

TECHNICAL DESCRIPTION



FYLDE SUPERTRUNK INFRASTRUCTURE

Version: 5.30

Date: 15th April 2002

APPLICABILITY

This document is intended as an introduction to the Fylde Microsystems Trunking product range. The information necessary to enable routine service, maintenance, and set-up work by competent engineering staff on infrastructure fitted with series IV software is contained in the full service manual which is supplied with each system sale.

ASSOCIATED DOCUMENTS

Operation and Service Manual for Fylde Trunked Infrastructure
Inter-Regional Processor Service and Maintenance manual
MHD - Message Handling Despatcher software manual
PCM Switch Matrix service and maintenance manual
SYSCON - System Terminal Manual for Fylde Trunking (DOS)
SYSCON for NT® - System Terminal Manual for Fylde Trunking

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INTRODUCTION

Company Background

Fylde Microsystems Ltd. specialises in the design and development of digital equipment for trunked mobile radio systems. The company, which is based in the Northwest of England, has over 15 years experience in this field. To date, Fylde Microsystems has supplied equipment into more than 50 countries throughout the world.

The Product

FyldeSuperTrunk radio systems and ancillary equipment conform to the MPT1327 standard. Systems range from single-site, single channel, up to wide-area networks of up to 800 sites.

MPT1327 Specification

The Department of Trade and Industry (DTI) in the U.K publish this specification. It details a common signalling standard for land based trunked-radio systems operating primarily in the UK's VHF Band III Sub-band 1 & 2. This protocol has become a de-facto standard for trunking systems across the world.

Fylde were pleased to be represented on the original MPT1327 drafting committee from the Spring of 1985 onwards, and thus have a complete understanding and extensive experience of the protocol, its workings and methods. In fact Fylde are probably unique in that their representative is also responsible for the design of the hardware and software for their range of mobile radio unit signalling boards.

MPT1343 is the "AIR INTERFACE SPECIFICATION" intended to ensure that mobiles behave correctly on MPT1327 networks thus providing true compatibility between radio units and systems originating from differing manufacturers.

MPT1352 is the "PERFORMANCE/TEST SPECIFICATION" for radio units operating under the above standards. To approve a radio unit to MPT1352, it must undergo a

comprehensive and exhausting series of tests under the close scrutiny of the DTI.

All new radio unit signalling boards from Fylde Microsystems meet both MPT1343 and MPT1352 specifications before they are released onto the market.

Salient Issues

Design Philosophy

Modular design and construction allows the system to be expanded or contracted as operational experience is gained. Any number of RF channels from 1 to 24 can be accommodated on a single site. Since each sub-rack houses a complete channel controller, channels may be added or removed simply. No software changes are necessary; the system automatically reconfigures itself. In fact changes may be made with the system 'live' to minimise disruptions to service. Single site installations can be upgraded to multi-site later by adding the *Regional Control Processor*. No software upgrades are required and there is no redundant hardware either.

Gradual Degradation

Gradual degradation is built into the system to greatly increase reliability and quality of service. If the *System Control Interface* fails, the *TSC Channel Cards* will continue to process traffic. Of course *System Control Interface* functions will cease and all subscribers will be 'white-listed' in this case. If a *TSC Channel Card* or its associated RF Equipment fails, then it will be taken out-of-service automatically and the failure reported. Should a *Channel Card* fail on a typical 5-channel site, system capacity will be reduced by only 20%. Functionality remains unchanged and there is no messy fall-back mode. Should the *RCP* fail in a multi-site system the TSC sites will still operate in local mode with no loss of performance.



SECTION 1

INTRODUCTION

1

Achieving Spectral Efficiency

In the UK, trunking systems were promoted from the start as a means of improving spectral efficiency. Fylde Trunking systems aim to be as efficient as possible in both control channel signalling and traffic channel management.

Control Channel Efficiency

Today, AVL, e-mail, and other short data messages put an increased burden on the control channel. Care must be taken to maximise data throughput whilst minimising delays to speech calls. Fylde achieve this through careful design honed by over 15 years of practical experience in system design. In practice:

- No unnecessary wait states on the control channel.
- Specific site registration, rather than multiple registration, avoids duplicate AHOY messages on adjacent cells.
- High-speed real-time processing ensures that call processing begins as soon as a request is received. There is no processor latency.

Traffic Channel Efficiency

Fylde realise that in many countries traffic channels are a scarce resource. It is therefore essential that systems are quick to react when calls are held on queue. Consider a one-second delay when each traffic channel becomes free. On a 20-channel site that would comprise a waste of 20 call-seconds on that site. Such resource could be used to support a better grade of service or additional users. Below are some of the features that Fylde provide to help the network operator extract the best return from valuable spectrum:

- Dynamic Call Timer
- Vote Now Advice
- Low processor latency to ensure traffic channels stand idle for as short a time as possible when they become free.
- Fine-grained subscriber control to accurately control features and coverage on a radio by radio basis.

- Automatic Group Roaming ensures that traffic channels will be allocated only on sites where members of the group are registered.

EMC Policy

Overall Responsibilities

The overall responsibility for compliance with EMC Directive 89/336/EEC(143) rests with the complete radio system supplier.

Where Fylde supply complete turnkey systems, we will ensure that all third-party supplied parts either conform in isolation or have the necessary approved screened casings fitted.

The Fylde EMC Philosophy

In order to simplify construction of systems for all customers, modules are certified for compliance individually unless specifically otherwise stated.

Fylde have taken a great deal of care in manufacturing their equipment so that unsightly ferrite cores on interconnection leads are not required.



The FYLDE Trunking Concept

Traditionally, communications systems comprise of a large central processor with, sometimes, a separate backup system in case of equipment failure. These systems do not exhibit any gradual degradation and a single failure can present a complete loss of service to the user.

Wherever possible, the Fylde Trunking System uses distributed processing, structured so that equipment failures only have a limited effect on system operation i.e. on a radio site each RF channel has a digital processor card associated with it. Therefore, should any 1 channel fail (Transmitter, Receiver or Processor) the other channels can continue normal operation. If a 5-channel system is considered, a failure of 1 channel simply reduces system capacity by 20%. In fact, 4 channels could fail and the system would actually operate in single channel mode! No messy fall-back mode is required for the radio units so that impact on the user is kept to a minimum.

Modular construction allows easy configuration changes to the system. Each site may have from 1 to 24 RF channels. Each regional system may comprise up to 10 of these sites, and 16 regions may be connected to an Inter-Regional Processor. In turn, 5 IRPs can be networked, making a total network capacity of 800 sites.

All site interconnections may be realised with low cost fixed-links to minimise operating costs. Of course, where they can be provided, digital circuits and microwave form an excellent bearer for site interconnection. Even when using low cost lines system performance is good. Fylde Trunking exhibits the fastest local call set-up times possible using the MPT1327 protocol. Inter-site call set-up time is approximately 2.0 seconds with the Go-To-Channel messages (these are the messages which switch the mobiles to a traffic channel) synchronised to within 0.5 seconds. Group calls within a single cell are set-up in just 217 ms.

System facilities are not compromised in achieving this, here are a few of the features available:

- Modular construction - channels or even complete sites may be added or removed

without the need to change software or even power off the existing equipment.

- Scalable - Single site installations may be upgraded to multi-site at any time without any hardware being made redundant.
- Full call logging. Over 20 parameters stored for each call.
- Operational Statistical Analysis graphs help determine system throughput and quality of service.
- Control Parameters can be set for each individual site. These may be changed automatically by time of day or day of week to optimise configuration.
- 12 selectable call timers, including a Dynamic Call Timer, allows for total operator flexibility.
- EVERY radio unit is validated at every call attempt to ascertain that the requested service is available to that radio unit.
- EVERY radio unit has over 25 control fields associated with it, all accessible from the system management terminal for the ultimate in subscriber control.
- Comprehensive system status reporting.
- Control of the system and individual subscribers by time and day.
- PSTN/PABX access at both site and regional level.

The basic components of the system

TSC Channel Card



Figure 1: 1U TSCC02f Channel Cards



Figure : 2 TSCC03 Channel Cards

The *TSC Channel Card* performs all the major MPT1327 trunked radio functions. It controls the radio base station associated with it and manages any line interfaces that may be optionally connected, so that audio paths may be correctly routed for both local and intersite calls. A *TSC Channel Card* can operate on its own as a single channel MPT1327 repeater. No other processors whatsoever are necessary.

A summary of what you can do with *TSC Channel Cards* on their own:

- i) Local RQS and RQE speech and non-prescribed data(NPD) calls
- ii) Local RQQ status calls
- iii) Local Short Data Message (SDM II) calls up to 184 bits free-format or MPT1343 types
- iv) With more than one channel - call queuing for channel
- v) With more than one channel - queuing for 'called party busy'
- vi) Operates with default control parameters - alterable with standard programmer

- vii) Monitor various alarms and provide visual indications of status.

The TSC03 channel card incorporates all the functionality of previous channel cards but also adds the following features

- i) Smaller size allowing up-to 4 units to be fitted into a 1U tray.
- ii) Flash configuration and upgrade.
- iii) Optional plug in line interface (LIFU) for inter-site audio switching including line mixing for inter-site group calls and automatic line loop-back for line testing.
- iv) Soft-pot control of FFSK input and output levels.
- v) Soft-pot control of inter-site audio line levels (when LIFU is fitted).
- vi) Built in virtual scope alignment tool for rapid in the field configuration and alignment.

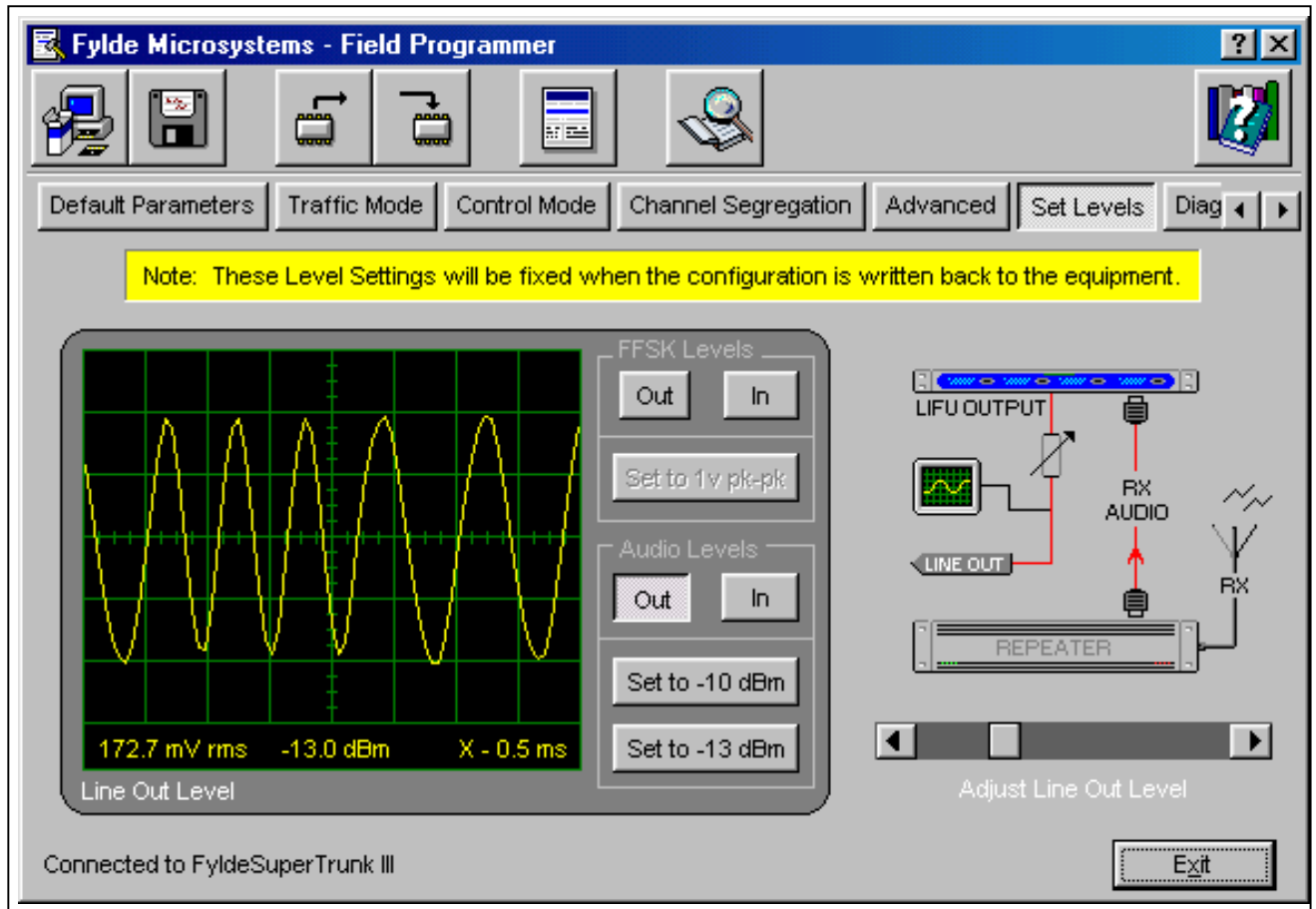


Figure : 3 TSCC03 Field Programmer showing virtual scope.

System Control Interface

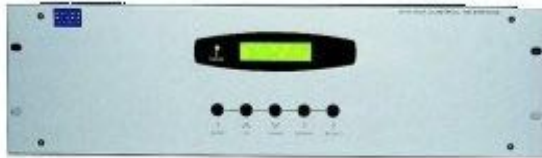


Figure 4: System Control Interface

The *System Control Interface* operates in conjunction with the *TSC Channel Cards* to form the complete trunking site. Its primary function is to connect the channel cards to the outside world. This could be a system terminal PC for a single-site system, or the *Regional Control Processor* if a multi-site wide area network. However, several other important facilities are provided as well:

- i) Individual subscriber validation - everyone is now 'black listed' until a record enabling access is entered.
- ii) Call records stored on a call by call basis.
- iii) Call statistics are compiled over a rolling 24 hour period.
- iv) Operational control parameters can be altered via the system terminal
- v) System alarms are presented to the system terminal
- vi) Rack temperature may be monitored remotely via the system terminal
- vii) Auxiliary monitoring and output drivers available for custom use, accessible via the system terminal.
- viii) Multi-site connection interface.
- ix) Interface for PSTN interconnect.

Regional Control Processor



Figure 5: Regional Control Processor

The *Regional Control Processor* is used to connect together up to 10 *System Control Interfaces* (10 sites) to form a regional network. Although schematic layouts suggest that this is a central processing element, in fact it is essentially a *router* of calls - but it does possess one or two value-added extras:

- i) Gateway to the PSTN via a maximum of 24 lines
- ii) Gateway to up to 8 PABXs via a maximum of 24 lines
- iii) Access to 16 PC-based line connected dispatchers
- iv) Call Diversion facilities
- v) Pooled Channels (frequency sharing)
- vi) Expansion port to the *Inter-Regional Processor* for very large networks of up to 800 sites

PCM Switch

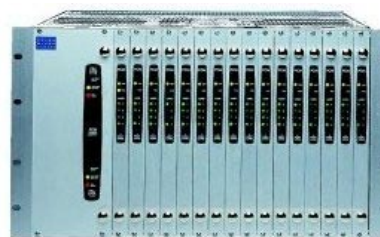


Figure 6: 6U PCM Switch

(2U 4 port version also available)

The *PCM Switch Matrix* provides for all the switching of speech (or non-prescribed data)

between radio sites, line dispatchers, the PSTN, or PABXs.

There is no call set-up logic as such in the switch, but it does provide intelligent processing to interface with phone systems e.g. E & M interfacing and DTMF dialling. 10 i.p.s. dialling is available outbound from the switch only. All common 2-wire and 4-wire analogue private circuits can be accommodated.

All barriers and interfaces are built into every 4-port card as standard so that configuration and wiring is very straightforward.

Inter Regional Processor



Figure 7: Inter Regional Processor

The *Inter Regional Processor* ties together as many as 16 regions where 160-site capacity is required. *IRPs* can run in parallel, connected by LAN or high-speed WAN running TCP/IP, to give 800-site coverage.

Inter-regional working is seamless and fully automatic. Users may roam anywhere in the network, so long as they are authorised by the system management terminals (*SYSCON*) to do so.

A *PCM Switch* may be optionally connected to the *IRP* to enable multi-region group calls, or simply to maximise fixed-link efficiency.

Let's Build a System

Step 1: First a repeater is required...



Step 3 Add more channels



Step 2: Attach a TSC Channel Card for MPT1327 operation



Step 4: Add an SCI for subscriber validation and system control.



1

SECTION 1 INTRODUCTION

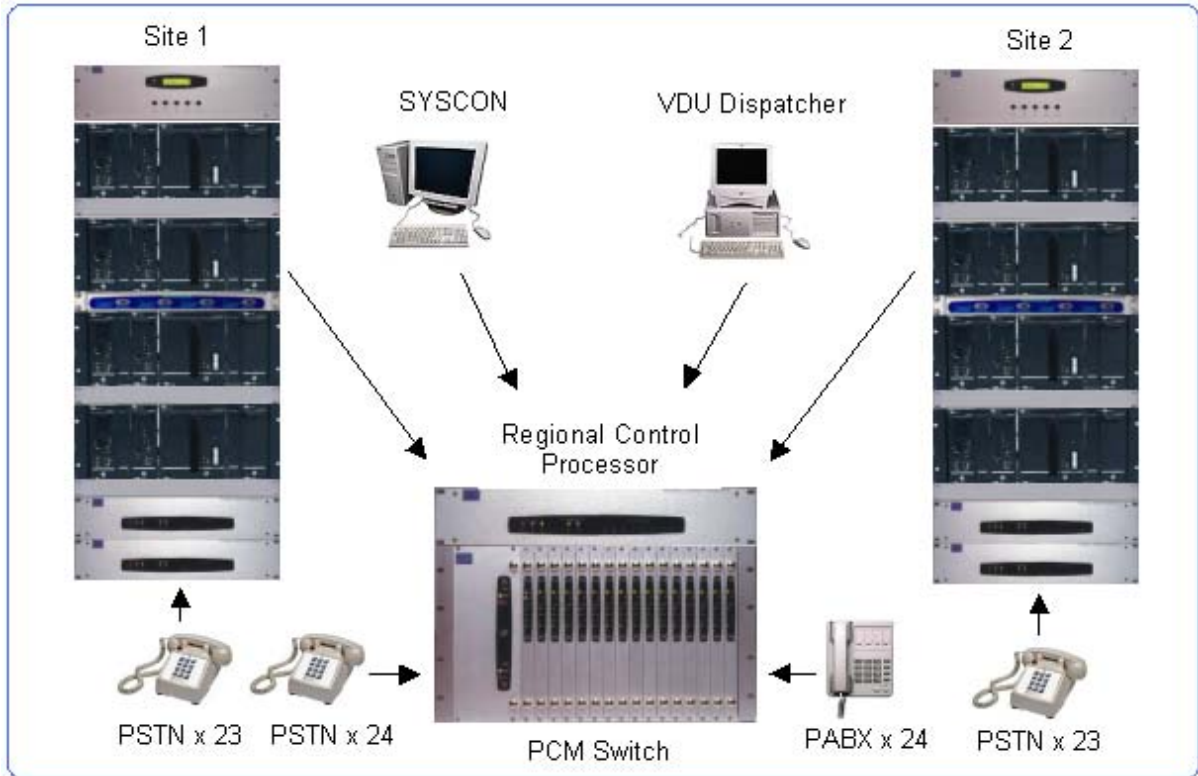


Step 5: Connect SYSCON to the SCI for network management and control.

Step 6: Add a local PCM Switch or SSTAK for PSTN Interconnect.



Step 7: Going regional – up to 10 sites

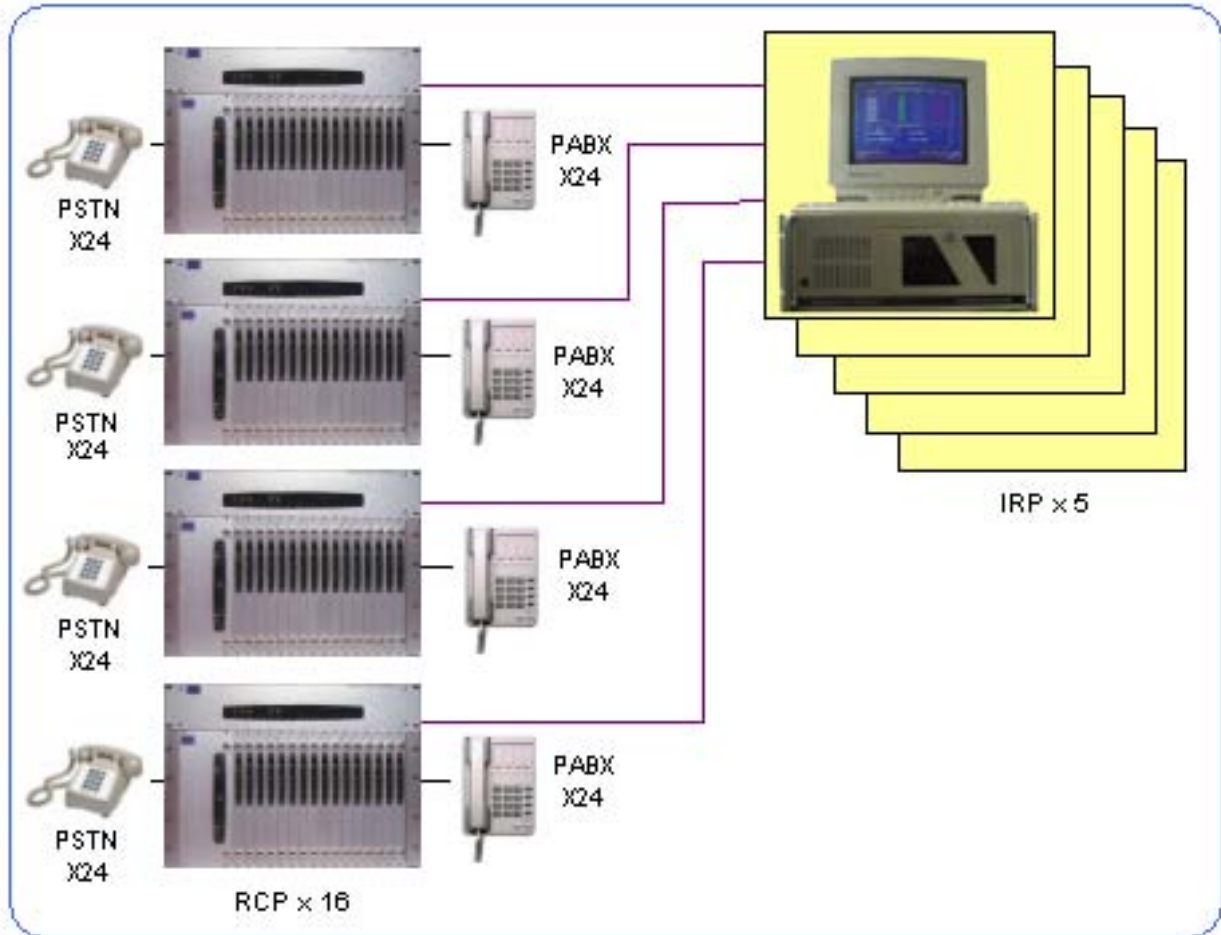


1 SECTION 1

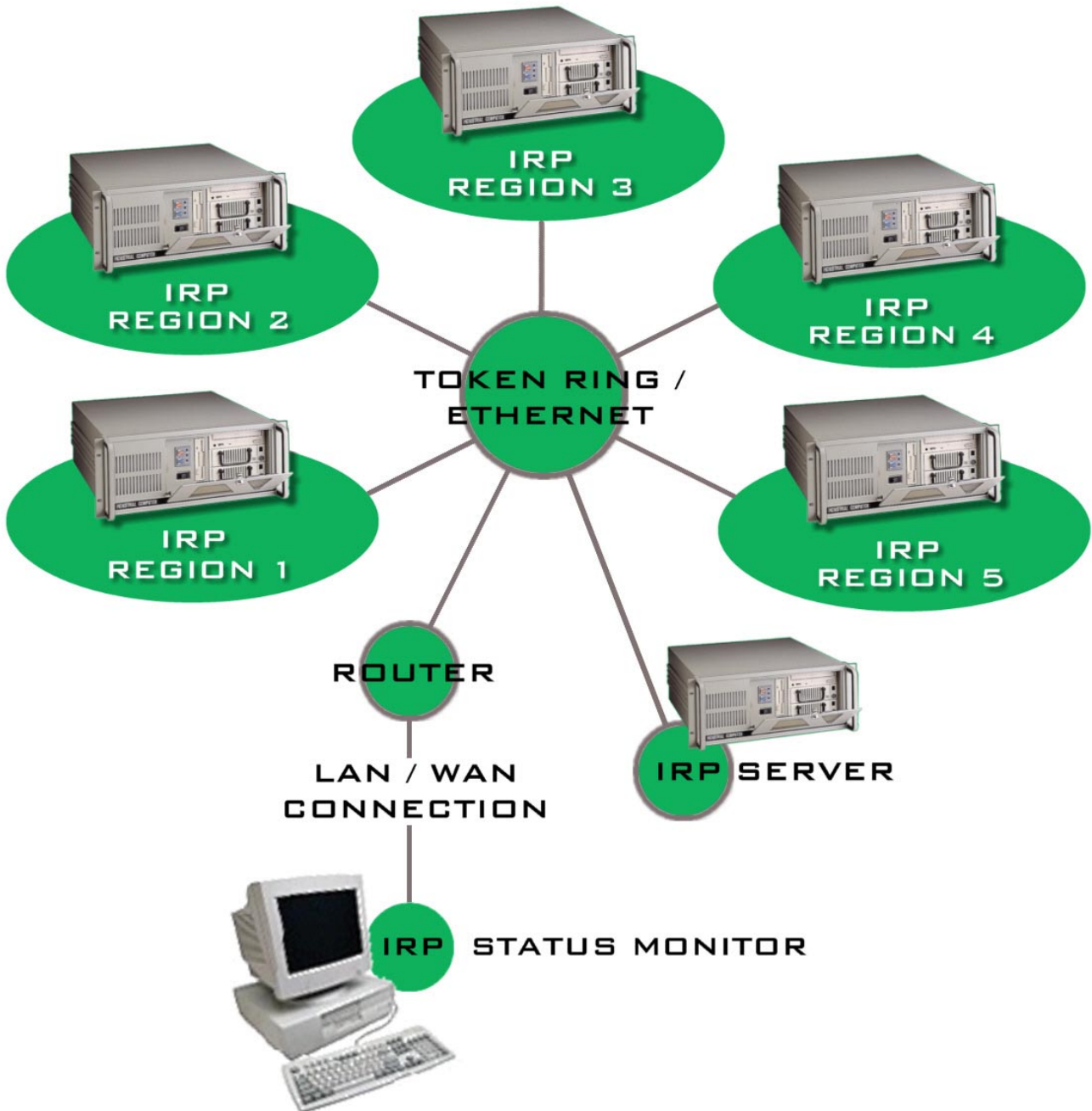
INTRODUCTION



Step 8: Connecting regions – 16 regions per IRP x 5 IRPs = 800 Sites



Step 9: Connecting upto 800 sites – 5 IRPs





How Do You Connect Them?

Connecting TSC Channel Cards

TSC Channel Cards talk to one another, and the *SCI*, via a bi-directional serial bus running at 63,000/126,000 Baud. The SIO Bus uses a proprietary protocol optimised for MPT1327 applications, with mild data compression to reduce processing overhead and provide additional security. A single twisted-pair overall screened cable makes for simple and robust connection.

Connecting the System Control Interface

On one side the *System Control Interface* communicates with *TSC Channel Cards*, on the other, with the outside world. This would be a system terminal (*SYSCON*) on single site systems, or the *Regional Control Processor* if multi-site. RS232 port A is used for conveying data at rates of between 1200 to 19200 Baud. The link protocol is binary, with mild compression yielding an approximate 3:1 advantage over an equivalent ASCII method. With appropriate interfacing, almost any bearer that exhibits a low end-to-end delay may be used, such as 2/4-wire, microwave, UHF radio-link, or digital 64Kbits/E1/T1.

RS232 port B can drive a *PCM Switch* to provide site-level connection to the PSTN. RS232 port B is also used for software upgrading and configuration.

In multi-site systems, speech circuits are fed directly from the base station audio interfaces to the regional node via 2/4-wire analogue, or 64Kbits/T1/E1 digital with the appropriate interfacing equipment.

Connecting to the Regional Control Processor

All control links to the *RCP* may run at any rate between 1200 and 19200 Baud. And with the exceptional of the connection to the *PCM Switch*, the Fylde Binary Links protocol as described for the *SCI* above, is used.

Connecting to the PCM Switch

Audio interfaces are provided for 2/4-wire analogue private circuits, 2-wire telephone extension mode (POTS), and E&M signalling to DC5A standard for telephones.

The *PCM Switch* is approved for operation in many parts of the world.

Connection to the Inter Regional Processor

All control links to the *IRP* may run at either 9600 or 19200 Baud. And with the exception of the connection to the *PCM Switch*, the Fylde Binary Links protocol as described for the *SCI* above, is used.

Connecting Inter Regional Systems together

Up to 5 inter regional processors (*IRP'S*) can be networked together using TCP/IP connections over a LAN or WAN. An *IRP* server, based on similar hardware to the standard *IRP* will act as the master controller for the network.

Each *IRP* will have a 10/100 Base T network card with suitable Packet TCP/IP drivers. This may then be connected to any suitable ethernet/token ring LAN/WAN or a dedicated LAN.

Each *IRP* and the *IRP* server will have a specific IP address, which will be fixed at commissioning.

(Note: care must be taken to maximise the performance of the LAN/WAN for *IRP* traffic, otherwise call setup time may be affected.)

All call setup and data transfer between *IRP's* will be via the TCP/IP links to and from the *IRP* server.

The *IRP* server may also have an associated *PCM* switch. Audio links between the *IRP's* may be routed via the *PCM* switch connected to the *IRP* server, or direct between the *IRP's*.

An optional *IRP* server status monitor may also be connected to the *IRP* server network.

This is a Windows based software package which can display the current status of the *IRP* server and links, including the TCP/IP loading, line status, alarms, calls in progress etc.

Connection to SYSCON and MHDs

The system terminal (*SYSCON*) and Message Handling Despatchers (*MHDs*) can connect into the host at any rate between 1200 and 19200 Baud. The Fylde Binary Links protocol as described for the *SCI* above, is used.



FEATURES & SPECIFICATIONS

HARDWARE SPECIFICATIONS

TSC Channel Card (TSCC02f)

DESCRIPTION		SPECIFICATION
POWER REQUIREMENTS (operational) – DC only	.....	8-18Vdc @ 375mA
POWER REQ. (Maximum current @ switch on)	.....	10A pk / 250μS max.
OPERATING TEMPERATURE RANGE	.....	-10°C to + 70°C
OPERATING HUMIDITY RANGE	.....	10% to 90% n/c.
MAXIMUM number of RF Channels per site	.....	24
MINIMUM number of RF Channels per site	.....	01
MAXIMUM Speech /NPD Call Queue Depth	.....	31
MAXIMUM Short Data Call Queue Depth	.....	16
MAXIMUM population (not limited by ch. card)	.....	1,036,800
DEDICATED Low Forward Power Alarm	.....	TTL input
DEDICATED High Reverse Power Alarm	.....	TTL input
DEDICATED Line Interface Unit Alarm	.....	TTL input
DEDICATED Receiver Mute Alarm	.....	TTL input
UNDEDICATED Alarms	.....	3 TTL inputs
BASE STATION INTERFACE connectors	.....	2 x 15 way D-types
SIO BUS INTERFACE connector	.....	9 way D-type
POWER connector	.....	9 way D-type
APPROVALS (TSCC02f)	.....	EMC Directive 89/336/EEC(143)

2

SECTION 2

Features & Specifications



TSC Channel Card (TSCC03)

DESCRIPTION		SPECIFICATION
POWER REQUIREMENTS (operational) – DC only	.....	8-18Vdc @ 225mA
POWER REQ. (Maximum current @ switch on)	.....	10A pk / 250µS max.
OPERATING TEMPERATURE RANGE	.....	-10°C to + 70°C
OPERATING HUMIDITY RANGE	.....	10% to 90% n/c.
MAXIMUM number of RF Channels per site	.....	24
MINIMUM number of RF Channels per site	.....	01
MAXIMUM Speech /NPD Call Queue Depth	.....	31
MAXIMUM Short Data Call Queue Depth	.....	16
MAXIMUM population (not limited by ch. card)	.....	1,036,800
DEDICATED Low Forward Power Alarm	.....	TTL input
DEDICATED High Reverse Power Alarm	.....	TTL input
DEDICATED Line Interface Unit Alarm	.....	TTL input
DEDICATED Receiver Mute Alarm	.....	TTL input
UNDEDICATED Alarms	.....	3 TTL inputs
BASE STATION INTERFACE connectors	.....	25 way D-type
SIO BUS INTERFACE connector	.....	9 way D-type
POWER connector	.....	Powered via BASE STATION interface connector
Line Interface Unit connector		RJ45
Line Interface Unit Interface		4 Wire 600 ohm
Line Interface Levels		-20dBm to 0dBm softpot adjustable.
APPROVALS (TSCC03)	.....	EMC Directive 89/336/EEC(143)

System Control Interface (SCI03e)

DESCRIPTION		SPECIFICATION
POWER REQUIREMENTS (operational) – DC only	.....	8-18Vdc @ 200mA
OPERATING TEMPERATURE RANGE	.....	-10°C to + 70°C
OPERATING HUMIDITY RANGE	.....	10% to 90% n/c.
MAXIMUM number of Validatable Radio Units	.....	> 100,000 Idents
MAXIMUM item billing store capacity	.....	> 20,000 calls
INTERFACE to System Terminal / RCP (Port A)	.....	RS232 (9 way D-type)
INTERFACE to Programming Terminal and optional local PCM Switch (Port B)	.....	RS232 (9 way D-type)
SIO BUS INTERFACE connector	.....	9 way D-type
POWER connector	.....	9 way D-type
INTERFACE to Remote Monitoring	.....	15 way sub D-type
APPROVALS (SCI03e)	.....	EMC Directive 89/336/EEC(143)



SECTION 2

Features & Specifications

2

Regional Control Processor (RCP02e)

DESCRIPTION		SPECIFICATION
POWER REQUIREMENTS (operational) - DC ONLY	.....	+10 to 18VDC @ .5A
OPERATING TEMPERATURE RANGE	.....	-10°C to + 70°C
OPERATING HUMIDITY RANGE	.....	10% to 90% n/c.
MAXIMUM number of TSC Sites	.....	10
MAXIMUM number of PSTN phone lines	.....	24
MAXIMUM number of PABX phone lines	.....	24 on 8 exchanges
MAXIMUM number of VDU Line Dispatchers	.....	16
MAXIMUM number of Inter-regional gateways	.....	1
MAXIMUM number of PCM switch interfaces	.....	1
MAXIMUM number of System Terminal interfaces	.....	2
MAXIMUM number of simultaneous speech calls	.....	64
All INTERFACE TYPES	.....	RS232 - 9 way D-type
APPROVALS	.....	EMC Directive 89/336/EEC(143)

Single Site Interconnect Unit (part of SSTAK)

DESCRIPTION		SPECIFICATION
POWER REQUIREMENTS (operational) DC ONLY	.....	+10 to 18VDC @ .5A
OPERATING TEMPERATURE RANGE	.....	-10°C to + 70°C
OPERATING HUMIDITY RANGE	.....	10% to 90% n/c.
MAXIMUM number of TSC Sites	.....	1
MAXIMUM number of PSTN phone lines	.....	24
MAXIMUM number of PABX phone lines	.....	24 on 8 exchanges
MAXIMUM number of VDU Line Dispatchers	.....	16
MAXIMUM number of Inter-regional gateways	.....	0
MAXIMUM number of PCM switch interfaces	.....	1
MAXIMUM number of System Terminal interfaces	.....	1
MAXIMUM number of simultaneous speech calls	.....	39 (23 traffic channels and 16 VDU dispatchers).
All INTERFACE TYPES	.....	RS232 - 9 way D-type
APPROVALS	.....	EMC Directive 89/336/EEC(143)

Inter-Regional Processor

DESCRIPTION		SPECIFICATION
POWER REQUIREMENTS - AC ONLY	.....	110/240VAC @ 500VA
OPERATING TEMPERATURE RANGE	.....	0°C to + 55°C
OPERATING HUMIDITY RANGE	.....	10% to 90% n/c.
MAXIMUM number of Regional Interfaces	.....	16
MAXIMUM number of speech ccts. per region	.....	24
MAXIMUM number of PCM switch interfaces	.....	1 (optional)
MAXIMUM number of Diagnostic Terminals	.....	1
MAXIMUM number of simultaneous speech calls	.....	64 (128 port switch capacity ÷ 2)
All INTERFACE TYPES	.....	RS232 - 25 way D-type
ADVANTECH industrial PC chassis	.....	EMC Directive 89/336/EEC(143)

2

SECTION 2

Features & Specifications



PCM Switch Matrix

DESCRIPTION		SPECIFICATION
POWER REQUIREMENTS - AC	.....	110/240VAC @ 100VA
POWER REQUIREMENTS - DC	.....	11-14VDC @ 10A
OPERATING TEMPERATURE RANGE	.....	-10°C to + 70°C
OPERATING HUMIDITY RANGE	.....	10% to 90% n/c.
MAXIMUM number of PCM ports	.....	192
MAXIMUM number of phone interfaces	.....	2 per 4-port card
CONTROL INTERFACE TYPE	.....	RS232 - 25 way D
APPROVALS	.....	BABT – UK EMC Directive 89/336/EEC(143)



SECTION 2

Features & Specifications

2

FEATURES

Single Site Systems

	DESCRIPTION	FUNCTION
1)	Alarms on Transmitter, Line Interface, and controller card with optional forwarding to e-mail destinations (e.g. mobile phones).	Monitoring & reporting of alarms to the system terminal with forwarding to e-mail destinations such as WAP phones and pagers.
2)	Auxiliary Alarm inputs / control outputs with optional alarm forwarding to e-mail destinations (e.g. mobile phones).	5 analogue (0-51 volt) and 2 TTL inputs with 5 o/c outputs provided per site. The user can define alarm thresholds. Forwarding of auxiliary alarms to e-mail destinations such as WAP phones and pagers is also provided.
3)	Broadcast Group Calls.	Group calls where recipients cannot transmit.
4)	Call Statistics.	Traffic channel usage statistics are recorded over a rolling 24-hour period as per UK specification MPT1318.
5)	Call Type-Dependant Timers.	Can be selected to override other call timers for: Non-Prescribed Data Calls, Emergency Calls, PSTN Calls, and PABX Calls.
6)	CBS Share.	A trunked channel can share a frequency with a <i>Community Base Station</i> (repeater). Either the CBS or trunking may be assigned priority.
7)	Channel Segregation.	Allows certain channels to be used only by defined radio sub-groups.
8)	Control Channel Anti-Jamming.	Protection is provided against jamming or interference.
9)	Dynamic Call Timer.	Modifies maximum call duration dependent upon system load.
10)	Extended Call Timer.	Maximum call duration upto 18 hours is available for specialist applications.
11)	Fine-Grained Subscriber Control.	25 fields provide control on a subscriber by subscriber basis.
12)	Fixed Call Timers.	6 Fixed call timers available on a subscriber basis.
13)	FLASH reprogramming and Configuration.	TSCC02e Channel Cards can be upgraded to Flash by way of plug-in modules. TSCC02f and TSCC03 units are flash equipped from new. SCI03 System Control Interfaces are also flash equipped.
14)	Group calls with 3 basic priority levels.	Normal, high, and emergency priority levels are available for group calls. Number of priority levels is multiplied when <i>Channel Segregation</i> is used.
15)	Individual calls with 3 basic priority levels.	Normal, high, and emergency priority levels are available for individual or private calls. Number of priority levels is multiplied when <i>Channel Segregation</i> is used.
16)	Inter-prefix calls.	Both common-prefix and inter-prefix addressing is supported for all call types.
17)	Item Billing of all call types with Call Record Analysis Tools.	Over 20 parameters are recorded for download to the system terminal. Advanced sorting and filtering is provided with outputs to tables, printed reports, or colour graphs. File format is industry standard MDB or CSV, for easy export and post-processing.
18)	Late Entry Group Calls.	Repeat Go-To-Channel messages are available during group calls for certain applications.

2

SECTION 2

Features & Specifications



	DESCRIPTION	FUNCTION
19)	Maximum subscriber capacity > 16,000.	Unlikely to be a limit on a single site system.
20)	Maximum call record storage > 20,000.	Provides a buffer in case regular downloads to the system terminal cannot be made.
21)	MPT1327, MPT1343, and CPS numbering.	In addition to the basic MPT1327 numbering, MPT1343, and Chinese Police System schemes are supported.
22)	Non-prescribed Data calls with 3 basic priority levels.	Normal, high, and emergency priority levels are available for individual and group calls. Number of priority levels is multiplied when <i>Channel Segregation</i> is used.
23)	Pre-emptive Emergency Call.	Full Emergency pre-empt for channel and ANY other conflict.
24)	PSTN Calls.	Up to 23 lines can be connected at site level by connection of a <i>PCM switch</i> directly to the <i>SCI</i> .
25)	PSTN Destination Barring.	1st 4 digits of dialling string checked against 8 entry barring table. Includes wildcards.
26)	PSTN Dial string filtering.	Caters for PSTN exchanges that require area code digits to be stripped and other complex conditions.
27)	Queuing on all call types for resources and for called party busy.	Ensures the maximum effect is derived from the trunking philosophy.
28)	Rack Temperature, SCI supply, and Lithium Battery monitoring at every site.	Provided by SCI03 to local display & SYSCON.
29)	Remote Diagnostics.	Fylde Microsystems can perform in depth diagnostics by dial-up access to any system equipped with a suitable modem.
30)	Remote Site Control.	Inhibit or restart any channel from system terminal.
31)	Remote Site Status.	Display of current site usage on system terminal.
32)	Status Calls.	30 x 5-bit status fields available for custom use.
33)	Short Data Messages.	Up to 184 bits of free-format data may be sent on the control channel (or MPT1343 format).
34)	Soft-Alignment.	TSCC03 channel cards allow for all FFSK and line levels to be set via the <i>Field Programmer</i> (Flash and configuration program). Built-in "Virtual Scope" displays FFSK and line signals for precision alignment.
35)	Time-tagged System Control.	Up to 16 sets of control parameters can be defined to become automatically active at predefined times/days.
36)	Time-tagged Customer Control.	Control by time of day of radio unit's ability to access the system.
37)	Traffic Channel Protection.	Protection is provided against interference or faulty receiver equipment.



SECTION 2

Features & Specifications

2

Regional Systems

Regional systems can comprise up to 10 radio sites. Features include all those listed for single site installations plus:

	DESCRIPTION	FUNCTION
38)	Additional PSTN Interconnect.	Inbound and outbound services via up to 24 PSTN phone lines.
39)	Automatic Group Roaming.	Ensures that traffic channels are allocated only on cells where members of the group are registered.
40)	Automatic Line Testing.	All circuits are continuously tested and faults reported via the system terminal.
41)	Call Diversion.	Call divert to another radio, a group, or a line connected destination.
42)	Internet connection & E-Mail services.	A gateway to the internet (or other network) is provided by the Line Connected VDU Dispatcher (see below). Short text e-mails to radio units can be accomplished by conversion to Short Data Messages. Conversion to Non-Prescribed Data is also possible for long transactions.
43)	Inter-site calling of all call types including group calls.	Full roaming and automatic call routing with control of coverage via system terminal.
44)	Line Connected VDU Dispatchers.	Up to 16 dispatchers can be accessed each with network operator definable numbers which may include wild prefix.
45)	Maximum subscriber capacity > 100,000.	Sufficient to realise national systems in many countries.
46)	Maximum call record storage > 20,000.	This is a <i>cache</i> store <u>additional</u> to the capacity provided at every radio site.
47)	PABX Interconnect.	Up to 24 lines can be allocated in any combination with up to 8 different exchanges.
48)	Pooled Channels.	Allows the use of co-frequency channels in areas of overlapping radio coverage.
49)	PSTN Shortform Dialling.	Global shortform PSTN destinations definable by network operator.
50)	Vote Now Advice.	Advises radio units of adjacent sites where signal strength could be better



 Inter-Regional Systems

Inter-regional systems provide all the major call types over the whole system.

	DESCRIPTION	FUNCTION
51)	Automatic PSTN routing	Calls from the PSTN will be routed through the <i>IRP</i> to the called party wherever registered.
52)	Alternate speech call routing.	With the optional PCM switch at the inter-regional node, maximum economy of speech circuits between regions can be achieved.
53)	Full Inter-Regional statistics.	Inter-regional usage statistics and registration change logs are available at the <i>IRP</i> .
54)	Home PABX	Calls to a PABX are routed back to the caller's 'home region' (<i>RCP</i>) so that connection to the appropriate exchange is made.
55)	Inter-Regional calls with fast call set-up.	Full seamless roaming over 160 radio sites per <i>IRP</i> . Call set-up times are increased by less than 350mS over regional calls.
56)	Inter-regional Group Calls	Must have the optional <i>PCM Switch</i> to enable this feature.
57)	Inter-regional Line Testing	All circuits are continuously monitored and faults reported to the system terminal.
58)	Wide-Area expansion	Upto 5 <i>IRPs</i> can be networked via economical TCP/IP control links to allow 800 sites to be interconnected.

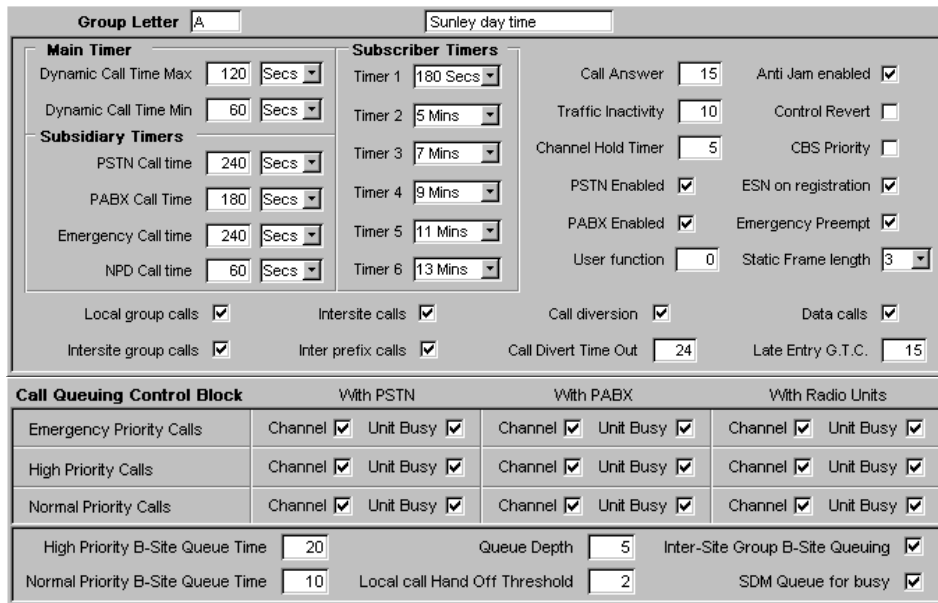
Controlling the system

Running under Windows™ NT4 on a PC with 200MHz processor and 32Mbytes of RAM or better, SYSCON performs all network and subscriber management functions. Industry standard file formats are used to simplify export and post-processing of data by Microsoft Office™ applications.

NOTE: MICROSOFT OFFICE and WINDOWS are registered trademarks of the Microsoft Corporation.

SYSCON Features – System Control

As many as 16 sets of *control parameters* are defined, assigning to each site in the region as required. In the example below, *Sunley Towers* site is using 3 parameter sets: 'Sunley day time', 'Sunley busy hours', and 'Sunley weekend'. Once data has been transferred to the system, control sequences will change automatically dependent upon time and day. SYSCON need not remain on line.



The screenshot displays the 'Control Parameters Definition' window. At the top, the 'Group Letter' is set to 'A' and the profile is 'Sunley day time'. The window is divided into several sections:

- Main Timer:** Dynamic Call Time Max (120 Secs), Dynamic Call Time Min (60 Secs).
- Subscriber Timers:** Timer 1 (180 Secs), Timer 2 (5 Mins), Timer 3 (7 Mins), Timer 4 (9 Mins), Timer 5 (11 Mins), Timer 6 (13 Mins).
- Subsidiary Timers:** PSTN Call time (240 Secs), PABX Call Time (180 Secs), Emergency Call time (240 Secs), NPD Call time (60 Secs).
- Call Handling:** Call Answer (15), Anti Jam enabled (checked), Traffic Inactivity (10), Control Revert (unchecked), Channel Hold Timer (5), CBS Priority (unchecked), PSTN Enabled (checked), ESN on registration (checked), PABX Enabled (checked), Emergency Preempt (checked), User function (0), Static Frame length (3).
- Local/Intersite:** Local group calls (checked), Intersite calls (checked), Call diversion (checked), Data calls (checked), Intersite group calls (checked), Inter prefix calls (checked), Call Divert Time Out (24), Late Entry G.T.C. (15).
- Call Queuing Control Block:**
 - With PSTN:** Emergency Priority Calls (Channel checked, Unit Busy checked), High Priority Calls (Channel checked, Unit Busy checked), Normal Priority Calls (Channel checked, Unit Busy checked).
 - With PABX:** Emergency Priority Calls (Channel checked, Unit Busy checked), High Priority Calls (Channel checked, Unit Busy checked), Normal Priority Calls (Channel checked, Unit Busy checked).
 - With Radio Units:** Emergency Priority Calls (Channel checked, Unit Busy checked), High Priority Calls (Channel checked, Unit Busy checked), Normal Priority Calls (Channel checked, Unit Busy checked).
 - High Priority B-Site Queue Time (20), Queue Depth (5), Inter-Site Group B-Site Queuing (checked).
 - Normal Priority B-Site Queue Time (10), Local call Hand Off Threshold (2), SDM Queue for busy (checked).

Figure 8: Control Parameters Definition

Time Periods	SUN	MON	TUES	WED	THURS	FRI	SAT	Available Control Parameters
00:00 to 02:59	C	A	A	A	A	A	C	A Sunley day time B Sunley busy hours C Sunley weekend
03:00 to 05:59	C	A	A	A	A	A	C	
06:00 to 06:59	C	A	A	A	A	A	C	D Bennet Street day time
07:00 to 07:59	C	A	A	A	A	A	C	E Bennet Street busy hou F Bennet Street weekend
08:00 to 08:59	C	B	B	B	B	B	C	G Default6
09:00 to 09:59	C	B	B	B	B	B	C	H Default7
10:00 to 11:59	C	A	A	A	A	A	C	I Default8
12:00 to 13:59	C	A	A	A	A	A	C	J Default9
14:00 to 15:59	C	A	A	A	A	B	C	K DefaultA
16:00 to 16:59	C	B	B	B	B	B	C	L DefaultB
17:00 to 17:59	C	B	B	B	B	B	C	M DefaultC
18:00 to 18:59	C	A	A	A	A	B	C	N DefaultD
19:00 to 19:59	C	A	A	A	A	A	C	O DefaultE
20:00 to 20:59	C	A	A	A	A	A	C	P DefaultF
21:00 to 21:59	C	A	A	A	A	A	C	
22:00 to 23:59	C	A	A	A	A	A	C	

Available sites
Sunley Towers

Figure 9: Applicability Map



Pooled Channels allows for the reuse of frequencies in overlapping coverage areas. Up to 6 channels can be *pooled* which will:

- For single cell calls – ensure that a *pooled channel* is used only on one radio site at one time.
- For dual-cell calls – ensure, as far as is possible, that the same pooled channel is used on both sites thus utilising just one frequency pair instead of two.

NOTE: *Pooled Channels* cannot be used if multi-site group calls are to be made on the system.

Channel Configuration makes it easy to:

- Inhibit channels.
- Restrict channels to handle only local calls.

- Force channels to handle only multi-site calls.
- Instruct channels to share frequencies with community repeaters (CBS Share).
- Reboot channels.

Line Testing is crucial if line faults are to be detected and lines inhibited from use before end-user dissatisfaction occurs. Since the fixed-link technology connecting radio sites could differ across a region, *SYSCON* allows for a *line loss threshold* to be entered individually for each port. Channels associated with failed lines are automatically prevented for handling multi-site calls until the fault is rectified.

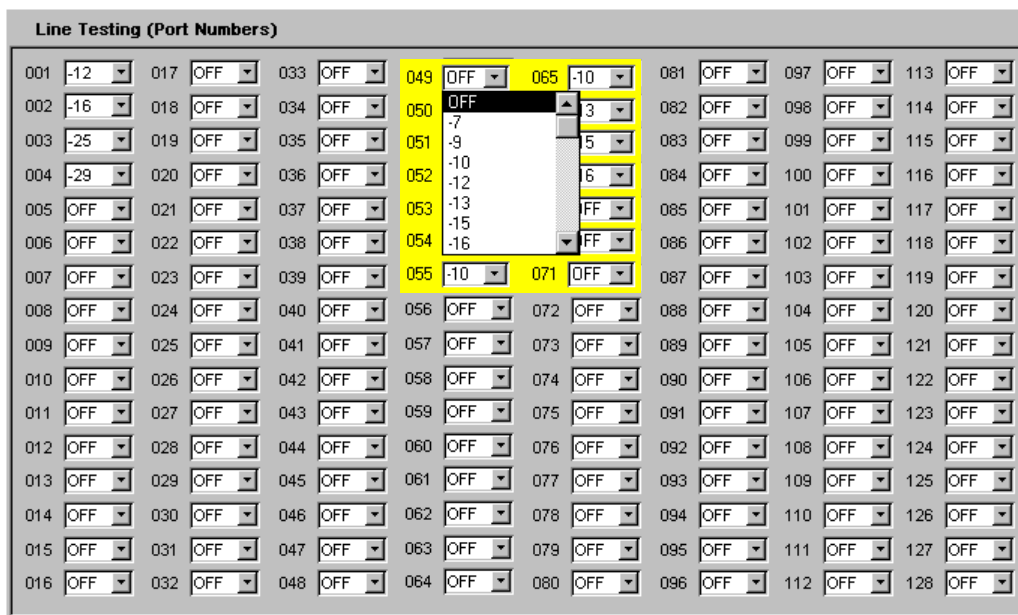


Figure 10: Line Testing Thresholds (in dbm)

Vote Now Advice controls the voting instructions that the system periodically transmits to radio units. Flexibility in use is assured through the ability to enter either RF channel numbers or site names into the voting list. The duration between voting messages may be specified between 20 seconds and 4 minutes.

PSTN Translation is designed to take IDD (Inbound Direct Dialling) strings of 3 digits. Where IDD is not available *PSTN Translation*

can nevertheless reduce the amount of inbound dialling required by a telephone user. Just 3 digits are required, these being assigned to as many as 1000 users.

Low Level reset allows the operator to clear any memory store, or reboot any processor form the *SYSCON* terminal.

SYSCON Features – System Status

Sophisticated status and error reporting ensure that the health of a Fyde Trunking system need never be left to chance.

System Overview provides an ‘at a glance’ report on the region.

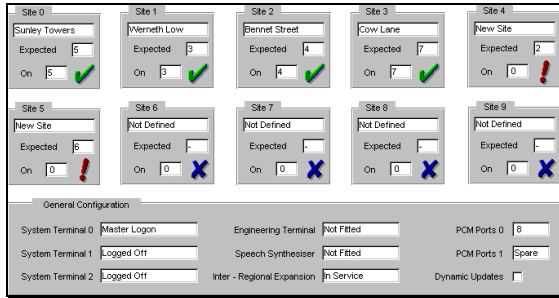


Figure 11: System Overview

Regional Control Processor Status reports on all links, lines, and memory modules associated with this regional controller.

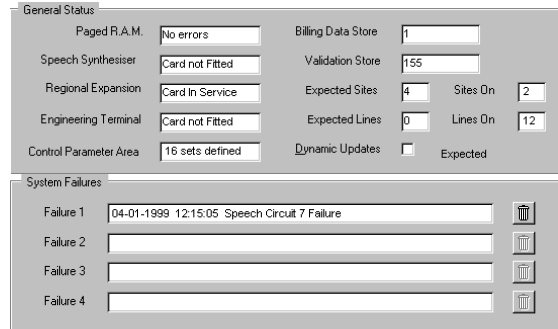


Figure 12: RCP Status

Site Status takes a close look at equipment at the radio site:

- Transmitter and receiver condition
- *TSC Channel Card* condition
- *System Control Interface* memory status.
- Auxiliary statuses such as, rack temperature, *SCI* supply, lithium battery condition, and any user-defined inputs.

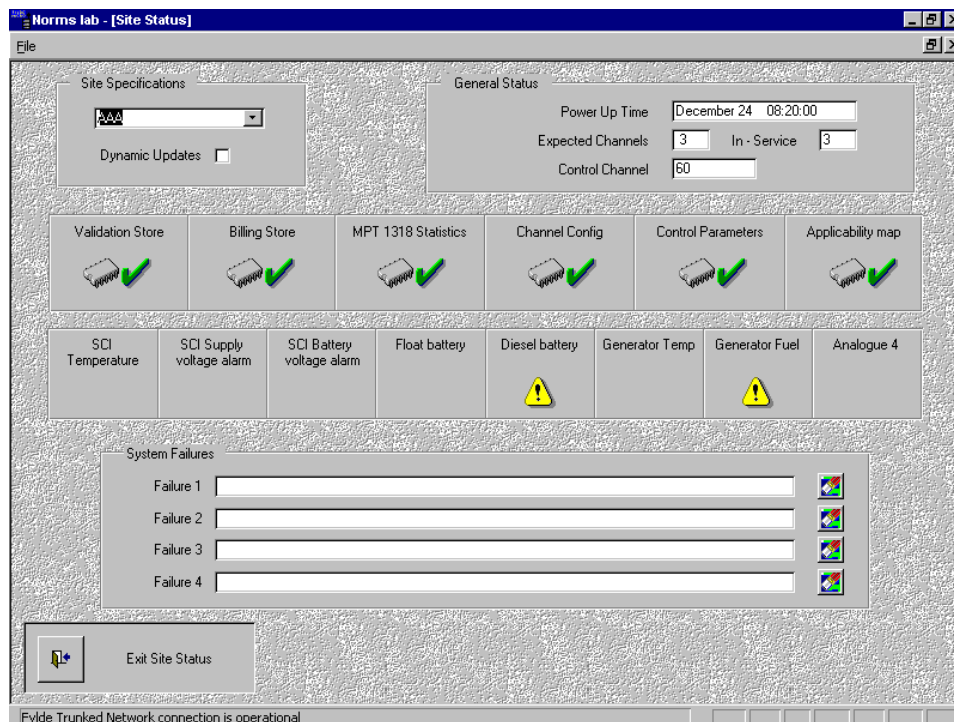


Figure 13: TSC Site Status

Dynamic Activity Display screen updates every 10 seconds with details of users currently on the system. Each site is shown separately with tallies of calls on channel and calls on queue. The top 5 channels are shown in detail.

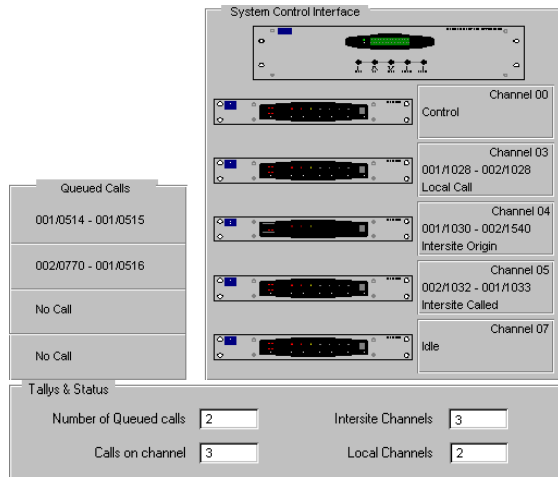


Figure 14: Dynamic Activity Display

A *Status Log* records the last 300 events for quick and easy review. All entries are time and date stamped. When the store is full, the new one replaces the oldest entry.

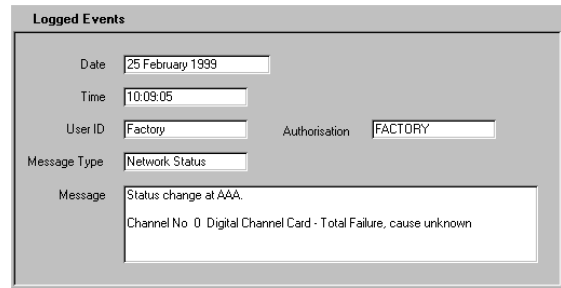


Figure 15: Status Log

Operational Statistics enable the network operator to determine the actual load experienced by radio sites and fixed-link speech paths to the regional node. This information can be used to fine-tune the system and ensure that all expensive resources are used to maximum benefit. These statistics meet the requirements laid down in MPT1318.

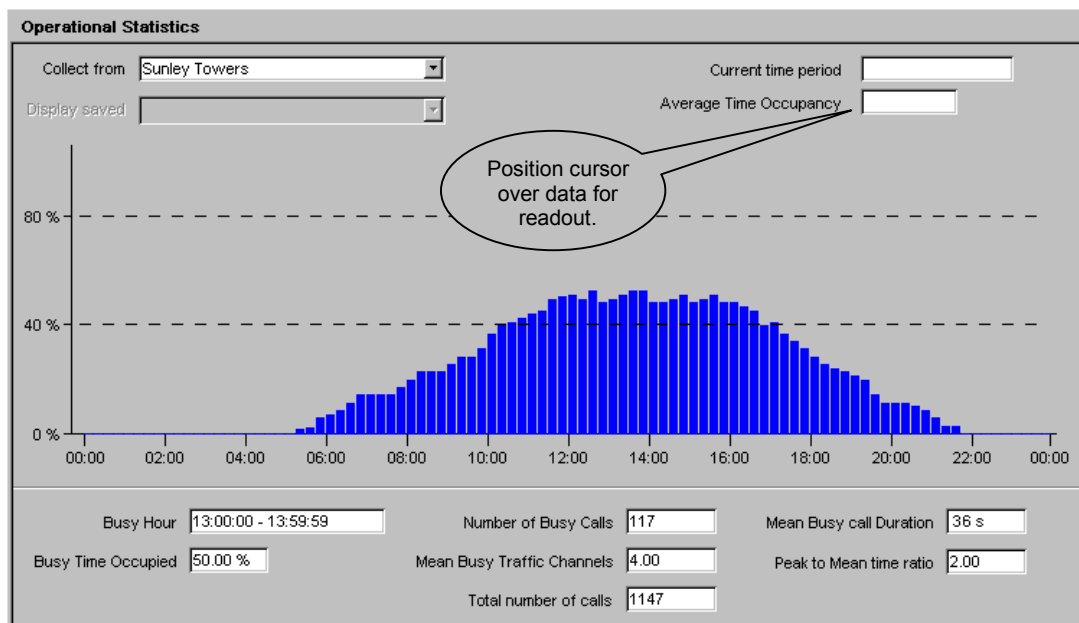


Figure 16: Operational Statistics

Error Counters show the state of all the control links running to the *Regional Control Processor*. Good links are fundamentally important to the correct operation of any network. To know exactly the error performance of the links is crucial to the well being of the system. Eight parameters are monitored for each link:

- Line Looping – some fixed-link providers test lines with warning creating havoc for users.
- Spurious Rx – microwave in particular can produce random spurious noise on control links.
- Framing – indicates noise or jitter on the link.

- Overrun – indicates software error in *RCP*.
- Parity – indicates noise or jitter on the link.
- Time-out – indicates noise, jitter, or a line break condition.
- Sumcheck – indicates noise or jitter on the link.
- Drop-out – indicates when the ARQ (retry) logic has failed to maintain the link.

When counters are reset, the time/date is noted. In this way 'error-rate' over a period may be known.

Link Diagnostics								
Serial Link	Looping	Spurious Rx	Framing	Overrun	Parity	Time Out	Sum Check	Drop Out
Sunley Towers	0	0	0	0	0	0	0	0
Werneth Low	0	0	0	0	0	0	0	0
Bennet Street	0	0	0	0	0	0	0	0
Cow Lane	0	0	0	0	0	0	0	0
New Site	0	0	0	0	0	Overflow	0	0
New Site	0	0	0	0	0	Overflow	0	0
TSC Site 6								
TSC Site 7								
TSC Site 8								
TSC Site 9								
PCM Switch	0	0	0	0	0	0	0	0
MHD	0	0	0	0	0	0	0	0
Reserved	0	0	0	0	0	0	0	0
Syscon Port 1	0	0	0	0	0	0	0	0
Syscon Port 2	0	0	0	0	0	0	0	0
Inter Regional	0	0	0	0	0	0	0	0

Counter Reset

Last reset was

Figure 17: Error Counters

Auxiliary Alarms are provided at each and every site, a number of which are available for free use by the network operator. In summary each site provides:

- 5 discrete open-collector outputs capable of sinking 100mA.
- 5 analogue inputs of range 0-51volts with a resolution of 200mV. Alarm thresholds may be defined independently with either a positive or negative slope, and variable hysteresis.

- Alarms are reported to *SYSCON* and forwarded to e-mail in the same manner as the main system alarms.

In the example overleaf, 2 outputs have been assigned to test start the diesel generator and to switch over to a standby antenna system. Generator running and antenna switch confirmation is fed in the 2 TTL discrete inputs.

Analogue channel 0 has been allocated to measuring the diesel generator fuel level. An alarm will occur when the fuel level drops too low.



Analogue channel 1 is measuring the diesel generator speed, an alarm being generated if RPM is too high.

Analogue channel 2 is tied to the main 12v DC supply rail. There is an active alarm state here since the measured voltage has dropped to 11.8v, below the threshold.

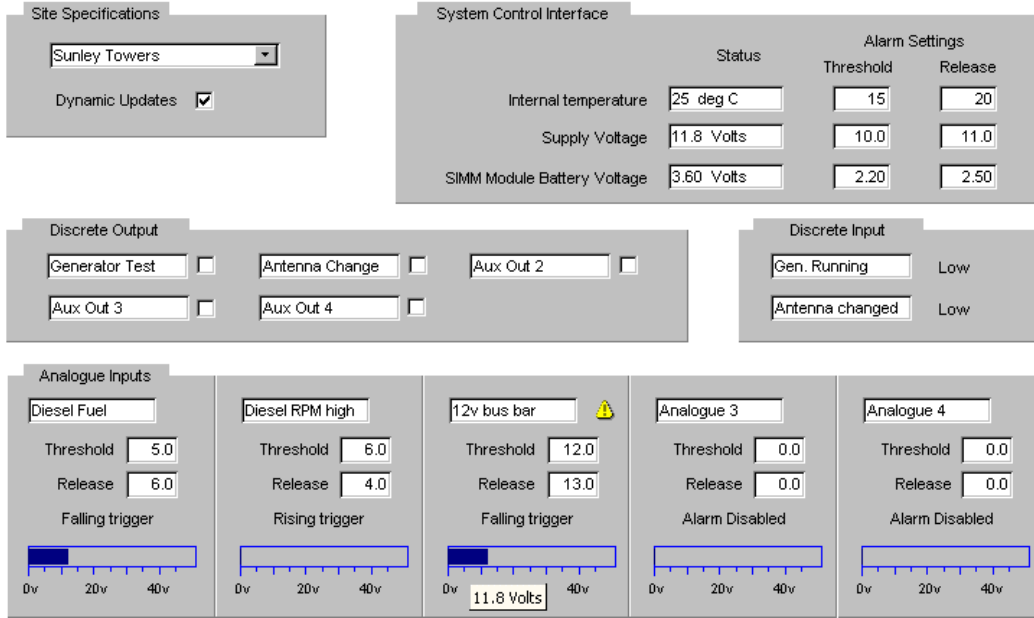


Figure 18: User Outputs and Alarms

SYSCON Features – Subscriber Control

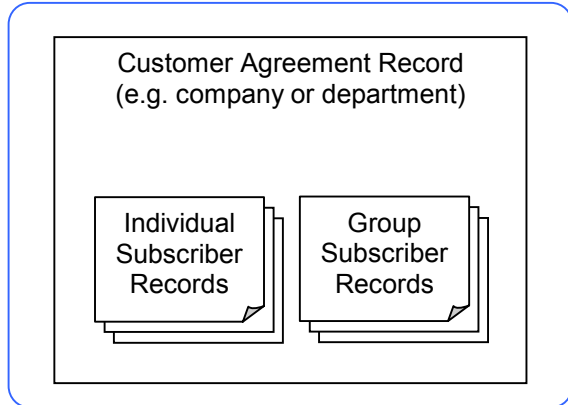


Figure 19: Customer Agreements Structure

Every radio unit and line despatcher (*MHD*) on the system must first be *validated*. SYSCON has a *Customer Agreements* database to hold the necessary control information.

This structure aims to:

- Keep in one place all subscriber records associated with the end-user fleet, whether this is a company (public access systems) or a department (private access system).
- Force common-prefix calls between members of the same fleet so maximising system efficiency.

A very high level of control is provided both for *Individual* and *Group* subscribers.

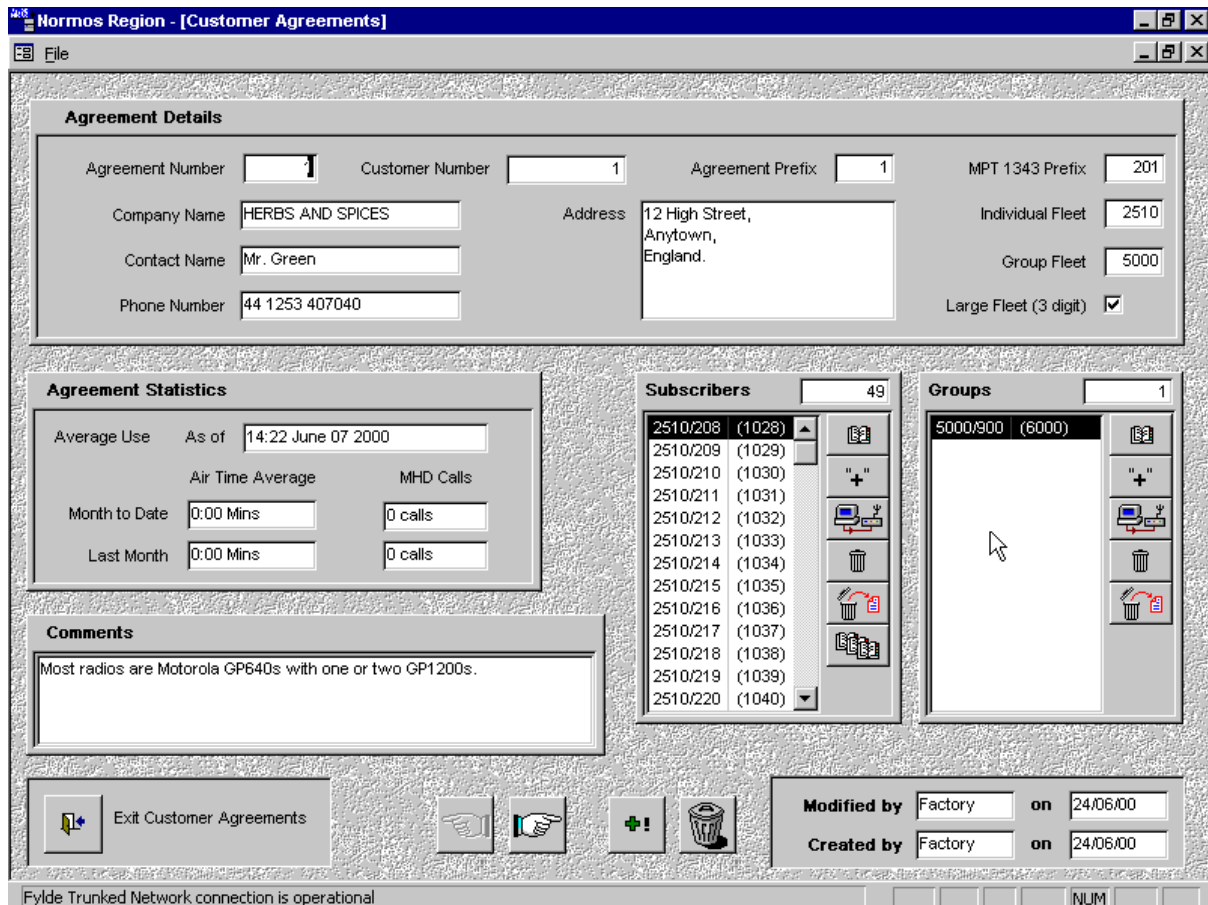


Figure 20: Customer Agreement Record



Subscriber Identity 2510/208

MPT 1327 Prefix: MPT 1327 Ident: Vehicle Reg:

MPT 1343 Prefix: Individual Fleet: Unit number:

Period 1-16: Days of the week:

Roaming Group Membership: Radio/MHD:

Coverage: Access: ESN:

Start Date: End Date: Speech calls:

Group Control: Timers: Radio to Radio:

Broadcast: Timer Lock: Call Home Mode:

Inter-Site: Duplex: Inter-Prefix:

Data Calls: SDM: NPD: All RQQ's:

Line Connect: PSTN In: MHD: PABX Ctrl:

Divert Service: PSTN Out:

Figure 21: Individual Subscriber Record

Group Identity 5000/900

MPT 1327 Prefix: MPT 1327 Ident:

MPT 1343 Prefix: Group number:

Period 1-16: Days of the week:

Coverage: Access: Automatic Roaming:

Start Date: End Date:

Timers:

Data calls: SDM: NPD: Inter-Prefix:

Line Connect: PSTN In: Speech calls: Inter-Site:

Figure 22: Group Subscriber Record

SYSCON also provides an easy way to find room to fit additional fleets. *Ident Map* shows 'at a glance' where space is available.

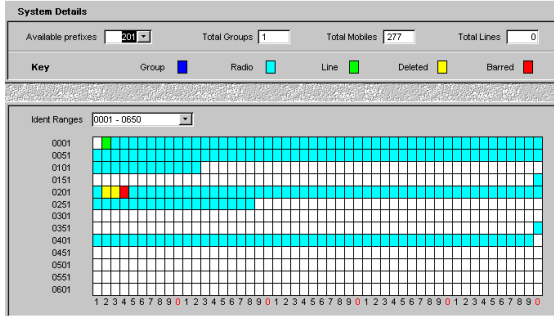


Figure 23: Ident Map

In telephony, it is normal practice to charge different rate dependent upon time of day and day of week. Fylde have incorporated this feature into radio trunking. Four charge bands can be defined ranging from 0% to 1000%. SYSCON multiplies *actual call time call* by the *billing factor*, both fields appearing in billing reports.

Period Applicability	SUN	MON	TUES	WED	THURS	FRI	SAT
00:00 to 08:59	A	A	A	A	A	A	A
09:00 to 17:59	B	B	B	B	B	B	B
18:00 to 20:59	C	C	C	C	C	C	C
21:00 to 23:59	D	D	D	D	D	D	D

Billing Factors	
Factor A	<input type="text" value="200"/>
Factor B	<input type="text" value="100"/>
Factor C	<input type="text" value="50"/>
Factor D	<input type="text" value="100"/>

Figure 24: Billing Factor



SYSCON Features – Subscriber Status

Data from every call is recorded so that the usage of every subscriber on the network is accurately recorded to a resolution of 1 second.

Records can be used to produce item billing or exception reports, or merely used as a background check on the airtime used.

SYSCON stored call records in Microsoft ACCESS™ .mdb file format so custom processing couldn't be easier.

NOTE: MICROSOFT ACCESS is registered trademark of the Microsoft Corporation.

For each call, the following are stored:

- 1) Customer agreement number
- 2) Originating region

- 3) Originating site
- 4) Originating channel
- 5) Destination region
- 6) Destination site
- 7) Destination channel
- 8) Inter-regional line in
- 9) Inter-regional line out
- 10) Start Time and Date
- 11) Originating party
- 12) Called party
- 13) Call type
- 14) Call priority
- 15) Call duration
- 16) Call units used (i.e. duration x billing factor)
- 17) RQQ status if RQQ call
- 18) Dialed digits if call to PABX or PSTN
- 19) Time on queue
- 20) Reason for call clear

Below are examples of the types of report available.

Item Billing (Partial Listing)													
Generated by Syscon for NT on 28/06/2000													
Company Name		HERBS AND SPICES											
Company Number		1											
Time	Date	Caller	Called	O/S	Channel	Type	Level	Mode	GM	D/S	Queue	Dur	Units
10:35	16/06/2000	201/2510/31	201/2510/28	Sun	68	RQS	High	Local	I	S	0:00	0:52	0:52
Originating Region		0	Destination Region	0	IRP Lines (in - out)			-	B-Site Queue time		0:00		
Destination Site		Sunley	Destination Channel	68	Cleared By		Called Party						
14:36	16/06/2000	201/2510/40	201/2510/50	Ben	66	RQE	Emerg	I-Site	I	S	0:00	13:10	13:10
Originating Region		0	Destination Region	2	IRP Lines (in - out)			1 - 3	B-Site Queue time		0:00		
Destination Site		4	Destination Channel	189	Cleared By		Called Party						
14:39	16/06/2000	201/2510/29	P.STN - 00441253407 040	Ben	90	RQS	Norml	I-Site	I	S	0:05	1:41	1:41
Originating Region		0	Destination Region	0	IRP Lines (in - out)			-	B-Site Queue time		0:00		
Destination Site		Sunley	Destination Channel	66	Cleared By		Calling Party						
17:13	16/06/2000	201/2510/28	002/1000	Sun	72	RQQ	N/A	I-Site	I	D	0:00	0:02	0:02
Originating Region		0	Destination Region	3	IRP Lines (in - out)			-	B-Site Queue time		0:00		
Destination Site		9	Destination Channel	732	Cleared By		SDM Transaction completed OK						

Figure 25: Billing Report Example

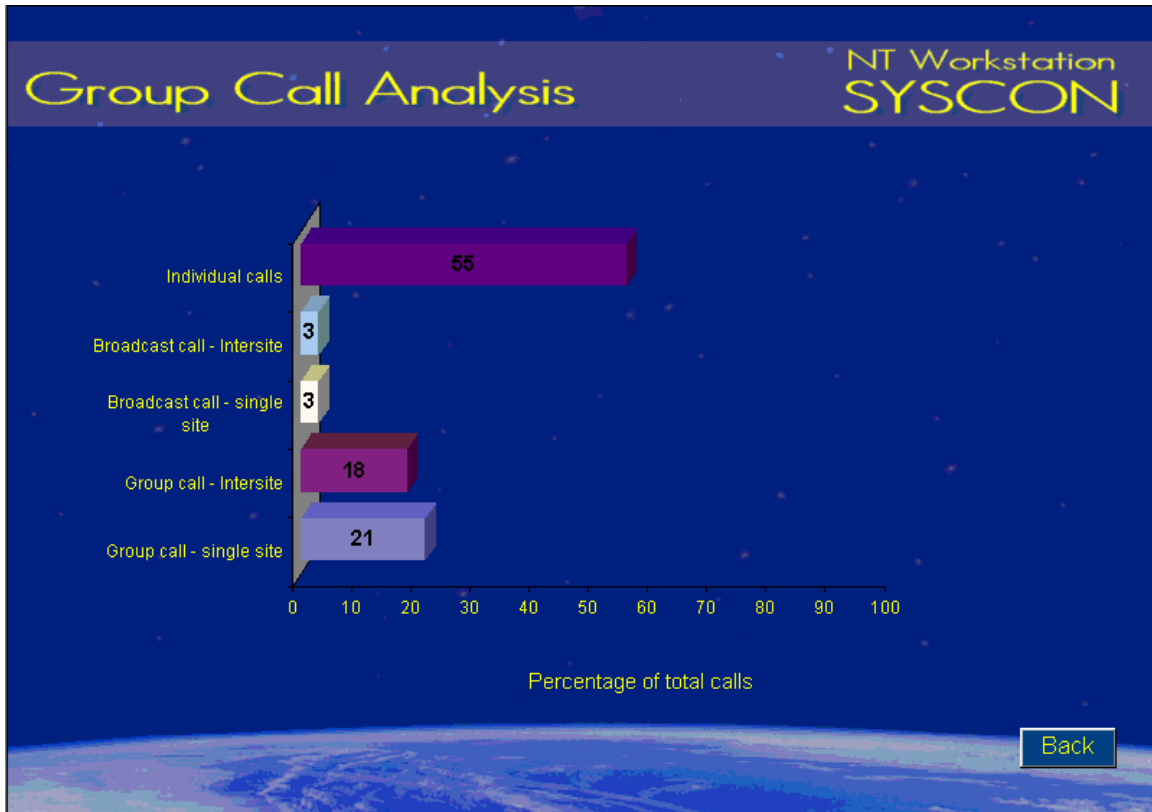


Figure 26: Call Record Analysis - Graph output

Call Record Analyser Wizard - Create Filter

Alter the filter criteria to select the required range of radios used, resources used and call parameters

Radio Usage

Calling Radio (s) to

Called Radio (s) to

Interprefix calls only

Call Types

Speech Non-prescribed data

Short data Status message

Emergency Priority Normal

Intersite Local Phone

Individual Group Broadcast

Network Resources

Calls from

Limit search to channel number

Calls to

Limit search to channel number

Calls started when

Date from

through to

Time from : but before : (hh:mm)

Day of week through

Call Parameters

Queue time between and seconds

Call duration between and (hh:mm:ss)

Call cleared by

Figure 27: Call Record Analysis – Record Selection Filter.

APPENDIX

Glossary of Terms

ARQ	.....	Auto Repeat Request – a method of error correction
ASCII	.....	American Standard Code for Information Interchange
AVL	.....	Automatic Vehicle Location
BCD	.....	Binary Coded Decimal
CSV	.....	Comma Separated Variables (text-based universal file format)
DTMF	.....	Dual Tone Multiple Frequency, tone dialling used in telephone systems
FSK	.....	Fast Frequency Shift Keying (sometimes referred to as Minimum Shift Keying [MSK])
GPS	.....	Global Positioning System
IPS	.....	Impulses per second, 10 I.P.S. dialling used by traditional telephones
LCD	.....	Liquid Crystal Display
LED	.....	Light Emitting Diode
LIFU	.....	Line Interface Unit
LSB	.....	Least Significant Byte
MDB	.....	Microsoft DataBase file format
MHD	.....	Message Handling Dispatcher (connects into the system at the Regional Control Processor)
IRP	.....	Inter Regional Processor
PABX	.....	Private Automatic Branch Exchange
POTS	.....	Plain Ordinary Telephone System
PSTN	.....	Public Subscriber Telephone Network
PCM	.....	Pulse Coded Modulation
PTT	.....	Press To Transmit - used generally to mean "transmit"
RAM	.....	Random Access Memory
ROM	.....	Read Only Memory
RCP	.....	Regional Control Processor
SCI	.....	System Control Interface, provides billing, status, customer validation, and enables system control
SIO bus	.....	Serial Input/Output bus connecting channel cards and System Control Interface
SSTAK	.....	Single Site Telephone Adaptor Kit. Used on single-site systems where PSTN interconnect is required.
TSC	.....	Trunking System Controller