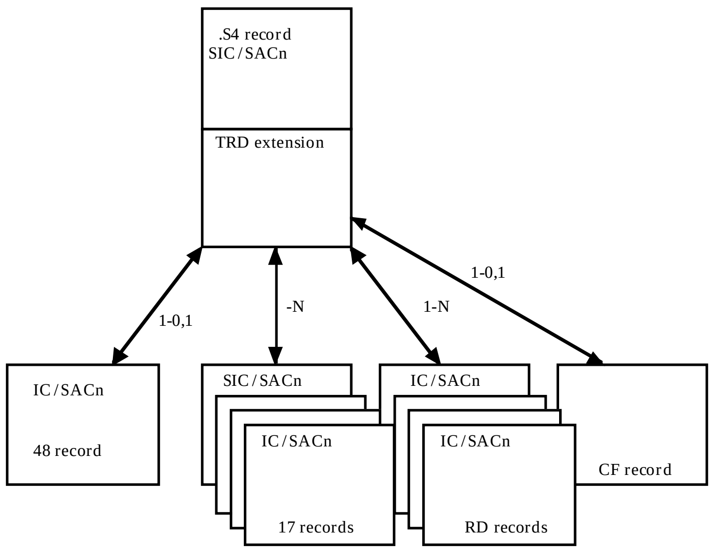

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Figure 3-2: General Data structure

The "TRD 5' data structure contains the main bundle of information and contains a repetition of multiple records, one for every detection of the target by any of the POEMS in the cluster. A combination of all TRD5 records of one particular target is combined into one TRD5 set and stored as a whole in the TRD5 file. The file therefore consists of multiple TRD5 sets, which in turn consist of multiple records. Each record has a one to one relation to a target detection. Previous developments for PTE created a whole library of access tools to read, write, create and manipulate the file structure created in this way.

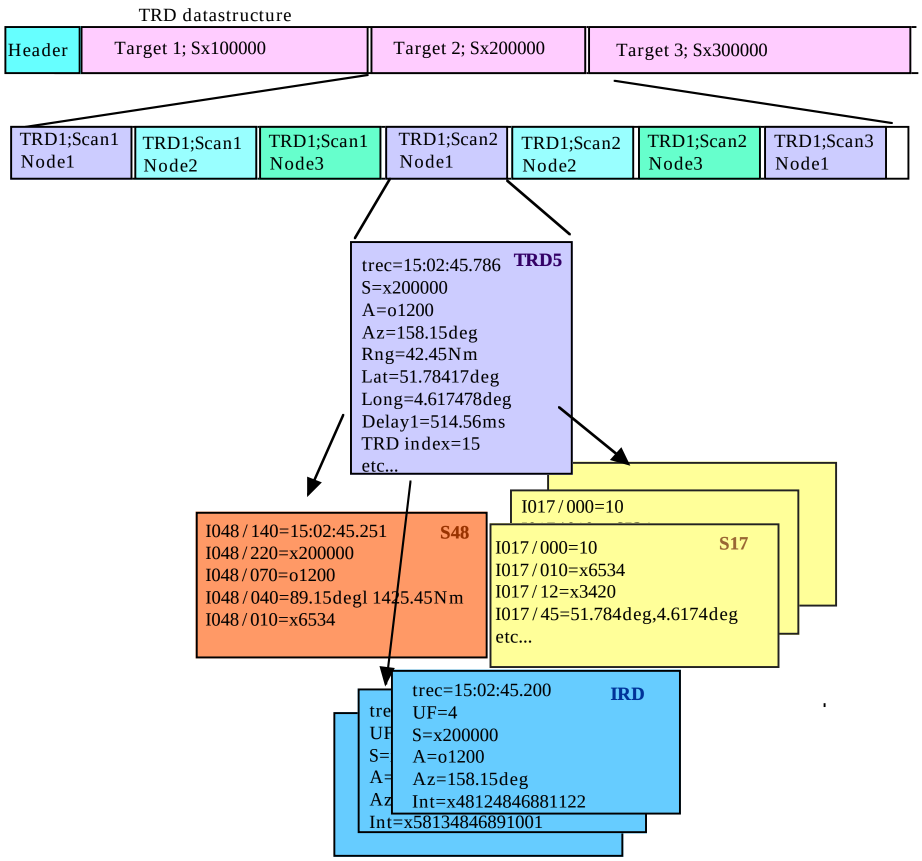


Figure 3-3: TRD file structure for P5

The file format is called "DSS" and is described in detail hereafter . It allows for the storage of multiple variable size records (TRD sets) and the storage of "Attributes" or single elements of data to be kept in the file. (e.g. Time of recording, number of records, index tables, etc..)

Each recording the DSS file contains the "reference" position, which is derived from the detected position of the target by one of the POEMSs , and all calculated fields (such as target longitude and latitude, delays and flags.

The positional information is determined by Lat, Long, Altitude, Range, Azimuth, Speed, Heading, etc… Latitude and longitude information is referenced towards the Cluster Origin (to be defined by the user.). The Range, Azimuth and XY information are re-calculated towards the cluster center coordinates.

The formulas used for this purpose are the ones described in Ref EC5.

The TRD5 record has a one to one link to one S48, multiple S17 and multiple IRD records. The link is made quite simple: All records with the same S address (except duplicate S addresses) are stored in one set. All S48 records are converted into TRD5 records (after calculations of long, lat, X, Y, R, Az, etc..) , which creates an one to one link with the S48.

All S17 records are linked to the TRD5 with a TOD (derived from the S48) that is the closest to the TOD or Time of recording of the S17 data.

The Analysis results are separately stored in the SCF result file.

3.2.2. File definition for TRD5 data

3.2.2.1. S4 part:

Bytes	Used	Type	Contents	Name	Unit
TRD Record					
8	*	Dbl	Time of recording (since 12:00 1/1/1904)		s
2	P2B2	U16	Target ID		-
2	P5	U16	Source/Destination		-
4	*	U32	Scan number		-
2	*	U16	Mode 1 code		-
2	*	U16	Mode 2 code		-
2	*	U16	Mode A code		-
4	*	I32	Altitude		Ft
4	*	U32	Time of detection(Radar time)		1/256s
4	*	Sgl	Range relative to cluster center		Nm
4	P2B2	Sgl	Delta Range Asterix-Reference		Nm
4	*	Sgl	Azimuth relative to cluster center		° (degrees)
4	P2B2	Sgl	Delta Azimuth Asterix-Reference		° (degrees)
1	P5	U8	Source		
1	P5	U8	Cluster State		
4	*	Sgl	Power		dBm
4	*	U32	Status		See 1)
4	*	Sgl	X coordinate relative to cluster center		Nm
4	*	Sgl	Y coordinate relative to cluster center		Nm
4	*	Sgl	Velocity		Nm/h
4	*	Sgl	Heading		° (degrees)
1		U16	Duplicate S address Ref nr		
4	*	U32	Mode S Address		-
1	*	U8	MB0: Coverage at current position seen by Node1		
1	P5	U8	MB1: Coverage at current position seen by Node2		“
1	P5	U8	MB2: Coverage at current position seen by Node3		“
1	P5	U8	MB3: Coverage at current position seen by Node4		“
1	P5	U8	MB4: Coverage at current position seen by Node5		“
1	P5	U8	MB5: Coverage at current position seen by Node6		“
1	P5	U8	MB6: Map Mismatch flags per Node		
1	P2B2	U8	Comm A/C segments		
1	*	U8	Comm Cap/Flight Status/ACAS		3/3/2 bits
1	P2B2	U8	Comm B/D segments		
4	P2B2	Sgl	Delta Time Asterix-Reference		s
1	*	U8	RES2Hh: Overlap		0-255
1	*	U8	RES2Hl: Target Generator (RES)		1-4
2	*	U16	RES2LTransponder nr (RES)		
1	P5	U8	RES3Hh: Surveillance Coverage flags		bit0=Node1 bit5=Node6
1	P5	U8	RES3Hl: DataLink Coverage flags		same
1	P5	U8	RES3Lh: Lockout Coverage flags		same
1	P5	U8	RES3Llh: Lockout override flags		same
2	*	U16	RES4H:Reflector (RES)		
2	*	U16	RES4L:Set number (RES)		
4	*	U32	RES5:Asterix multi level index		bytes
4	P2B2	U32	RES6:Data link Counters		See 4)
4	P2B2	U32	RES7:Status2		See 2)
8	*	8*char	RES8/9:Target ID		
4	P2B2	U32	RES10:Data link type		See 3)

3.2.2.2. TRD part:

Bytes	Used	Type	Contents		Unit
4	*	U32	Index TRD to S48,S18,S17,IRD		
4	P5	U32	Longitude		180/2^31
4	P5	U32	Latitude		180/2^31
4		U32	TRD Pointer (logical Sequence number of TRD in file)		
1	*	U8	Count A48		
1	*	U8	Count A18		
1	*	U8	Count IRD		
1	*	U8	Count A17		
0.5	*		Roll Call Count		
		U4	UF4 count		
		U4	UF5 count		
		U4	UF20 count		
		U4	UF21 count		
		U6	UF24 UELMcount		
		U6	UF24 DELM count		
		U4	UF11 count		
4	P2B2	U32	Data link state		
4	P2B2	U32	Data link message		
8	*	dbl	S48 Time of detection		
1	*	U8	Re-interrogation rate Ni		
1	*	U8	Re-interrogation rate Ni		
2	P2B2		Comm B counter		
		U4	Broadcast CommB Counter		
		U4	Ground Initiated CommB Counter		
		U4	Air Initiated CommB Counter		
		U4	Resolution Advisory Counter		
4	P2B2		Comm ACD count		
		U8	Comm A segment Counter		
		U8	Comm C 1st or intermediate segment Counter		
		U8	Comm C last segment Counter		
		U8	Comm D segment Counter		
2	P2B2	U16	Run nr		
1	P2B2	U8	Comm C segment re-transmission counter		
1	P2B2	U8	Comm D segment re-transmission counter		
4	P2B2		S18 Count		
		U4	S18 Uplink Short Packet Counter		
		U4	S18 Uplink Long Packet Counter		
		U4	S18 Cancel Uplink Packet Counter		
		U4	S18 Uplink Packet Acqnowledge Counter		
		U4	S18 Downlink Short Packet Counter		
		U4	S18 Downlink Long Packet Counter		
		U4	S18 Down link Broadcast message Counter		
		U4	S18 GICB extraction Message Counter		
4	*		Failure		
		U4	Spare		
		U4	Mode A change Failure		
		U4	ACAS RA failure		
		U4	AICB failure		
		U4	Broadcast Comm B failure		
		U4	Comm D failure		
		U4	Comm A invalid sequence		
		U4	Comm C failure		
4	P2B2	U32	FSPEC delays P2B2		
4	*	Sgl	delay1		
4	*	Sgl	delay2		
4	*	Sgl	delay3		
4	*	Sgl	delay4		
4	*	Sgl	delay5		
4	*	Sgl	delay6		
4	*	Sgl	delay7		
4	*	Sgl	delay8		

4		U32	Index to TRD info		
4		Sgl	delay9		
4		Sgl	Delay10		
2	P5	 U4 U4 U4 U4	An_Link Analysis Link fields (4*U4) An Link Spare 3 An Link Spare 2 An Link Spare 1 An Link SCF (Count # of SCF analysis fields (0/1)		
2	P2B2	U4 U4 U4 U4	Broadcast Comm B Announcement Count Res Advisory Announcement Count Air Initiated Comm B Announcement Comm D Announcement		
2	P2B2	U4 U4 U4 U4	Broadcast Comm B Started&Completed Count Broadcast Comm B Started& Not Completed Count Broadcast Comm B Ongoing Count Broadcast Comm B Completed Count		
2	P2B2	U4 U4 U4 U4	GICB Started&Completed Count GICB Started& Not Completed Count GICB Ongoing Count GICB Completed Count		
2	P2B2	U4 U4 U4 U4	Res Advisory Started&Completed Count Res Advisory Started& Not Completed Count Res Advisory Ongoing Count Res Advisory Completed Count		
2	P2B2	U4 U4 U4 U4	AICB Started&Completed Count AICB Started& Not Completed Count AICB Ongoing Count AICB Completed Count		
2	P2B2	U4 U4 U4 U4	CommA single segment Started&Completed Count CommA single segment Started& Not Completed Count CommA single segment Ongoing Count CommA single segment Completed Count		
2	P2B2	U4 U4 U4 U4	CommA multi segment Started&Completed Count CommA multi segment Started& Not Completed Count CommA multi segment Ongoing Count CommA multi segment Completed Count		
2	P2B2	U4 U4 U4 U4	Comm C Started&Completed Count Comm C Started& Not Completed Count Comm C Ongoing Count Comm C Completed Count		
2	P2B2	U4 U4 U4 U4	Comm D Started&Completed Count Comm D Started& Not Completed Count Comm D Ongoing Count Comm D Completed Count		

Table 3-1; TRD5 data contents

3.2.2.3. Status:

bit 31 Valid A	bit 15 Emergency 7500
bit 30 Valid C	bit 14 Radio fail 7600
bit 29 Valid 3D	bit 13 Hijack 7700
bit 28 Valid 1	bit 12 SPI
bit 27 Valid 2	bit 11 RA_Present (=BDS 30 data present)
bit 26 Valid S	bit 10 Simulated
bit 25 Garbled A	bit 9 RFM
bit 24 Garbled C	bit 8 MODE S Data
bit 23 Garbled 3D	bit 7 Mil ident
bit 22 Garbled 1	bit 6 Mil emergency
bit 21 Garbled 2	bit 5 Reflection
bit 20 Garbled S	bit 4 False Plot
bit 19 Track	bit 3 A code swap
bit 18 Plot	bit 2 Acquisition
bit 17 PSR detect	bit 1 Roll-Call detect
bit 16 SSR detect	bit 0 Sector Message

3.2.2.4. Status2

Bit 28: Map Mismatch flag
Bit27:: Chain Drop /End of Chain
Bit 26: Start of chain
bit25: Info field linked to TRD
bit 24 BDS20: BDS 20 (AC ID) data present
bit 19/16 #MB data found in Asterix
bit 14: Resolution flag
bit 13: Duplicate S address
bit 12: Manual Designation flag
bit 11: All Call
bit 10 CNF: 0=Confirmed Track/1=Tentative Track
bit 9/8 RAD: Type of sensor : 00=Combined;01=PSR;10=SSR/S Track;11=Invalid
bit 7 DOU: Confidence (0= Normal;1=Low)
bit 6 MAH: Maneuver detection Hor sense
bit5/4CDM:Climbing/Descend Mode:00=Maintaining;01=Climbing;10=Descending;11=Invalid
bit 3 TRE: End of Track?
bit 2 GHO: Ghost track?
bit 1 SUP: Track from neighbor Node in cluster
bit 0 TCC: Type of plot coordinate transform (1=Slant range corr)

3.2.2.5. Data link type

bit 31 Broadcast Comm A	bit 15 Comm A multi element Transmission 1st el
bit 30 Code Change announcement	bit 14 Comm A 1 element Acknowledge
bit 29 Comm D Closeout	bit 13 Comm A 1 element Transmission
bit 28 Comm D Reply last segment	bit 12 Air Initiated Comm B Closeout
bit 27 Comm D Reply intermediate segment	bit 11 Air Initiated Comm B Reply
bit 26 Comm D Extraction	bit 10 Air Initiated Comm B Extraction
bit 25 Comm D Reservation	bit 9 Air Initiated Comm B Reservation
bit 24 Comm D Announcement	bit 8 Air Initiated Comm B Announcement
bit 23 Comm C Closeout	bit 7 Ground Initiated CommB Reply
bit 22 CommC technical acknowledge	bit 6 Ground Initiated CommB Extraction
bit 21 CommC Delivery last segment	bit 5 Resolution Advisory Reply
bit 20 CommC Delivery n th segment	bit 4 Resolution Advisory Extraction
bit 19 Comm C Delivery 1st segment	bit 3: Resolution Advisory Announcement
bit 18 Comm C Reservation	bit 2 Broadcast CommB Reply
bit 17 Comm A multi element Acknowledge	bit 1 Broadcast comm B Extraction
bit 16 Comm A multi element Tx nth element	bit 0 Broadcast commB Announcement

3.2.2.6. Data link counters:

bit 25..27:CD Closeout
bit 23..24:CC Acknowledge
bit 21..22:CA Acknowledge
bit 19..20:AICB Closeout
bit 18:BRCB Closeout
bit 17:Code events
bit 15..16:CommD events
bit 13..14:CommC events
bit 11..12:CA m el events
bit 9..10:CA 1el events
bit 7..8:AICB events
bit 3..6:GICB events
bit 1..2:RA events
bit 0..1:BcCB events

3.2.3.S48 data

The S48 data is converted 1 to 1 from the recorded Asterix data and is described in great detail in ref doc EC 11. Multiple S48 records can exist for the same target when it is under surveillance of multiple radars. In that case, multiple TRD5 records will be created. A resolution and formatting of data in the S48 is the same as in the Asterix Cat48.

All TRD5 data is derived from the S48 data. If no S48 is found, no TRD5 data will be present. . P5 requires that the Radar outputs miss data as coasted targets. Misses that were not outputted by the radar will NOT be filled by the P5 linker.

The format for the S48 record is described hereunder

3.2.3.1. .S48 file

Bytes	Type	Contents	Name	Unit
A48 Record				
8	Dbl	Time of recording		[s]
4	U32	ARP/ACP of recording		
4	U32	FSPEC 48		
4	U32	File Offset for Prot. Viewer		
1	U8	SIC	I048/010	
1	U8	SAC	I048/010	
2	U16	Target Report descriptor	I048/020	
4	U32	Warning/Error	I048/030	18 bits
2	U16	Rho Measured	I048/040	
2	U16	Theta Measured	I048/040	
2	U16	X calculated position	I048/042	
2	U16	Y calculated position	I048/042	
2	U16	Mode 2	I048/050	
1	8	Mode 1	I048/055	
1	U8	Mode 1 code confidence	I048/065	
2	U16	Mode 2 code confidence	I048/060	
2	U16	Mode A	I048/070	
2	U16	Mode A code confidence	I048/080	
2	U16	Mode C	I048/100	
2	U16	Mode C Code confidence	I048/100	
4	I32	Flight level	I048/090	(ft)
4	I32	Measured Height by 3D radar	I048/110	(ft)
2	U16	Presence of raw Doppler speed	I048/120	Boolean
2	U8	Radar Plot Chars	I048/130	
1	U8	SSR plot run length	I048/130	[deg]*0.44
1	U8	Nr of received SSR replies	I048/130	
1	U8	Amplitude of SSR reply	I048/130	[dBm]
1	U8	Primary plot run length	I048/130	[deg]*0.44
1	U8	Amplitude of PSR reply	I048/130	[dBm]

1	U8	Difference in range SSR-PSR	I048/130	[Nm]
1	U8	Difference in Az SSR-PSR	I048/130	[deg]
3	U32	Time of Day (detection)	I048/140	[sec]/256
2	U16	Track nr	I048/161	
2	U16	Track status	I048/170	
2	U16	Calculated Ground Speed	I048/200	[Nm/h]
4	U16	Calculated Heading	I048/200	[deg]
4	U8	Track Quality Sigma x	I048/210	[Nm]
4	U8	Track Quality Sigma y	I048/210	[Nm]
4	U8	Track Quality Sigma v	I048/210	[Nm/h]
4	U8	Track Quality Sigma h	I048/210	[deg]
4	U32	Aircraft address	I048/220	
2	U16	Com/ACAS/flight	I048/230	
6	6*U8	AC Indent (56 bits)	I048/240	
8	8*U8	Res Advisory Message	I048/260	
4	U32	MB index	pointer to I048/250	
4	U32	BDS registers available BDS05..24	flag indicating presence of I048/250	See 2)
4	U32	S48 Spare3		
4	U32	S48 Spare4		
4	U32	S48 Spare5		
4	U32	S48 Spare6		
4	U32	BDS registers available BDS25..F0		See 2)

Table 3-2: File definition for S48 data (updated)

3.2.3.2. .BDS file

The S48 file is accompanied by a .BDS file. This file is a variable length DSS file , with records of length N*8 bytes, where N is the number of BDS register data available in the file.

The index table is used to access the data. The field " MB index" in the S48 data is the record number or entry in the index table. The index table length must be retrieved from the header information of the file. The index table contains the pointer to the position of each data entry. If no BDS data is available (no item 250 present in asterix), no record is written to the BDS file.

Each record contains N*8 bytes, where the record is a copy of data item 048/220 of the asterix item 250 (with REP cut)

Bytes	Type	Contents	Name
BDS Record			
1	U8	MSB BDS data (b55-b48)	I048/250 MB1
1	U8	BDS data	I048/250 MB2
1	U8	BDS data	I048/250 MB3
1	U8	BDS data	I048/250 MB4
1	U8	BDS data	I048/250 MB5
1	U8	BDS data	I048/250 MB6
1	U8	LSB BDS data(b7-0)	I048/250 MB7
1	U8	BDS address high / low data	I048/250 BDS

3.2.4. S17 data

The S17 data is converted one to one from the recorded Asterix data to the S17 data format. Format for S17 is described hereunder. The format is a one-to-one flat copy of the Asterix data. Separate fields are foreseen for each sub-field of ASTERIX Cat017. Fields not present in the Asterix are not filled in the S17 file. The FSPEC of the S17 can be used to determine which fields are filled.

The only exception to this method is the NNCOP messages. For these messages, one record per Mode S address found in item 17/210 will be created.

The linking of the S17 records with the target data is purely based on the time of recording of the S17 data, except for Target Data messages, since the S17 data does not always contain a TOD data element. Therefore it is ABSOLUTELY required that the S17 data is recorded using an EDR with GPS UTC synchronization.

The linking process also links duplicate messages, since normally every message will be recorded TWICE (a send message and a received message). This also means that the linker can determine whether the network lost messages, and how many were lost at any given time.

This information (if messages are lost) is included in a calculated field added to every S17 record. This is accomplished my means of a calculated field “S17 Network propagation delay”. If two S17 records (one for each side of the connection) are found, the field is entered with the difference in UTC time of recording of the two messages, and only one S17 is stored in the linked TRD5 structure. If, for any reason, only one message is found, or only one side has been recorded, the value is filled with a “Not-a number” error value. The data display will allow parametric filtering on this condition, such that the number of lost messages can be counted and the valid transmission values can be put in a graph (versus any other parameter such as range, azimuth, time, etc..) or histogram. (Spec PTE-P5-FUN-REQ-0057).

S17 file format is a DSS file containing a set of A17 records. The PTE P2B1 tool “Data Import/Export” is enhanced to import the A17 records into S17 format.

The A 17 format is described in Ref. 7

The S17 record is described in Table 3-3: File definition for S17 data.

Bytes	Type	Contents	Name	Unit
A17 Record				
8	Dbl	Time of recording		[s]
4	U32	ARP/ACP of recording		
1	U8	Message	I017/000	
1	U8	Type		List enumerated
1	U8	Number of Stations	IO017/350	
1	U8	SPI Length	/	
4	U32	Aircraft S address	I017/220	
4	U32	FSPEC17		
4	U32	File Offset		
1	U8	SAC	I017/010	
1	U8	SIC	I017/010	
1	U8	DAC	I017/012	
1	U8	DIC	I017/012	
1	U8	SAC 1st station	IO017/350	
1	U8	SIC 1st station	IO017/350	
1	U8	SAC 2nd station	IO017/350	
1	U8	SIC 2nd station	IO017/350	
1	U8	SAC 3rd station	IO017/350	
1	U8	SIC 3rd station	IO017/350	
1	U8	SAC 4th station	IO017/350	
1	U8	SIC 4th station	IO017/350	
1	U8	SAC 5th station	IO017/350	
1	U8	SIC 5th station	IO017/350	
1	U8	SAC 6th station	IO017/350	
1	U8	SIC 6th station	IO017/350	
4	Sgl	Latitude in WGS.84	IO017/045	
4	Sgl	Longitude in WGS.84	IO017/045	
2	U16	Flight Level	IO017/050	25ft
2	U16	Mode A	IO017/070	
4	U32	Time of day	IO017/140	[sec]/256
2	U16	Calculated ground speed	IO017/200	2^{-14} NM/s
2	U16	Calculated heading	IO017/200	$360/2^{16}$ °
2	U16	I17/210 repetition	IO017/210	
2	U16	Duplicate Reference Number	IO017/210	
1	U8	Transponder capability	IO017/230	
1	U8	Track status	IO017/240	
1	U8	Cluster controller command state	IO017/360	
1	U8	Nr of duplicate messages		
4	U32	TASP number	Calc field	
2	U16	Source/Destination Nodes	Calc field	
4	sgl	Delta Longitude S17-S48	Calc field	deg
4	sgl	Delta Latitude S17-S48	Calc field	deg
4	sgl	Delta Speed S17-S48		Nm/h
4	sgl	Delta Heading S17-S48		deg
2	U16	Size		
4	U32	S17 Link index		
4	U32	Spare2		
4	U32	Spare3		
4	U32	Spare4		
4	U32	Spare5		
4	sgl	Delta Altitude S17-S48	Calc field	ftt
4	sgl	S17 Propagation delay	Calc field	sec
4	U32	Status	Calc field	

Table 3-3: File definition for S17 data

3.2.5. IRD data

The IRD data is almost identical to the format used in PTE P2B2. The only additional field added to the format is the SIC / SAC address value (2 bytes), allowing later identification of the source of the interrogations by the linker. The PTE P2B2 IRD format still had some spare fields, so it was easy to include these values. The SIC SAC codes are copied from the Cluster information file upon linking the data (See later) .

The inclusion of the IRD data is optional, meaning that the user has a parameter (checkbox) available in the linker to include or not include the final IRD data into the "LINKED_DATA" folder. If IRD data is not included but was recorded anyway, the TRD counters (e.g. nb of UF4 , nb of UF5 , etc) will be correctly filled but the link to the IRD data will be lost. This has an influence on the SCF status display in the Data Display, since this one will no longer allow linking to IRD data. (only the arrows will be drawn, no details on IRD , such as S contents, timing etc.. will be available).

The format for the IRD data is described in Table 3-4:File definition for IRD data

Bytes	*Type*	*Contents*	*Name*	*Unit*
4	Sgl	Range Reply		µs
	8 Dbl	Azimuth(ACP) Interrogation		deg
8	Dbl	UTC Time of day Int		sec
8	Dbl	Azimuth Reply (ACP)		deg
8	Dbl	Azimuth Target		deg
2	U16	Scan nr		
1	U8	Interrogation type		List
1	U8	Reply Type		list
4	U32	S address		
2	U16	ID/SSR Code		
4	Sgl	Interrogation Power		dBm
4	Sgl	Reply Power		dBm
4	Sgl	OBA Value		V
1	U8	Reply Flag		Status field
1	U8	#SSR/All Call Replies		
4	U32	Data link type		Status field
14	14*U8	Interrogation		14 bytes data
14	14*U8	Reply or Code		14 bytes data
4	U32	Index		
4	U32	Data link transaction flags		Status field
4	Sgl	IRD2:Relative Time in Roll Call scedule		µs
2	U16	IRD3H: Target Generator		
2	U16	IRD3L:Transponder number		
1	U8	IRD4Hh: SAC interrogator		
1	U8	IRD4Hl: SIC interrogator		
2	U16	IRD4L: Spare		
4	U32	IRD5 :Spare		
4	U32	IRD6 :Spare		
4	U32	IRD7 :Spare		
4	U32	IRD8 :Spare		

Table 3-4:File definition for IRD data

3.2.6. File definition for SCF Analysis result data file

The SCF analysis result file was added to the TRD structure to contain all analysis results of the SCF analysis for PTE P5. All TRDs having S17 linked to it have an SCF record. All TRD records with no analysis results have no physical SCF record written to the SCF file. Those TRDs have a SCF count value of zero.

The index table of the S17 has the same size as the index table of the TRD file. All records having a valid SCF record attached, have a valid index in the index table. All TRDs having no SCF data attached have a zero entry in the index table of the SCF file.

The sequence of accessing the SCF data is the same as the sequence of the TRD . Use the "TRD pointer" index to access the SCF, not the "TRD index" (since this is used for access to S17,S18 and S48 data).

Bytes	Type	Contents	Name	Unit
TRD Record				
1	U8	TASP status station 1		Bit7:1=TAP Bit6;1=TSP bit5: TASP Overlap/Miss bit4: TASP running bit3: TASP expected bit2: TASP initiated bit1: TASP Completed bit0: TASP Successfull
1	U8	TASP status station2		"
1	U8	TASP status station3		"
1	U8	TASP status station4		"
1	U8	TASP status station5		"
1	U8	TASP status station6		"
1	U8	NNCOP initiated TAP expected		bit0=Node1 bit5=Node6
1	U8	FSPEC delay P5:H	*	Bit 0-5 (= FSPEC bit 32—37): Track Acquisition Roll Call Reaction time
4	U32	Track Data Stop bits Track Data Stop Status station1 Track Data Stop Status station2 Track Data Stop Status station3 Track Data Stop Status station4 Track Data Stop Status station5 Track Data Stop Status station6		Bit29=TDSN1Procedure Ongoing Bit28=TDSN1 Expected Bit27=TDS N1 Running Bit26=TDS N1 Initiated Bit25=TDS N1 Completed Bit24= TDSN2Procedure Ongoing
4	U32	FSPEC delay P5: L	*[1]	bit0:Cluster ack delay bit1 Station-re acquisition delay bit2-7: TAP duration, bit2=Node1,bit7=Node6 bit8-13: TSP duration bit8=Node1,bit13=Node6 bit 14-19:Track data Cancelation Time bit20-25: Track data request reaction Time bit26-31: Track Data Stop reaction Time
2	U16	TASP_NR_1 : Tasp nr for Node 1		
2	U16	TASP_NR_2 : Tasp nr for Node 2		
2	U16	TASP_NR_3 : Tasp nr for Node 3		
2	U16	TASP_NR_4 : Tasp nr for Node 4		
2	U16	TASP_NR_5 : Tasp nr for Node 5		

[1] FSPEC Delay is numbered according to the following rule: the delays are entered according to the sequence found in the FSPEC, starting with delay11 and FSPEC L bit 0. In case multiple identical delays are present, the bit position in the FSPEC denotes the related node : e.g. in a TRD of Node 1, a TAP duration of Node 2 will be stored in delay 11 and the bit 3 of the FSPEC L will be set.

2	U16	TASP_NR_6 : Tasp nr for Node 6		
1	U8	RCCnt_N1: Roll Call Count for Node 1		
1	U8	RCCnt_N1: Roll Call Count for Node 2		
1	U8	RCCnt_N1: Roll Call Count for Node 3		
1	U8	RCCnt_N1: Roll Call Count for Node 4		
1	U8	RCCnt_N1: Roll Call Count for Node 5		
1	U8	RCCnt_N1: Roll Call Count for Node 6		
1	U8	TASP Error Code 1		See 1)
1	U8	TASP Error Code 1		
4	U32	Spare4		
4	U32	Spare5		
4	U32	Spare6		
4	Sgl	Delay1		
4	Sgl	Delay2		
4	Sgl	Delay3		
4	Sgl	Delay4		
4	Sgl	Delay5		
4	Sgl	Delay6		
4	Sgl	Delay7		
4	Sgl	Delay8		
4	Sgl	Delay9		
4	Sgl	Delay10		
4	Sgl	Delay11		
4	Sgl	Delay12		
4	Sgl	Delay13		
4	Sgl	Delay14		
4	Sgl	Delay15		
4	Sgl	Delay16		
4	U32	Spare7		
4	U32	Spare8		
4	U32	Spare9		
4	U32	Spare10		

Table 3-5: SCF Analysis File structure

3.3. P5 Modules

3.3.1. Recording of data

The data recording will take place by means of the existing P1 equipment. Each station involved in the cluster will require a P1 recording setup. This consists of the following hardware tools:

- One EDR
- One GPS
- One PowerBook G3/G4 computer for EDR
- Cabling and connections for double T connection (passive recording)
- One RFTS or RES for interrogation recording
- One PowerBook G3/G4 computer for RFTS or RES
- One CD-RW drive for data distribution
- A Local Ethernet Network linking the two computers (trough a HUB)
- Optionally one internet connection for email or ftp data distribution

The software involved is standard PTE P1/2 recording software, enhanced with two methods to allow multi radar recording: Center based recording and Endless loop recording.

3.3.1.1. Center Based Recording

The simplest way of ensuring that a multi radar recording is synchronous is to bring the data physically to the same position. This could be a center or one of the POEMS stations. or in case of the limited 3 station POEMS cluster , it could be eighter the Gatwick shelter, the Dusseldorf Shelter or the Toulouse STNA/4 Lab. In this case, only one station will be providing interrogation data (and optionally Cat 17 data). The Cat 48 of all stations can be recorded simultaneously.

In the STNA case, interrogations can not be recorded along with the asterix, since they are not transmitted to the STNA lab in Toulouse.

A recording setup that shall be used during the initial test phase of the SCN implementation is the one shown in figure 3.2. Here we see the three stations Orly, Gatwick and Dusseldorf in the SCN cluster, and the use of leased lines to transfer the Cat 48 data to and from the different stations. This allows the use of a local P5 system, where we record the Cat 17 and interrogations of only one station (Dusseldorf in the example), and the Cat 48 of the two other stations. This type of setup allows a full analysis of the correct SCN functionality of the one system (Dusseldorf). The data of the other two stations is used in the analysis, but P5 will not provide performance figures on these stations.

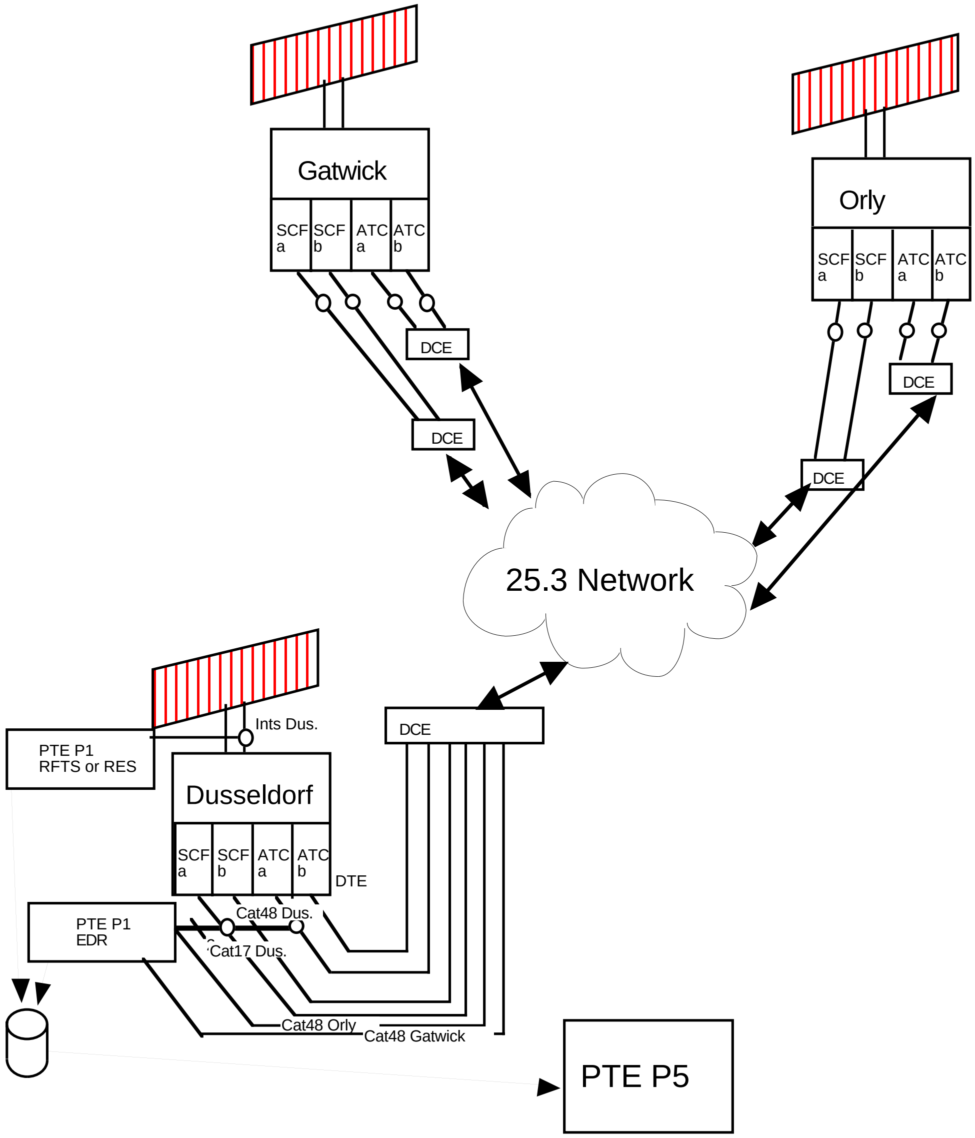


Figure 3-4: Setup for Local P5

3.3.1.2. Endless Loop Recording

The second method incorporated in the P5 enhanced P1 recording software is the "endless loop" recording. In this case, the EDRs are simply started at whatever point in time prior to the period of interest. Later, after the period of interest, the users decide what period in time they want to copy. The tool will then automatically search the section of interest on the EDR hard disk and copy that data. The files on all recording sites will obviously contain the same sections. A big advantage of this kind of recording is that the user can leave the EDR recording all the data in an endless loop. This means that at all times, a certain amount of history is present on the disk. The maximum size of the history period will depend on the load present on the recorded lines.

A typical setup for this is shown in figure 3.3 hereafter. This case shall be used more specifically by STNA, who will record the Cat 48 data of all 3 POEMS stations and the Cat 17 to and from Orly at their HQ in Toulouse, FR,

The interrogations of the Orly station can not be recorded at Toulouse, so these are recorded at the Orly station itself. For this to work, the Orly station must be connected to the RES (or RFTS) for interrogation recording, and a local EDR for UTC time-stamping of the interrogations.

Furthermore, a second EDR is required at Toulouse centre, since this shall be the place where all asterix is recorded. This second EDR does NOT require a ACP / ARP connection, but does need a separate GPS to get the "UTC time of Recording".

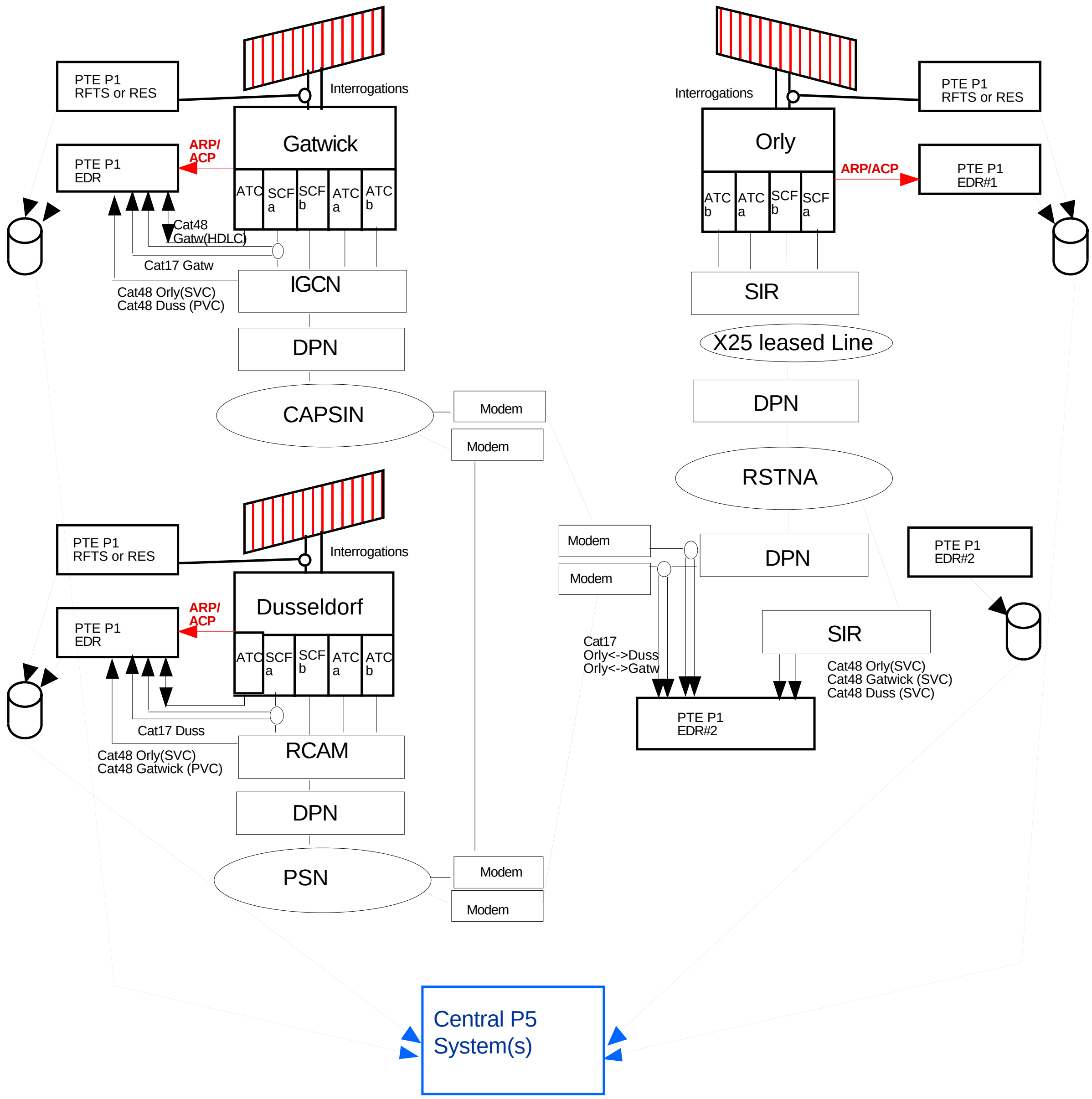


Figure 3-5: Mixed Recording Setup

The setup above shows one PTE per station. This is optional, since Cat 48 data is dsitributed trough the WAN between the stations Therefore it is sufficient that each administration records data on their own premises.

The STNA situation is specific since the interrogations are not transmitted from Orly to Toulouse. Therefore the interrogations will be recorded seperately in the Orly station.

The recording in Toulouse will NOT require the ACP / ARP to be connected.

3.3.1.3. Recording setup details

The layout for the recording is already shown in figure 3.1. through 3.3. Basically, each station requires recording of two SCF lines and two ATC lines. All recording are of Asterix data under the HDLC, Lap-B or X25.3 protocol. The recording must be made passively, which implies that the EDR requires two channels per SCF line. (Tx and Rx) The ATC lines can either be recorded active, or they can be recorded passively on Rx side only. (no uplink stream is anticipated on this line), or optionally passively on two lines (Rx and Tx).

In case the ATC data is recorded passively on one channel only (Only downlink data), no Error recovery of re-transmitted packets can be performed. For this feature a double channel Passive recording is required.

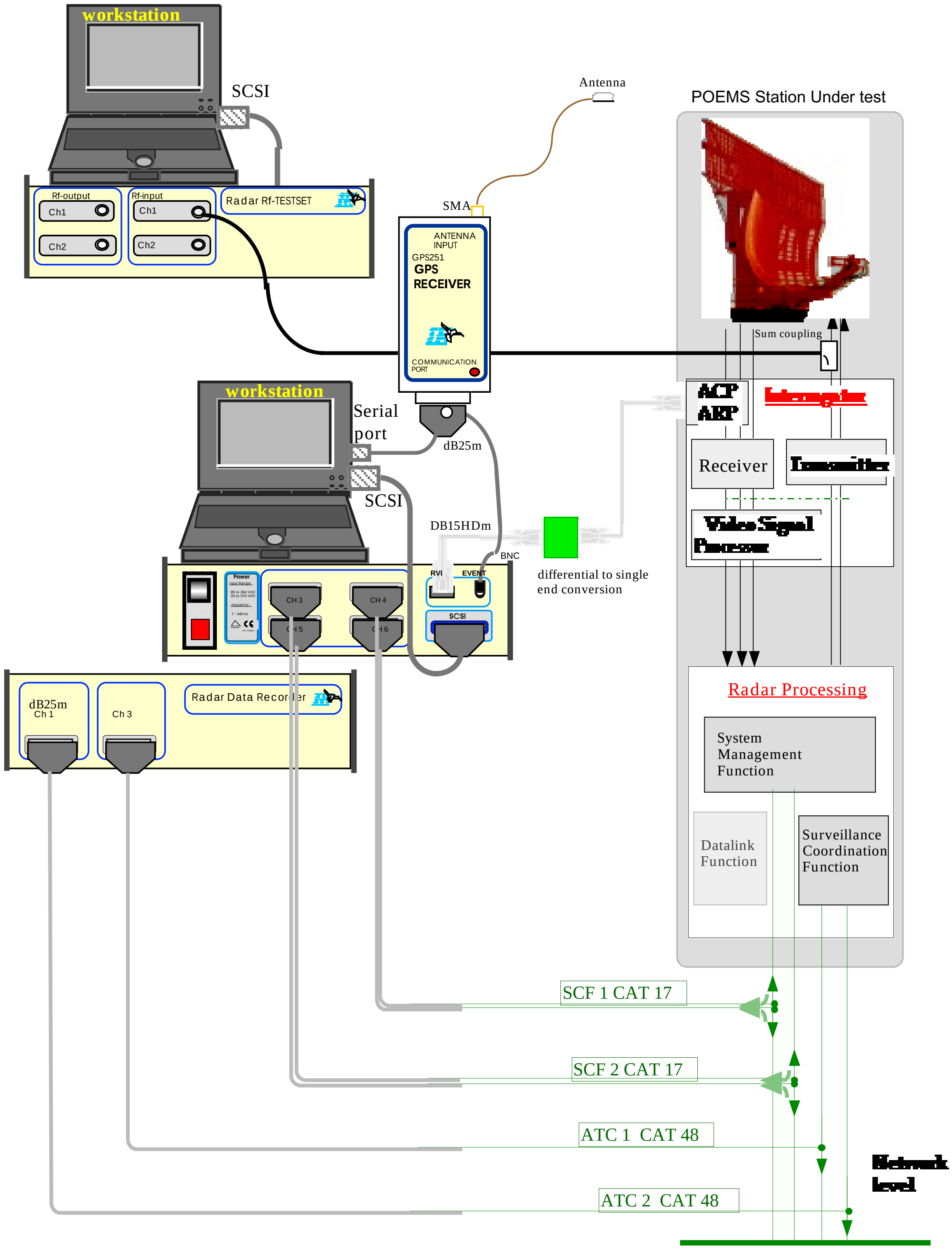


Figure 3-6: P5 recording facilities

Furthermore, some parts of the P5 analysis also require Roll Call information. For this purpose, the P1/2 section needs to record at least interrogations. This can be done by using a RFTS or (more complex) a RES. Either of these solutions can produce the required IRD data. The setup of these tools is described in detail in ref doc EC14 e. and f. The recording of the data is handled by the PTE user manual, specifically volume 5 , chapter III (RES software) and volume 8, Chapter I, (PTE P2B1 reference manual) , so this should not be issued here.

3.3.1.4. HMI for Data Recording

The HMI for the PT P5 Data Recording is very similar to the one used in earlyer versions of PTE P1/P2. The HMI use is described in detail in volume 4 of the PTE user manual.

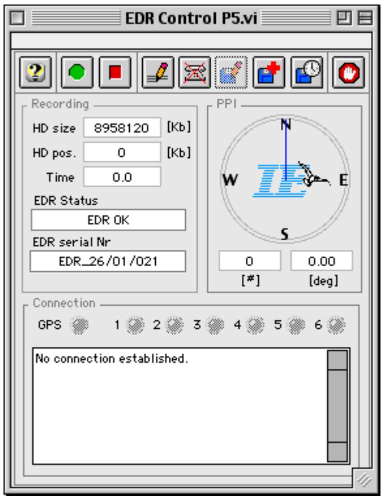


Figure 3-7: The PTE P5 EDR endless loop recording tool.

3.3.1.5. Specifications for data recording

This section contains a roundup of all the PTE P5 specifications involved in the recording, and the methods used to implement them.

3.3.1.5.1. Endless Loop Duration

The endless recording tool remains running for 2 days.

The PTE P5 allows the user to start an endless loop recording of ASTERIX or RDIF data under Lab-B or X25.3 protocol using a fixed length wrap around buffer. The size of the buffer is determined by the size of the hard disk of the EDR

Without a power failure the EDR endless loop recording should remain running indefinitely. Once the end of the buffer (hard disk) is reached, the recording continues (without any loss of data) at the start of the buffer overwriting the previously recorded data. This means that at all times the amount of recorded data available to the user is slightly less than the size of the buffer. Depending on the load, the contents and number of lines to be recorded, the time period covered by the recorded data in the buffer changes.

The PTE P5 EDR recording is always configured for endless loop recording without any manipulation by the user. The PTE P5 EDR recording can be operated in the same way as the PTE P1/P2 recording by using the start/stop buttons and by saving individual files. The PTE P5 EDR recording tool will replace the PTE P1/P2 EDR recording tool in future releases.

3.3.1.5.2. Data Recall

The user is able to recall the recorded data at any time. The user is able to select a section in time to be retrieved from the hard disk. The minimum time of this retrieval shall be the start time of the recording or the wrap boundary. The maximum time shall be the time of data retrieval

By selecting the Custom Save option (in the EDR record user interface) , the user is able to select a section in time to be retrieved from the buffer.

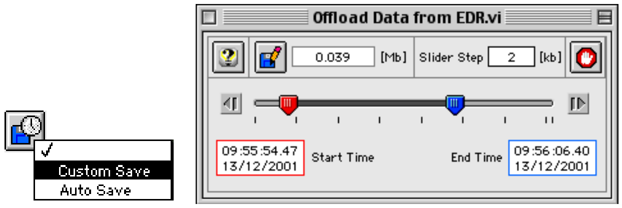


Figure 3-8: Custom Save tool for endless loop recording.

The red slider marks the start of the selected section and the blue slider marks the end of the selected section. The corresponding time (UTC if GPS is used) is displayed in the red and blue box. The maximum file that can be downloaded is limited to 1 Gb.

By clicking the  button and selecting a destination folder, the selected data is saved to disk for further processing.

3.3.1.5.3. Definition of Time Sections

The endless loop recording can save data in sections of a predefined period of time and maintain an archive of a predefined number of files

By selecting the Auto Save option, the user can program an automatic save function. The user can predefine the size (length in time) of the files and the number of files that are stored in an archive on a disk. Once the limit of the archive is reached, the oldest file is deleted and replaced by the newest one. The size of the archive is limited by the size of the destination disk.

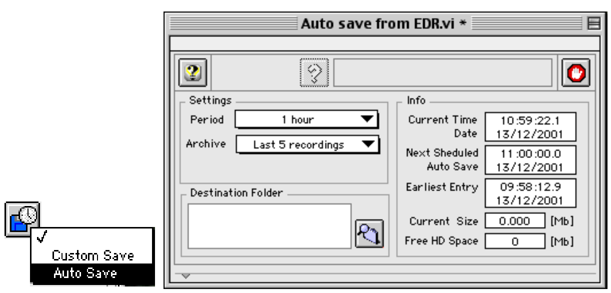
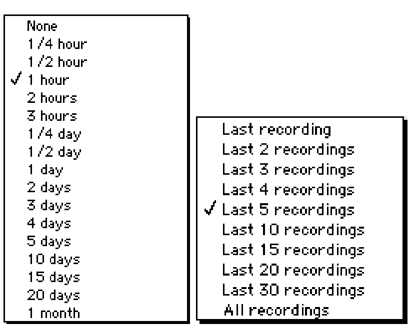


Figure 3-9: Auto Save tool for endless loop recording.

The user can select from the following time periods and / or archive sizes:



The tool displays the current time, the time of the next scheduled auto save and the time of the earliest entry present in the current recording. All times are expressed in UTC if the EDR recording tool is used in combination with a GPS. Otherwise local computer time is used.

3.3.1.5.4. Recording Formats

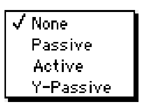
The format of the recorded data is backwards compatible with the format of the previous version of PTEP1/P2 (v 4.3.3).

The difference between the PTE P1/P2 and PTE P5 recording format is the absence of the .UTC file in the PTE P5 recording folder. Because the UTC time stamping is done instantaneous (during the recording in stead of during the offline processing), there is no need for the .UTC file any more. The PTE P5 convert and export tools can handle both recording formats. The recording format handling is completely transparent for the user. The user can use the PTE P5 convert and export tools to process data previously recorded with the PTE P1/P2 recording tools. The PTE P5 convert and export tools will replace the PTE P1/P2 convert and export tools in future releases.

3.3.1.5.5. Active and Passive recording

The PTE P5 allows the active/ Y-passive recording of Asterix Cat 17 and Cat34/48 data using Rx/Tx data, to allow for eventual re-transmission of packets or frames for data recovery/error correction without creating duplicate messages in the resulting S48 or S17 data streams

A new type of recording is added to the two (passive/active) already existing PTE P1/P2 recording modes: Y- passive.



By selecting this recording mode, two physical hardware lines are logically paired to spy both the Rx and Tx side of a particular connection. The pairs are 1/2, 3/4 and 5/6. By selecting the Y-passive recording mode for hardware line 1, hardware line 2 is automatic logically paired with line 1. The user has to foresee the appropriate hardware connections (Y-splitter) in order to record the correct signals on both lines. The software will merge both lines during the convert/export phase without any interference from the user. This Y-passive recording mode can be used for LAP B as well as for X25 (using SVC and/or PVC). Multiple (maximum 32) logical X25 channels are allowed on one physical hardware channel.

3.3.1.6. Endless loop Interrogation Recording (RFTS/RES)

The endless loop interrogation recording can be executed using the RFTS or the RES. Both methods have a similar user interface and use the same file format to store the recorded data. The file format is backward compatible with the format of the previous version of PTEP1/P2. The endless loop interrogation recording is synchronised by the endless loop EDR recording. This way, the EDR data stored in a particular file matches the data stored in the corresponding interrogation file. The computer controlling the EDR recording (master) and the computer controlling the interrogation recording (slave) should be connected through an (ethernet) network.

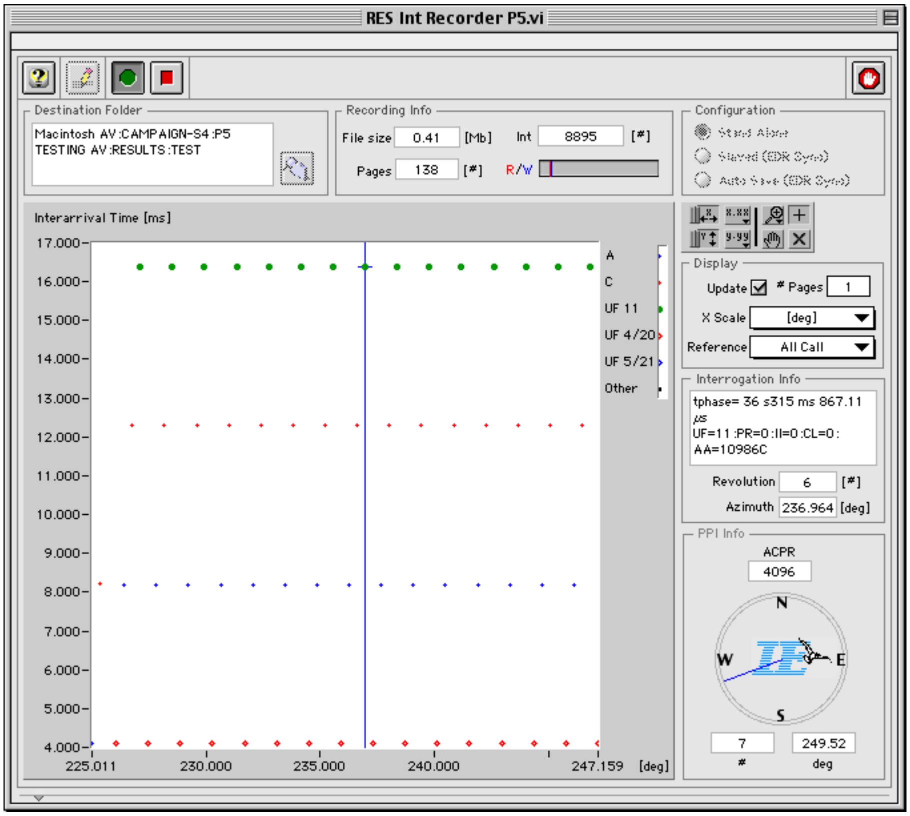


Figure 3-10: RFT/RES endless loop interrogation recording tool.

3.3.1.6.1. Endless loop Interrogation Recording duration

The endless recording tool for interrogations remains running for 2 days.

The PTE P5 allows the user to start an endless loop recording of interrogations synchronous with the endless loop EDR recording

Without a mains power failure the endless loop interrogation recording should remain running indefinitely. The endless loop interrogation recording can be synchronised with the endless loop EDR recording. This is done by connecting both computers that control respectively the EDR recording and the interrogation recording software through a network. This network connection is a standard feature of the PTE P1/P2 platform computers. No extra hardware or software is needed and once configured it is completely transparent for the user and will be automatically available at start up of the system.

3.3.1.6.2. Definition of Time sections

The endless loop interrogation recording results in data sections of predefined time period. The time period is determined by the setting of the endless loop data recording. The size is limited by the available disk space of the computer running the recording software for RES.

The endless loop interrogation recording results in data sections of predefined time period. The time period is determined by the setting of the endless loop data recording. The size is limited by the available disk space of the computer running the recording software for RFTS.

The computer controlling the EDR recording is the master and sends the computer controlling the interrogation recording the necessary commands at the appropriate times through the network connection. The computer controlling the interrogation recording is the slave and only listens for the commands from the master. The names of the corresponding EDR and interrogation files are the same and are configured as follows: YYMMDD_HHMM meaning the year, month, day, hour (24) and minutes of the starting moment of the file. This way it is easy to find corresponding EDR and interrogations files on both computers.

Although the size of the files is determined by the selected time period of the endless loop EDR recording, the size of the archive can be selected differently for both systems. The size of the interrogations archive is limited by the available disk space of the computer running the interrogation recording software. Bear in mind that an interrogation recording contains considerable more data than an EDR recording.

3.3.1.6.3. Recoriding File Formats

The format of the recorded data is backwards compatible with the format of the previous version of PTEP1/P2 (v 4.3.1).

The format for the endless loop interrogation recording is identical to the PTE P1/P2 interrogation recording format. More details about the interrogation recording format can be found in the ICD.

This means that all the PTE P1/P2 interrogation analysis software can be used. Moreover the endless loop interrogation recorder can be configured to operate is stand-alone mode (without the EDR endless loop recording synchronisation). This allows the user to make PTE P1/P2 compatible interrogation recording with the PTE P5 RFTS/RES interrogation recording software.

3.3.2. Processing of data

3.3.2.1. Principles of data processing

It is advisable to process the recorded data prior to distribution, since in that case the recording can be repeated if something was not recorded correctly or errors were found in any of the recorded data. This processing consist of conversion of the EDR data into two separate files: S48 and S17. (See description above) and the conversion of the recorded interrogation data into an IRD data file.

All these actions are taken under one user interface "shell", namely the P5 Merger and Linker tool. (see later). This tool translates the individual raw recordings into one general TRD dataset.

The "P5 Merger and Linker" combines several functions:

- -Conversion of serial ASTERIX Cat 48 and 34 stream into S48
- -Conversion of serial ASTERIX Cat 17 data into S17 data
- -Conversion of raw interrogation data of RES or RFTS and merging with UTC recording of EDR to allow UTC time stamped IRD data.
- Conversion of the SMGET generated MAP data into PTE P5 formats
- -Linking of S48, S17 and IRD into one TRD logical data-set per radar.
- Combining these data-sets into one TRD logical data-set per cluster.
- Optionally analysing the dataset

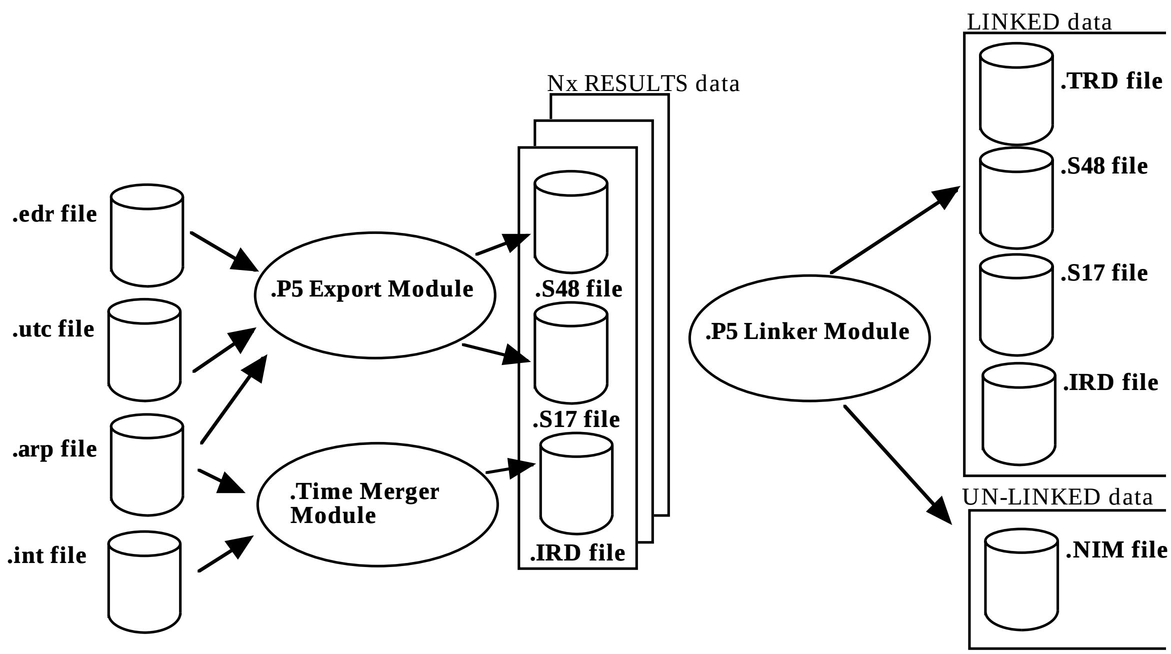


Figure 3-11: P5 recorded data processing

The EDR ASTERIX data processing is done by an EDR Export module and integrated in the P5 Linker and Merger.

The interrogation data, recorded by the RFTS or RES, requires some processing to create the IRD data. This step also adds UTC time stamping to the interrogation data, because the RFTS or RES only perform relative time stamping.

The result data of these steps is a .S48, .S17 and .IRD file contained in a RESULT folder on the local disk of the computer. A copy of the SMGET generated map data (as used by the radar at the time of recording) also needs to be copied onto the computer prior to distribution of the data towards the central P5 system.

3.3.2.2. Linking of data on sensor level

This (optional) step allows the user to link the recorded data, for one radar, into the TRD-5 format and check and visualize the recorded data in a copy of the P5 Data Display (typically run on the P1 platform). For this purpose the PTE P5 software is merged with the PTE P1 / P2 software and should be installed on the P1 / 2 recording platforms as well.

The linking process is identical to the linking process defined hereafter as linking on cluster level, but the major difference lies in the use of only one RESULT folder. For the rest all features of the P5 Data Display shall allow the user to verify the data recorded prior to shipping.

The measurement procedures should include this verification phase to avoid unnecessary transferal (centralization) of corrupt or inaccurate data.

3.3.2.3. Centralization of data

Once all data is recorded and converted into appropriate formats, the users in the different nodes must gather the data and send it to a central point (e.g. EC HQ), where the data can be further examined and analyzed.

In the simplified setup of Figure 3-1, where the ASTERIX Cat 48 data is centralized, this step can be skipped.

The process of centralization can be made by several means:

- Email
- ftp site (internet)
- CD / DVD-RW
- Zip disks
- Jazz disks

All these means are foreseen in the PTE P1 / P2 configuration, except the CD-RW drive. A possibility exists to transfer the data to a P4 system via ftp and then write the data to CD, but this seems to much problems. We therefore suggest to add a CD-RW drive to each P1 / 2 configuration (most of these configurations already have this extension bought by the users).

All PTE P5 Macintosh G4 -866 Mhz platforms) have a CD / DVD RW drive build in.

All P1 computers are also equipped with Internet software and 56K modems. The customer or user is responsible for providing the Internet account. Once the computer is online, ftp or email can be used to transfer the data.

The data to be copied consists of the RESULT folder containing the converted Asterix data (S48, S17) and the IRD data, plus a copy of the Map data used by the station.

3.3.2.4. Linking of data (on cluster level)

3.3.2.4.1. Principles of data linking

Once the data is copied onto the target P5 system, the linking process can start. The linking process consists of several steps:

- Parse all S48 files of interest and create index list with fields <time><S address><Duplicate S address Ref. nb><Source Destination><File index><File ref. nb>; Sort list

- Parse all S17 files of interest and create index list with messages 10,20,22,21 and 23 for fields <time><S address> <Duplicate S address Ref. nb> <Source Destination><File index><File ref. nb; sort list
- Create separate S17 index for all S17 messages with no S address present :00,30,31,32,33,110,111
- Parse all IRD files of interest and create index list ; <time><S address> <Source Destination><File index><File ref. nb>;
- From S48, S17 and IRD indexes, a linking can be made per target. This results in a new logical data set (comprising of four physical files) , containing one TRD5 set per target. This set is sub-divided in TRD5 records, one per radar beam dwell. (See Figure 3-3)
- Calculate all “Calculated Fields” of the TRD, such as lat,Long,X,Y, Range, Az, Counters , etc..
- The records of the newly created “TRD5” files, contain a reference position (containing lat.-long data, calculated fields etc..), plus one or more links to the S48 records, S17 records and IRD records (all of multiple sources).
- The S17 messages 00,30,31,32,33,110,111 shall not be stored in the linked S17 datafile, but must be analysed using the original S17 file contained in the RESULTS folder(s). These files shall be used for cluster state and stability calculations.

The TRD5 records are basically created from the S48 records.

The S17 messages are linked to the TRD records based on Time of RECORDING of the S17 data and Time of Detection of the S48 data. The general rule is:

‘Link All incoming (Rx) and Outgoing (Tx) S17 messages to the previous TRD record (Time of Detecton TRD n +1 > Time of recording S17n ≥ Time of Detection TRD n) except for all Received Target Data S17 messages or if no previous TRD exists, in which cases the message should be linked to the Next TRD. “

If S17 track data message data present is present earlier in time than S48 and IRD, the S17 is used a basis to create the TRD5 record. This record will than have no linking to IRD or S48.

3.3.2.4.2. Duplicate S address data linking

A special rule should be applied in case duplicate S addresses are present.

These rules can be devided in three separate pieces:

- Separating duplicate S address targets per radar (based on tracks with Error warning I48/030 set to 16) and attribution of DRN number per radar
- Parse S17 data and linking the correct S17 messages to the correct TRD records
- Unifying the DRN numbers for the cluster (making sure all duplicate S address numbers match between radars)

All S17 messages with a DRN should be matched to the “Closest” TRD record, based on TRD position (Lat-Long).

All S17 messages without a DRN which can be linked to multiple (duplicate S address) TRDs should be linked to each of the matching TRD.

See figure on next page

Linking Algoritm for Duplicate S address

1) Create Index table for Cat48 data (=TRD) S address<-> Time <-> DSA flag
flag all duplicate S addresses (warning I48/030 issued)
2) Create index table for Cat 17 data S address<->Time<->Type

3) Link all records of one S address

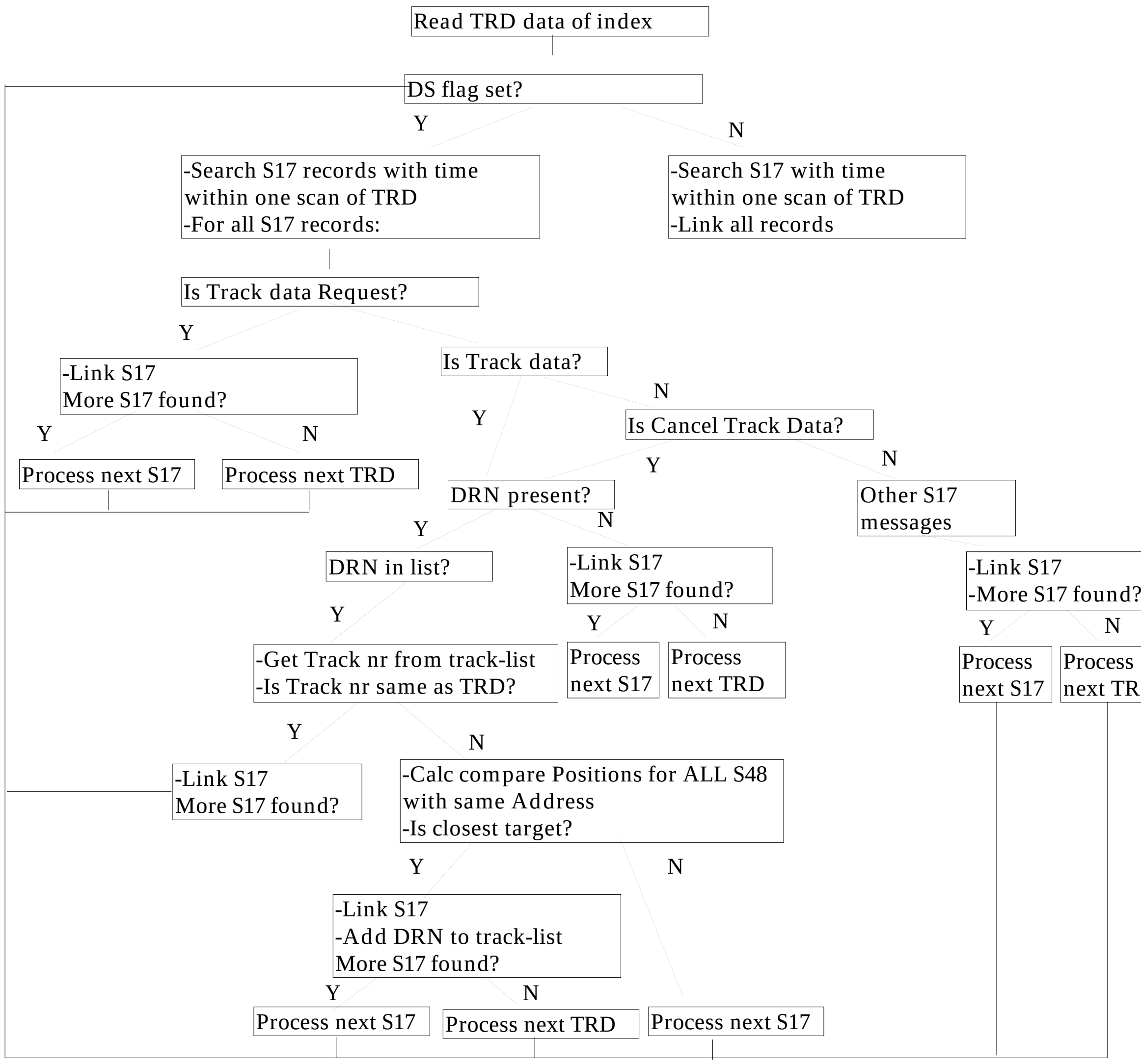


Figure 3-12: Duplicate Mode S address linking

3.3.2.4.3. Map import and coverage flags

The Linker also reads the System Map files stored in each of the N "map" folders (supplied by the export function of the SMGET tool) and recalculates this data such that is easily accessible for the Data display tool and the Linker tool. (thus into a DSS file) . This file shall contain N * 64 maps, where N = number of Nodes (some of which will be empty). The user interface of the Data Display will allow the user to select the proper map from the selected Node and State. Optionally, individual maps of one Node or “Merged” maps of all nodes (for the same State) together can be displayed. All the map data is pre-calculated by the “Map Processing tool” and saved in a Map DSS file. This DSS Map file is stored together with the linked data.

The cluster Node locations and configurations are read from the "Cluster.dat" File, stored in each of the N "map" folders and are imported into the Multi-Site information file (.msit file) for further use in the P5 data display. (See also HMI of Multi site File).

What is more important, is that from the recalculated System Map information, the Linker determines the coverage flags for each TRD5 record.

In the TRD5 record, a byte is reserved for the six possible surveillance coverage nodes. A second byte is available for the Data link responsibility node number, and two bytes are reserved for the Lockout responsibility and Lockout override responsibility. On top of this, the use of the "status display" requires the linker to put the Surveillance coverage flags of as seen by all six stations in the TRD structure. A last byte is reserved for the six possible surveillance mismatch flags. 10 bytes of TRD5 space are used for this purpose. The flags are attributed as seen by the station that provided the S48 data (or derived from their coverage maps) The other maps are also verified for the targets position. If a map mismatch is present, the map mismatch flag is set for the corresponding node.

The link tool shall also considers the contents of the NNCOP messages and set a flag if a TAP is expected due to a channel changeover procedure message.

This allows the user to defined specific filtering.

3.3.2.4.4. TRD5 calculated fields

Some calculated fields in the TRD5 records are calculated while linking the data. The most important information for the TRD5 is derived from the linked S48 data:

- Longitude and Latitude of TRD5 record
- Range and Azimuth relative to cluster centre (calculated from cluster positions found in Map data)
- X and Y data relative to cluster centre
- Speed and Heading vectors relative to cluster centre.
- Flag indicating if target flew in map mismatch
- Delta values for Latitude, Longitude, Altitude, etc..

The positional information, longitude, latitude, etc.. are derived from the S48 data linked to the TRD. The formulas used for this translation are derived from the formulas found in reference doc EC5.

The delta values are only calculated for Track data messages.

The calculation is different for Transmitted Track data than for Received Track data.

In the transmitted Track data, the Cat17 data should be the same as the last detected Cat48 position. Therefore the Cat 17 Longitude-latitude is compared with the transformed (towards geodesic coordinates) Cat48 position. The difference is stored in the S17files.

In the case of Received Cat 17 Track data, the Lat-long differences are recalculated using the TOD differences present in the S48 and S17 data and the speed vector found in the Cat 17 data.. For this purpose the incoming Cat 17 Long-lat information is first transformed into the local coordinate system of the Node receiving the data. Next the time difference between the Cat 17 TOD and the NEXT Cat 48 TOD is determined . Using this time difference, a delta X and delta Y value is determined using the Speed and Heading vector present in the Cat17 data.
Using the delta values, a new extrapolated Cat17 position on the Time of detection of the next Cat48 is determined in the local coordinates system. Both positions are then re-calculated towards geodesic coordinates, after which delta Longitude and delta latitude is determined.

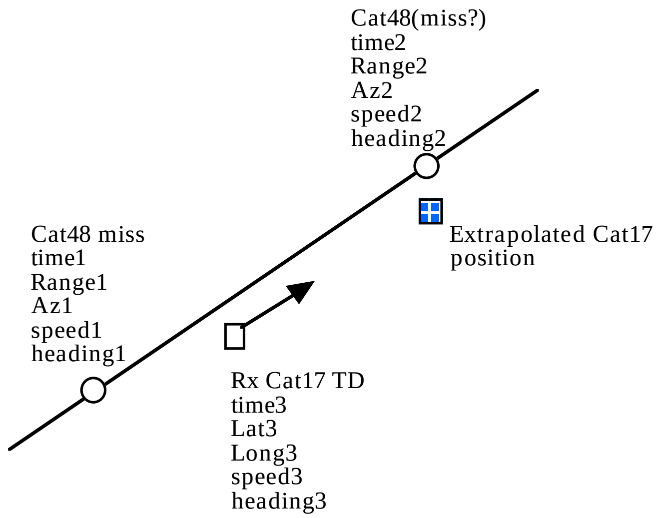


Figure 3-13: Calculation of Delta Range-Azimuth

3.3.2.5. HMI for Time Merger and Linker

The PTE P5 "Time Merger and Linker" tool allows the user to select a wide range of input data and convert, link and analyse this data. Consult the user manual Vol 4 for more details.

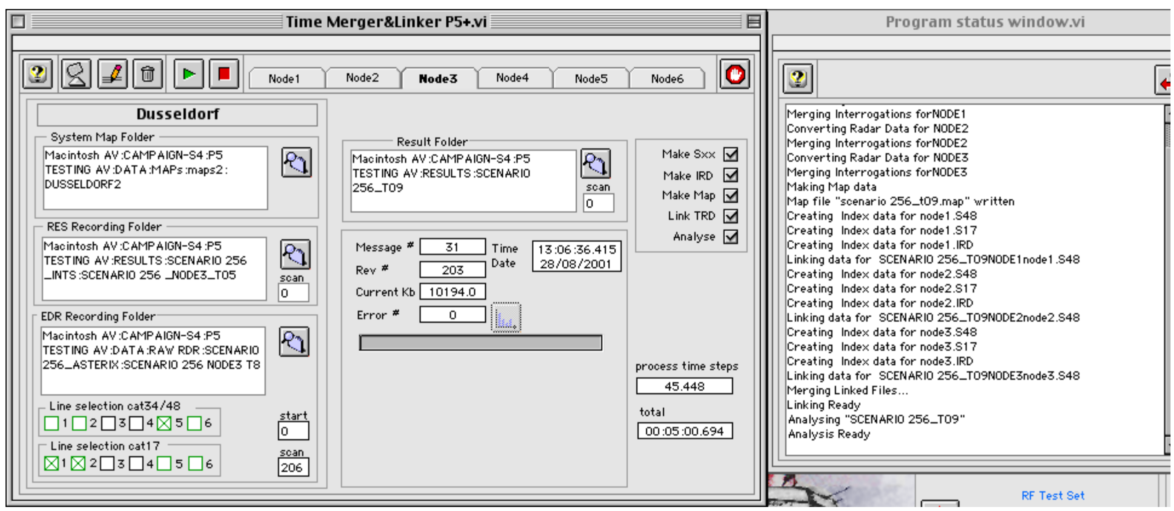


Figure 3-14: HMI for Time Merger and linker

3.3.2.6. Data Processing Related Specifications

3.3.2.6.1. Asterix Convert

The P5 Convert tool correctly converts all recorded Simulated and life Asterix Cat48 and Cat 17 data into S48 and S17 records.

The P5 “Time merger and linker" correctly converts the Asterix data into S48 records. This can be verified by using the Asterix viewer and the S file viewer on a number of test data elements.

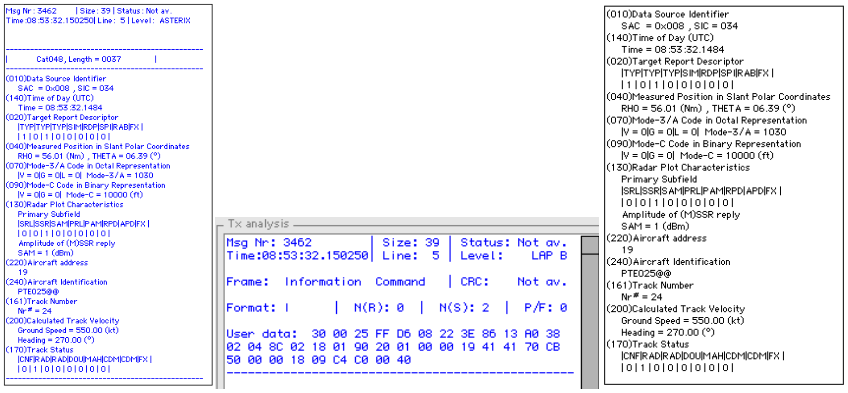


Figure 3-15: Comparison of Asterix data with S48 records of simulated data

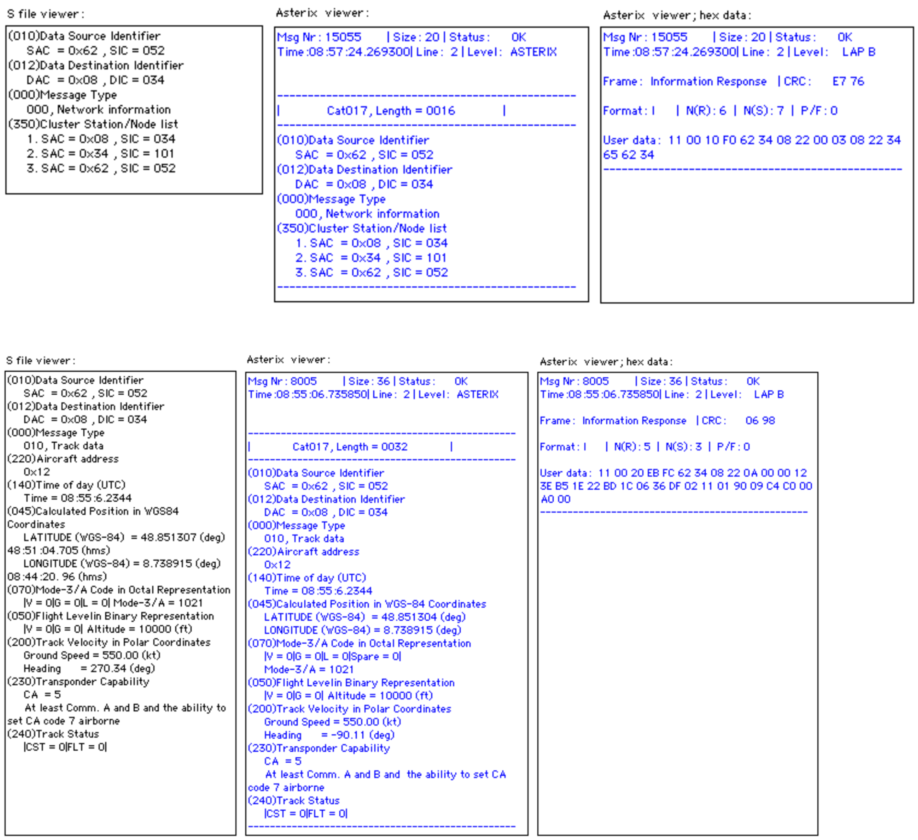


Figure 3-16: Comparison of Asterix data with S17 records of simulated data

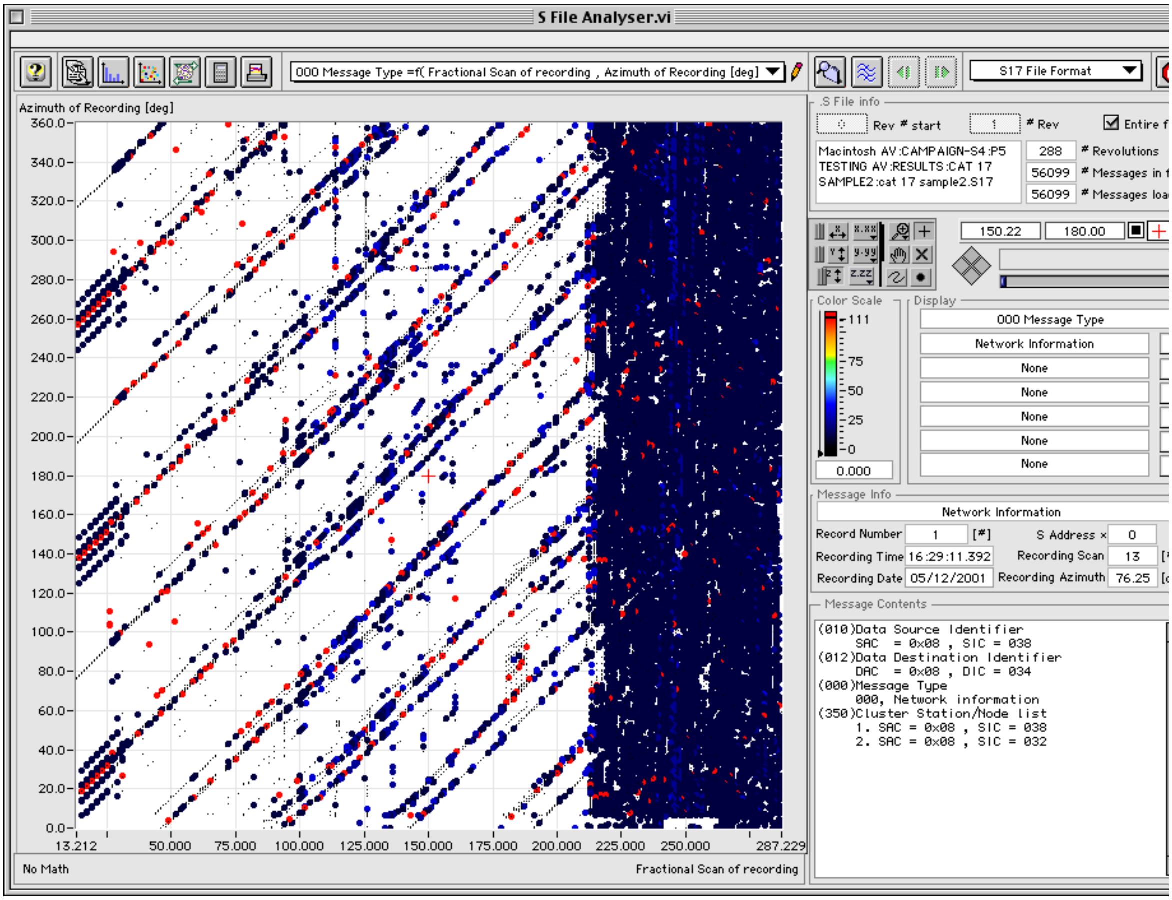


Figure 3-17: View of S17 data using S file Viewer

3.3.2.6.2. Map data Conversion

The P5 Convert tool correctly converts the POEMS Map files (cluster file and system map files) as specified in document Ref. EC09. data in a format readable using the PTE P5 data display..

The cluster Map data is read by a specific set of sub modules of the P5 tool, (Map Server.vi and Sysmap to amp.vi) These tools are incorporated in the PTE P5 Time Merger and linker.

The cluster specification file is also imported by the tool and re-written in a ".msit" or multi - site data file. This data can later be visualised using the "View multi site" tool, to be called from the data display.

The resulting Maps can be visualised using the Data Display.

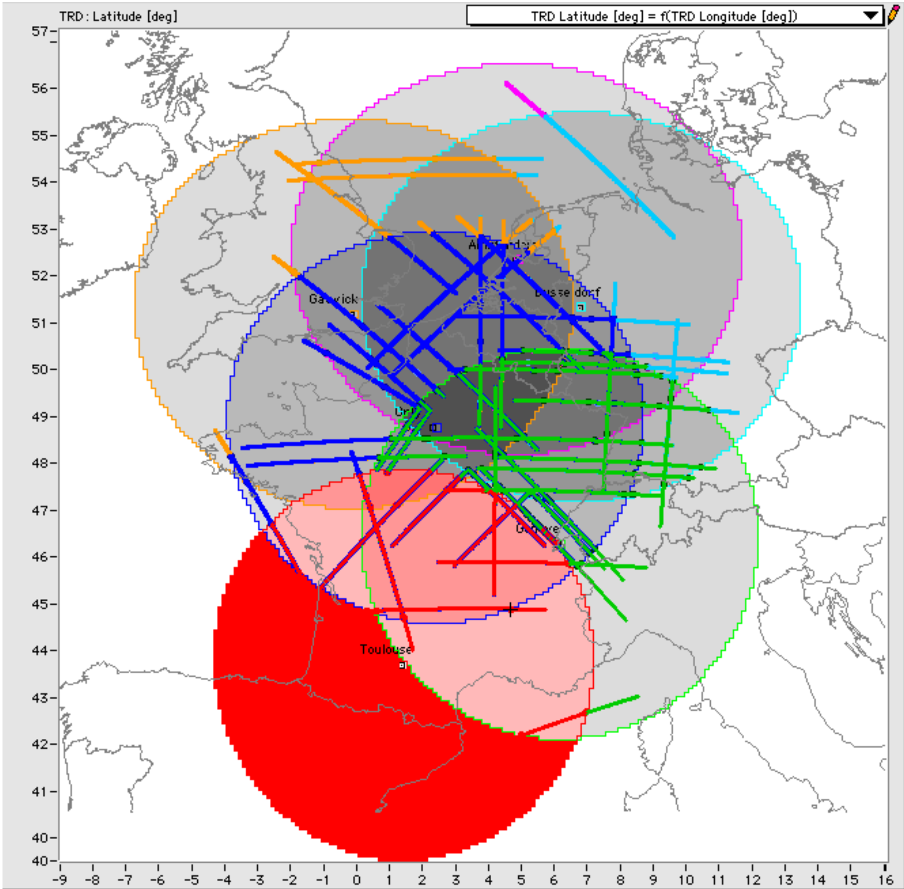


Figure 3-18: Map displayed in Data Display

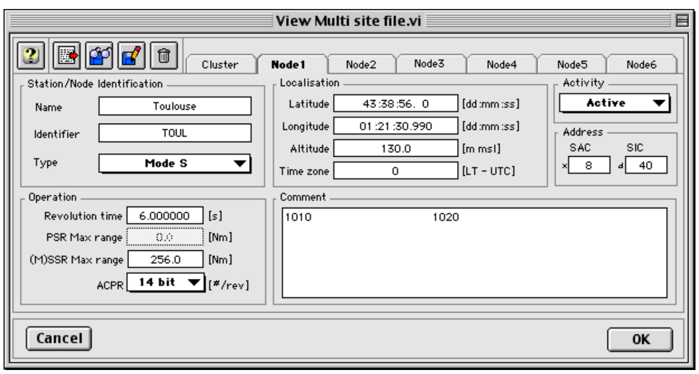


Figure 3-19: MSIT file viewer: Data derived from the cluster.dat file of SMGET tool

3.3.2.6.3. Import of pre-compiled S48 or S17 files

The system is able to import POEMS ATCC outputs, i.e. Target Report (Asterix category 048) information or POEMS SCN inputs/outputs, i.e. Surveillance Co-ordination Messages (Asterix category 017) information, through the use of one of the following file formats:
-Raw EDR
-S48
-S17

The Time merger will use eighter raw EDR data (default) or pre-converted S48 or S17 data files ..

3.3.2.6.4. Import of pre-compiled IRD files

The system is able to import POEMS Roll Call interrogation information, through the use of one of the following file formats:
-Raw int recording of RES
-IRD data

The Time merger will use eighter raw RES or RFTS interrogation (see above) or pre-converted IRD data.

3.3.2.6.5. Spilt up of NNCOP messages

The PTE P5 Converter tools shall prepare the NNCOP analysis by splitting all NNCOP and NNCOP reply messages in separate messages, allowing the linking of each individual message to the separate targets.

This can visualised using the S file Viewer showing the NNCOP messages:

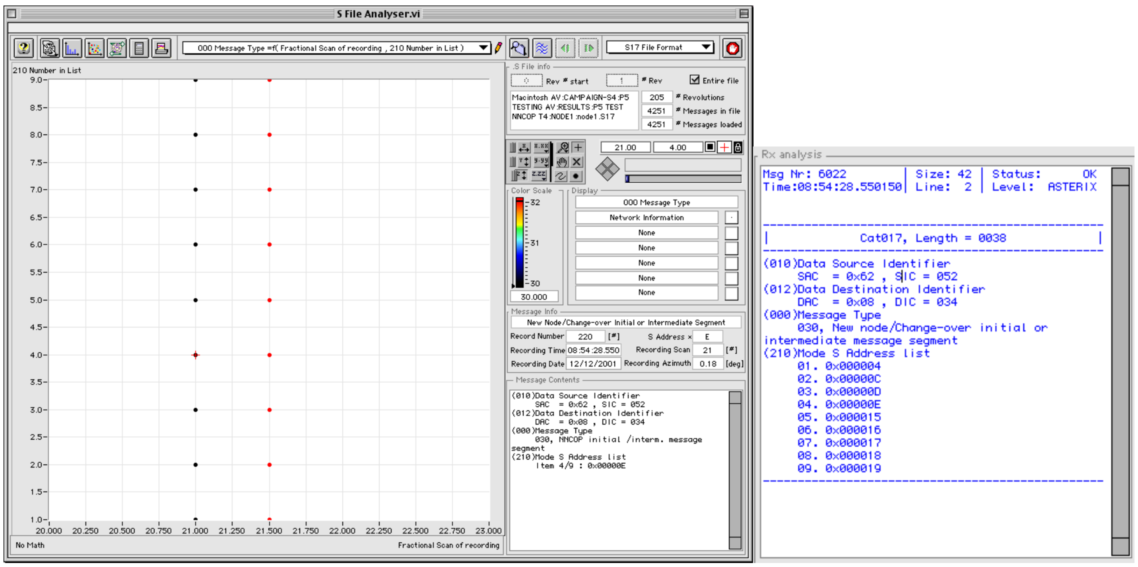


Figure 3-20: NNCOP messages split into pieces

3.3.2.7. Data Linking Related Specifications

3.3.2.7.1. General Linking

The linking tool is capable of linking all scenario reference data, Surveillance data , SCF data and Interrogation-Reply data to one logical TRD record.

The PTE P5 Linking tool correctly creates a TRD record for every S48 detected in the asterix data of one station.

The PTE P5 Linking tool correctly links the S48 (asterix Cat 48) and the S17 (asterix Cat 17) records of one station to its TRD records.

Using the Data Display, we can verify the correct linking of S48 and S17 records to the TRD records. The following display shows S address of TRD versus S address in S48 (Item 048 / 220)

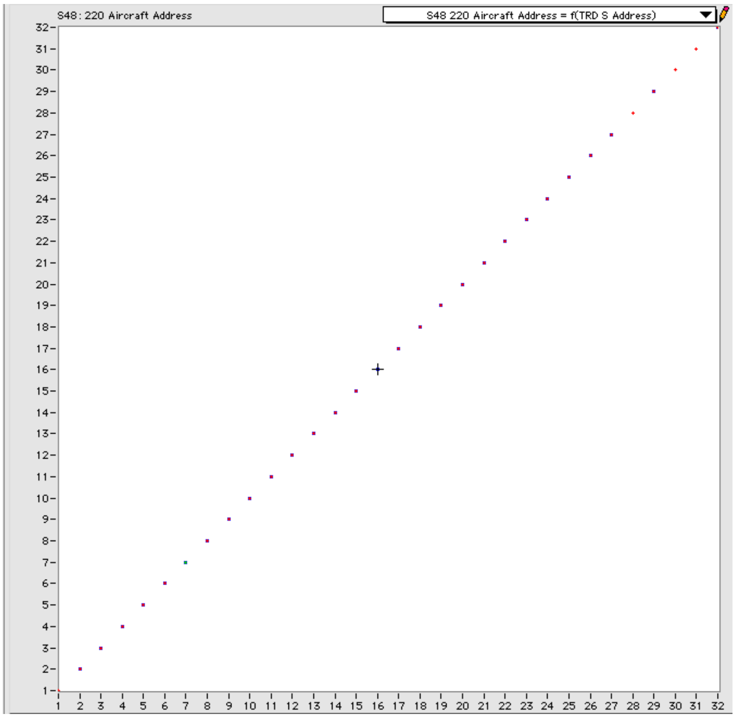


Figure 3-21: S address TRD versus S address linked S48

3.3.2.7.2. Inter station linking of data

The PTE P5 Linking tool correctly links all TRDs of one station to the corresponding TRDs of up to 5 other stations.

This can be verified using the Data display and status display. The upper layer shows data from orly, whereas the lower layer shows data from Gatwick. The display shows the TAP that is going on between the two stations and shows the linking of the two datasets. (The time cursors show the time difference between the S48 record of Orly and that of Gatwick)

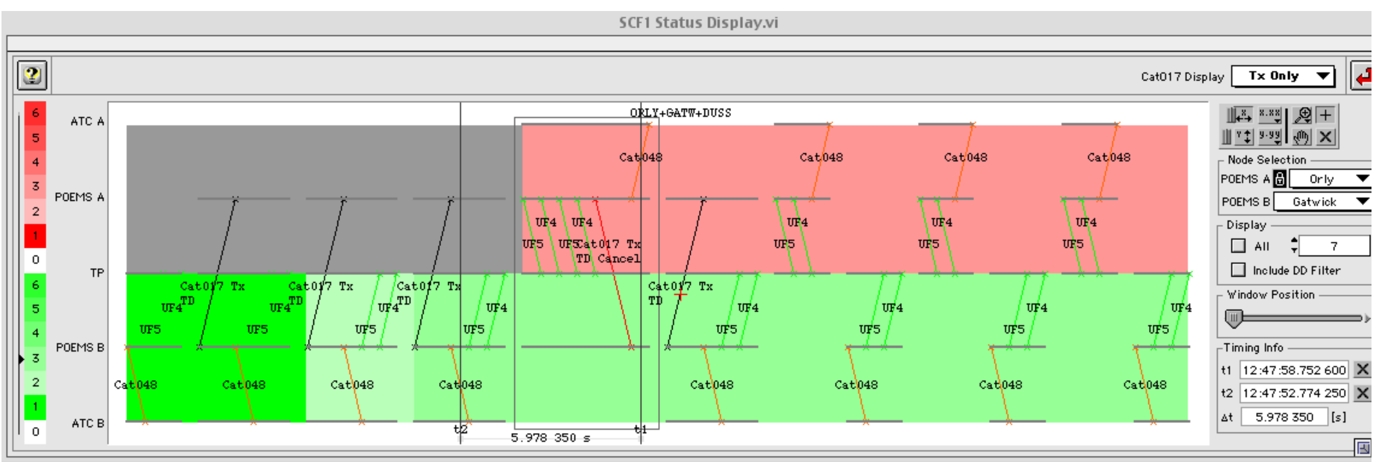


Figure 3-22: Status display showing linking between two stations

3.3.2.7.3. Coverage Flags

The PTE P5 Linking tool correctly sets the coverage flags in all TRDs of one station corresponding to the linked coverage Maps.

This can be verified using the Data display and Third view display. The third view is set to put "Coverage" as third axis (this is the number of stations in coverage at any given time). The display hereunder shows the effect.

In case the user only wants to verify the Maps created by the SMGET tool, he can also load map only data (without linked data). For this purpose, the data linker can create "dummy" TRD files.

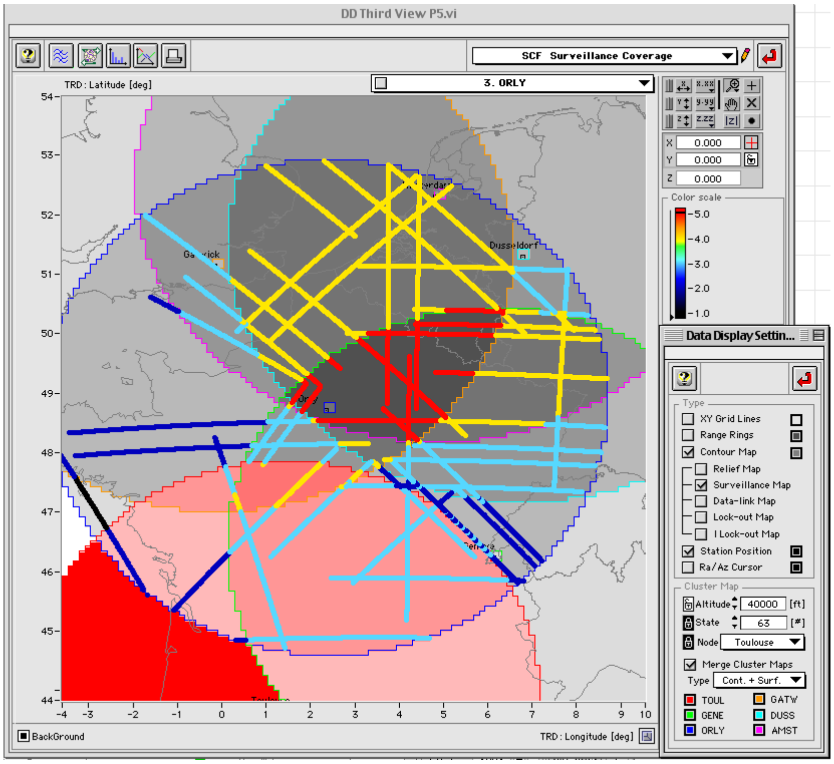


Figure 3-23: Third View display showing coverage

3.3.2.7.4. Linking using EDR recordings

The PTE P5 Linking tool user interface allows the selection of raw recorded data (Raw EDR and Interrogations) of one or multiple stations for merging and linking.. After selection, the HMI shall provide a method of starting, halting and progress monitoring of the linking process.

The Time Merger and Linker tool allows the selection of the data using the standard user interface items (folder selection, Menus, buttons..) as used in the well known other PTE tools.

The Linking starts using the start button (green triangle) , can be stopped using the stop button (Red square) and its progress is monitored using the "Program status window".

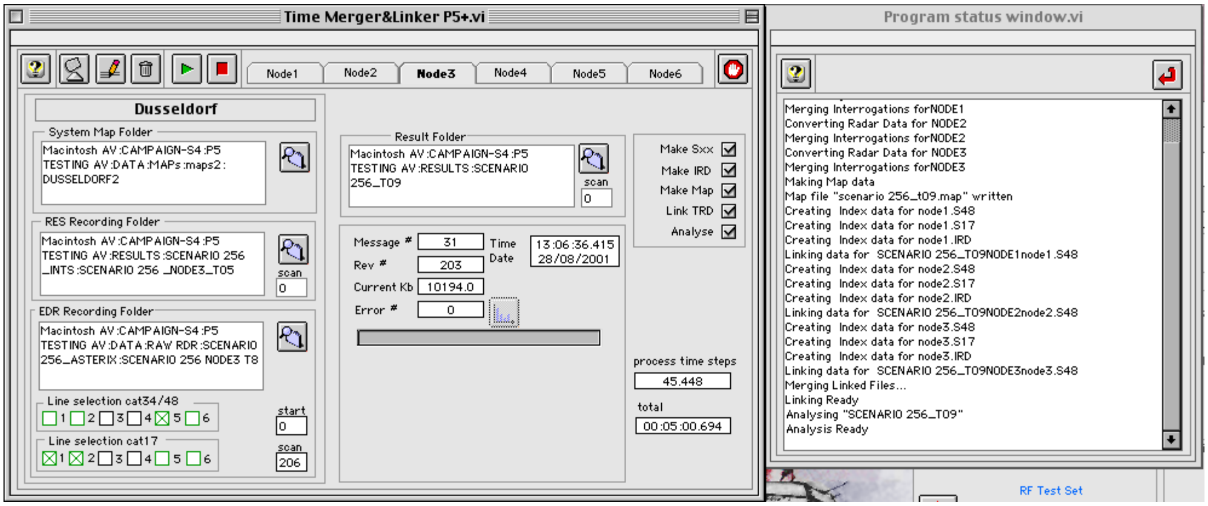


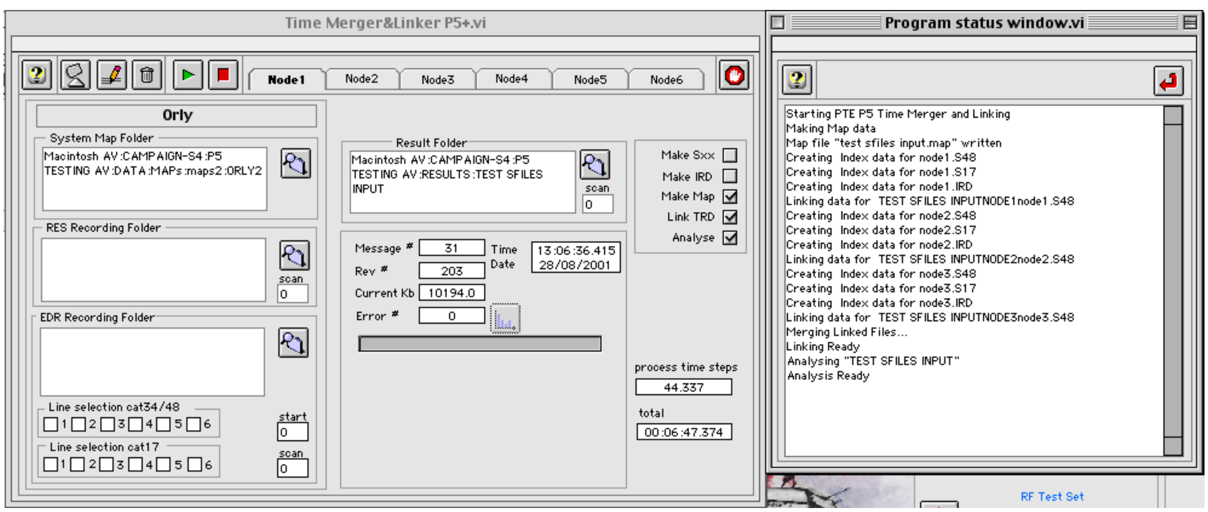
Figure 3-24: HMI of Time Merger and Linker for PTE P5

3.3.2.7.5. Linking using pre-compiled S48,S17 and IRD data

The PTE P5 Linking tool user interface allows the selection of pre-linked data (S48 ,S17,IRD) of one or multiple stations for merging and linking. After selection, the HMI shall provide a method of starting, halting and progress monitoring of the linking process.

The Time Merger and Linker tool allows the selection of the S file data using the standard user interface items. The tool does not allow the individual selection of S files per node, but requires that the RESULT folder is subdivided into N folders, names NODEn, with n the Node number [1..6].

The Linking starts using the start button (green triangle) , can be stopped using the stop button (Red square) and its progress is monitored using the "Program status window"..



3.3.2.7.6. NNCOP message Linking

The linker and merger shall prepare the NNCOP analysis by linking all separate NNCOP and NNCOP reply to separate targets (TRD sets).

This feature allows the analysis of the NNCOP data. The picture below provides an insight in this method. The status display shows that dusseldorf joins the cluster at a certain time. Dusseldorf sends an NNCOP message to Orly, containing the S address of the TRD of interest shown in this display, but the NNCOP reply message does not contain the S address. Therefore no NNCOP reply message (split) is linked to this TRD and a TAP is initiated.

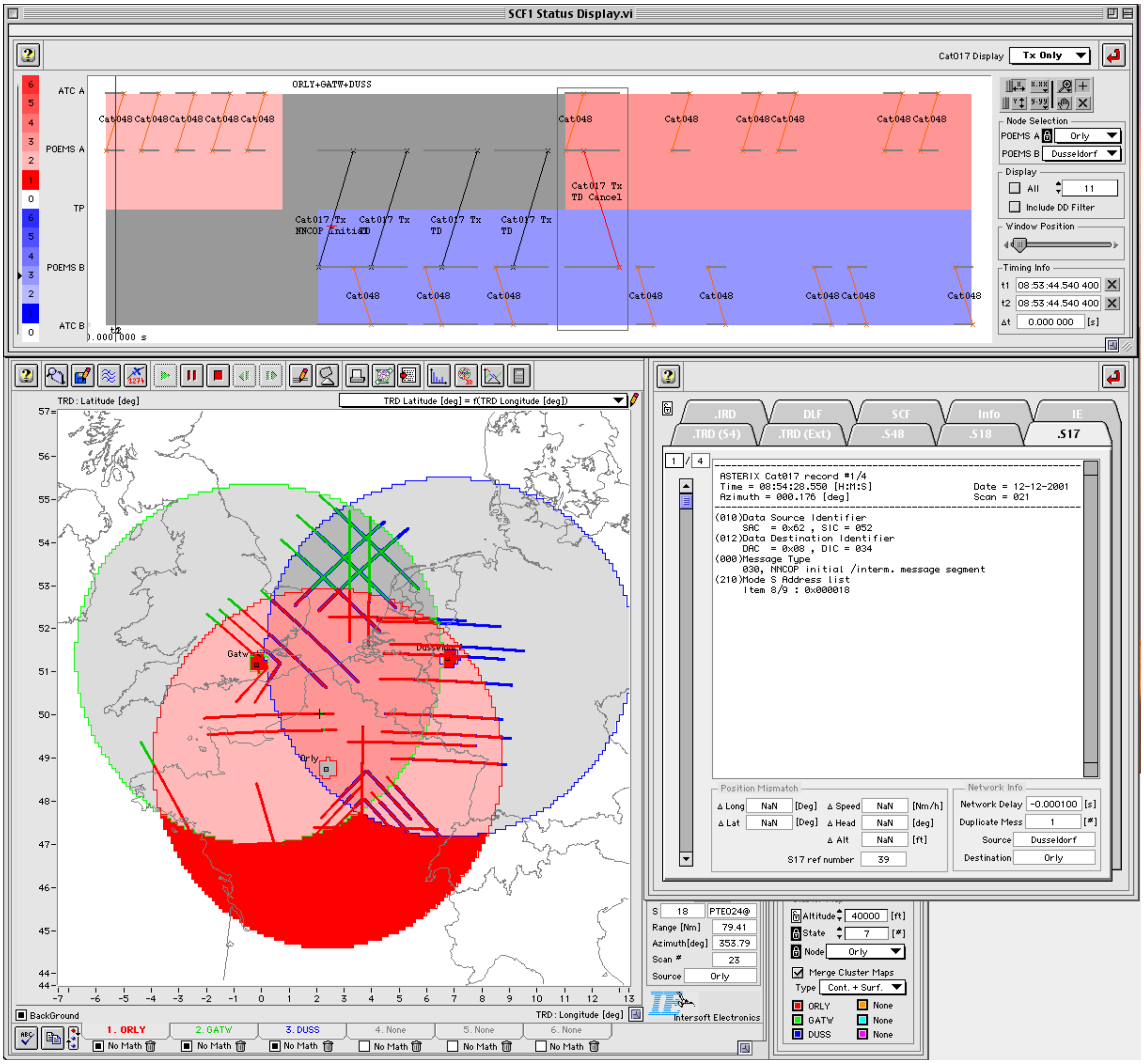


Figure 3-25: NNCOP transaction

3.3.3. PTE P5 Analysis

Once the data has been linked into one TRD5 logical file, the data is be fed to the P5 analyzer tool. This tool calculates from the TRD5 data, set per set (or target per target) the required analysis results for PTE P5.

3.3.3.1. Analysis and Calculation of Flags

The PTE P5 Analyser first starts by calculating the TASP status flags. This process determines the following data:

- TSP status flags
- TAP status flags
- Track Data Stop status flags
- 0 to 5 TASP numbers (stored in S17 fields)
- Number of associated Roll Calls

The TASP status flags are available in six fold, since the TASP can be between any of these six nodes.(one of the six always remains unused, since it will be the source station) A set of 8 bits is available for every DESTINATION Node: ; Each set contains two bits to distinguish between a TAP and a TSP (which never co-exist towards the same Node) and further six flags, called "Procedure". “Expected”, "Running" “Initiated” , “Completed” and “Successful”. This brings the total number of fields to 48 bits or 6 bytes per TRD5 record. A further 6 bits are used to indicate whether a TAP is caused by a NNCOP procedure.

TAP flags are always put in the TRD records originating from the <u>server</u> side of the procedure.

for a TAP:

- Expected is true for <u>one</u> TRD record (to allow counting) at the moment the coverage indicates a TAP is expected. (see definition in par. 2)
- Procedure is True from the moment the TAP is expected, and goes false again when the TAP is completed.
- Initiated is true for <u>one</u> TRD record (to allow counting) at the moment the first Track Data is send. (see definition in par. 2)
- Running is true from the moment the TAP is initiated, and goes false again when the TAP is completed. (by a Track data Cancellation or Track data stop)
- Completed is true for <u>one</u> TRD record (to allow counting) at the moment the first Track Data Cancellation or Track Data Stop is send.
- Successful is true for <u>one</u> TRD record (to allow counting) at the moment the first Track Data Cancellation is send and the Procedure bit is true (so the TAP was expected)

TSP flags are always put in the TRD records originating from the <u>client</u> side of the procedure.

for a TSP:

- Expected is true for <u>one</u> TRD record (to allow counting) at the moment the ASTERIX Cat 48 of the client indicates a miss and thus a TSP is expected. (see definition in par. 2)
- Procedure is True from the moment the TSP is expected, and goes false again when the TSP is completed.
- Initiated is true for <u>one</u> TRD record (to allow counting) at the moment the first Track Data Request is send. (see definition in par. 2)
- Running is true from the moment the TSP is initiated, and goes false again when the TSP is completed. (by a Track data Cancellation or Track data stop)
- Completed is true for <u>one</u> TRD record (to allow counting) at the moment the first Track Data Cancellation or Track Data Stop is send.

- Successful is true for <u>one</u> TRD record (to allow counting) at the moment the first Track Data Cancellation is send and the Procedure bit is true (so the TSP was expected)

Each linked S17 TASP related message (Track data request, Track data, Track data cancellation, etc..) is attributed a unique TASP number by the Linker. (This allows multiple TASPs to be linked to one TRD5 record). The TASP status flags are always updated for all Nodes.

A New NNCOP message will always reset the existing TAP state flags.

3.3.3.2. Analysis and Calculation of Delays and Counters

The following information is determined in the "Analysis" stage of PTE P5:

- Cluster acquisition delay
- Station re-acquisition delay
- Track Acquisition procedure duration
- Track Acquisition Roll Call reaction Time
- Track support Procedure duration.
- Track Data Request Reaction Time
- Track data Cancellation Reaction Time
- Cluster Stability
- Counters for All conditions of the TASP
- Counters for Roll Calls during TASP activities

In order to calculate the TASP related results, S17 data is required. If Only S48 data is available, the tool informs the user by disabling these options from the analysis tool. The same applies for roll Call assessment if no IRD data is available..

The information determined this way is presented to the user either in the data display (where the values can be plotted in a scatter diagram or histogram against any other TRD5 field) or in a separate Result view graph, where the delay or duration values are plotted against target nb or S address.

3.3.3.2.1. Cluster Acquisition and Station re- acquisition delays

These two delay values can be calculated from the TRD5 data with linked S48 data.

The cluster acquisition delay is calculated each time a target enters the coverage of any radar. If the coverage status of a particular TRD5 record (of one given target) changes, the tool searches for differences in TOD of the target for the different radars. The tool has the ability to calculate these values since all S48 records are linked to the one TRD5 data set (all TRD5 data of one target is read in one time).
The Cluster Acquisition delay value is stored in the the SCF result data linked to the station that newly acquired the target. (The Client station for TAP)

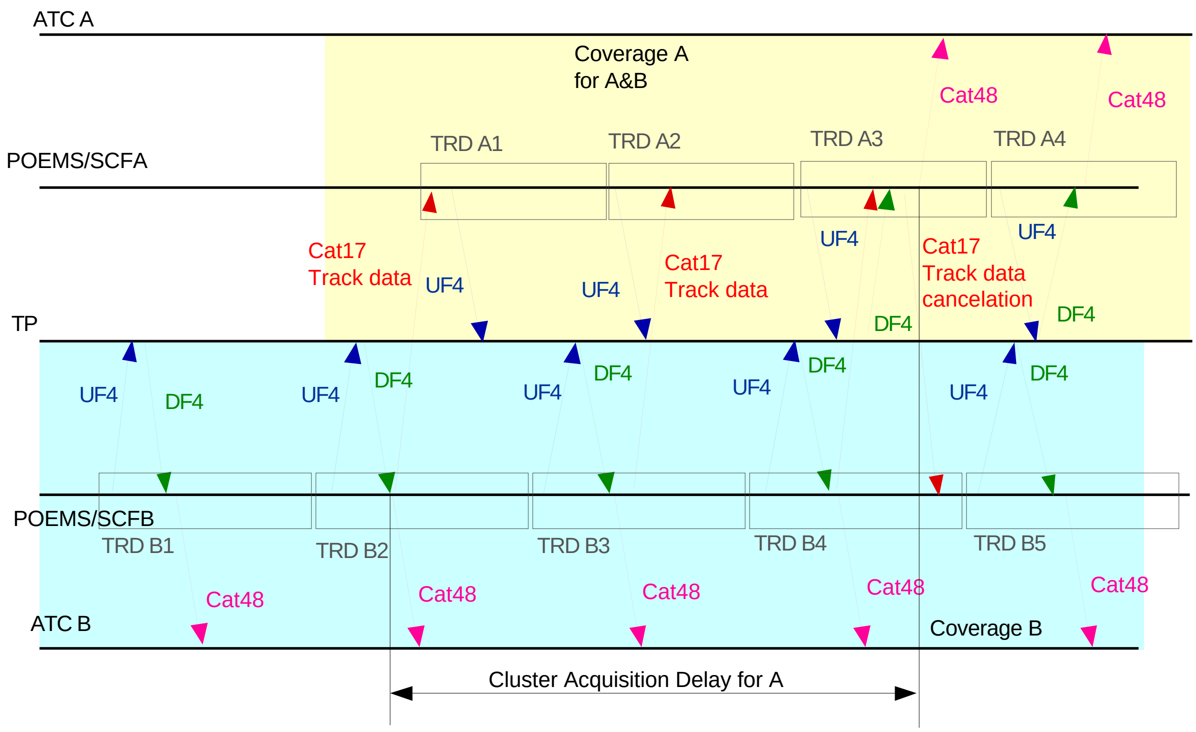


Figure 3-26: Cluster Acquisition delay; simple case

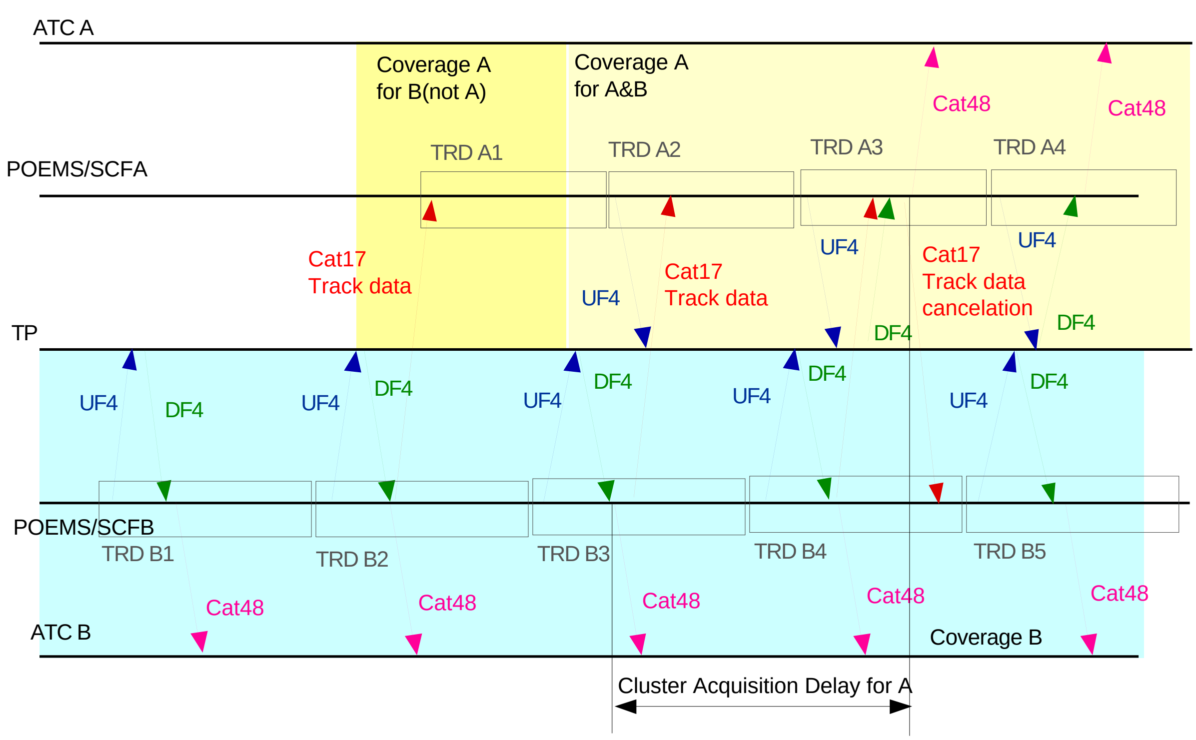


Figure 3-27: Cluster Acquisition delay; case of Map mismatch

The station re-acquisition delay of the target is determined each time a target was reported as a miss by one particular radar. The TOD of the first non-miss target report by a radar is compared with the TOD of the first missed report for the same target. The Station Re-acquisition delay value is stored in the the SCF result data linked to the station that showed the missing detection for the target. (= The Client station for the TSP)

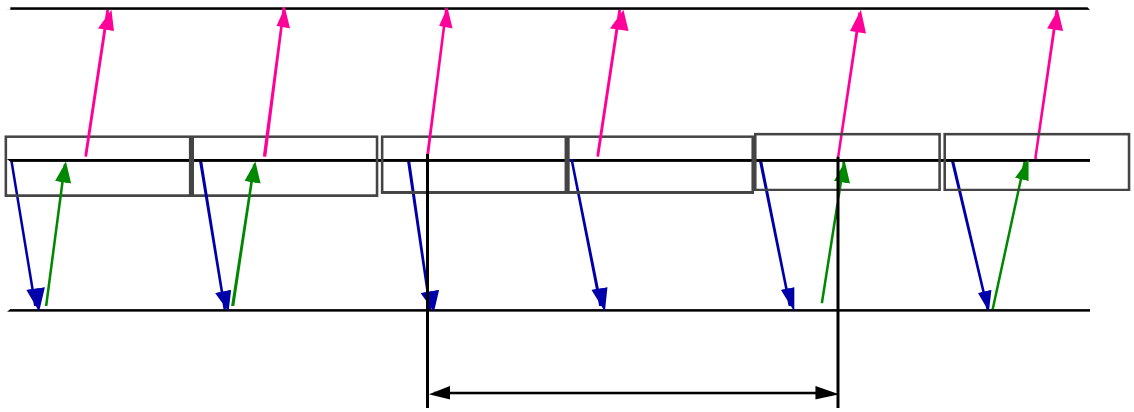


Figure 3-28: Station re-acquisition delay y

Both values (if present) are stored as a delay value in the SCF result . A flag is set in the TRD5 delay FSPEC to indicate that the timer is filled with a value. Up to 16timers in total can be set in one SCF record. The data can be visualized in the data display (see further).

3.3.3.2.2. Track Acquisition and Track Support Delay

These two delay values can be calculated from the TRD5 data with linked S48 data and S17 data.

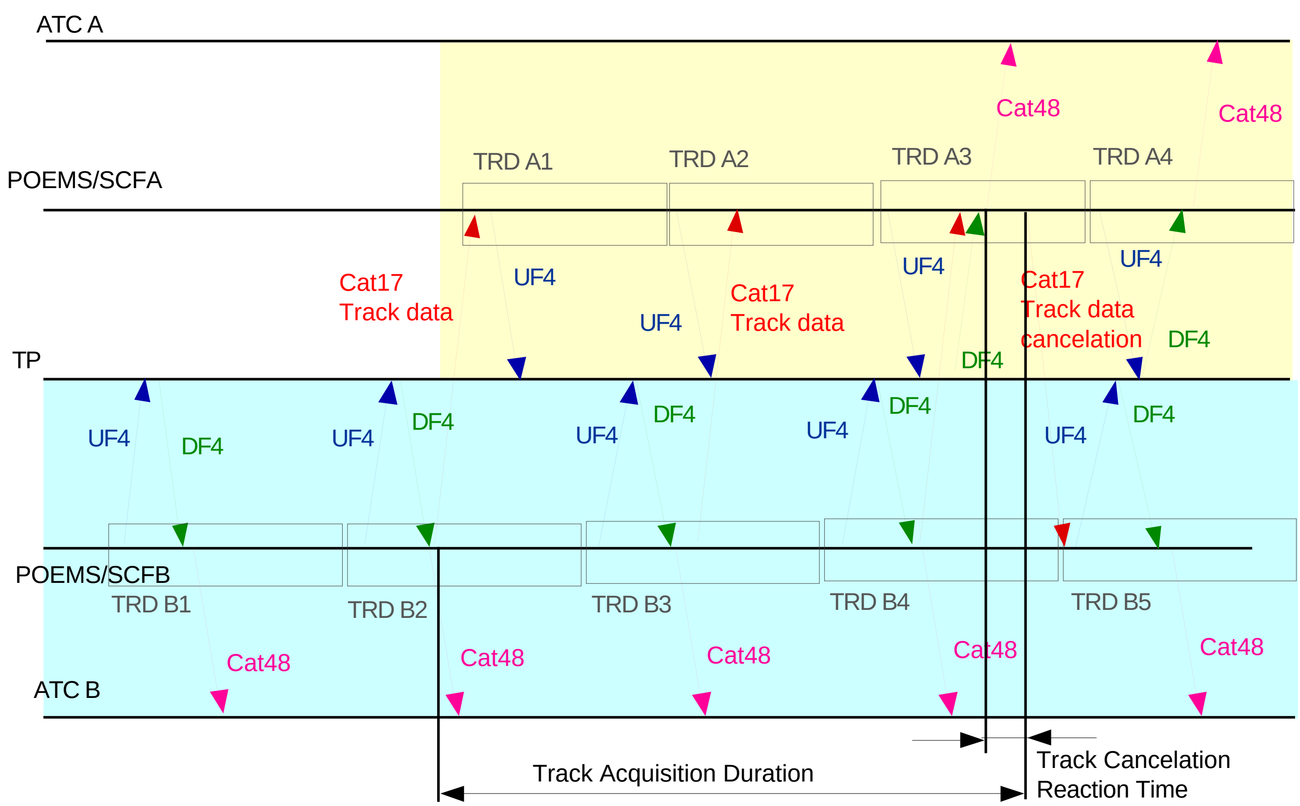


Figure 3-29: Track Acquisition duration and Cancellation Reaction Time

The track acquisition delay is calculated each time a target enters the coverage of a particular radar and acquisition is supported by an other Node in the network. The delay is calculated by using the recording times (or TOD values where available) of the linked S17 messages. The correct TRD5 records are located by using the TRD5 flags for TASP (expected, Initiated, Completed). These flags are also set by the linker.

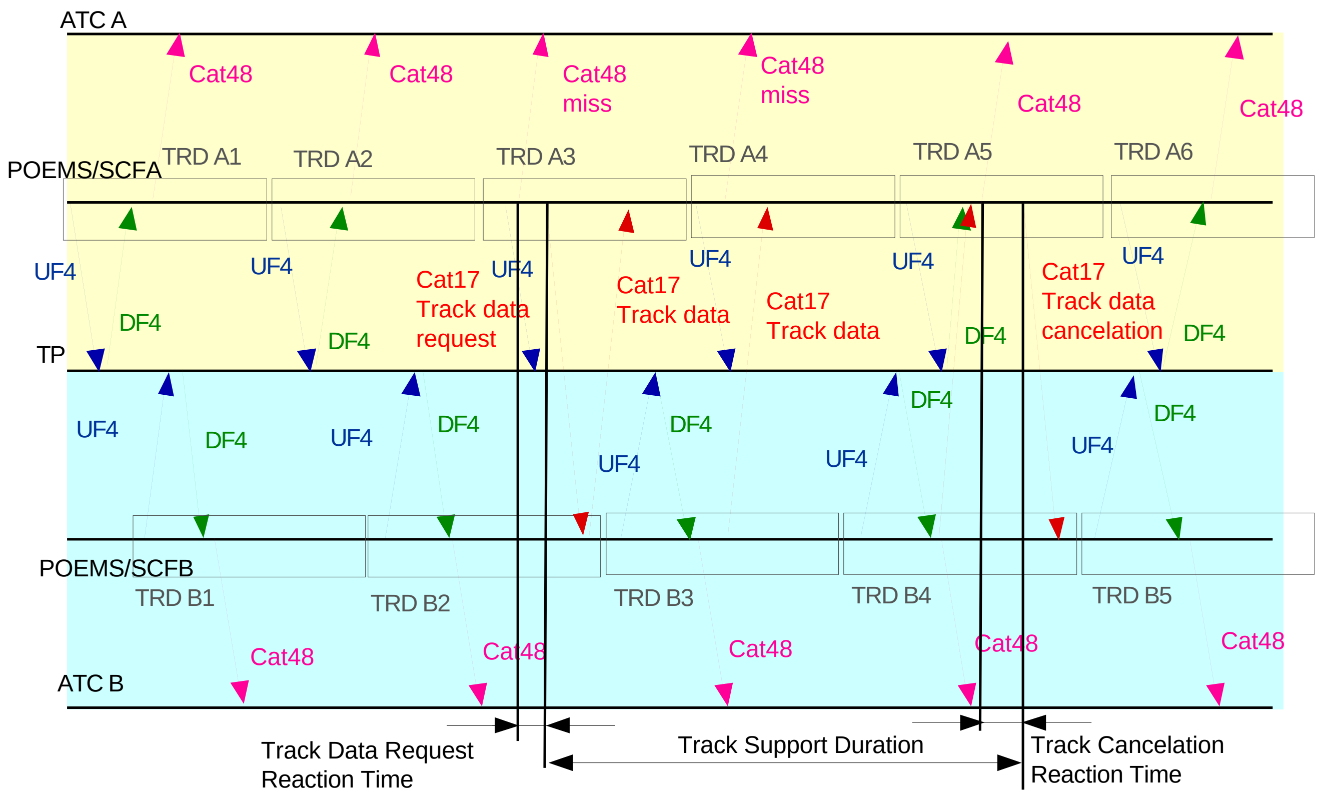


Figure 3-30:Track Support Duration, Track Data Request and Cancellation Reaction Time measurements

The track support delays are calculated each time a target in overlapping coverage shows a miss and a TSP is initiated and completed.

Both values, if present, are stored as a delay value in the TRD5 data structure. A flag is set in the TRD5 delay FSPEC to indicate the timer is filled with a value. Up to 10 timers in total can be set in one TRD5 record. The data can be visualized in the data display (see further).

3.3.3.2.3. Roll Call Interrogation analysis

The Data linking process already included Roll Call counters per TRD5 record. (Counts individually each type of roll Call).

Each linked S17 TASP related message (Track data request, Track data, Track data cancellation, etc..) has been attributed a unique TASP number by the Linker. (This allows multiple TASPs to be linked to one TRD5 record). The TASP status flags are always updated for all Nodes.

The data display allows us to visualise any X versus any Y versus any Z, so we could for example show nb of roll calls in Y versus TASP number in X.

These individual counters can thus be grouped per TASP or counted individually using the data display. This tool also allows a histogram view or scatter diagram view (with color as # of Roll Calls). No extra Analysis is required.

A second type of analysis based on the Roll Call is determining the. Track Acquisition Roll Call Reaction Time. The Data Linker also includes the “First Roll Call detection time” in each TRD record. This allows simple calculation of delay.

To get this value, the Time of recording of the first Received Cat 17 Track data message involved in a TAP is kept in memory.

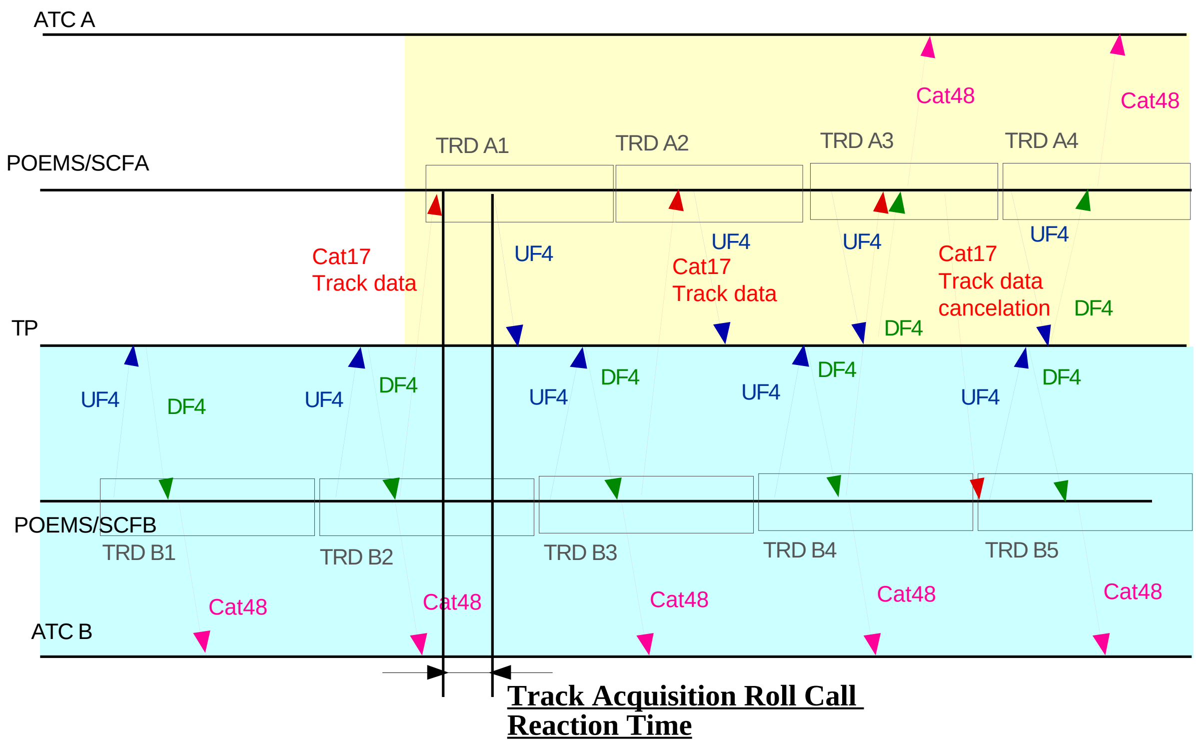


Figure 3-31: Track Acquisition Roll Call Reaction Time

The Time of detection of the first Roll Call (IRD record linked to the TRD) is subtracted by this memory value, which results in a delay value. The difference is stored in one of the 16 delay storage fields in the SCF result file and the corresponding P5 delay FSPEC bit is set. Track Acquisition and Support Procedures Assessment

The TASP procedure occurrences are found in the TRD5 flags. The Analysis tool allows the user to count individual the number of individual TASP conditions (as described in ref EC 17) and shows these in a separate display or in the Data Display tool relative to other parameters.

3.3.3.2.4. New Node/Node Change over procedure

The data export (S17 export tool) splits all NNCOP and NNCOP reply messages into separate messages, such that they can be linked multiple times to each of the TRD sets. (One NNCOP message becomes multiple sections and each section is linked to one TRD set (= track of one targets). On top of this, the time of the first NNCOP message segment and the time of the last NNCOP reply segment is retained in memory for later analysis. For all TRD records involved in the NNCOP, the “NNCOP Started” flag is set if the TRD time falls within the NNCOP – NNCOP reply interval.

If a TRD is linked to an NNCOP segment, the “NNCOP Initiated” flag of that TRD is set.

If a TRD is linked to an NNCOP reply segment , the “NNCOP successfull” flag is set.

The first TRD that falls just after the last NNCOP reply segment , or the one that is linked to a NNCOP reply segment, the “NNCOP completed” flag is set.

If a NNCOP message is send or received, and no corresponding NNCOP reply message is found by the P5 Analyser , the NNCOP TAP expected bit is set. This corresponds to a condition where NNCOP Initiated is true and sucessfull is false, or visa versa (and the NNCOP is completed).

The flags in the TRD5 allow the filtering of TRD records on any of the five NNCOP status flags..

The initiation of the NNCOP flag is accompanied by copying the Time of recording of the message into a buffer. Once the TAP is completed, the time is read and subtracted from the Time of Recording of the Track data cancellation message. The delay value is included in the SCF result record of the TRD5 that was linked to the Track data cancellation message.

3.3.3.2.5. Track Data Stop Procedures Assessment

The track data stop procedure is assessed in two ways:

-Determining of Track Data Stop status flags(Procedure, Running, expected, Initiated, Completed)

Determining of Track Data Stop Acknowledge reaction time.

These two actions are performed while analyzing the data.

If a Track data stop message is expected and the procedure flag is also true , (a target leaves a certain coverage) , the corresponding bit is set in the TRD record. The expected bit active for one TRD only, while the procedure is kept active as long as the Track data stop acknowledge is not received.

If a Linked Track data Stop message is found in the TRD, the corresponding “Initiated” and “Running” flags are set and the Time of Recording of that message is kept in memory. The “initiated “ flag is active for one TRD only and the “Running” flag is kept active for all next TRDs of the same target until a Completed state is reached.

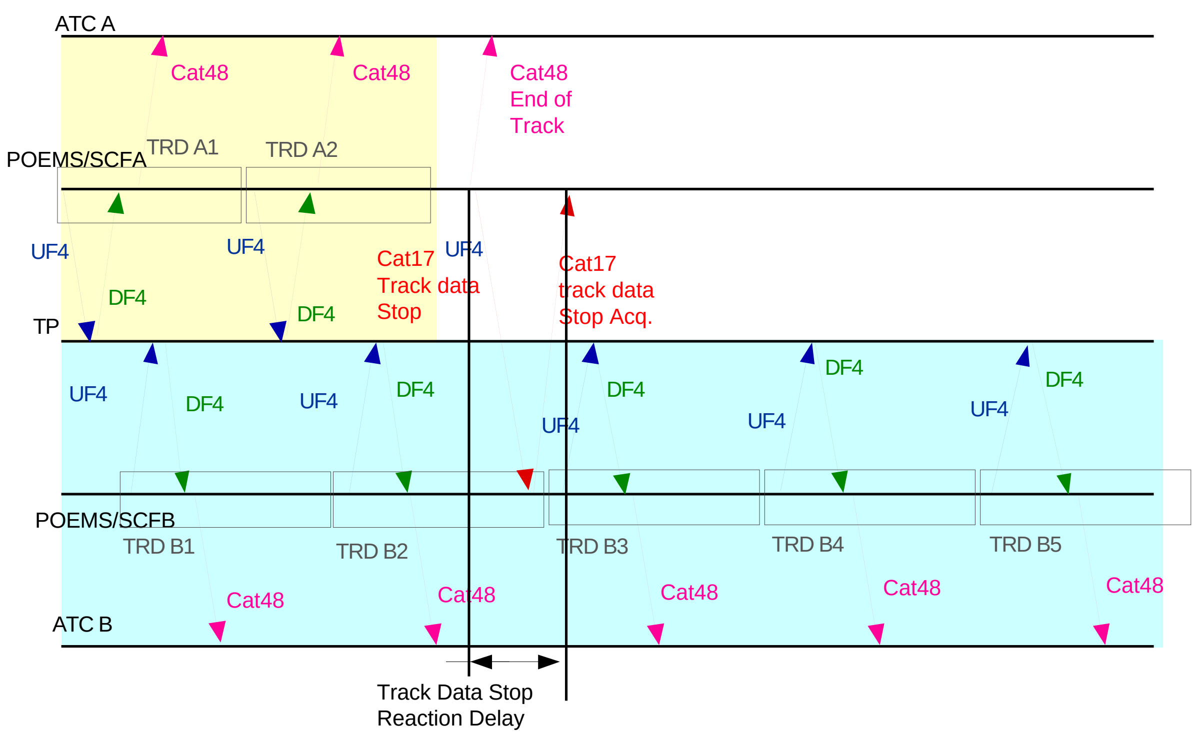


Figure 3-32: Track Data Stop Reaction Delay

If a Linked Track data Stop Acknowledge message is found in the TRD and the “Running” flag is true, the corresponding “Completed” flag is set. The time of recording of the Track data Stop message (kept in memory) is subtracted from the time of recording of the “track Data Stop Acknowledge” message. The difference is stored in one of the 16 delay storage fields in the SCF result file and the corresponding P5 delay FSPEC bit is set.

3.3.3.3. Data Analyser HMI

The analysis function is embedded in the "Time Merger and Linker" tool, but can also be called separately from the RASS-S toolbox. In the later case, the tool has its own HMI and informs the user wheter a valid analysis was carried out or not.

The Analysis feature can be started using the start button (green triangle) , can be stopped using the stop button (Red square) and its progress is monitorred using the "Program status window".

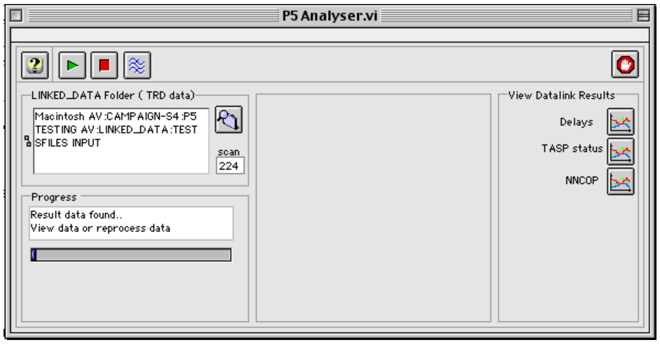


Figure 3-33: Data Analyser HMI

The results of the analysis is written into a separate file, which is linked to the TRD data. This file is called .SCF and can be used as input for data visualisation in the data display.

3.3.3.4. Data Analyser Related Specifications

3.3.3.4.1. Roll Call Count

The PTE P5 Analyser provides the number of roll call interrogations per TAP or TSP procedure for a selected data set..

The Number of roll calls can be seen in the SCF result field. following examples are extracted from the Simulated Demo data included in the P5 delivery.

3.3.3.4.2. Example 1: TAP

A TAP is initiated between Gatwick (Server) and Orly (Client). The TAP analysis parameters are always stored at the server side (even though the number of roll calls is counted on the Client side). It can be observed in the status display that the TAP uses 4 roll calls before it the Track data Cancellation is send.

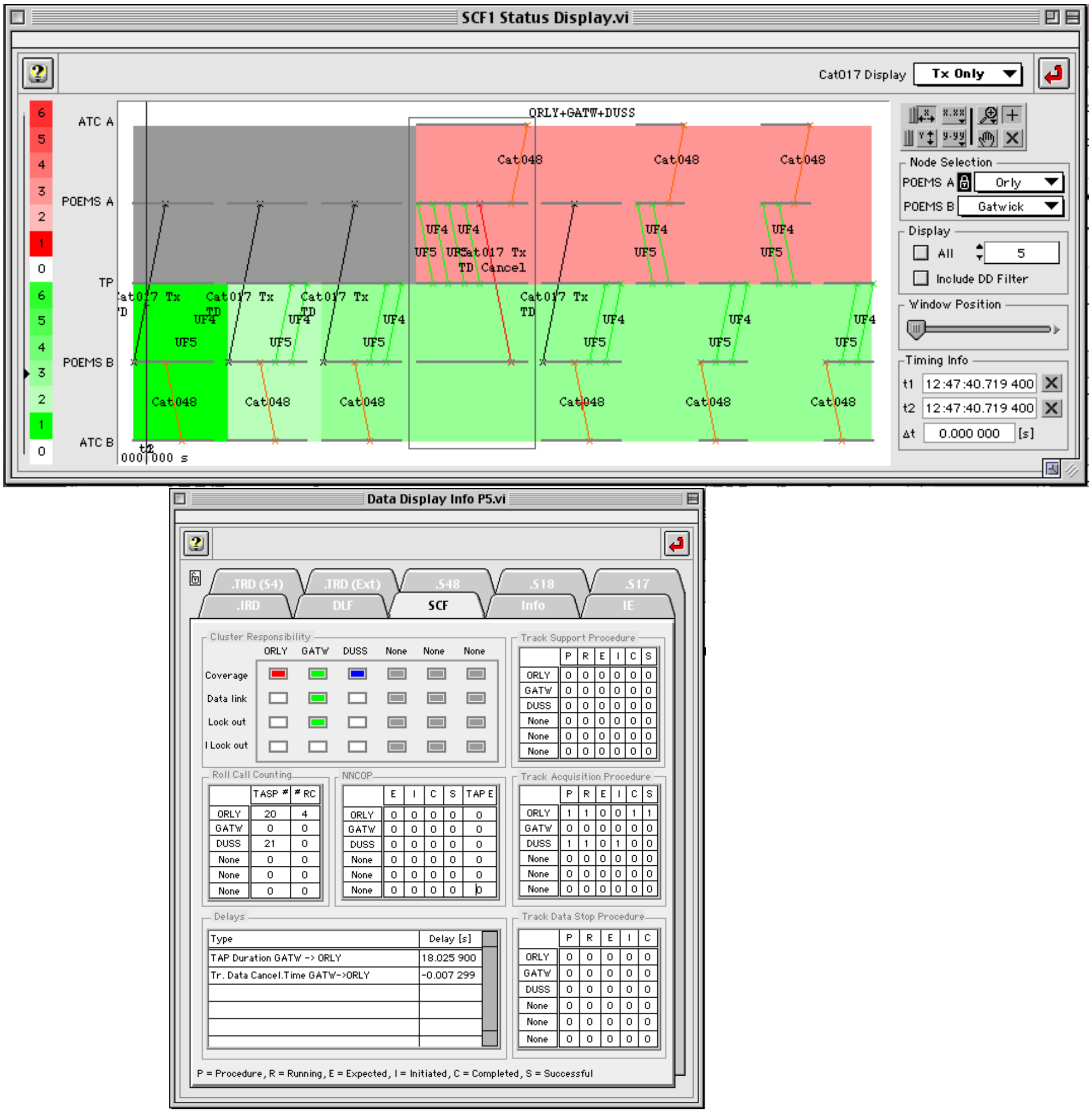


Figure 3-34: example of number of roll call count for a TAP

3.3.3.4.3. Example 2: TSP

A TSP is initiated between Gatwick (Server) and Orly (Client). The TSP analysis parameters are always stored at the Client side (and the number of roll calls is also counted on the Client side). It can be observed in the status display that the TSP uses 8 roll calls between the Track data Request and the Track data Cancellation.

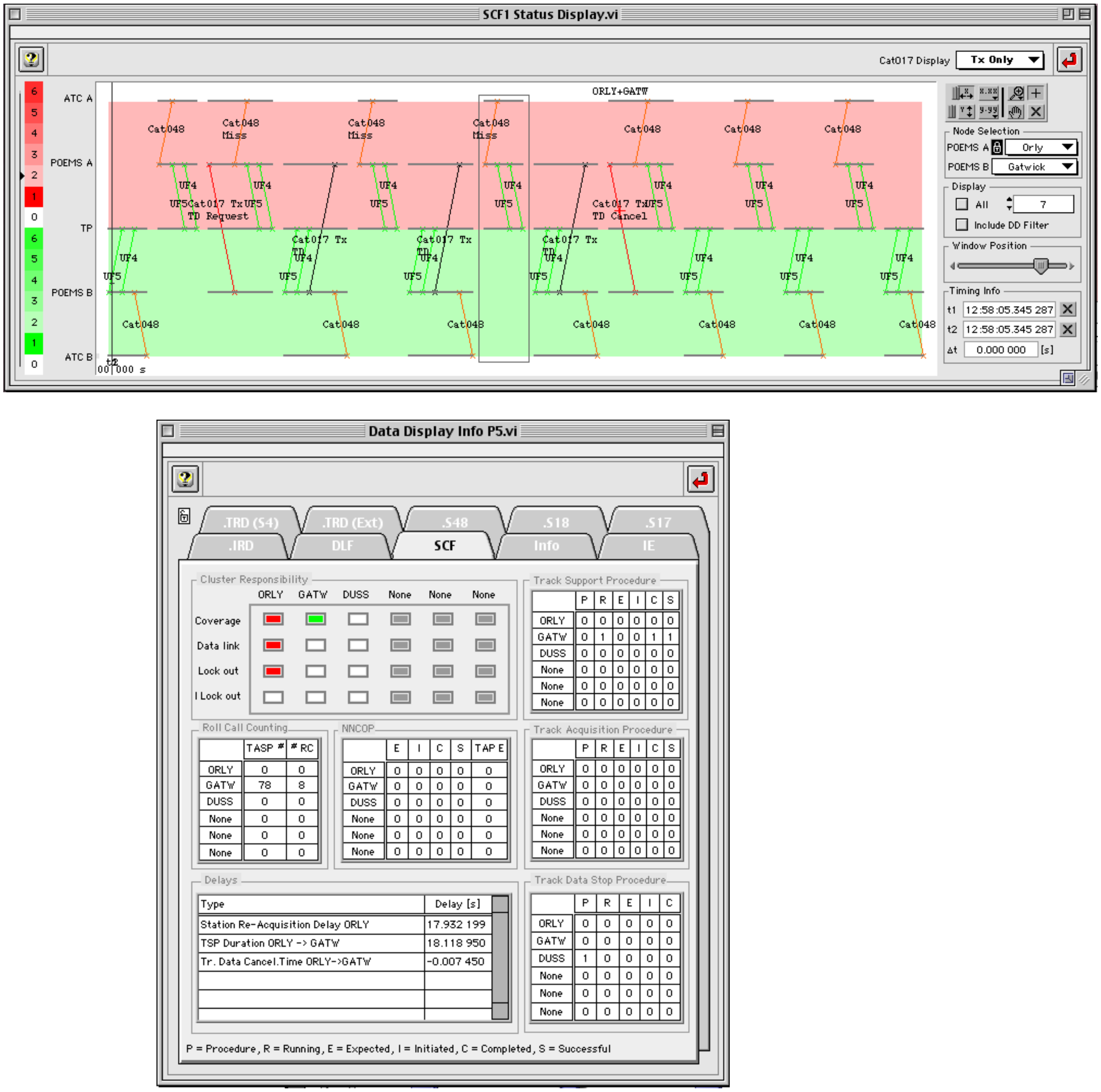


Figure 3-35: example of number of roll call count for a TSP

3.3.3.4.4. TASP Procedures vrs. Roll Call Count

The PTE P5 Analyser provides the number of track acquisition/support procedures as a function of the number of associated roll-call interrogations for the selected data set.

The above calculated number of associated Roll Calls can be set as a function of TASP number using the data display: The data can also be shown in a histogram.

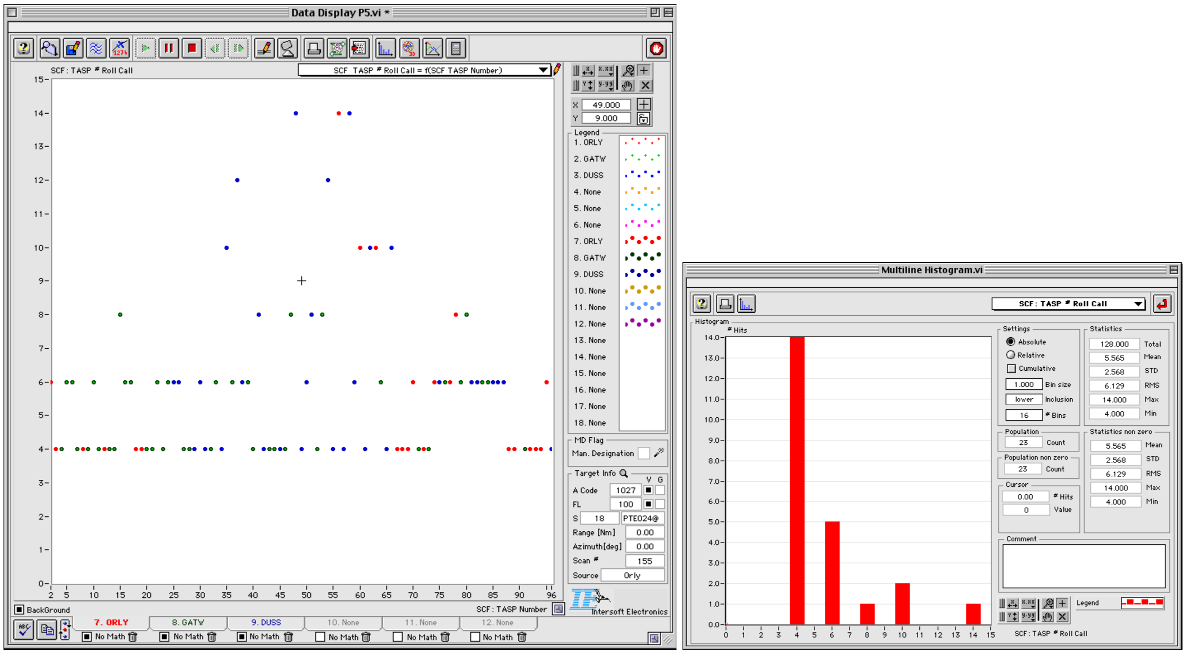


Figure 3-36: Data Display and histogram Showing number of Roll Calls versus TASP number

3.3.3.4.5. TASP status flags

The PTE P5 Analyser overwrites the TRD flag fields with a set of flags showing the status of the TASPs related to each of the 6 nodes in the cluster. 12 flags per Nodes (so in total 72 flags) are foreseen:

- TAP P : track acquisition Procedure occurrence: True as long as TAP runs, including expected state
- TAP E :Expected track acquisition procedure occurrence,: True on first occurance of Expected TAP
- TAP R: Running track acquisition procedure,: True as long as TAP runs
- TAP I: Iinitiated track acquisition procedure, True once , at moment TAP is initiated
- TAP C: Completed track acquisition procedure, true once at moment TAP is completed
- TAP S successful track acquisition procedure, true once at moment TAP is completed and is successful
- TSP P : track support Procedure occurrence: True as long as TSP runs, including expected state
- TSP E: Expected track support procedure occurrence, True on first occurance of Expected TSP
- TSP R: Running track support procedure,: True as long as TSP runs
- TSP I: Iinitiated track support procedure, True once , at moment TSP is initiated
- TSP C: Completed track support procedure, true once at moment TSP is completed
- TSP S:Successful track support procedure. true once at moment TSP is completed and is successful

The Flags are used throughout PTE P5, and their validity can best be witnesssed by using an interactive view of the data in the status display.

Following pictures provide show the operation for "Standard" TAP and TSP procedures.

3.3.3.4.6. Example 1: TSP

A TSP is initiated between Orly(Server) and Gatwick (Client). <u>The TSP analysis parameters are always stored at the Client side</u> . It can be observed in the SCF Tab in the info window that the TSP flags are maintained.

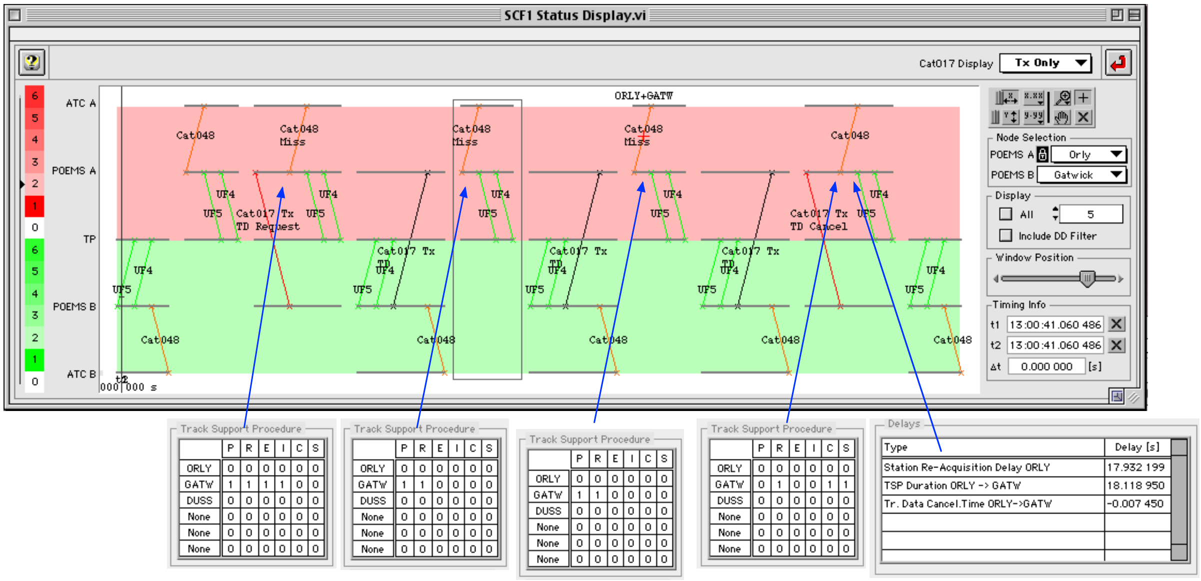


Figure 3-37: Example of TSP with TASP status flags

3.3.3.4.7. Example 2: TAP

A TAP is initiated between gatwick(Server) and Orly(Client). <u>The TAP analysis parameters are always stored at the Server side</u> . It can be observed in the SCF Tab in the info window that the TAP flags are maintained.

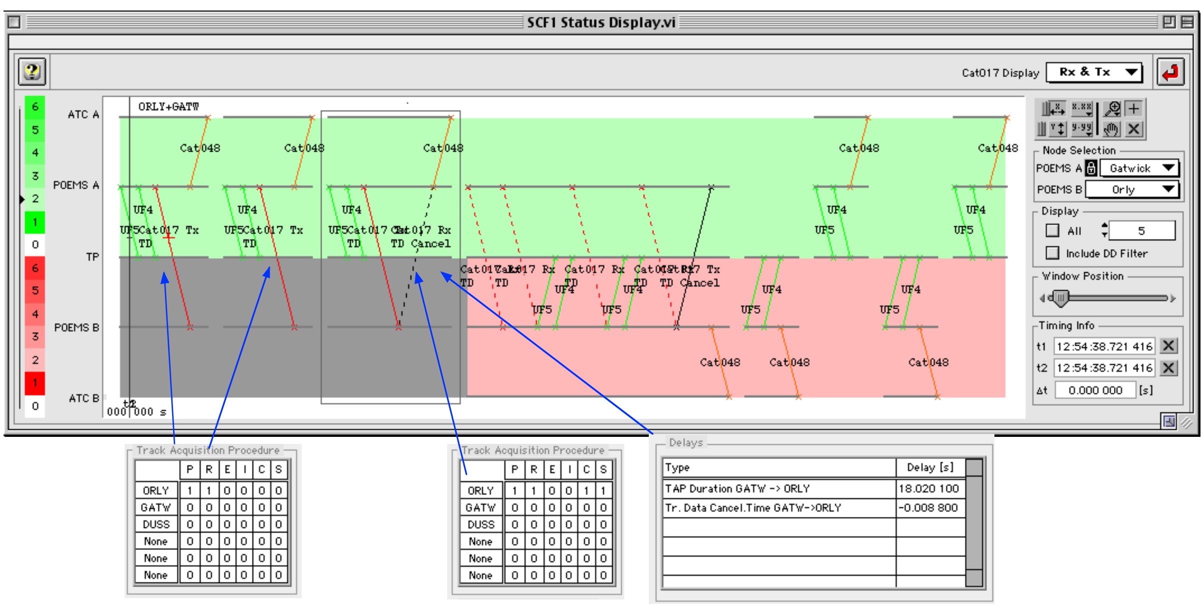


Figure 3-38:Example of TAP with status flags

3.3.3.4.8. NNCOP flags

All Flags are reset in case of a NNCOP procedure (e.g. typically in case of channel changeover) . In case the NNCOP message is accompanied by a TAP , The TAP will set the TAP initiate flag, and the NNCOP will set the TAP expected flag

The NNCOP itself also has five flags per Node: (So in total 30 flags)

- NNCOP E :Expected NNCOP procedure occurrence,: True on first occurance of an NNCOP message (even not including this targets' S address)
- NNCOPP I: Iinitiated NNCOP procedure, True on the occurence of an NNCOP message for <u>this</u> target
- NNCOP C: Completed NNCOP procedure, True onlast occurance of an NNCOPreply message (even not including this targets' S address)
- NNCOP S successfulNNCOP procedure, True on the occurence of an NNCOP reply message for <u>this</u> target
- NNCOP TAP E: NNCOP Initiated Track Acquisition Procedure: True once at the end reception of a NNCOP procedure.

The NNCOP flags are maintained separately. They can be observed using the Data Display Info.

3.3.3.4.9. Example 1: NNCOP with reply: no TAP expected.

This example shows the NNCOP and NNCOP reply detected. No TAP is expected.

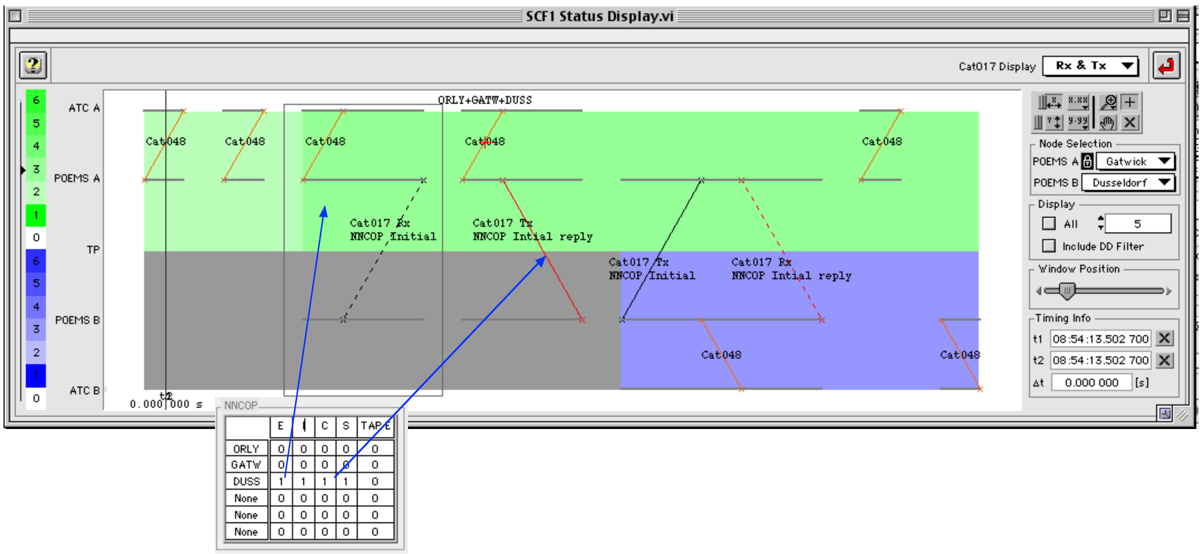


Figure 3-39: example of NNCOP and NNCOP reply; no TAP expected

3.3.3.4.10. Example 2: NNCOP with no reply: TAP expected.

This example shows the NNCOP and no NNCOP reply detected. A TAP is expected. and executed. by the station that joins the cluster.(duss to gatwick in this example)

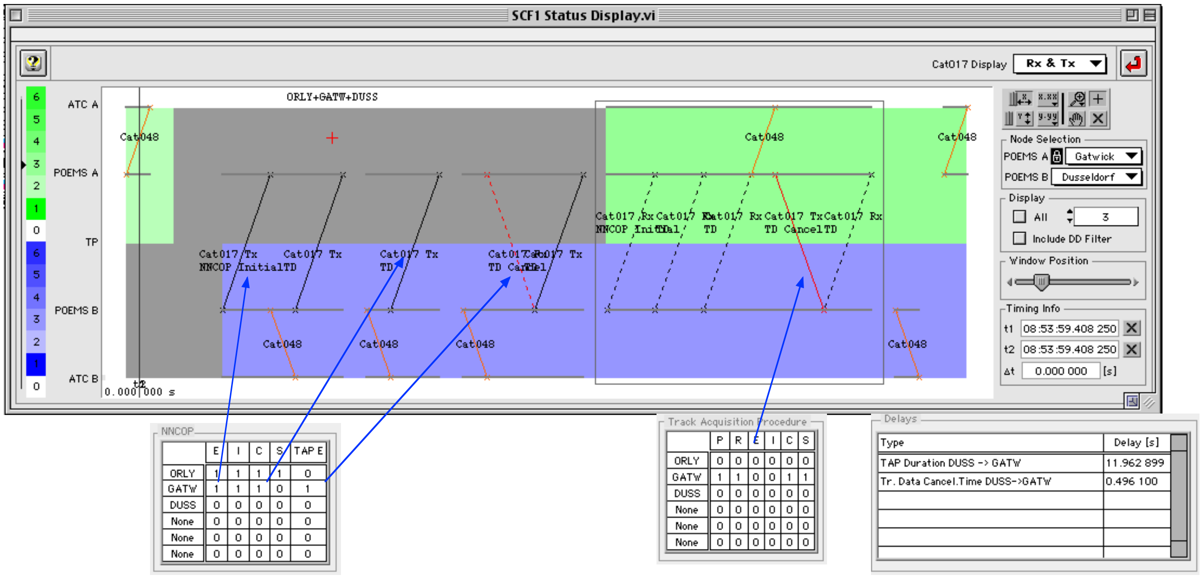


Figure 3-40: example of NNCOP without NNCOP reply and thus TAP expected

3.3.3.4.11. Example 3: NNCOP reply without NNCOP: TAP expected.

This example shows the NNCOP reply and no NNCOP detected. A TAP is expected. and executed by the station that sends the NNCOP reply towards the station that joins the cluster. (Orly to dusseldorf in this example)

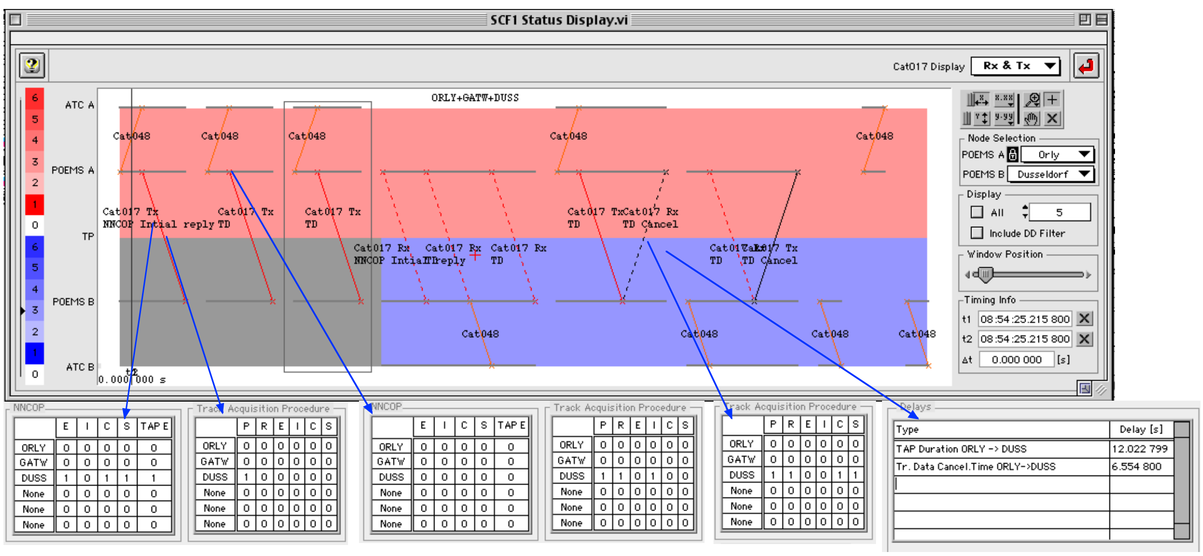


Figure 3-41: example of NNCOP reply without NNCOP and thus TAP expected

3.3.3.4.12. Start of Track/End of Track flags

The PTE P5 Analyser overwrites the TRD flag fields with a set of flags showing the status of the Chain or TRD set : 3 flags are foreseen:

- Start of Track (TRD set)
- End of Track/Track Drop (TRD set)

The Start of chain and end of Chain flags can be seen in the Data Display. For this purpose, several layers were loaded using the filter "Start of Chain" = True and "End of Chain" is True.

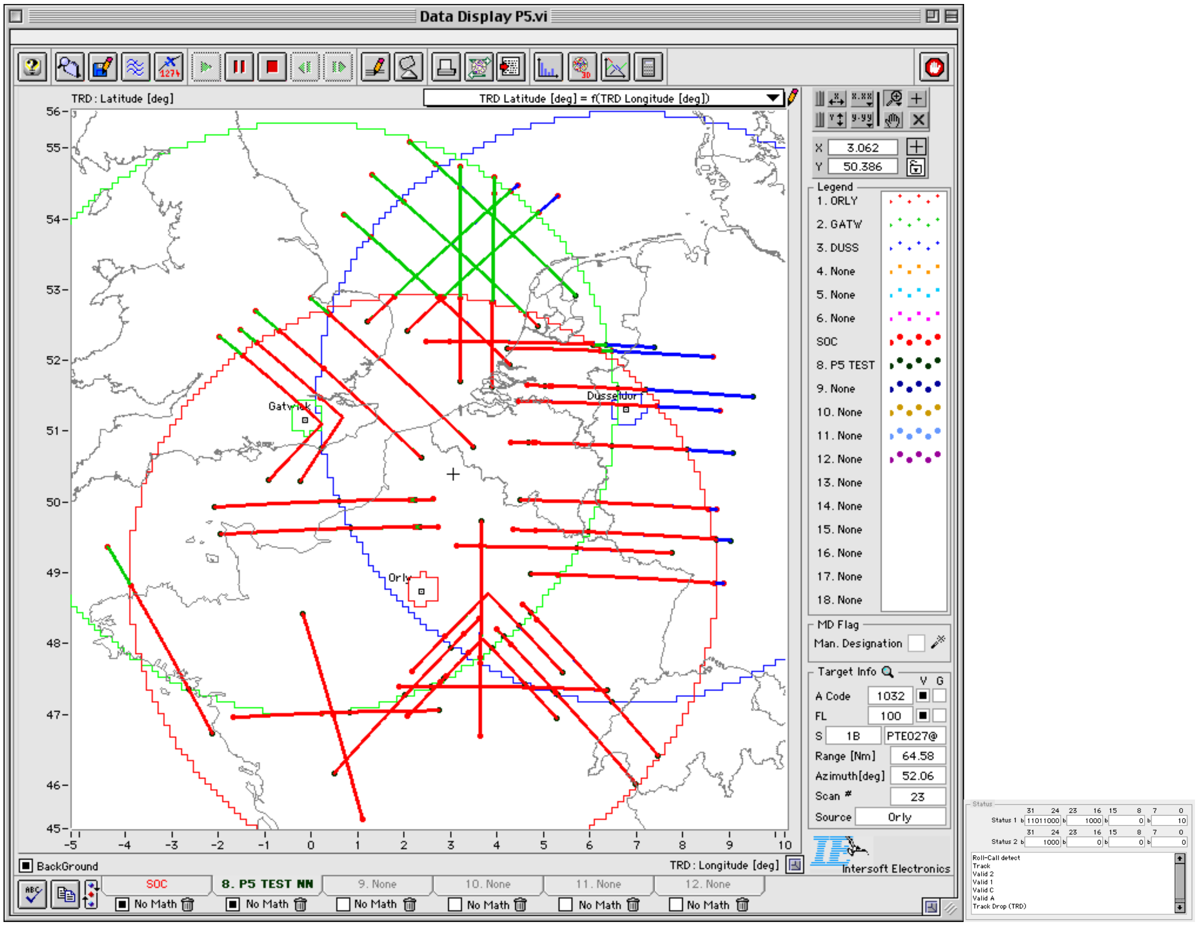


Figure 3-42: Start of Chain/ Chain drop flag in Data Display

3.3.3.4.13. Track Data Stop Flags

The PTE P5 Analyser overwrites the TRD flag field swith a set of flags showing the status of the Track Data Stop messages related to each of the 6 nodes in the cluster. 5 flags per Node (so in total 18 flags) are foreseen:

- Procedure Track Data Stop occurrence,: True as long as the TDS Procedure is running, from expected state to completed state
- Running Track Data Stop occurrence, True between (and including) Track Data Stop and Track Data Stop Acqnowledge
- Expected Track Data Stop occurrence, True once at the occurrence of a Track data Stop expected state (track moves out of the coverage of a certain node)
- Initiated Track Data Stop procedure, True once at the occurrence of a Track data Stop message
- Completed & Successful Track Data Stop procedure, True once at the occurrence of a Track data StopAcqnowledge message

The contents of these flags can be seen in the data display and seen in detail on the Info window. The data display also allows filtering on the occurrence of these flags.

The picture below illustrates the behaviour of the Track Data Stop procedure and its flags.

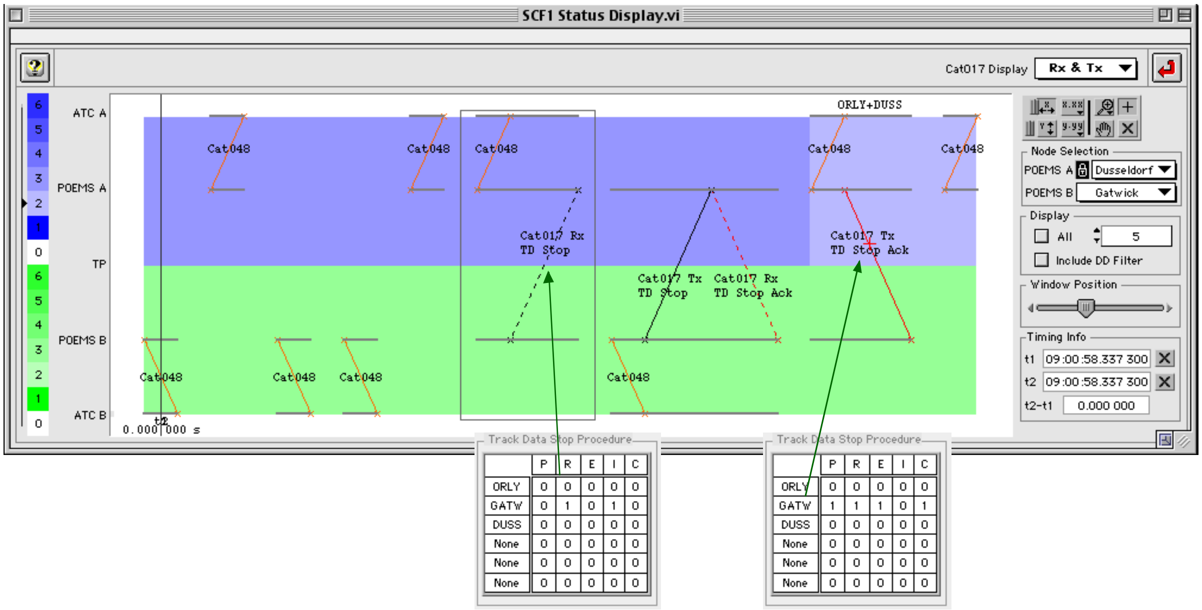


Figure 3-43: Track Data Stop Status Flags

3.3.3.4.14. Counters For Occurrences of TASPs

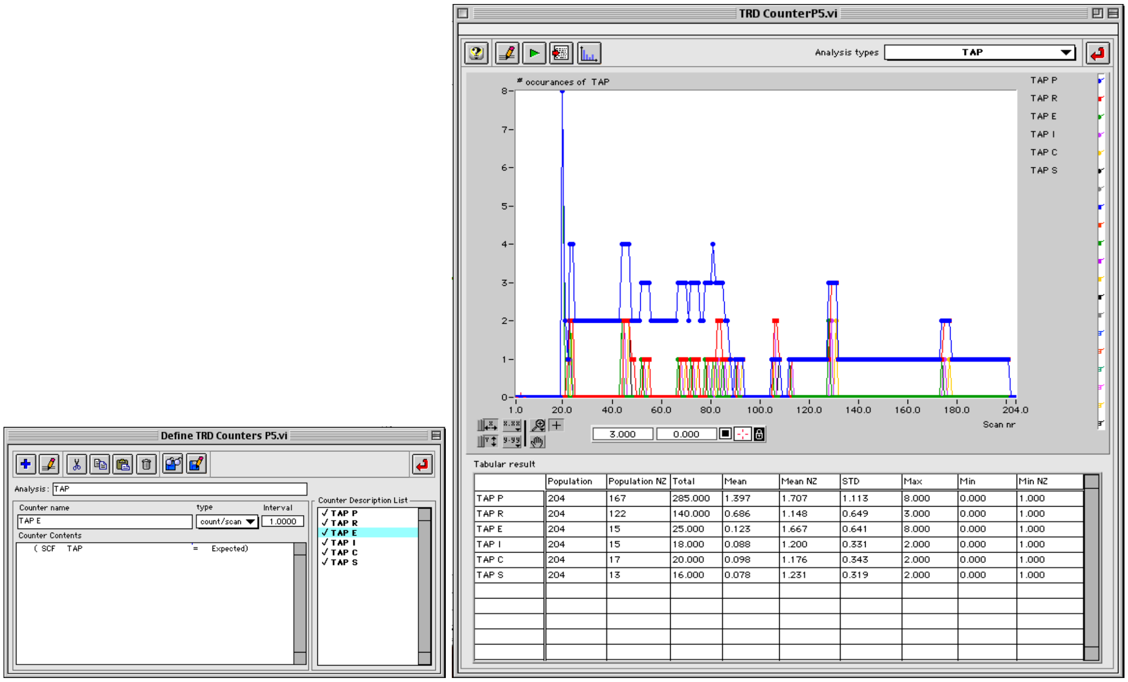
The PTE P5 Analyser counts, in the overlapping coverage of a selected POEMS station with other POEMS stations of the cluster,:

- *the number of expected track acquisition procedure occurrences,*
- *the number of initiated track acquisition procedure,*
- *the number of completed track acquisition procedure,*
- *the number of successful track acquisition procedure,*
- *the number of expected track support procedure occurrence,*
- *the number of initiated track support procedure,*
- *the number of completed track support procedure,*
- *the number of successful track support procedure.*

These counters are based on the flags previously entered in the TRD data-structure.

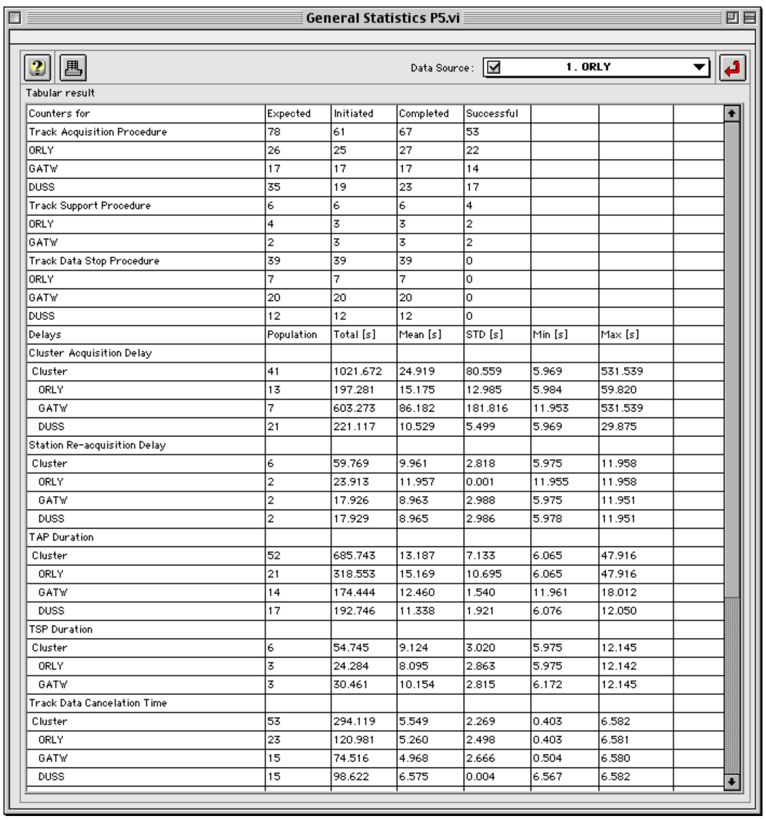
The counting of the occurance of the TASP statuses can be counted by means of the "Count" Function in the data display. Each flag, available in the TRD , can be counted. The user can create as many counters as he wishes, by means of a definition of counters. See graphs below.

A second method is by using the "Statistical Overview SCF" function in the Data Display. see figure below.



	Population	Population NZ	Total	Mean	Mean NZ	STD	Max	Min	Min NZ
TAP P	204	167	285.000	1.397	1.707	1.113	8.000	0.000	1.000
TAP R	204	122	140.000	0.686	1.148	0.649	3.000	0.000	1.000
TAP E	204	15	25.000	0.123	1.667	0.641	8.000	0.000	1.000
TAP I	204	15	18.000	0.088	1.200	0.331	2.000	0.000	1.000
TAP C	204	17	20.000	0.098	1.176	0.343	2.000	0.000	1.000
TAP S	204	13	16.000	0.078	1.231	0.319	2.000	0.000	1.000

Figure 3-44: TRD Counter used to count TASP occurrences per scan or per time frame



Counters for	Expected	Initiated	Completed	Successful		
Track Acquisition Procedure	78	61	67	53		
ORLY	26	25	27	22		
GATW	17	17	17	14		
DUSS	35	19	23	17		
Track Support Procedure	6	6	6	4		
ORLY	4	3	3	2		
GATW	2	3	3	2		
Track Data Stop Procedure	39	39	39	0		
ORLY	7	7	7	0		
GATW	20	20	20	0		
DUSS	12	12	12	0		
Delays	Population	Total [s]	Mean [s]	STD [s]	Min [s]	Max [s]
Cluster Acquisition Delay						
Cluster	41	1021.672	24.919	80.559	5.969	531.539
ORLY	13	197.281	15.175	12.985	5.984	59.820
GATW	7	603.273	86.182	181.816	11.953	531.539
DUSS	21	221.117	10.529	5.499	5.969	29.875
Station Re-acquisition Delay						
Cluster	6	59.769	9.961	2.818	5.975	11.958
ORLY	2	23.913	11.957	0.001	11.955	11.958
GATW	2	17.926	8.963	2.988	5.975	11.951
DUSS	2	17.929	8.965	2.986	5.978	11.951
TAP Duration						
Cluster	52	685.743	13.187	7.133	6.065	47.916
ORLY	21	318.553	15.169	10.695	6.065	47.916
GATW	14	174.444	12.460	1.540	11.961	18.012
DUSS	17	192.746	11.338	1.921	6.076	12.050
TSP Duration						
Cluster	6	54.745	9.124	3.020	5.975	12.145
ORLY	3	24.284	8.095	2.863	5.975	12.142
GATW	3	30.461	10.154	2.815	6.172	12.145
Track Data Cancelation Time						
Cluster	53	294.119	5.549	2.269	0.403	6.582
ORLY	23	120.981	5.260	2.498	0.403	6.581
GATW	15	74.516	4.968	2.666	0.504	6.580
DUSS	15	98.622	6.575	0.004	6.567	6.582

Figure 3-45: general Statistics SCF overview

3.3.3.4.15. Track Acquisition Duration Calculation

The PTE P5 Analyser calculates the track acquisition procedure duration (successful cases) for the selected data set. The results of these calculations (maximum 5 results per TRD) are included in the TRD record. The Data Display tool can be used to display and calculate statistical values on the data.

The Track acquisition procedure delay is calculated by the P5 Analyser function. The result is included in the last TRD record related to the TAP, on the server side of the TAP. The result can be shown in the data display as a X, Y or Z scale (3rd view) , and statistics can be determined using the "Histogram" function.

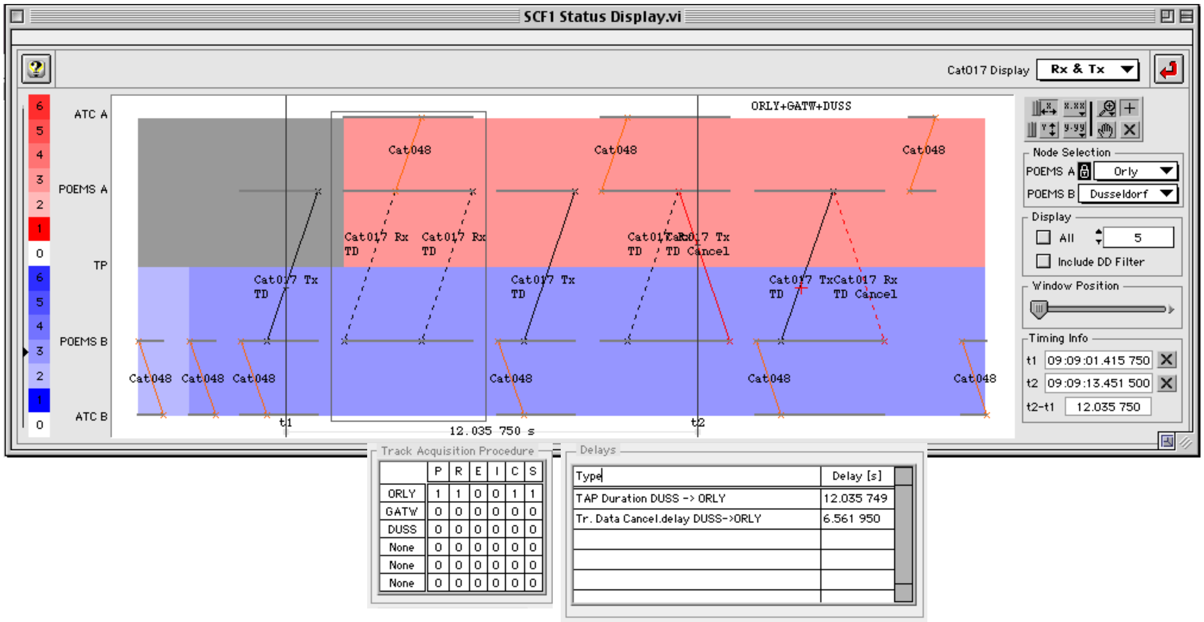


Figure 3-46: Track Acquisition Delay

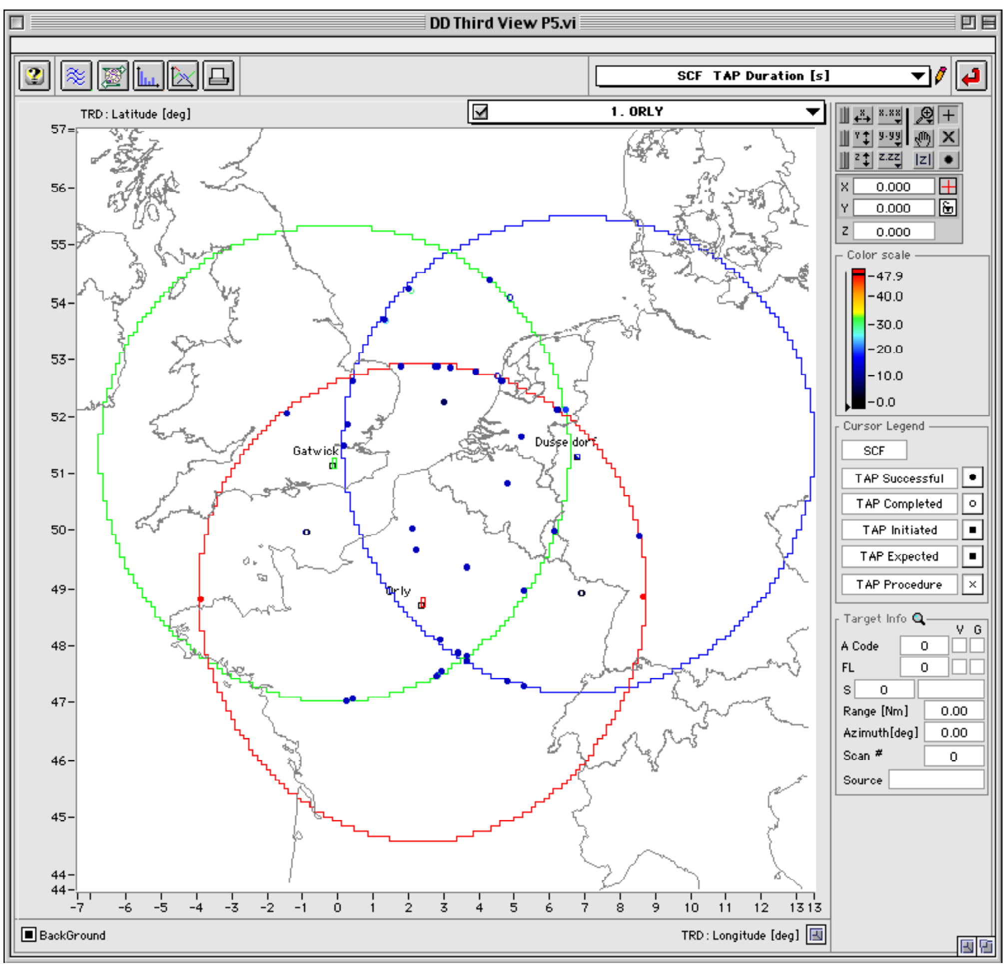


Figure 3-47: TAP Duration in third View (Z axis)

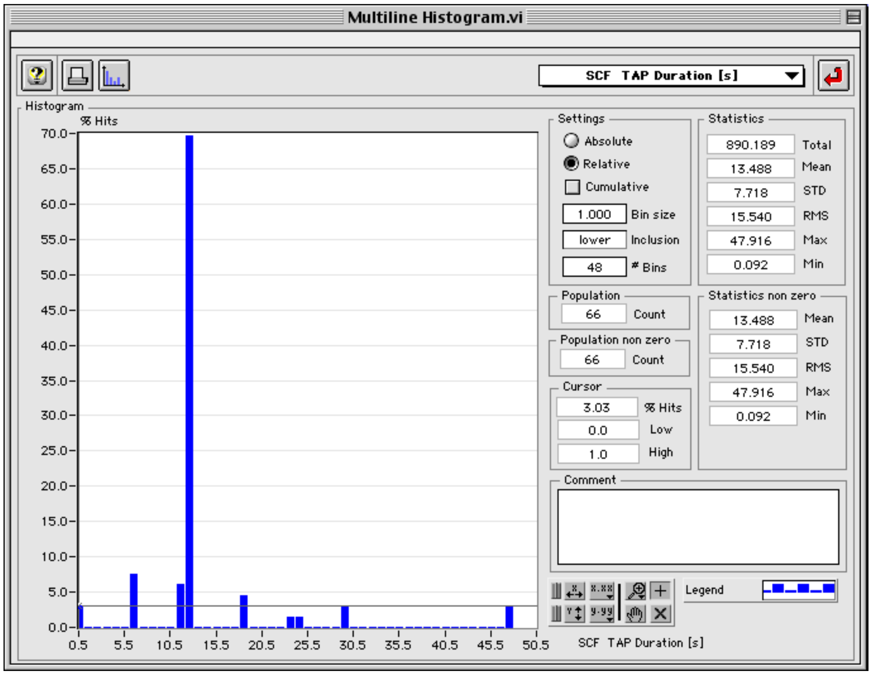


Figure 3-48: TAP Durration histogram and statistics

3.3.3.4.16. Track Data Cancellation Reaction Time Calculation

The PTE P5 Analyser calculates the Track Data cancellation reaction delay for TAP for the selected data set. The result of these calculations are stored in the linked data fields (TRD records) and can be displayed in the Data Display tool.

The Track Data Cancelation reaction delay is calculated by the P5 Analyser function. The result is included in the last TRD record related to the TAP, on the server side of the TAP. The result can be shown in the data display as a X, Y or Z scale (3rd view) , and statistics can be determined using the "Histogram" function.

For result data , see figure above. The same rules as for TAP duration apply.

3.3.3.4.17. Track Support Procedure Duration Calculation

The PTE P5 Analyser calculates the track support procedure duration (successful cases) for the selected data set. The results of these calculations (maximum 5 results per TRD) are included in the TRD record. The Data Display tool can be used to display and calculate statistical values on the data

The Track Support procedure duration is calculated by the P5 Analyser function. The result is included in the last TRD record related to the TSP, on the Client side of the TSP. The result can be shown in the data display as a X, Y or Z scale (3rd view) , and statistics can be determined using the "Histogram" function.

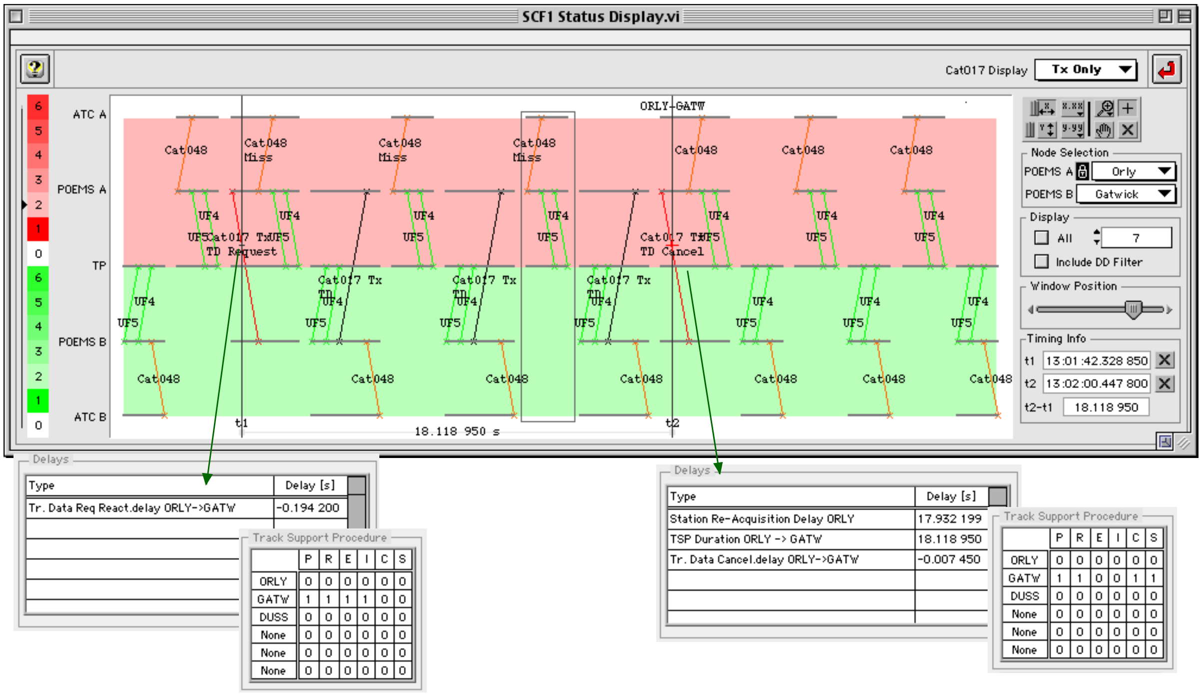


Figure 3-49: Track Support procedure Duration

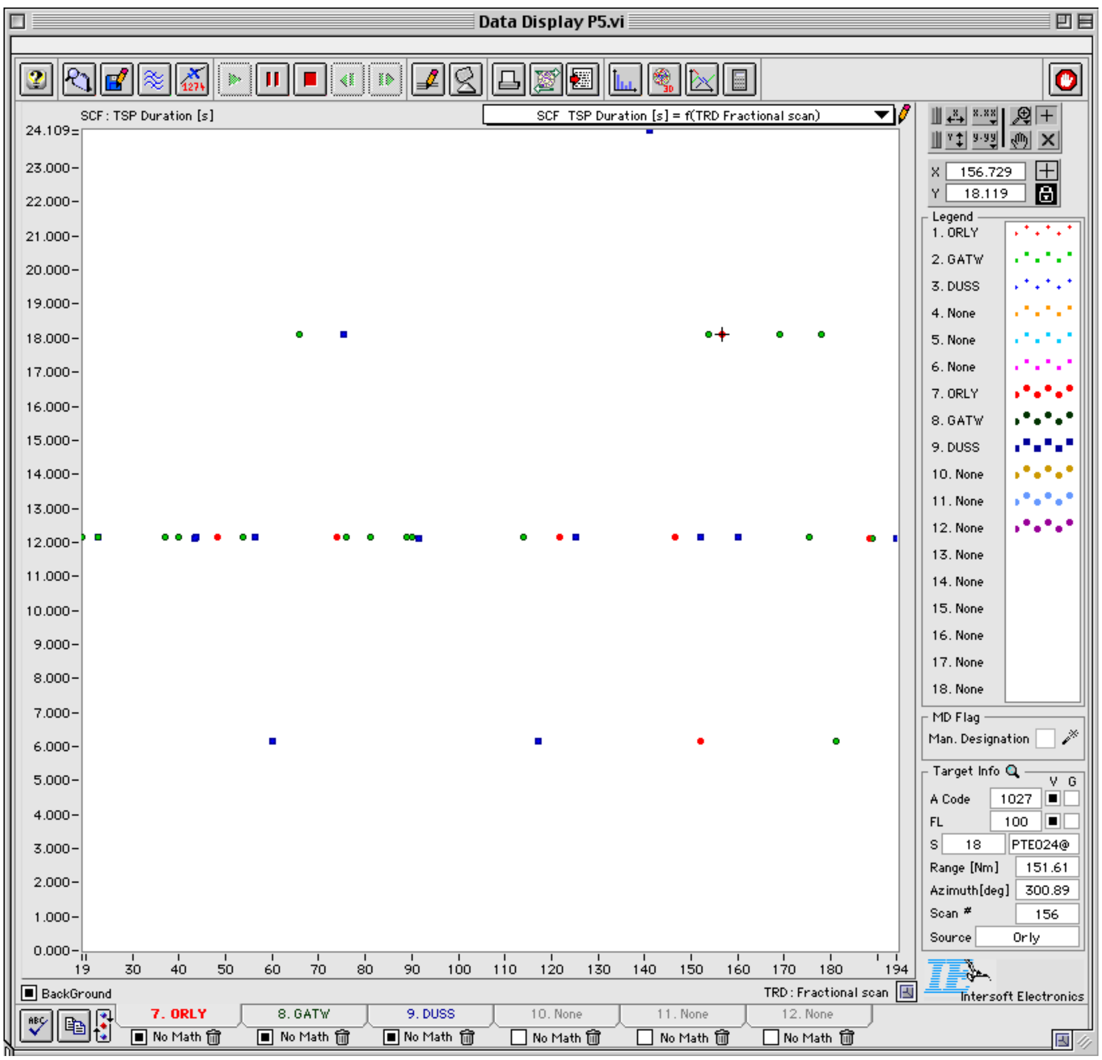


Figure 3-50:TAP duration in Y axis of data display

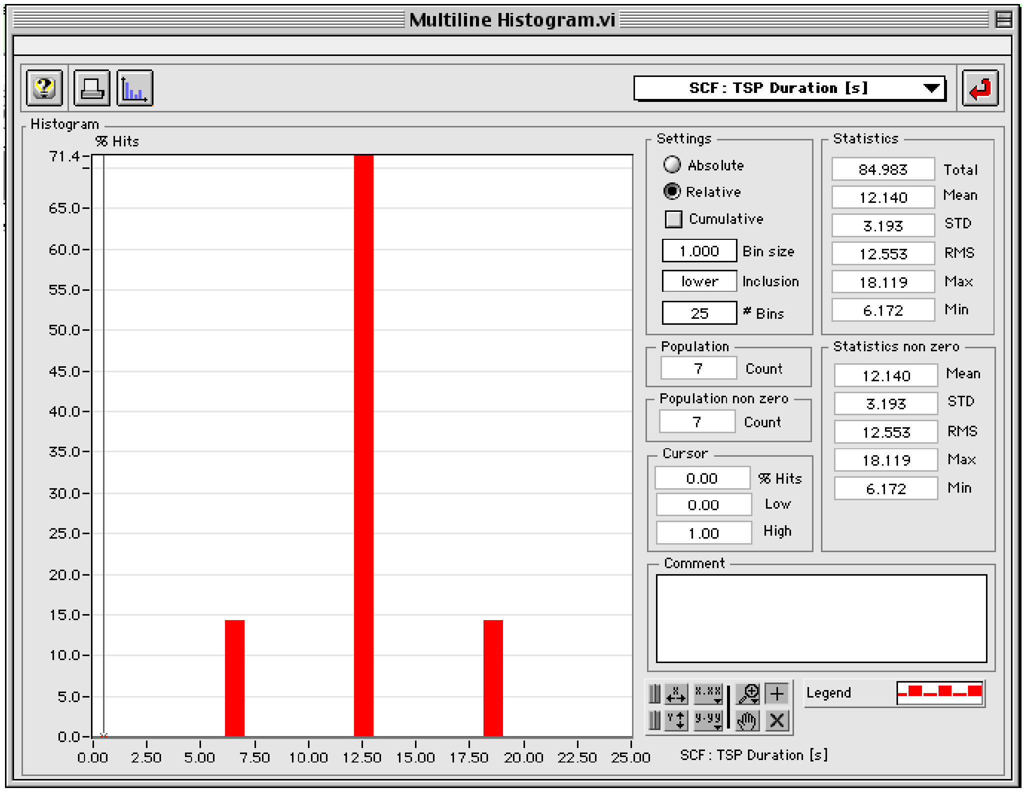


Figure 3-51: TSP duration Histogram

3.3.3.4.18. Track Data Request Reaction Delay Calculation

The PTE P5 Analyser calculates the Track Data Request reaction delay for the selected data set. The results of these calculations (maximum 5 results per TRD) are included in the TRD record. The Data Display tool can be used to display and calculate statistical values on the data

The Track Data Request Reaction Time is calculated by the P5 Analyser function. The result is included in the first TRD record related to the TSP, on the Client side (= side with the miss, station requesting data from of the TSP). The result can be shown in the data display as a X, Y or Z scale (3rd view) , and statistics can be determined using the "Histogram" function.

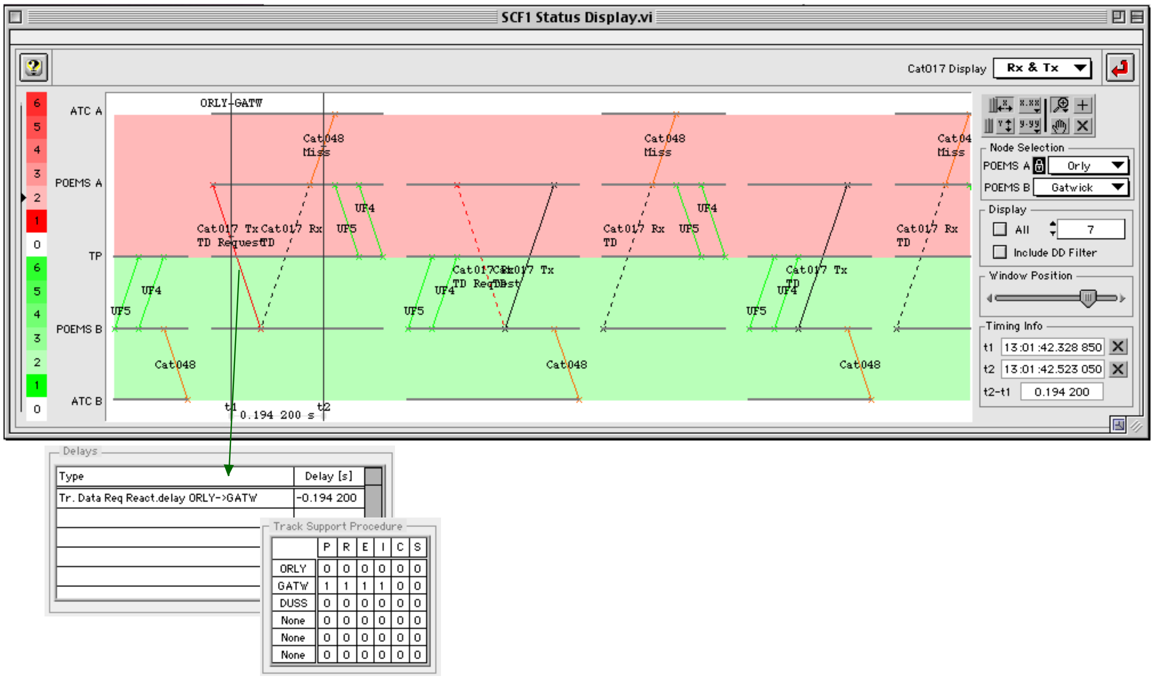


Figure 3-52: Track Data Request Reaction Time

3.3.3.4.19. Track Data Cancellation Reaction Delay Calculation

The PTE P5 Analyser calculates the Track Data cancellation reaction delay for the selected data set. The results of these calculations (maximum 5 results per TRD) are included in the TRD record. The Data Display tool can be used to display and calculate statistical values on the data.

The Track Data Cancelation Reaction delay for TSP is calculated by the P5 Analyser function. The result is included in the last TRD record related to the TSP, on the <u>Client</u> side of the TSP. The result can be shown in the data display as a X, Y or Z scale (3rd view) , and statistics can be determined using the "Histogram" function.

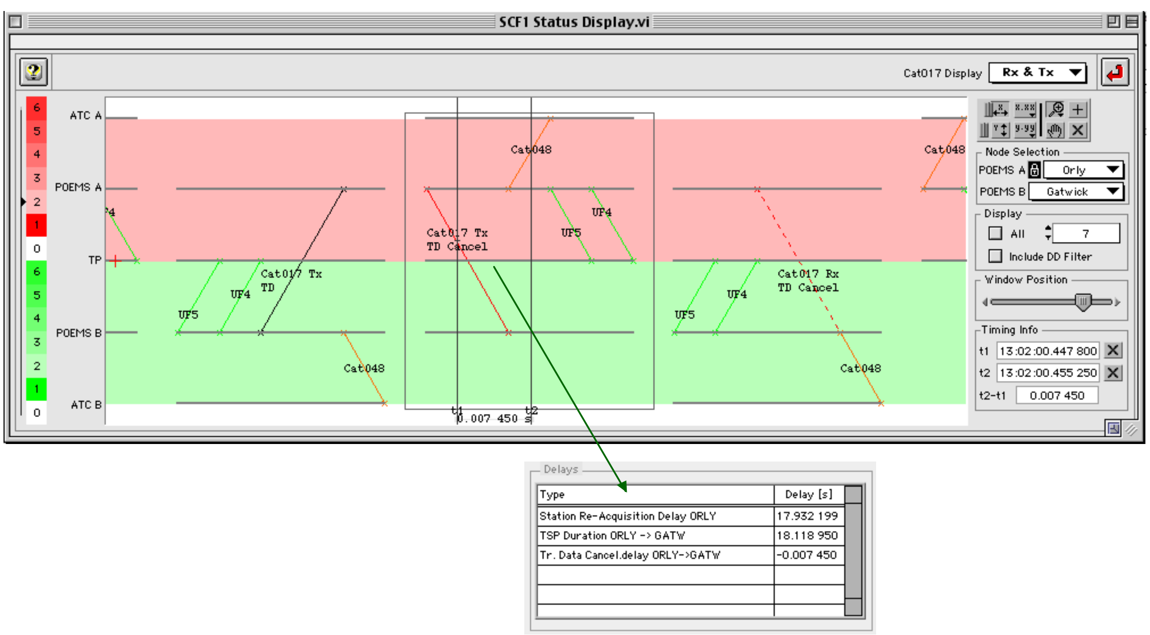


Figure 3-53: Track Data Cancelation Reaction Delay

3.3.3.4.20. Cluster Acquisition Delay Calculation

The PTE P5 Analyser calculates the cluster acquisition delay for the selected data set. The results of these calculations (maximum 5 results per TRD) are included in the TRD record. The Data Display tool can be used to display and calculate statistical values on the data.

The Cluster Acquisition delay is calculated by the P5 Analyser function. The result is included in the last TRD record related to the TAP, on the <u>Server</u> side of the TSP. The result can be shown in the data display as a X, Y or Z scale (3rd view) , and statistics can be determined using the "Histogram" function.

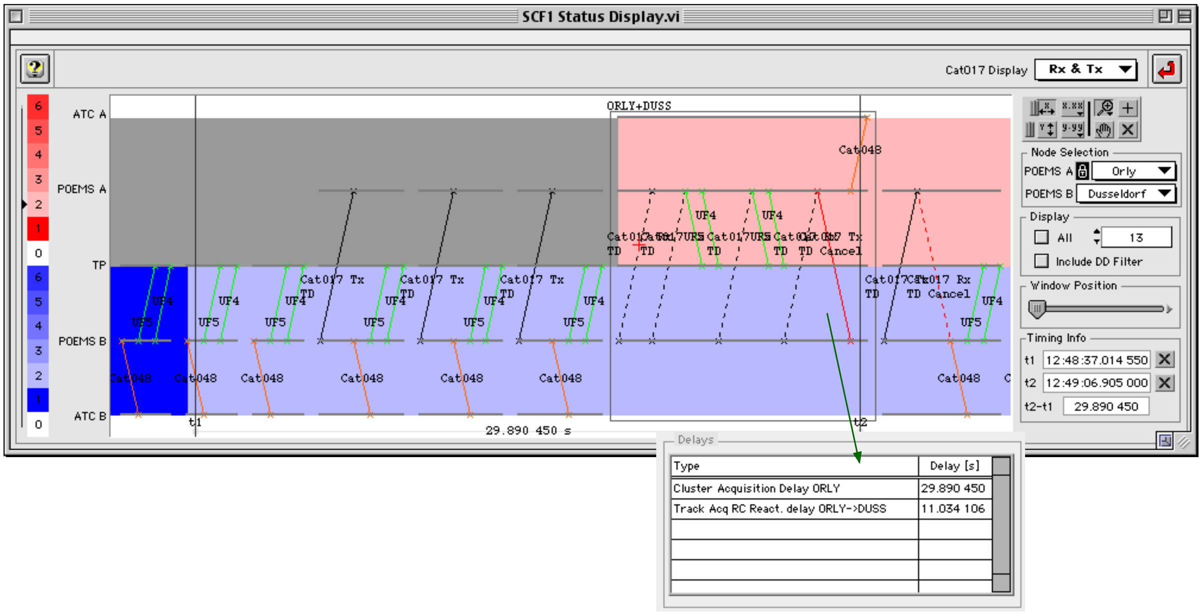


Figure 3-54: Cluster Acquisition delay

3.3.3.4.21. Station Re-Acquisition Delay Calculation

The PTE P5 Analyser calculates the station re-acquisition delay for the selected data set. The results of these calculations (maximum 5 results per TRD) are included in the TRD record. The Data Display tool can be used to display and calculate statistical values on the data.

The Station Re- Acquisition delay is calculated by the P5 Analyser function. The result is included in the last TRD record related to the TSP, on the <u>Client</u> side of the TSP. The result can be shown in the data display as a X, Y or Z scale (3rd view) , and statistics can be determined using the "Histogram" function.

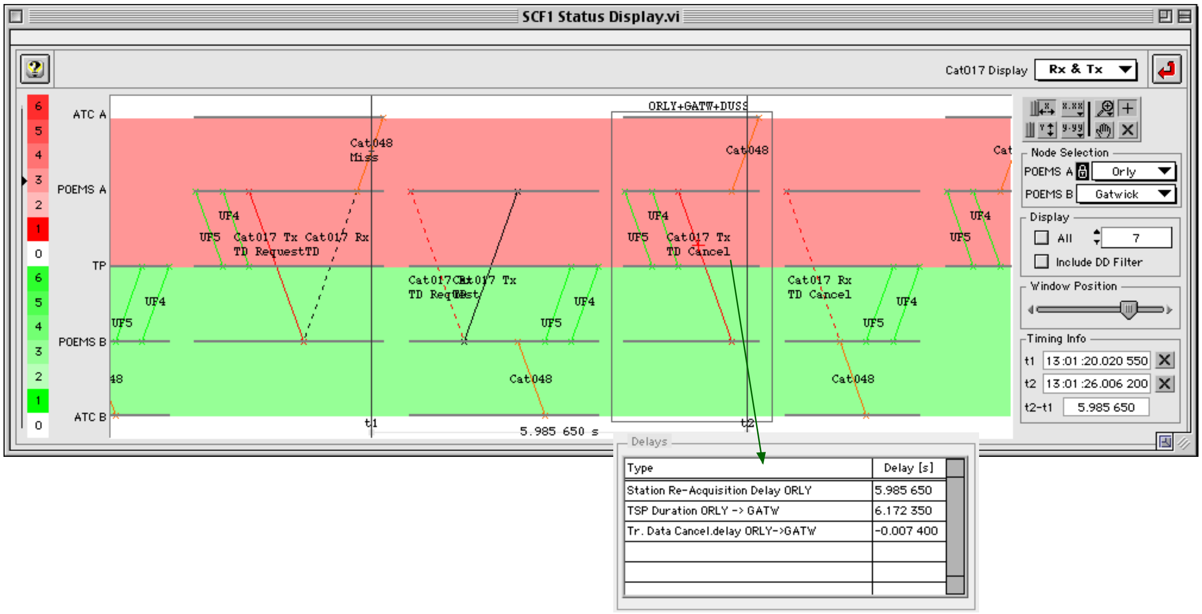


Figure 3-55:Station re-acquisition delay

3.3.3.4.22. Track Data Stop Delay

The PTE P5 Analyser calculates the Track data Stop delay for the selected data set. The results of these calculations (maximum 5 results per TRD) are included in the TRD record. The Data Display tool can be used to display and calculate statistical values on the data.

The Station Track Data Stop delay is calculated by the P5 Analyser function. The result is included in the last TRD record related to the TDS. The result can be shown in the data display as a X, Y or Z scale (3rd view) , and statistics can be determined using the "Histogram" function.

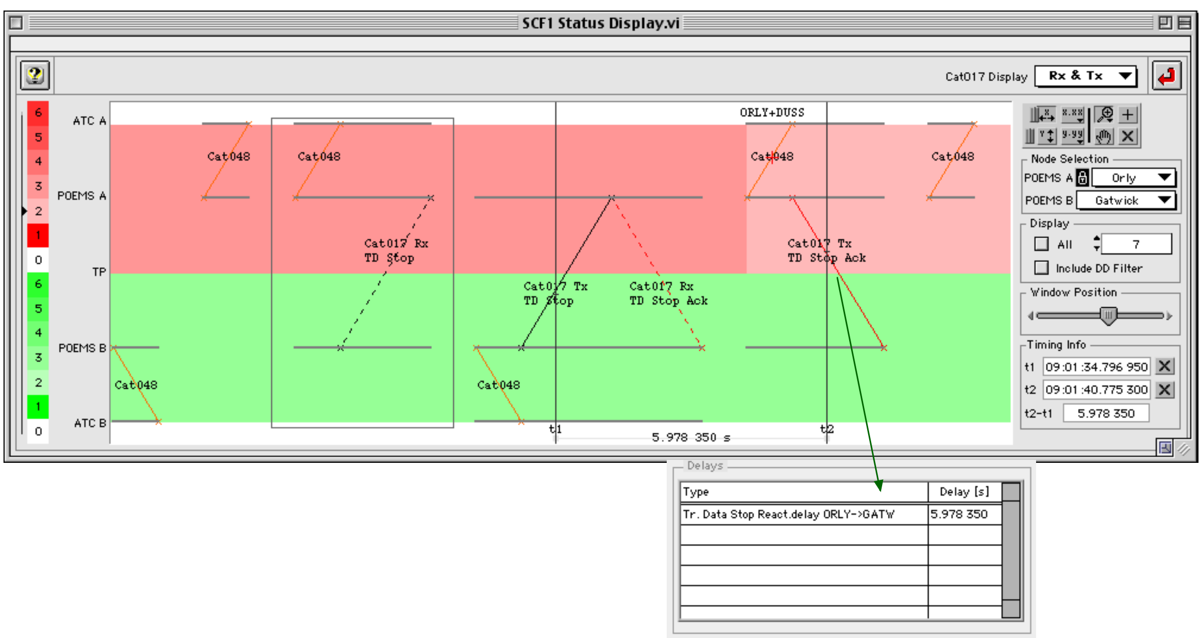


Figure 3-56: Track Data Stop Delay

3.3.3.4.23. Track Acquisition Roll Call Reaction Time Calculation

The PTE P5 Analyser calculates the Track Acquisition Roll Call Reaction Time for the selected data set. The results of these calculations (maximum 5 results per TRD) are included in the TRD record. The Data Display tool can be used to display and calculate statistical values on the data.

The Track Acquisition Roll Call Reaction Time is calculated by the P5 Analyser function.

The result is included in the first TRD record related to the TAP, on the <u>Client</u> side (= side that received track data from Server).

The result can be shown in the data display as a X, Y or Z scale (3rd view) , and statistics can be determined using the "Histogram" function.

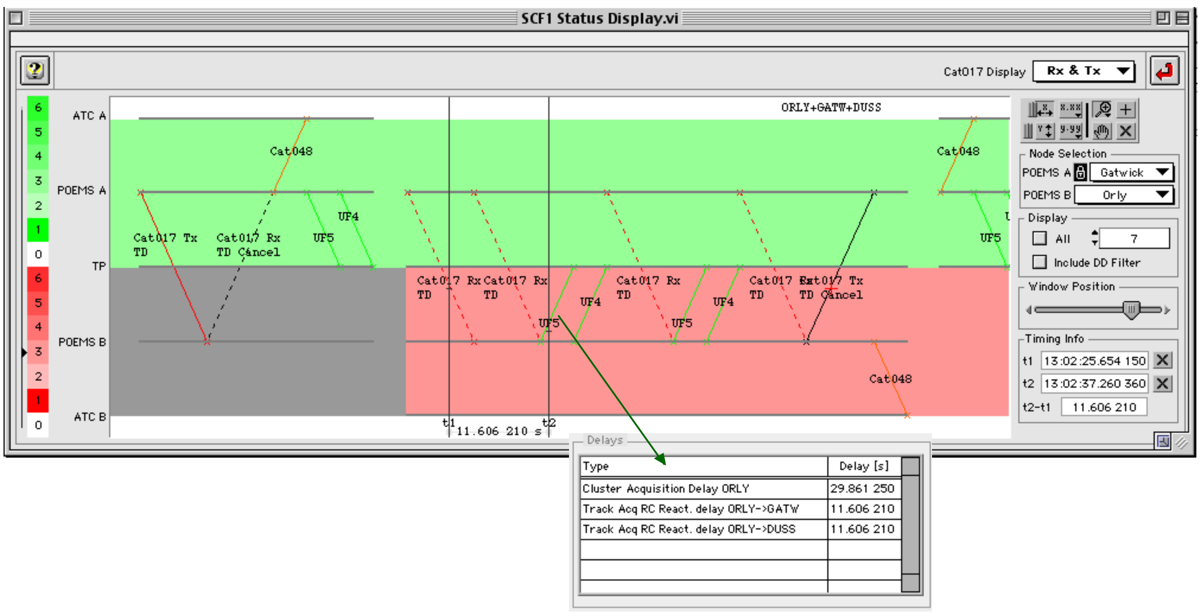


Figure 3-57: Track Acquisition Roll Call Reaction Time for TAP

3.3.3.4.24. NNCOP Duration Calculation

The PTE P5 Analyser calculates the following parameters corresponding to a connection of a new node or to a change-over of a node :

- name of the stations,
- duration of the new node procedure from the time of output of the NNCOP message (category 017) to the end of the acquisition of the targets located in the overlapping area of that station (i.e. end of the last track acquisition procedure).

The Name of the stations and the values of the duration can be displayed by means of the data display tool.

The NNCOP delay is calculated by the P5 Analyser function. The result is included in the last TRD record related to the TAP , caused by the NNCOP, on the <u>Client</u> side (= side that received track data from Server). (The NNCOP delay is always calculated together with a TAP duration; If no TAPs are present (no NNCOP induced TAPs), no NNCOP durations will be present.

The result can be shown in the data display as a X, Y or Z scale (3rd view) , and statistics can be determined using the "Histogram" function. The maximum of all the

TAP durations (as requested) can be shown by means ofthe data display using then "math" function. (showing max i.s.o. value itself).

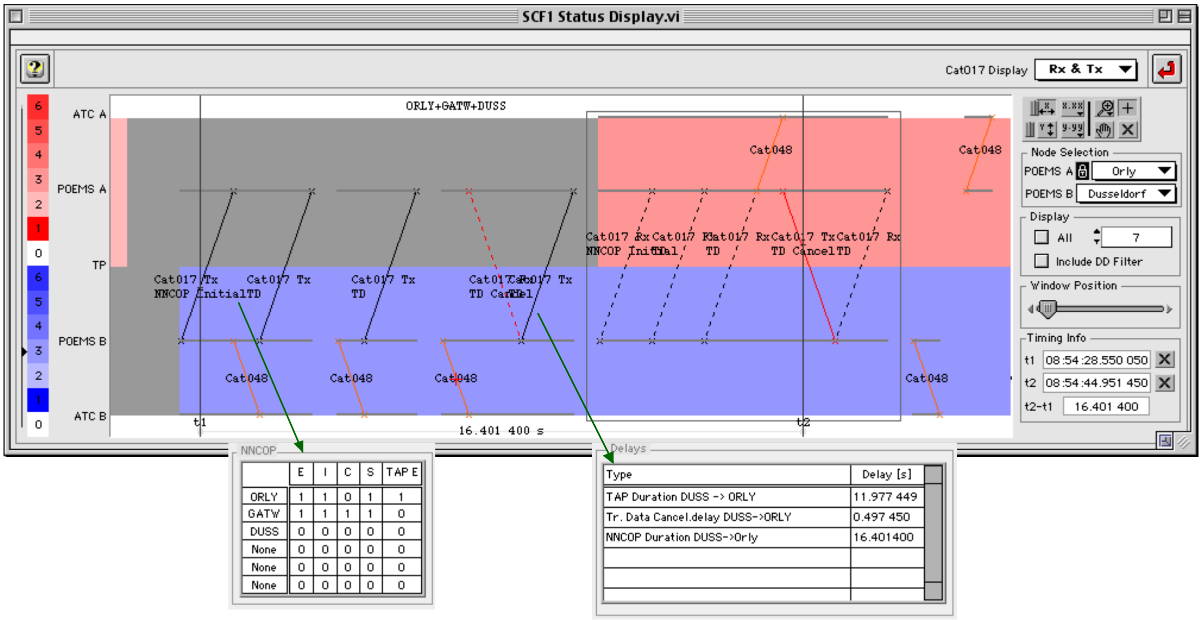


Figure 3-58: NNCOP Duration and Station Names

3.3.3.4.25. NNCOP Flags

The PTE P5 Analyser marks specifically, for further filtering, the category 017 messages sent and received by a station and which are due to a connection or channel change-over of that station

The PTE P5 Analyser marks all targets involved in a NNCOP as "Expected" for the TAP using the corresponding flag. A separate set of 6 flags is used to indicate that the "expected" state is due to a NNCOP procedure

The Cat 17 messages involved in an NNCOP procedure are marked with the "NNCOP E" bit. This bit can be used as a filter condition,

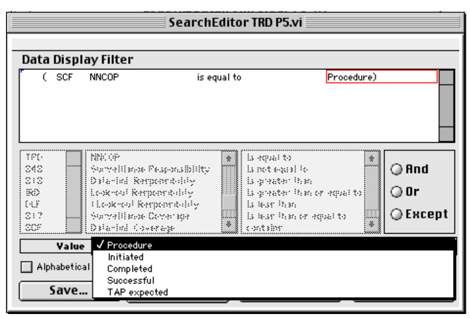


Figure 3-59: NNCOP filter editting

3.3.3.4.26. Transmission Delay Calculation

The PTE P5 Analyser calculates the transmission delay of category 017 messages on the SCN . For this purpose the tool calculates the transmission delay from all double recorded messages (Once at sending node, once at receiving node.) This value is overwritten as a calculated field in the S17 data structure.

The Transmission delay is calculated in the P5 Analysis module and is added to the S17 data file. The information can be shown in the data display info window or in the data display as a XY or XYZ graph.

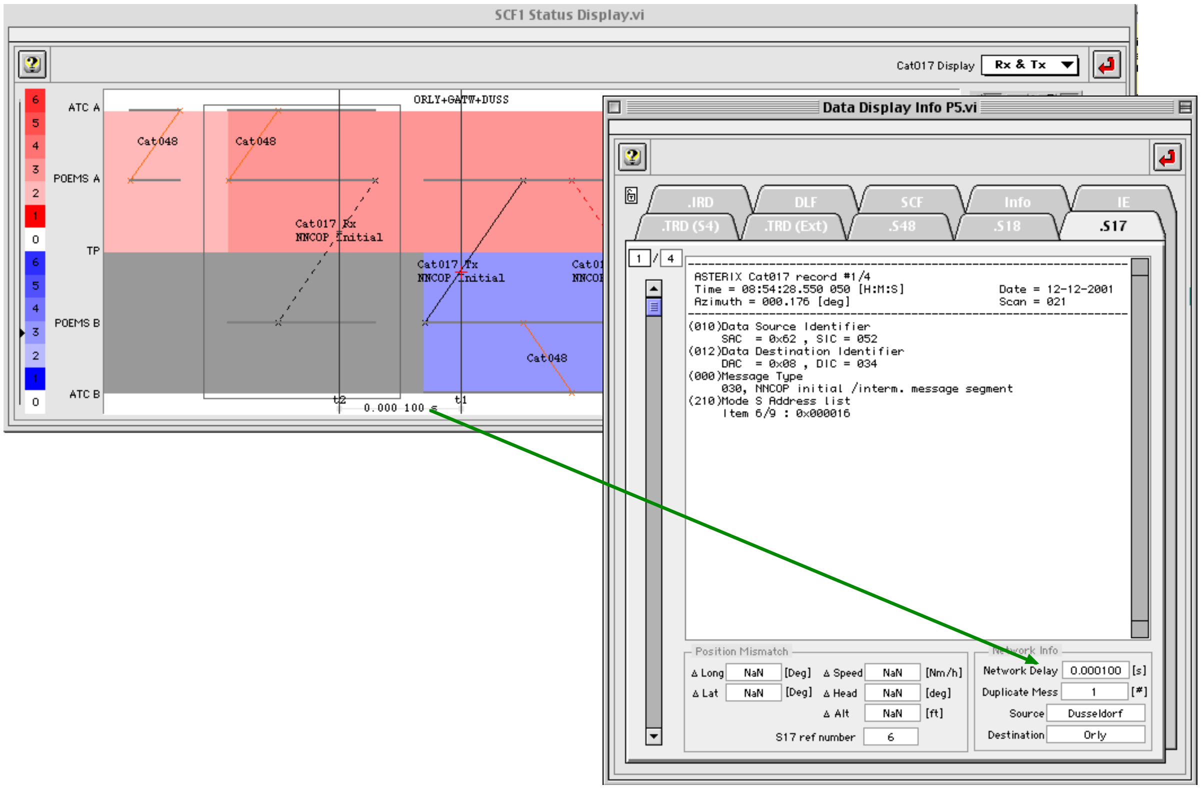


Figure 3-60: S17 Transmission delay

3.3.3.4.27. SCF Network Load Calculation

The PTE P5 Analyser calculates the load of the SCN Network. This load is defined as the number of messages received and transmitted at one Node per second. Alternatively , the tool could calculate the load as the number of bytes per second throughput at the Node.

The load of the SCN network can be shown in the "S file viewer" tool. For this purpose theS17 file, present in the RESULT folder (so the unlinked file) needs to be used. Then select "Asterix size" as Y axis and "Time " as X axis. Next, select a mathematical function (sliding window sum) over a delta x of 1 second. This results in the requested load (in number of bytes per second) figure.

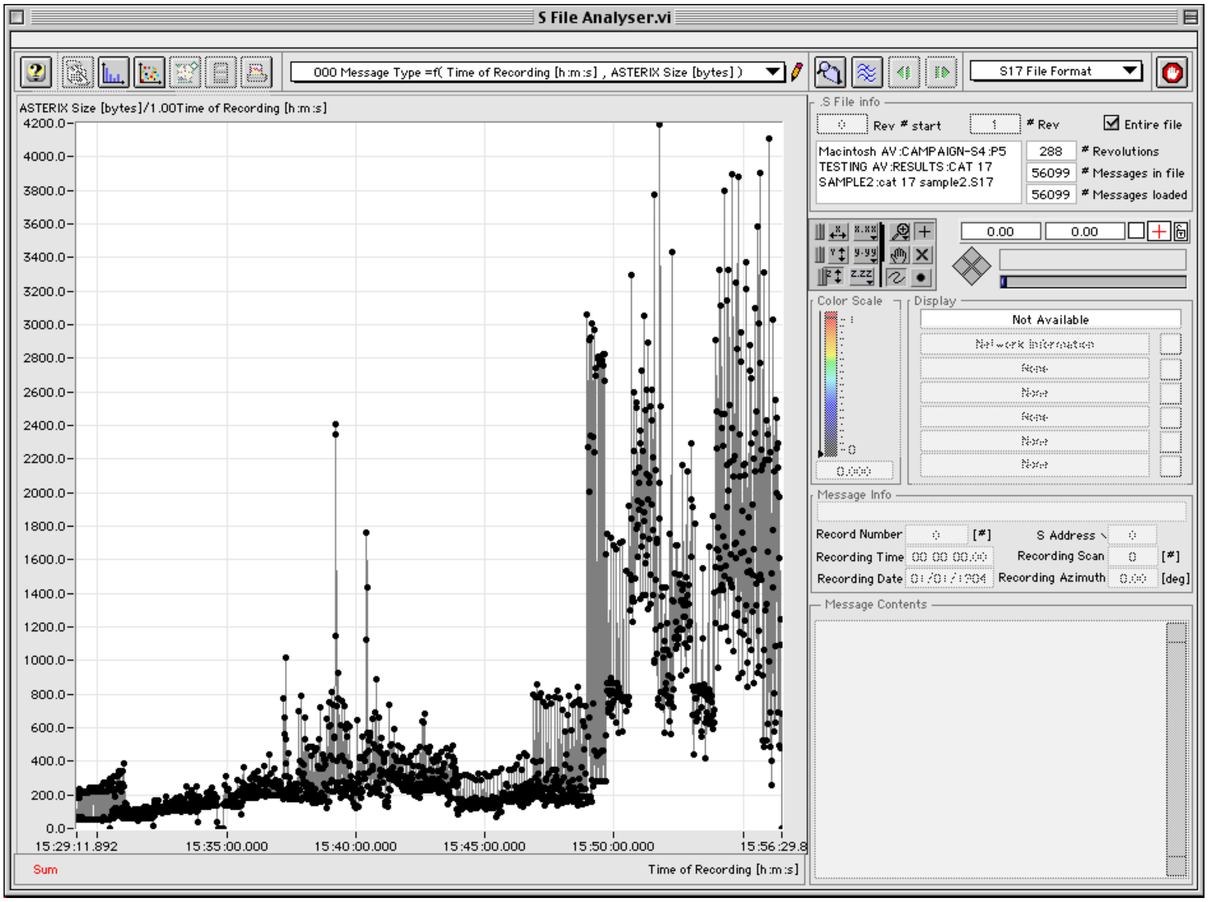


Figure 3-61: SCN Load Calculation

The second alternative for this calculation is to set "Asterix message present" as y scale . This creates a graph " number of Messages per second".

3.3.4. Data Filtering

An important section of the tool shall be the filtering of the data. IE proved in the past that the SASS-S and PTE P1/2 filter tools are strong and easy to use For PTE P5 we added a simple extension of these filters. Typically the PTE P2B2 filter was extended with a S17 section, plus the new calculated fields will be added.

Filtering can be applied in two levels:

- 1) At the linker and
- 2) At the result display.

Prior to linking data, the user can specify a certain filter, e.g. Mode S data only, or only data in coverage overlap, etc.. This results in a Linked_data TRD5 FILE which contains a limited subset of data.

Once the linker and data analysis has been performed, a second level of filtering can be performed in the data display, allowing the user to query for specific situations.

This allows the user to filter, either prior to linking or during data investigation, on Calculated TRD5 fields (Latitude, Longitude, X, Y, altitude, Range , Azimuth , Coverage responsibility, Data link responsibility, TASP status, etc..). Any field available in the S48 data (e.g. Cat48 Range, Azimuth, A code, etc.. refer to PTE P2B2 for details), S17 and any field of the IRD data (e.g. UF code, RR values, etc.. refer to PTE P2B2 for details).

The Data Filtering module carries out a parametric filtering on the linked data at the level of the individual TRD5 record. Only those data items associated to the TRD5 record passing the filter criteria, are passed for further processing by the software. The Data Filtering module is incorporated into the P5 Data Display tool and SCF S17 Analysis tool. This allows the user to apply any parametric filter prior to executing any of the analysis or display functions

The Data Filtering module is based on the existing filtering module currently used in the PTE tools. The “feel and look” stays the same. This means that the filter is build up from the same elementary filter criteria with the addition of a new elementary filter criteria: User selectable source

The elementary filter criteria are:

- -User selectable source
- - User selectable data field
- - User specified arithmetic logical relation
- - User specified value.

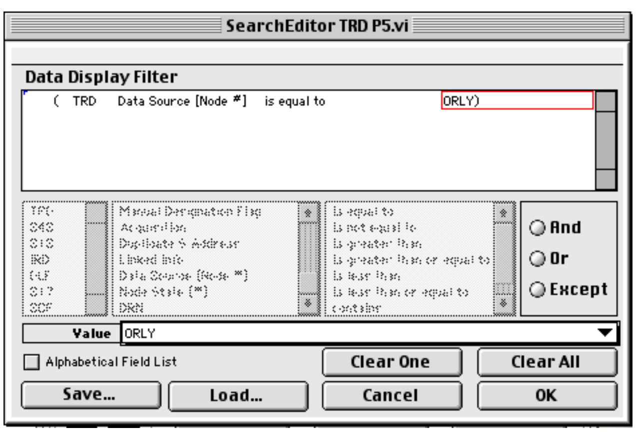


Figure 3-62: Filter example

The complete filter is a logical combination of multiple “OR” of multiple “AND” sets of elementary filter criterion. This logical combination is made clear by using brackets.
The following user selectable sources are available:

- .TRD5, .S17, .S48, .IRD

This selection defines which user selectable data fields are presented to the user. Each of the user selectable sources has a matching set of user selectable data fields. This makes the total number of user selectable data fields more manageable and long selection lists are avoided.

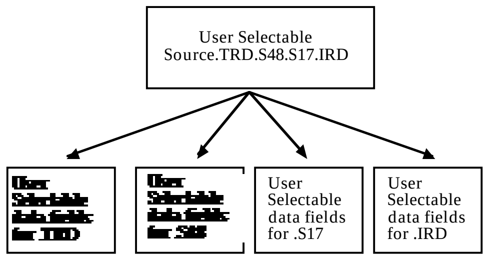


Figure 3-63: TRD5 structure filtering

3.3.5. Data Visualization

The data visualization part is the most important section of the PTE P5 tool. It will allow the user to view the data produced by the cluster in geographical, Scatter, line chart and histogram displays, all of them in two or three axis. The data source of each of these axes can be selectable between all data available in the TRD55 records.

Some data can not be visualized directly in the Data Display tool, because it does not have a target relation. (e.g. NIM data messages). For this purpose, a special viewer tool (S File viewer) is build. Furthermore, a tool for the assessment of the cluster stability shows this information in a separate window.

3.3.5.1. S file Viewer

3.3.5.1.1. Cat 17 Viewer and Analyzer

This tool allows the visualization and querying of all Cat 17 data gathered in the individual S17 files. The tool can read the linked data (target related) or the NIMs and other non-target related messages separately and can visualize the data in a scatter diagram. X, Y and Z scale (color) can be selected from any S17 data field (S address, Message type, TOD, etc..) or a from extra information added by the EDR recorder (Azimuth and time of recording.).

The tool has an interactive display, showing the S17 data in geographical (Track data messages only) or scatter diagram. All data shown in this display can be subject to filtering on any Asterix Cat 17 field. Each point in the scatter diagram can be queried and traced back to the original contents of the Asterix message. The message itself is shown in a textual manner (see figure). Histogram (1D, 2D) functions and calculation functions are foreseen to count the number of messages of a specific type.

The complete data set or parts of the data shown in the display can always be exported to a sub-set or a tab separated file.

The HMI of the S File Viewer tool is presented hereafter.

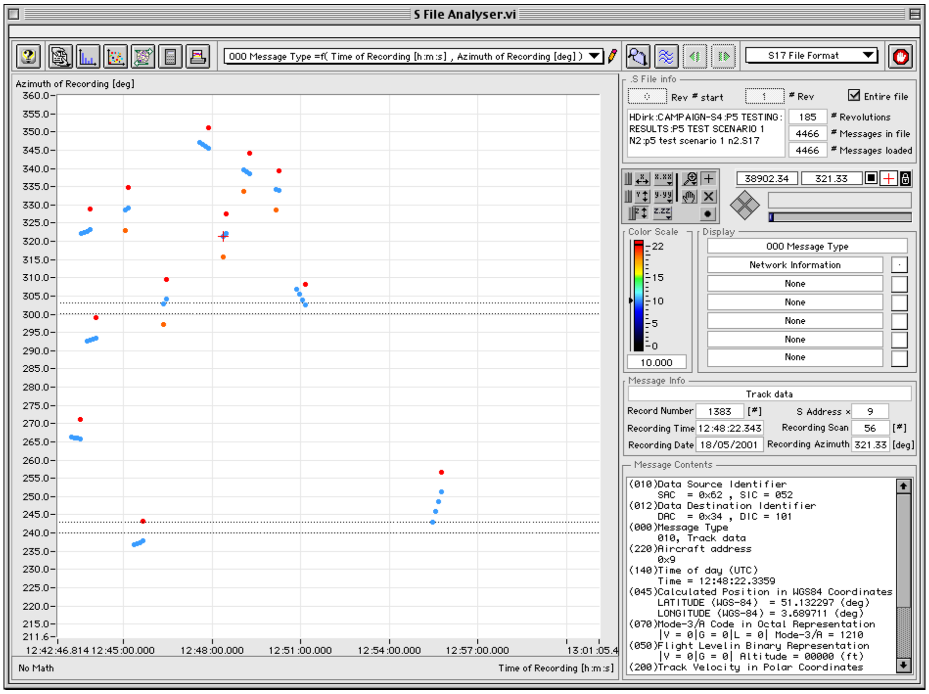
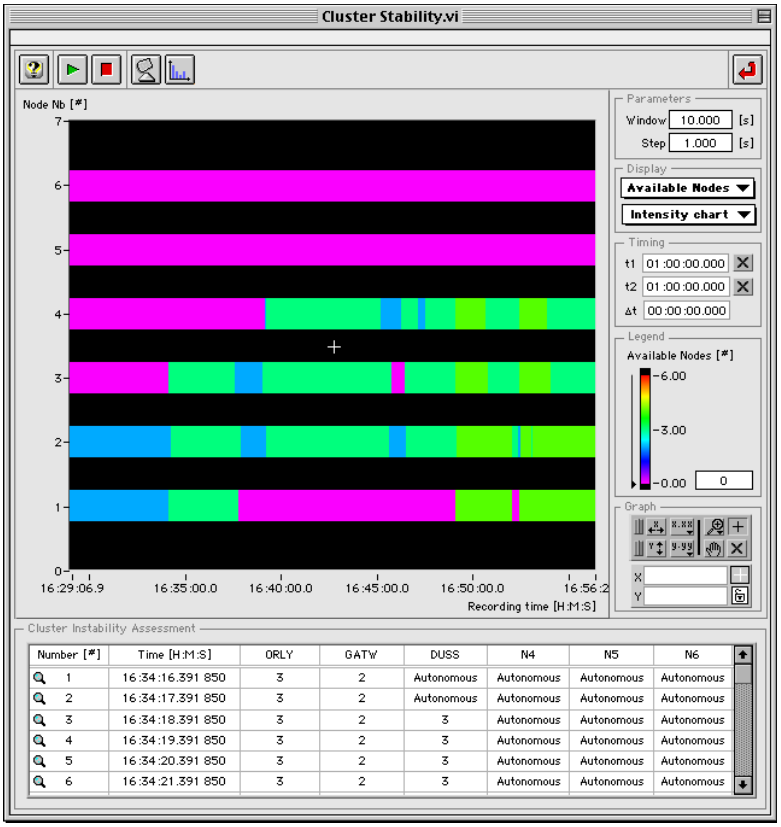


Figure 3-64: Example of S17 analyzer

3.3.5.1.2. Cluster Stability Display

The concept behind the Cluster stability analysis is that the user needs to know whether all Nodes in the cluster report the same cluster configuration in the same way. For this purpose, the NIMs will be analyzed and the information is put in a scatter graph. The X scale of this graph represents time of recording (UTC), while the Y scale represents the available nodes seen from each individual node of the cluster or the state of each of the six nodes. Both displays provide a good feedback on the cluster stability.

The information is shown in a scatter/intensity graph, showing Available nodes/Node State for each of the six stations in time. Scanning of this data results in a table, listing the possible cluster instabilities.



Number [#]	Time [H:M:S]	ORLY	GATW	DUSS	N4	N5	N6
1	16:34:16.391 850	3	2	Autonomous	Autonomous	Autonomous	Autonomous
2	16:34:17.391 850	3	2	Autonomous	Autonomous	Autonomous	Autonomous
3	16:34:18.391 850	3	2	3	Autonomous	Autonomous	Autonomous
4	16:34:19.391 850	3	2	3	Autonomous	Autonomous	Autonomous
5	16:34:20.391 850	3	2	3	Autonomous	Autonomous	Autonomous
6	16:34:21.391 850	3	2	3	Autonomous	Autonomous	Autonomous

Figure 3-65: Cluster Stability Display

3.3.5.2. P5 General Data Display

A last and very important tool for querying and displaying P5 data is the P5 Data Display. This tool is an enhanced version of the PTE P2B data display and allows the user to visualize the linked data found in the TRD5, S48 and S17 data (Except NIM messages).

It also allows the user to see the calculated fields (see above) as a function of any other calculated or recorded data field.

The Data Display HMI allows the user to specify the X, Y and optionally Z axes of the display, and this for up to 18 overlaying layers. (Expansion of P2B2 tool, this had only 10 layers).

The layers can be filled with the same or other data set, each time related to a separate parametric filtering. (e.g. all track support procedure targets in one color, or all targets in overlapping coverage of radar A and B in a different color or point style. The user can define the color, style and type of the points used in each layer.

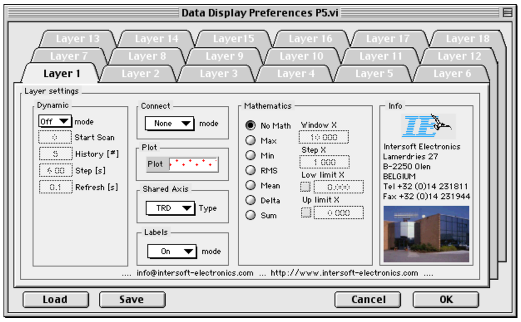


Figure 3-3-66: 18 Layer Data Display Preferences

Depending on the type of axis selected, the graph can show a background map of Europe, showing the borders of countries and the positions of the related radar stations in the data set (geographical display). The X and Y axes for geographical displays will allow longitude and latitude values, X –Y, slant X slant Y values or Range – azimuth values (relative to one radar or relative to cluster center).

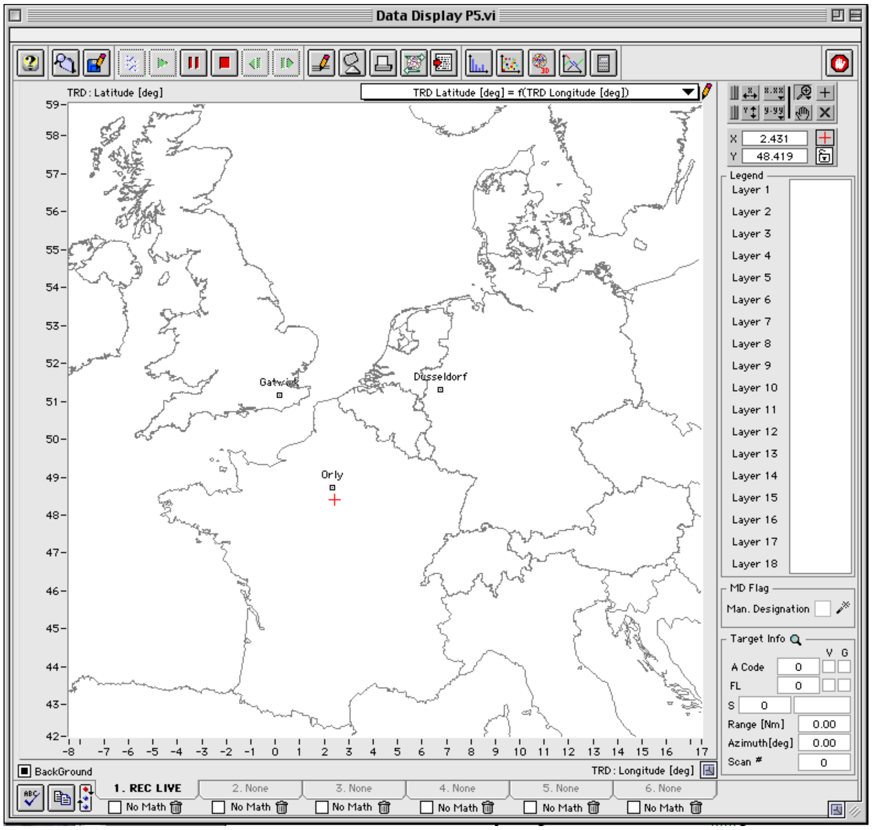


Figure3- 3-67: Data Display in Longitude-Latitude mode

The data shown in the graph(s) can be zoomed (Horizontal only, vertical only, box zoom, center zoom in, center zoom out, undo zoom), panned or axes min and max values can be set manually. The data can be centered automatically.

All data shown in the display can be printed to a color printer, included in a "report" file, or the data can be copied in a picture format, which can be included in word processor documents for further documentation.

A new feature for the P5 Data Display is the inclusion of the responsibility maps of the cluster nodes. The user has the possibility to enable the coverage maps to be shown as colored cells in background behind the track data in case a geographical display is selected. Depending on the state of the Cluster at a given time (determined by means of the time of the selected TRD5 record by the graph cursor), the corresponding System Map data, as calculated during linking of the data, is drawn in background. The user can select different colors for the coverage of each of the N radars. Overlapping areas incorporating the selected node are drawn in shades of the selected node's base color. Overlapping areas not incorporating the selected node are drawn in shades of gray. The number of overlapping areas determine the brightness of the shading. Map mismatches are displayed in black.

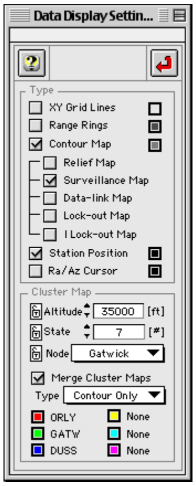


Figure 3-3-68: Data Display background selection HMI

A legend, visible at all times, shows the mapping between the data subsets and the color and symbol used. Up to 18 different user specified sub-sets of data can be displayed at the same time using distinctive symbols and coloring. Each sub-set is accessible with a single click on the corresponding tab.

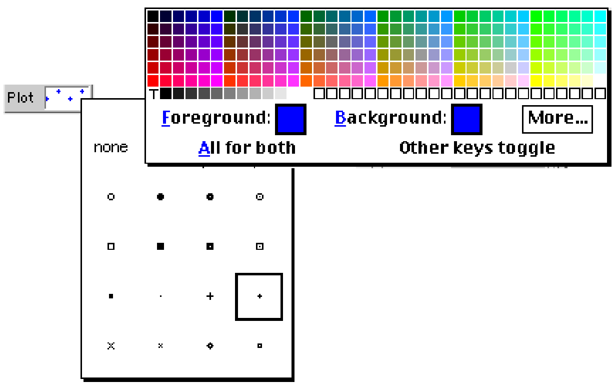


Figure 3-69: Color scales

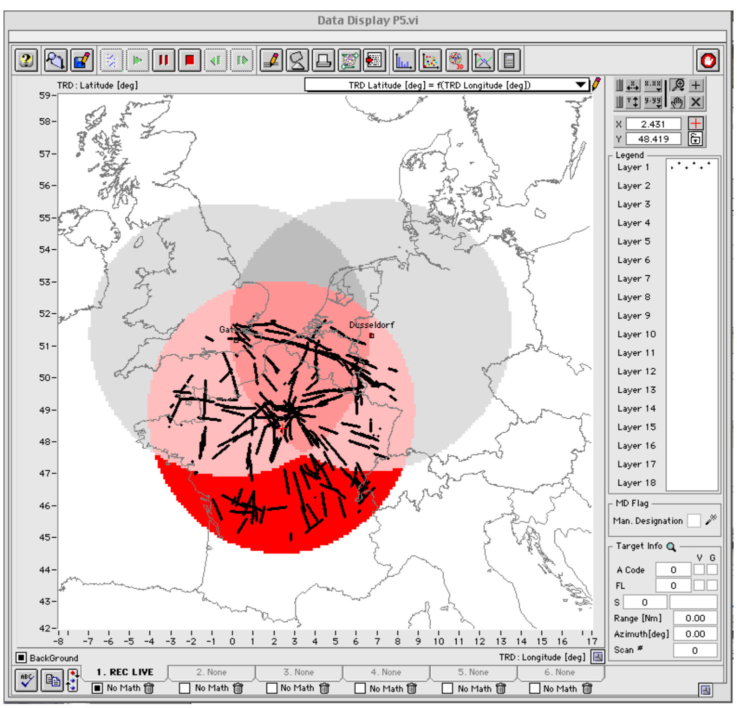


Figure 3-3-70: P5 Data Display with coverage map and radar data

The user can at all times query the TRD5 data in the Data Display or Third View graphs and look at details on each record by means of the Info Window available in the Data Displaytool . This is enhanced to support the viewing of the contents of all the .TRD5, .S48, .S17 and .IRD data fields related to the individual TRD5 records selected by the pointing device. It consists out of a window with a tab for each file. This way, all relevant data is kept within one window and the user can quickly choose between the sections of data available in the TRD5. The data content is displayed in a text format. If multiple related records are available for a specific TRD5 record, they are displayed in chronological sequence in the Info Window. A scroll bar allows to view each record individually. For the .S17 and .S48 file, the ASTERIX FSPEC is used to display only those data fields present in the file.

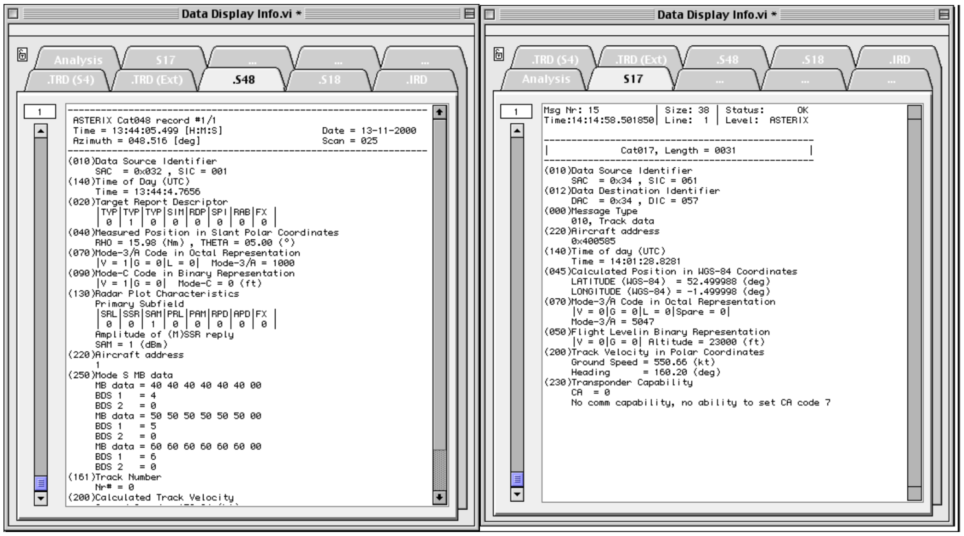


Figure 3-71: Data Display Info fields

3.3.5.2.1. Third View display

In case the user selects the “Third View” option, one layer is shown with a third axis (Z) shown as a color scale. This color can typically represent calculated values (e.g.. Latitude error S17-S48 data etc..). Any calculated or recorded value can be selected to act as a third axis. On top of this, the user has the option of selecting up to 6 different point styles for different flag settings in the recorded or calculated fields.

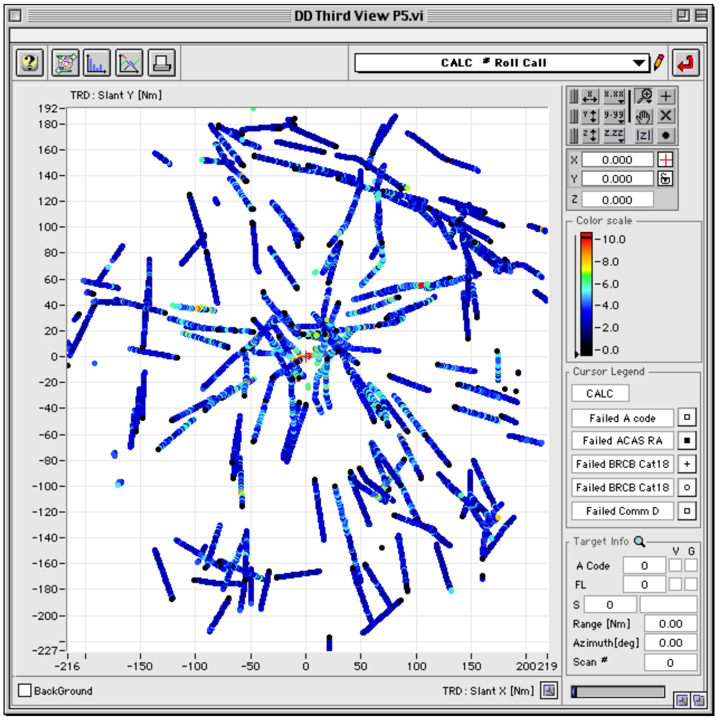


Figure 3-72: Using color as third dimension in Data display graphs

3.3.5.2.2. Tabular display of data

Each sub-set created by parametric filtering and / or zooming and panning can be saved as a separate data set. At that moment, not only the .TRD5 file but also the .S48, .S17 and .IRD file are rebuild according to the parametric filter. This procedure allows the user to create smaller data sets for individual analysis.

The data selected this way can also be exported into tabular displays. The data available in this tabular display are similar to those in the PTE P2B1 exports. Each field can individually selected to be included or rejected in the export.

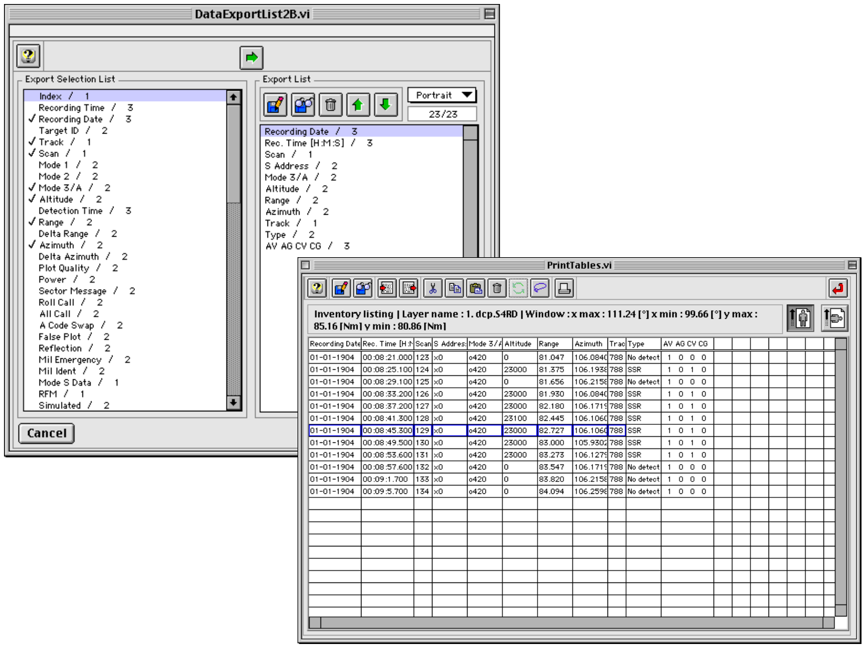


Figure 3-73: Tabular displays in Data Display

3.3.5.2.3. 1D Histogram View

A 1D histogram function allows the user to count a number of statistical values (mean, Max, min, population, STD, RMS, mean non zero, etc..) plus a histogram with selectable bin size, number of bins and upper and lower boundaries. This function will also allow the user to count certain values like number of Roll Calls per TASP procedure etc.. Any chosen axis can be used as an input for this 1D Histogram function.

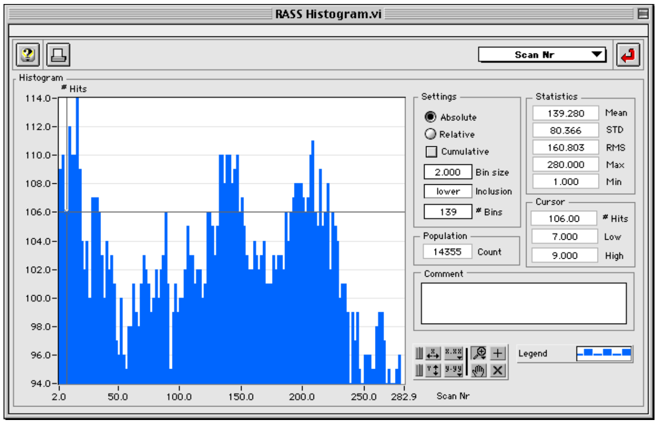


Figure 3-74: 1D Histogram function incorporated in Data Display

3.3.5.2.4. 2D Histogram View

A 2D histogram function allows the user to count a number of statistical values (mean, Max, min, population, STD, RMS, mean non zero, etc..) plus a histogram with selectable cell size, number of cells and upper and lower boundaries. This function will also allow the user to count certain values like number of Roll Calls per TASP procedure etc.. Any pair of chosen axes can be used as input for this 2D Histogram function.

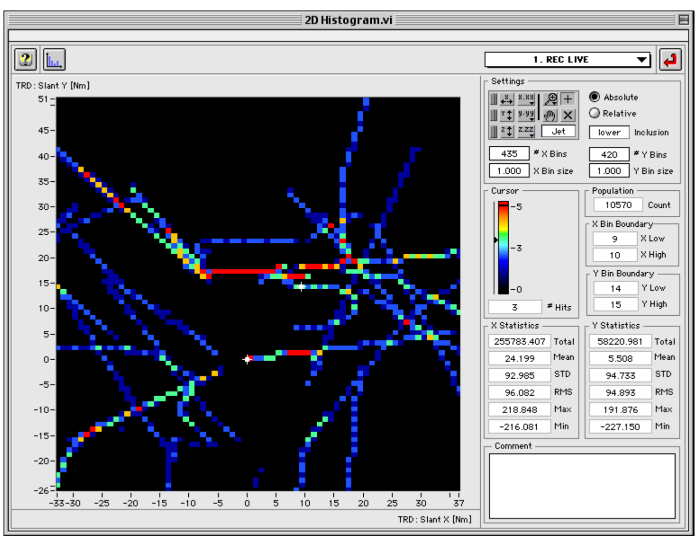


Figure 3-3-75: 2D Histogram function incorporated in the Data Display

3.3.5.2.5. SCF Status display

A final and very important investigation tool for P5 is the P5 SCF status display. The status display shall be derived from the PTE P2B2 status display, but this time it will show somewhat different data. Whereas in P2B2 the data levels were subdivided

"ATC-GDLP-DLF-POEMS-TP and ADLP, in the P5 version the user shall have the following layers:

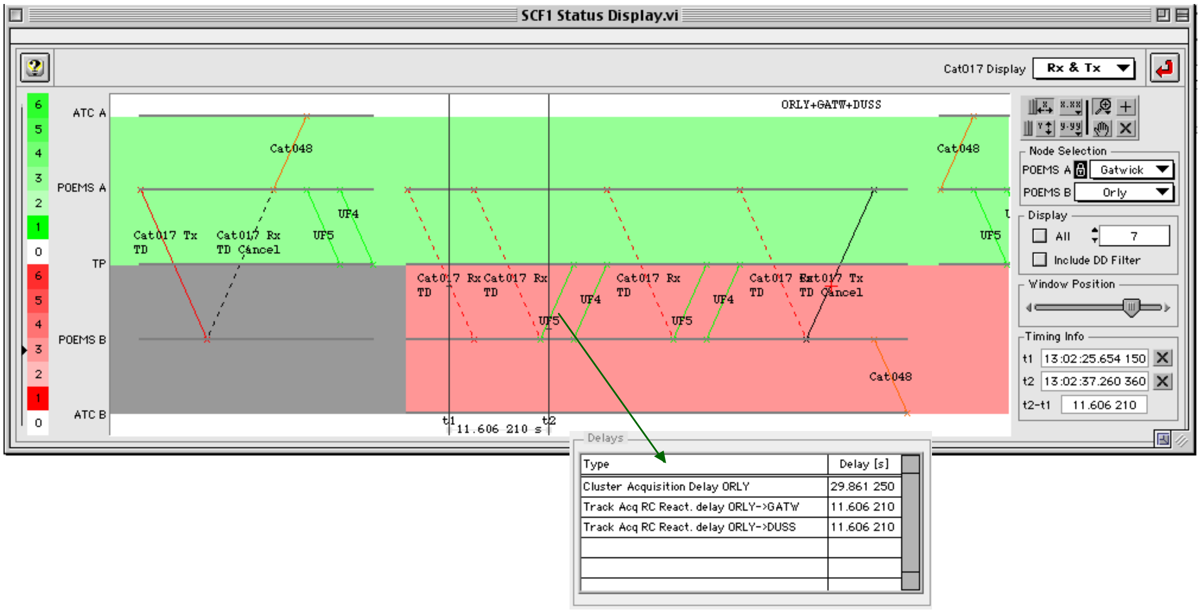


Figure 3-76: SCF Status display example (Track Acquisition)

"Arrows " show activities or interactions between different layers. Each color denotes a different activity. Typically, the activities will be

Cat 48 messages (black), Roll Call Ints (green) , Cat 17 messages (red, orange and purple)

Typically, a user will use the filter or zoom and pan function of the Data Display to locate points of interest (track acquisition or support regions) and will then put the pointing device on one of these points. By doing so, in most cases the tool can figure out from the calculated TASP flags (see calculated fields above) which two Stations (hereby coded as POEMS A –POEMS B) it needs to put in the display. If this is not clear, the user will manually select the two stations of interest.

The display will be interactively linked to the selected point in the data display, and the user can select the timeframe of the display by selecting the number of "virtual scans" shown in the display.

The tool is also interactively linked to the Info window, allowing details of each interaction (be it interrogation, Cat 17 message or Cat 48 message) to be shown. The user can use two cursor lines to calculate any time relation between two transactions automatically.

3.3.5.3. Data Display Related Specifications

3.3.5.3.1. Display Types

The following types of displays are available depending on the type of information to be displayed :

- textual / tabular display (each message and its additional information (e.g. time stamping) being decoded and displayed in a textual manner within tables),

The Displays are all recalled from within the Data Display.

Textual tables:

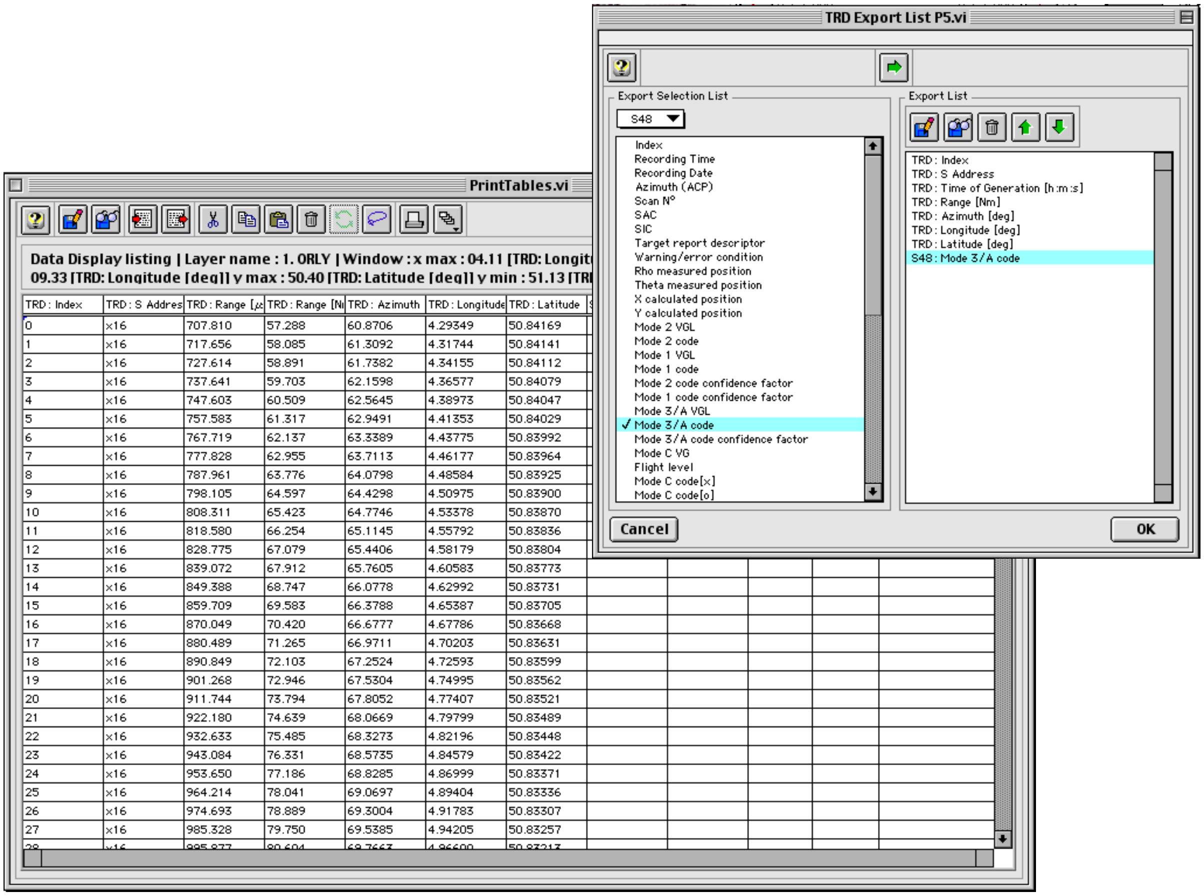
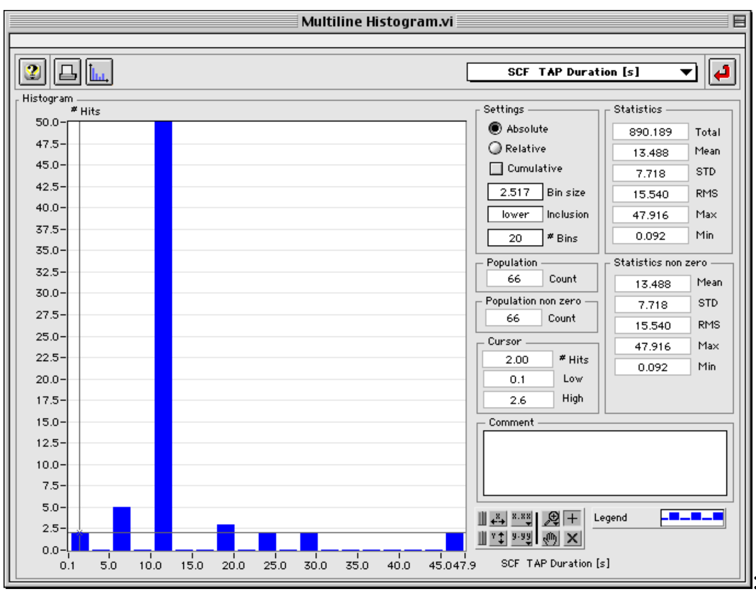


Figure 3-77: Data Display textual display

- 1D histogram display (each bar corresponding to the number of entities for which a parameter is comprised within an interval),



:

Figure 3-78: 1 D histogram display

- 2D histogram display (each cell corresponding to the number of entities for which two parameters are comprised within an interval)

The 2D Histogram allows the user to see a histogram (counting of the number of elements) per cell :

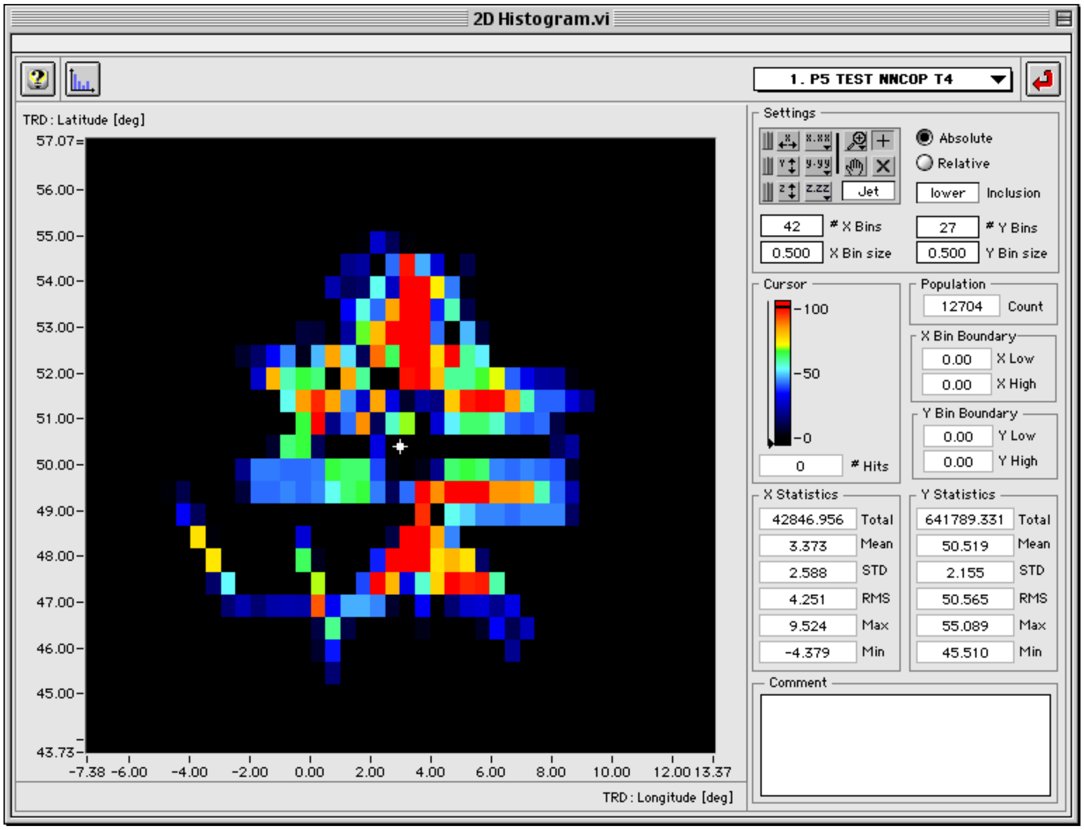
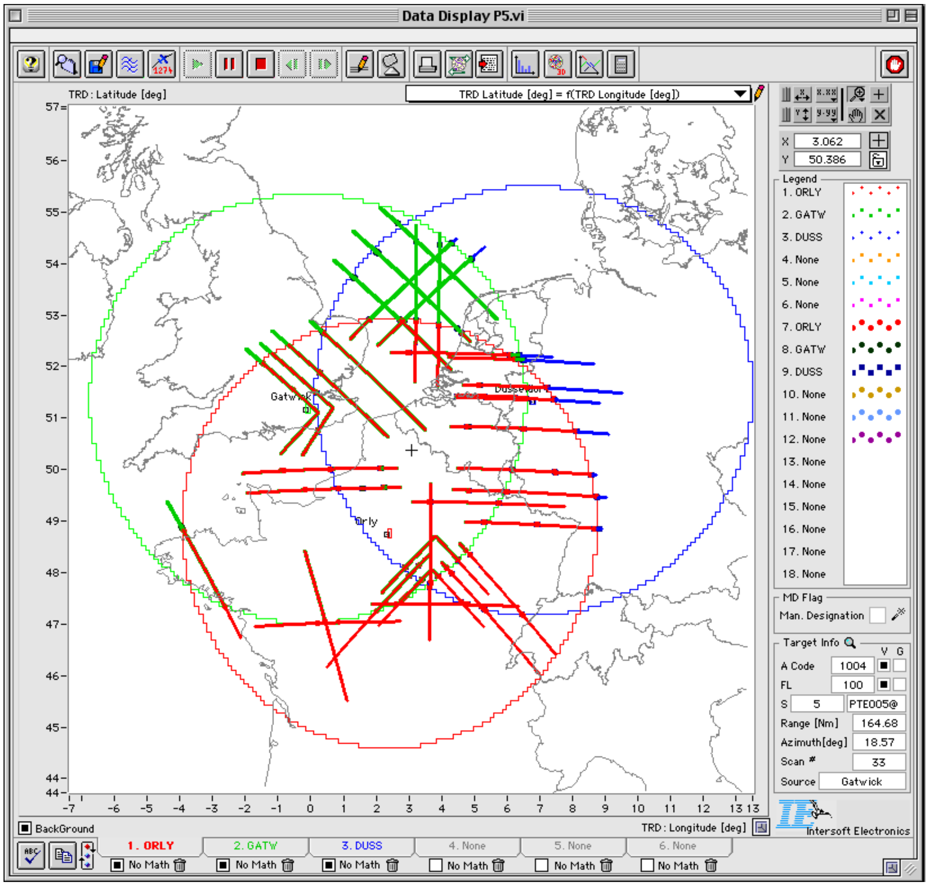


Figure 3-79: 2D Histogram View

- geographical display of target positions (included in the different messages : category 048 and category 017), of POEMS station locations and of coverage map cells in a 2D Cartesian co-ordinate system representing WGS 84 latitude and longitude,

The geographical display of targets is a standard view for the data display:
-Projected XY
-Longitude, Latitude
The data can be viualised in 2D (multiple layers) or 3d (using colour as Z axis)



- scatter diagram (dot drawing of one parameter as a function of another for the set of selected entities)

The Scatter diagram is also part of the data display tool

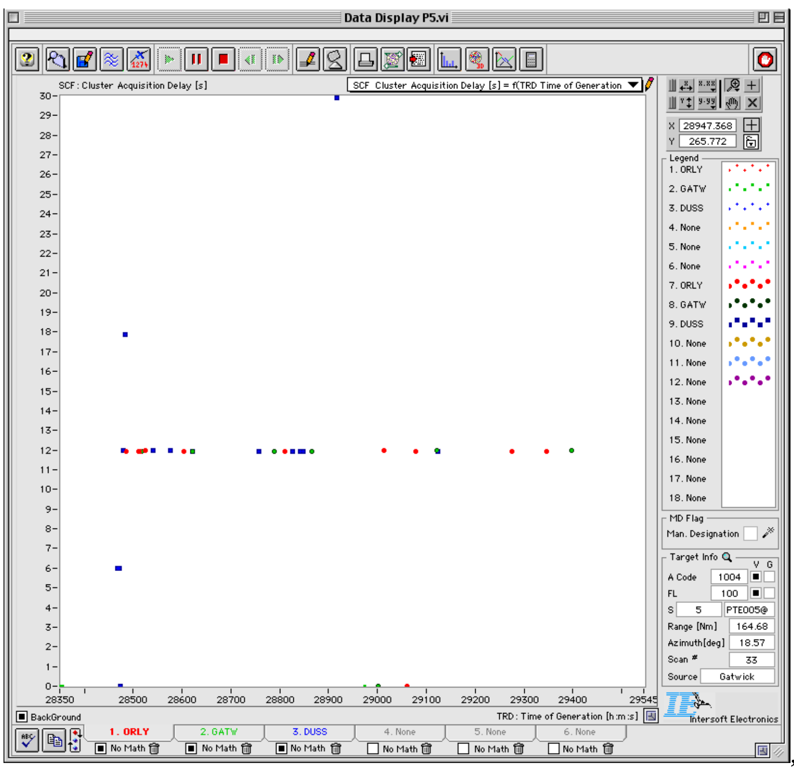
,

Figure 3-80: Scatter Diagram display

- 3D colour scatter diagram (dot drawing of one parameter (using colours) as function of two others for the set of selected entities), including various dot types for representing different entities

The 3D scatter diagram can both be used on top of a geographical display and a Scatter display (using the X and Y axis information.)

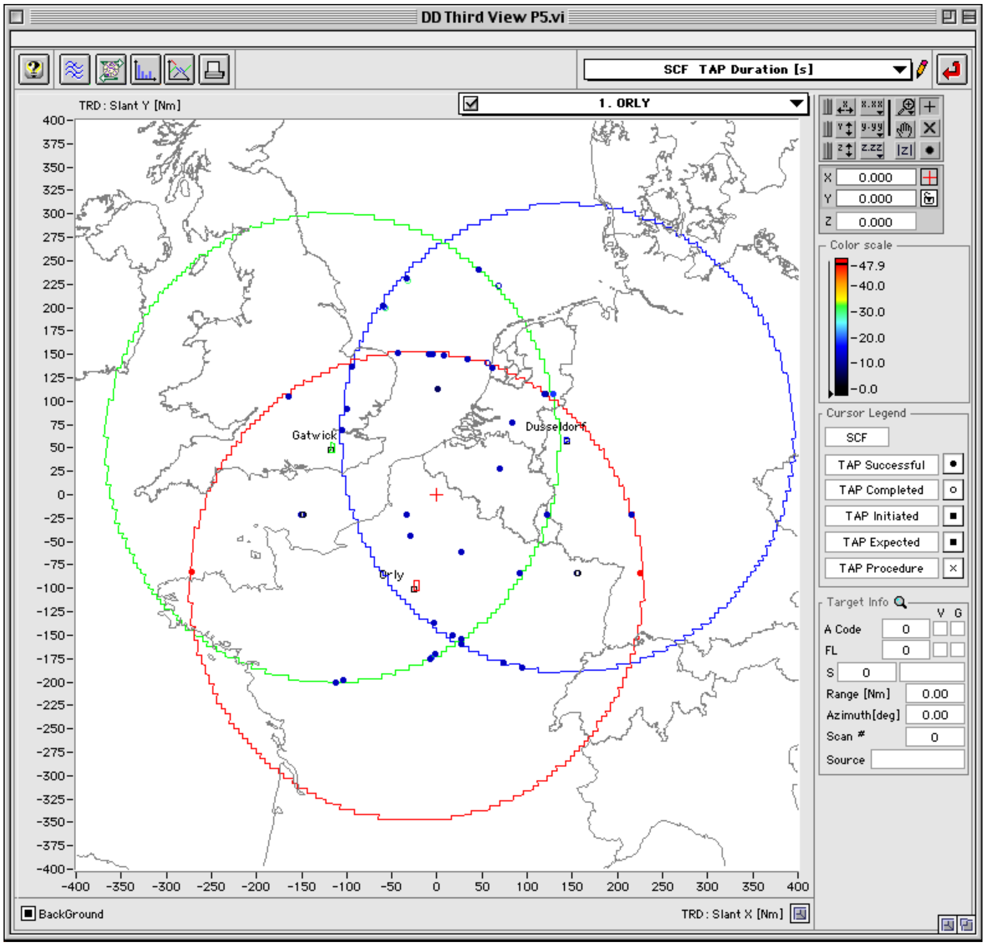


Figure 3-81: 3D scatter diagram

- Status display (display all related information of a specific occurrence of a TASP)

Two status displays can be called at once, to show data from one node relative to two others.

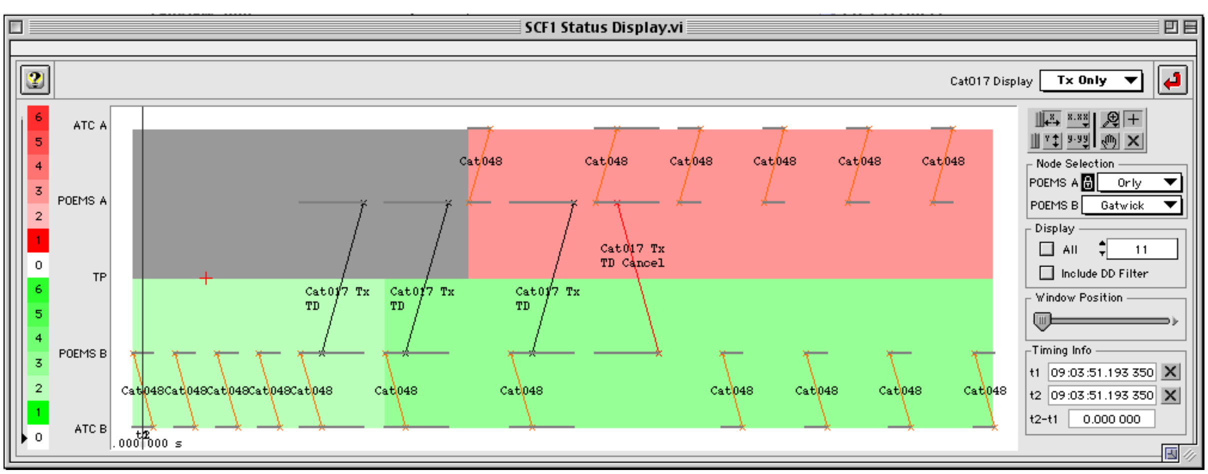


Figure 3-82: Status displays

3.3.5.3.2. Histogram Displays

For histogram display, the data display provides a facility to the user to set up the width of the intervals and the min and max values of each axis, by default the min and max values and scale of each axis are adapted to display the results of the whole selected data set.

The histogram allows the setting of the bin size (width of the interval)or the number of bins , using the min and max value of the dataset on which the histogram is taken. The min and Max values are copied from the original graph that contained the data. Using a zoom or re-scale function , the min and Max can be modified.

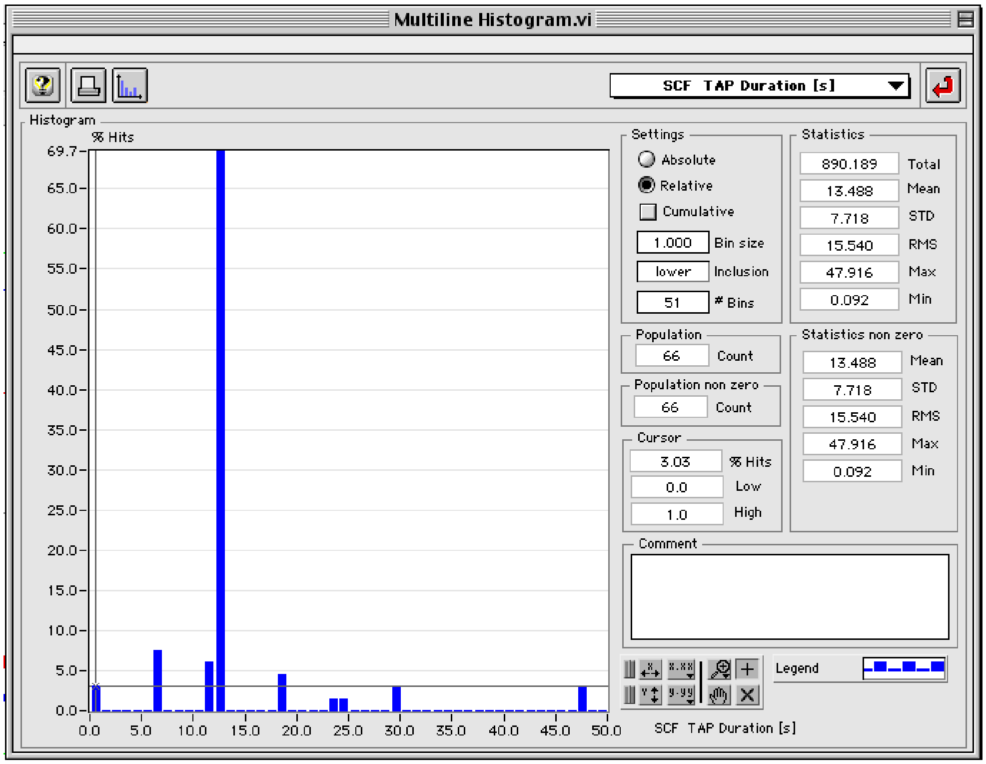


Figure 3-83: Histogram parameter input

3.3.5.3.3. Geographical Display Zooming

For geographical display, the data display provides a facility to the user to provide a facility to the user to zoom in/out and to center the display.

Zooming is a standard feature of the PTE (LabVIEW) HMI and must not specifically be added to any of the graphs.

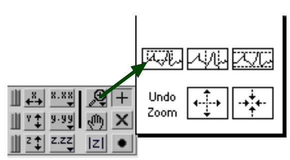


Figure 3-84: Use of Zoom tool in graphs

3.3.5.3.4. Background Cell Colour Displays

For geographical display, the data display provides a facility to the user to allocate cell background colour as a function of the stations having surveillance responsibility for that cell.

The background for the geographical display can be selected using a special HMI. This allows the user to select a surveillance map, datalink map, lockout or Lockout override map. The maps can be shown for any of the available states or nodes.

In case the user only wants to verify teh Maps created by the SMGET tool, he can also load map only data (without linked data). For this purpose, the data linker can create "dummy" TRD files.

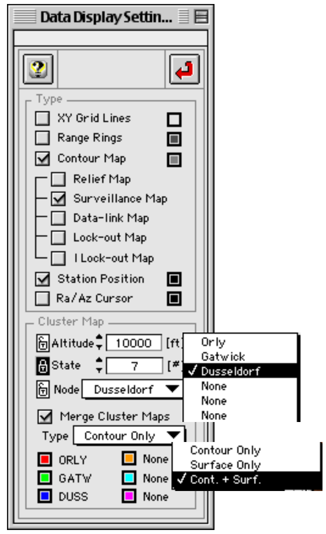


Figure 3-85: Data Display Background setting

3.3.5.3.5. Scatter Diagrams

For scatter diagram displays, the data display provides a facility to the user to set up the scale and the min/max value of each axis, by default the min and max values and scale of each axis are adapted to display the results of the whole selected data set.

The setting of the min and Max values of any of the three axis is a standard PTE or LabVIEW HMI feature and should not be explained.

3.3.5.3.6. Layers

T he data display provides a facility to the user to layer, on a geographical display, up to 18 different sub data sets resulting of 18 filtering (based on exclusive filtering criteria, i.e. multi-criteria selection or geographical selection) of the same data set. Additionally the system provides a facility to the user to allocate at each layer a particular colour and a particular dot type.

The Data display allows for the loading of data in any of the 18 available layers. Data of all Nodes can all be loaded into one layer (Single load) or can be loaded individually per Node in one user operation (cluster load). The colour, style and properties of each layer can be set using the preferences window.

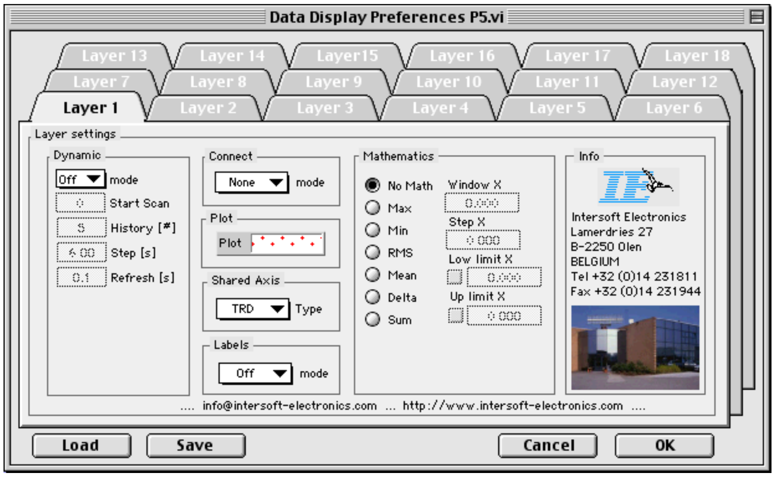


Figure 3-86: Layer Preferences

3.3.5.3.7. Connection of Dots

T he data display provides a facility to the user to connect dots in a scatter diagram . The feature shall be switched off or on at user request.

Dots can be switched on or off using the preferences window (connect dots option) .

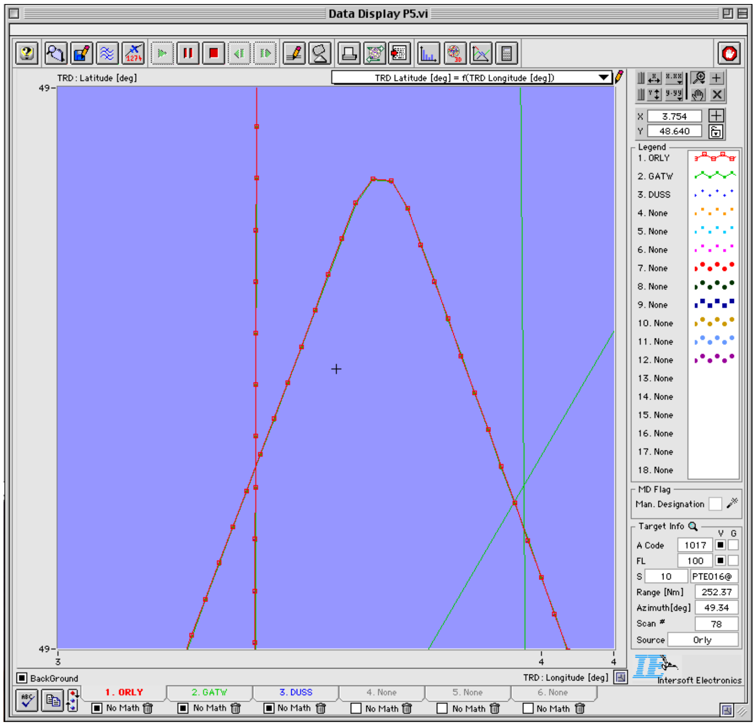


Figure 3-87: Connect dots option

3.3.5.3.8. Event Display

T he data display provides a facility to the user to make a geographical display showing the different track data/target reports (category 017 / category 048) included in the current data set together with the positions of the stations forming the cluster, and with the applied coverage map and with the geographical filter applied, if any. On this display the following events can be specifically identified using specific filtering :

- expected track acquisition procedure occurrence,
- initiated track acquisition procedure,

- completion of track acquisition procedure,
- successful track acquisition procedure,
- expected track support procedure occurrence,
- initiated track support procedure,
- completion of track support procedure,
- successful track support procedure.

This complex display can be created using the "Shared axis" display. For this purpose, select the display type "Shared axis" , X= longitude, Y= Latitude. Next define layer 1,2,3,4,5,6 as "TRD" shared axis (thus showing Cat 48 converted lat-lon coordinates) and select shared axis "S17" for layer 7 through 15.

Next load the data as a cluster in layer 1-6 and perform the same action in layer 7-12.

Layer 13-18 can be used to add filtered data, such as the points showing expected TASP, etc..

The setup of the display can be saved and recalled later for retreival (including all the filters) .

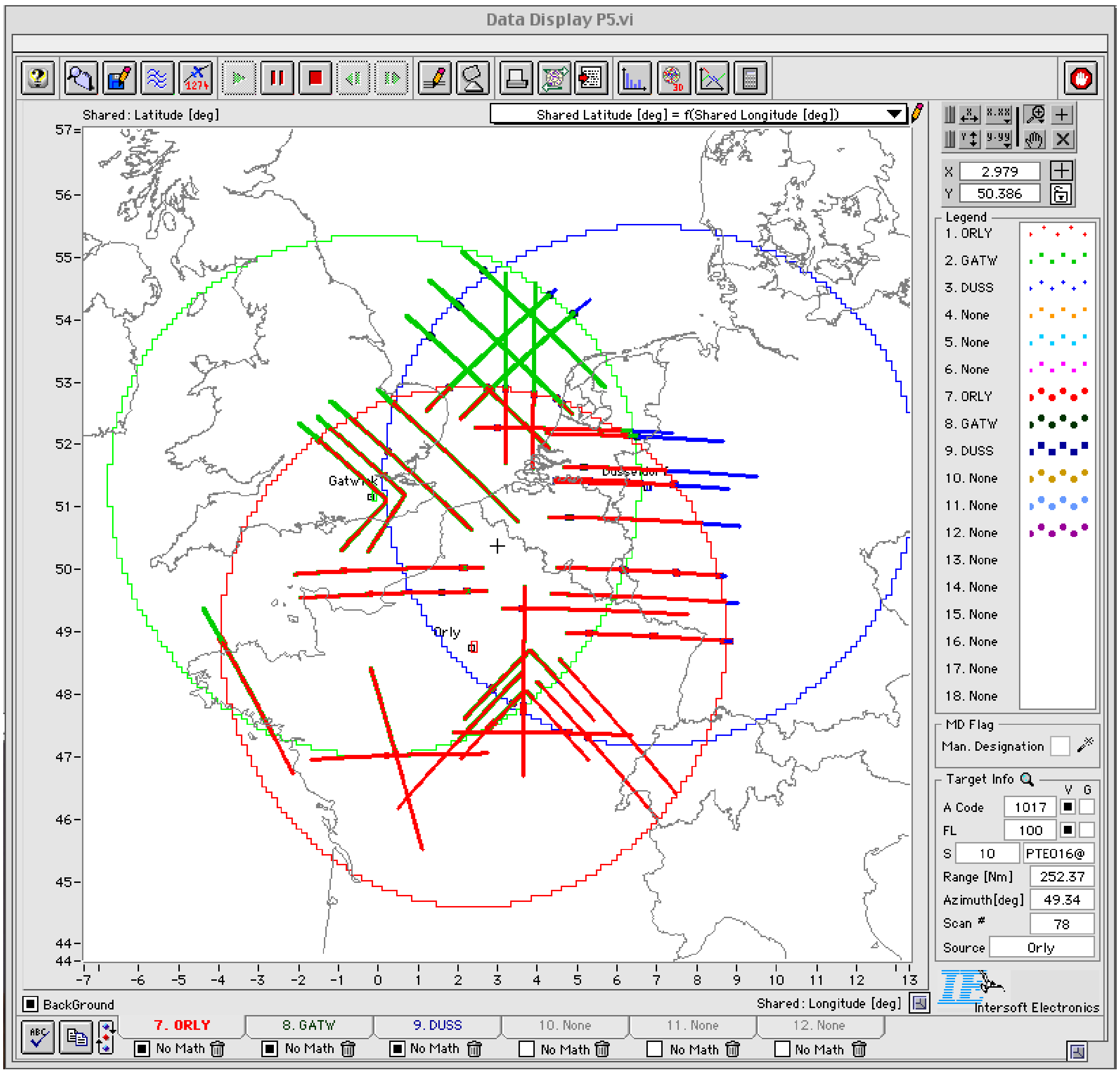


Figure 3-88: Shared axis display

3.3.5.3.9. Status Display Contents for TAP

T he SCF Status display provides the user with the following parameters corresponding to a selected occurrence of a track acquisition procedure in distributed mode :

- name of the stations involved (station A performing the acquisition, station B providing track data to A to facilitate acquisition),
- A graphical representation of the Roll Calls (and optionally their replies) between the Transponder and the two stations involved.
- A graphical representation of the Surveillance ATCC output (S48)messages of both stations
- A graphical representation of the SCF (S17) messages between the two stations using the SCN.
- The status of the TASP (i.e. expected Y/N, initiated Y/N, completed Y/N, successful Y/N), using a linked info window.
- a visual indication (using colour) to indicate if the target flew in a map mismatch area between stations A and B,
- number of roll-call interrogations (found in TRD data) using a linked info window
- duration of the track acquisition procedure, according to the definition provided in § 2.3 of the SRD using a linked info window

All the points mentioned above can be seen by using the Status display along with the info window. The validity of this spec has been proven in numerous specs described above.

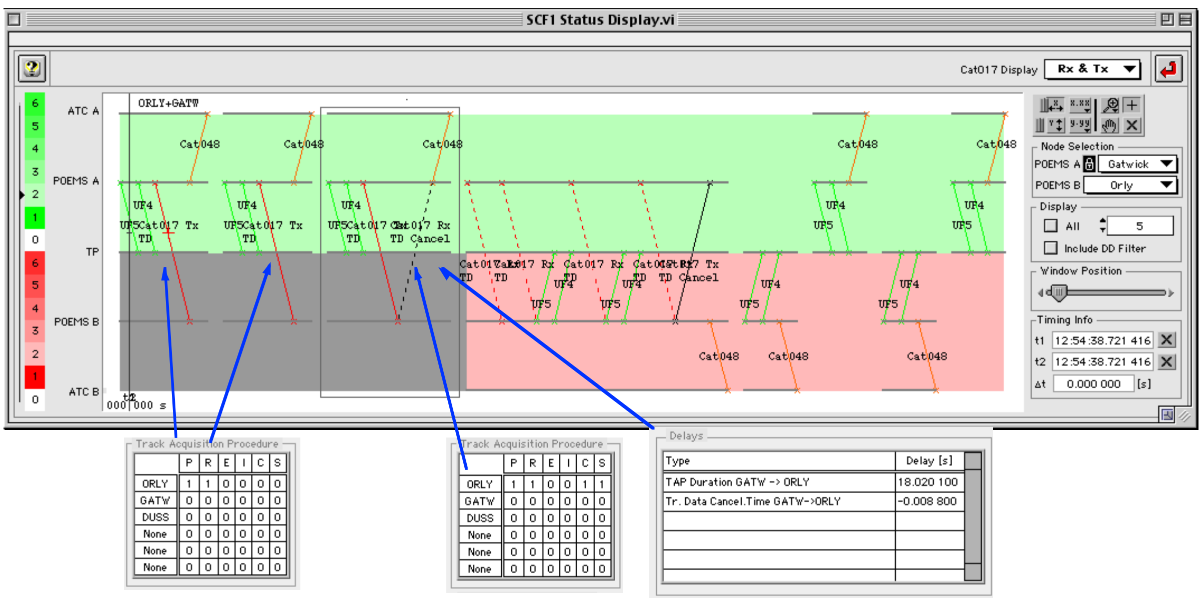


Figure 3-89: Status display showing TAP with Status flags

3.3.5.3.10. Status Display Contents for TSP

T he SCF Status display provides the user with the following parameters corresponding to a selected occurrence of a track support procedure in distributed mode

- name of the stations involved (station A asking for support, station B providing track data to A to facilitate re-acquisition),
- A graphical representation of the Roll Calls (and optionally their replies) between the Transponder and the two stations involved.
- A graphical representation of the Surveillance ATCC output (S48)messages of both stations
- A graphical representation of the SCF (S17) messages between the two stations using the SCN.
- The status (i.e. expected Y/N, initiated Y/N, completed Y/N, successful Y/N) using a linked info window.

- a flag to indicate if the target flew in a map mismatch area between stations A and B,
- number of roll-call interrogations (found in TRD data) using a linked info window
- duration of the track support procedure, according to the definition provided in § 2.3 of the SRD using a linked info window.

All the points mentioned above can be seen by using the Status display along with the info window. The validity of this spec has been proven in numerous specs described above.

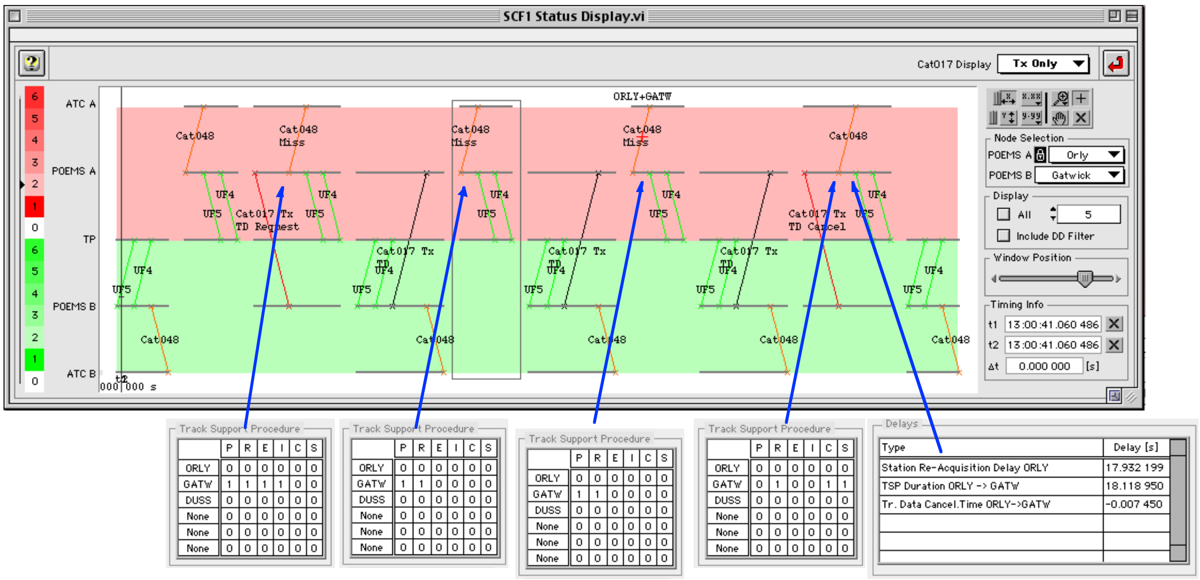


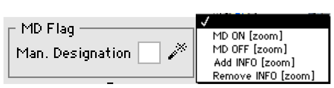
Figure 3-90: Status display showing TSP and status information

3.3.5.3.11. Manual Designation Flags

T he data display provides a facility to the user to identify specifically on all displays a selected entity

The "marking" of an entity can be performed using the "MD flag". (Manual designation). The user can select, using a cursor, any record (dot) in the data display, and set the manual designation flag for this entity. The same can be done for a set of records, simply by zooming in until only those entities the user wants to designate are visible. Then, the manual designation flag for all the selected entities can be set on using the menu associated with this function.

Another posibility is to associate comment (info) to a certain entity. Association of comment is done in the same way.



Once the manual designation bit is set, or comment is added, the user can filter on the presence of the bit, or on the presence of information, or on the contents of the information field.

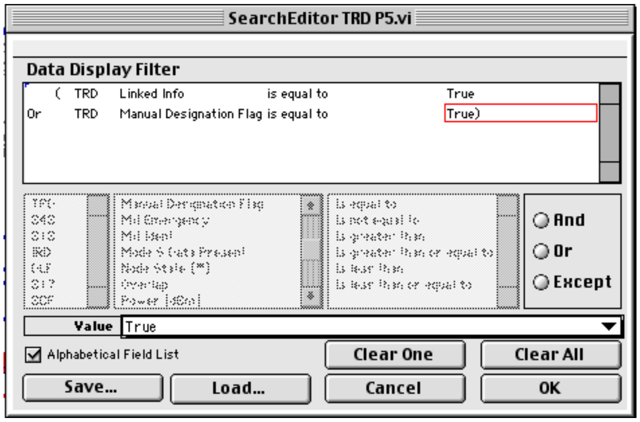
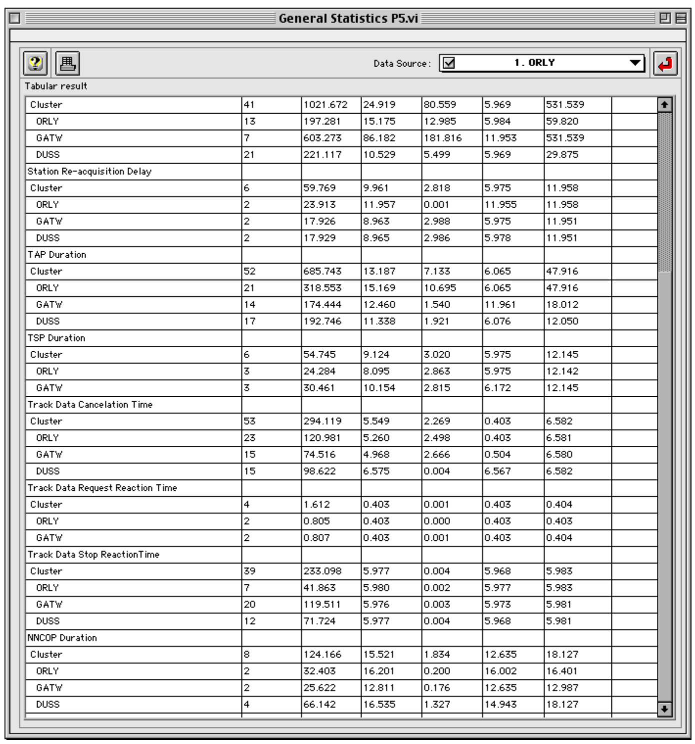


Figure 3-91: filtering on MD or Info flags

3.3.5.3.12. Statistics

T he data display provides a facility to the user to display statistics (min, max, mean, standard deviation, histogram displays) on the following parameters (delays)for the selected data set:

- the cluster acquisition delay
- Station re-acquisition delay
- track acquisition procedure duration
- track Support procedure duration
- transmission delay of category 017
- the load of the SCN



Cluster	41	1021.672	24.919	80.559	5.969	531.539
ORLY	13	197.281	15.175	12.985	5.984	59.820
GATW	7	603.273	86.182	181.816	11.953	531.539
DUSS	21	221.117	10.529	5.499	5.969	29.875
Station Re-acquisition Delay						
Cluster	6	59.769	9.961	2.818	5.975	11.958
ORLY	2	23.913	11.957	0.001	11.955	11.958
GATW	2	17.926	8.963	2.988	5.975	11.951
DUSS	2	17.929	8.965	2.986	5.978	11.951
TAP Duration						
Cluster	52	685.743	13.187	7.133	6.065	47.916
ORLY	21	318.553	15.169	10.695	6.065	47.916
GATW	14	174.444	12.460	1.540	11.961	18.012
DUSS	17	192.746	11.338	1.921	6.076	12.050
TSP Duration						
Cluster	6	54.745	9.124	3.020	5.975	12.145
ORLY	3	24.284	8.095	2.863	5.975	12.142
GATW	3	30.461	10.154	2.815	6.172	12.145
Track Data Cancelation Time						
Cluster	53	294.119	5.549	2.269	0.403	6.582
ORLY	23	120.981	5.260	2.498	0.403	6.581
GATW	15	74.516	4.968	2.666	0.504	6.580
DUSS	15	98.622	6.575	0.004	6.567	6.582
Track Data Request Reaction Time						
Cluster	4	1.612	0.403	0.001	0.403	0.404
ORLY	2	0.805	0.403	0.000	0.403	0.403
GATW	2	0.807	0.403	0.001	0.403	0.404
Track Data Stop ReactionTime						
Cluster	39	233.098	5.977	0.004	5.968	5.983
ORLY	7	41.863	5.980	0.002	5.977	5.983
GATW	20	119.511	5.976	0.003	5.973	5.981
DUSS	12	71.724	5.977	0.004	5.968	5.981
NNCOP Duration						
Cluster	8	124.166	15.521	1.834	12.635	18.127
ORLY	2	32.403	16.201	0.200	16.002	16.401
GATW	2	25.622	12.811	0.176	12.635	12.987
DUSS	4	66.142	16.535	1.327	14.943	18.127

Figure 3-92: Statistics overview

The Explanation of ANAlysis specs above already showed that the results of these calculations can be shown in the data display. Once the data is in the data display, a simple transition to the histogram display shows the statistical data for the required data. The load of the SCN should be calculated using the S file viewer tool. This way the NIMs (not linked in the Data Display) are included in the SCF load.

3.3.5.3.13. Information displays for NNCOP

T he data display provides a facility to the user to display (textual/tabular display of time ordered messages and geographical display for positional information) the following information corresponding to a selected occurrence of a new node connection or of a node change-over in distributed mode :

- all category 048 target reports sent by the involved stations during the procedure,
- all category 017 messages sent and received by the involved stations during the procedure (excluding NIM).

This function is automatically included in the tool and requires the use of the filters "NNCOP " is equal to "Procedure". Next, the data can be shown in the geographical display or textual display using the data display shared axis.

3.3.5.3.14. Information displays for TASPs

T he data display provides a facility to the user to display (textual/tabular display of time ordered messages and geographical display for positional information) the following information corresponding to a selected expected occurrence of a track acquisition procedure or a track support procedure in distributed mode

- *all category 048 target reports sent by the involved stations during the procedure,*
- *all category 017 messages sent and received by the involved stations during the procedure (excluding NIM).*

This function is automatically included in the tool and requires the use of the filters "TAP " or "TSP" is equal to "Procedure". Next, the data can be shown in the geographical display or textual display using the data display shared axis.

3.3.5.3.15. Delta values Display

T he data display provides a facility to the user to calculate and display the following delta parameters corresponding to a selected transmitted track data category 017 message :

- delta in range,
- delta in azimuth,
- delta in altitude,
- delta in ground speed,
- delta in calculated heading.

These values are calculated using the PTE P5 Analyser function and can be shown in the Data display or in the info window.

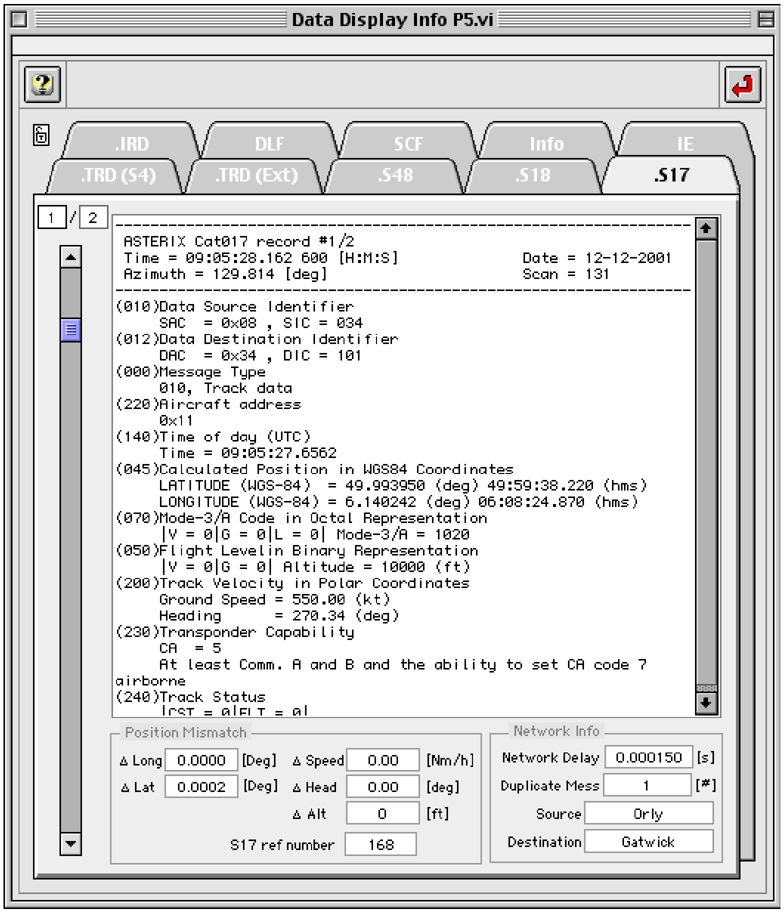


Figure 3-93: Info window showing delta calculated data

3.3.5.3.16. Delta Calculation

The deltas above are calculated against a trajectory derived from the target reports category 048 messages output by the same station. It is assumed that the positional and kinematics information contained in a track data message (category 017) is provided at the same date as the previous target report (category 048). In case this assumption would not be valid, a method will need to be agreed to provide date consistency.

The current method of calculating the delta's between Asterix Cat 48 and cat 17 does not use the target kinematics, and therefore assumes that the cat 17 derived data and the cat 48 data is time consistent. This will be modified in next release of PTE.

3.3.5.3.17. Statistics Display

T he data display provides a facility to the user to calculate and display statistics (min, max, mean, standard deviation, histogram displays) on the selected data set and per station for any of the above parameters

These parameters can be shown in the data display as Y or Z scale, and then the histogram function can be used to calculate and display statistics..

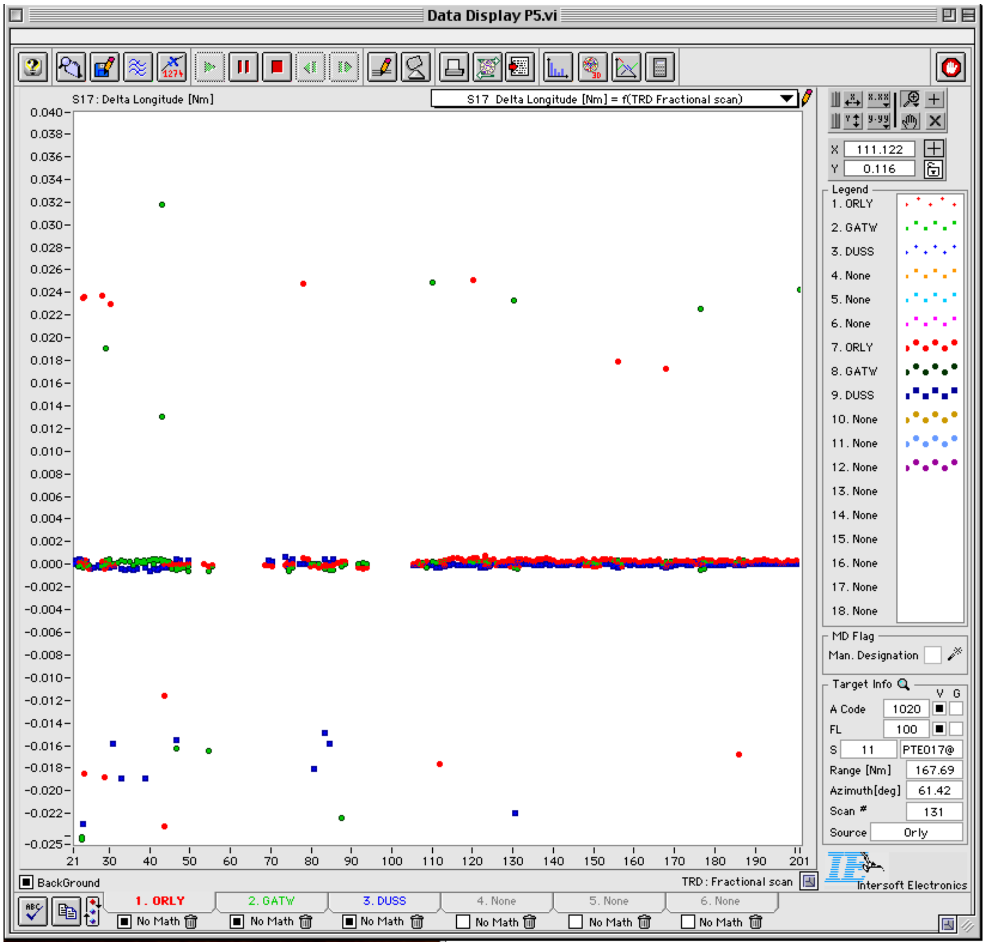


Figure 3-94: Delta Longitude graph

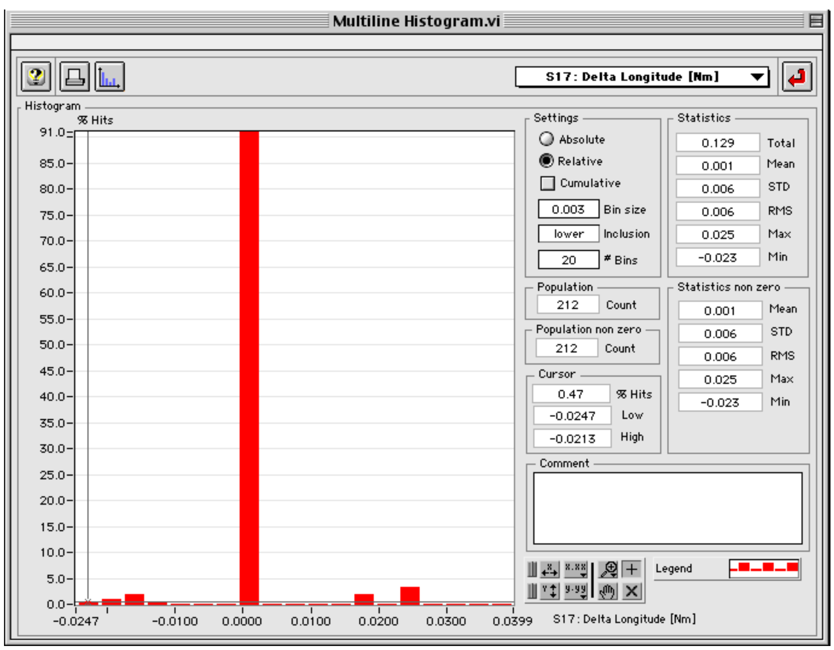


Figure 3-95: delta longitude Histogram and statistical values

3.3.6. PTE –P5 Export features

3.3.6.1. General

The P5 Data Display tool offers a number of specific Export Functions, which are not to related to the Data Display section. These are treated in this chapter.

3.3.6.2. Export Related Specifications

3.3.6.2.1. Saving of Subset of data

Once imported and filtered or not, the system provided a facility to the user to save the resulting data set (to be retrieved in a later session) under a user specified data set name and to associate a comment to this file.

Any data set shown in the data display can be saved and recalled later using the save subset function.

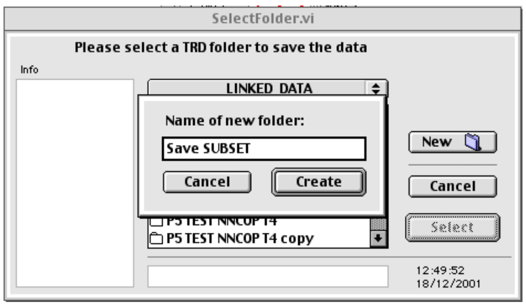


Figure 3-96: Save subset function

3.3.6.2.2. TSF export

The system provides a facility to the user to export under a tab or comma separated variable format any results displayed in a textual format.

The data shown in the tabualr views (see spec DISP 00) can also be saved as a TSF format. This feature is a standard HMI function of PTE , developed under PTE P2B1.

3.3.6.2.3. Meta File export

The system provides a facility to the user to export under a metafile format any results displayed in order to allow its importing in a Word document.

The Mac OS has a standard function embedded (using the Command-Shift-3 or Command - shift-4 key combination) to create metafiles on disk. The Command-Shift-3 function creates a picture of the entire screen, while Command - shift-4 allows the selection of a section of the screen. This files can easily be imported in an existing COTS reporting tool, such as MS-Word.

3.3.6.2.4. Printing of Data

The system shall provide a facility to the user to print any displayed results.

The printing function is a standard feature of the PTE tool. All displays can be printed or saved to pdf format.