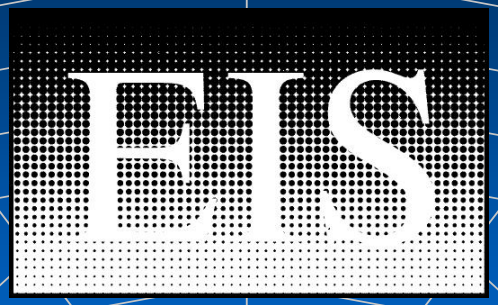


SPIDER

Simple Presence In-lane Detection Event Reporting

Course Outline

- **Overview of SPIDER**
- **Radio Operation**
- **System Design**
- **Installation**
- **Software Utility**
- **Troubleshooting**

Overview

Description

- **Wireless system for concentration of vehicle detection's from multiple RTMS detectors**
- **data is transmitted via wireless RF radio modems from RTMS detectors to the SPIDER Controller**
- **SPIDER converts into contact closure data to be read by controller**

Components of System

- **SPIDER has an on board master radio modem (900Mhz or 2.4Ghz) for communication**
- **Omni antenna, surge suppressor, RF cable and wall cube power supply are supplied**
- **1 to 8 RTMS units with built in radio modems can be connected**

SPIDER Operation

- SPIDER employs Time Division Multiple Access (TDMA) protocol to communicate with the RTMS units
- this allows each RTMS to transmit its data every 0.5 seconds
- 10mS resolution of data
- converts data into dry relay contacts
- up to 32 contacts available

Radio Operation

Radio MODEM

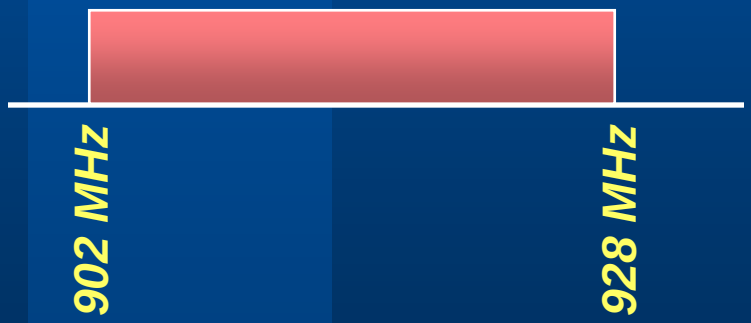
- License free Digital Spread Spectrum radio
- available in 900MHz or 2.4GHz
- all radio accessories can be supplied
- Data rate is 115Kbps

Spread Spectrum Radios

Spread Spectrum Frequency Allocation

NO FCC License Required

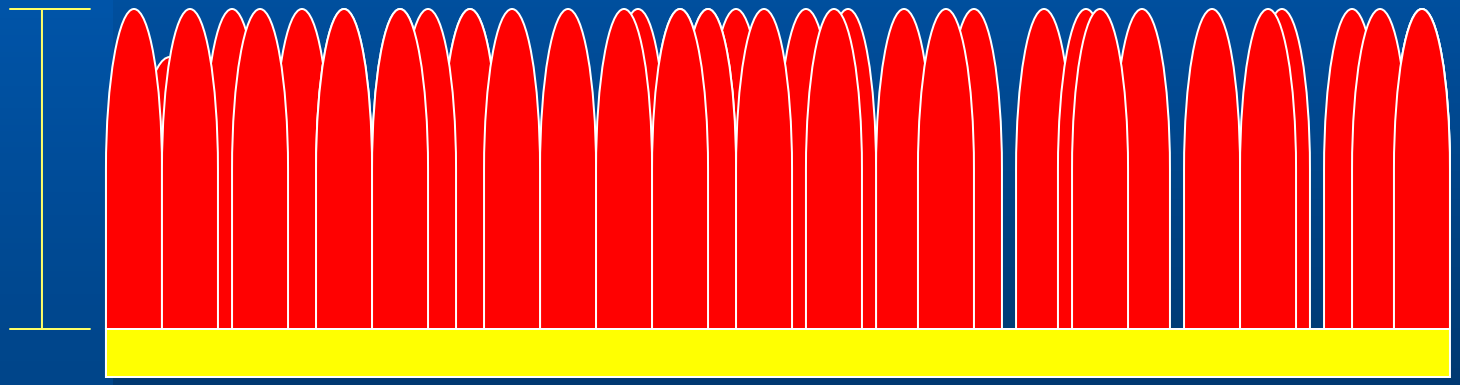
900 MHz Spectrum



2.4 GHz Spectrum

FHSS Technology

Narrow Band Signal is continually Hopped in a specified pattern over the spectrum many times per second.

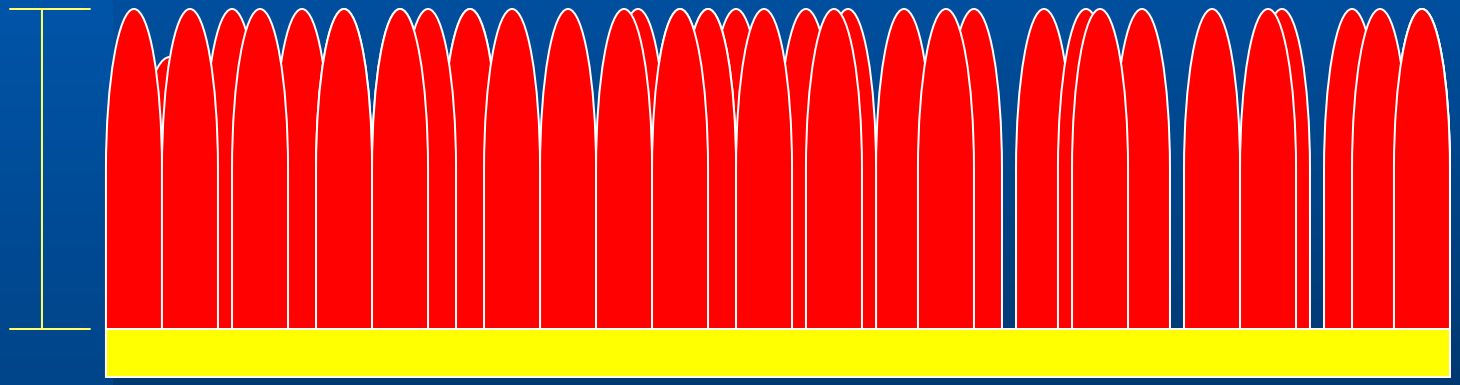


902 MHz **928 MHz**

ROBUST **RELIABLE** **LICENSE FREE**

Hop Pattern

- **A Hop Pattern determines the frequencies that the radio Hops between**
- **All Radios within a System MUST have the same HOP PATTERN**



902 MHz **928 MHz**

Wireless Fundamentals

MULTI-PATH FADING

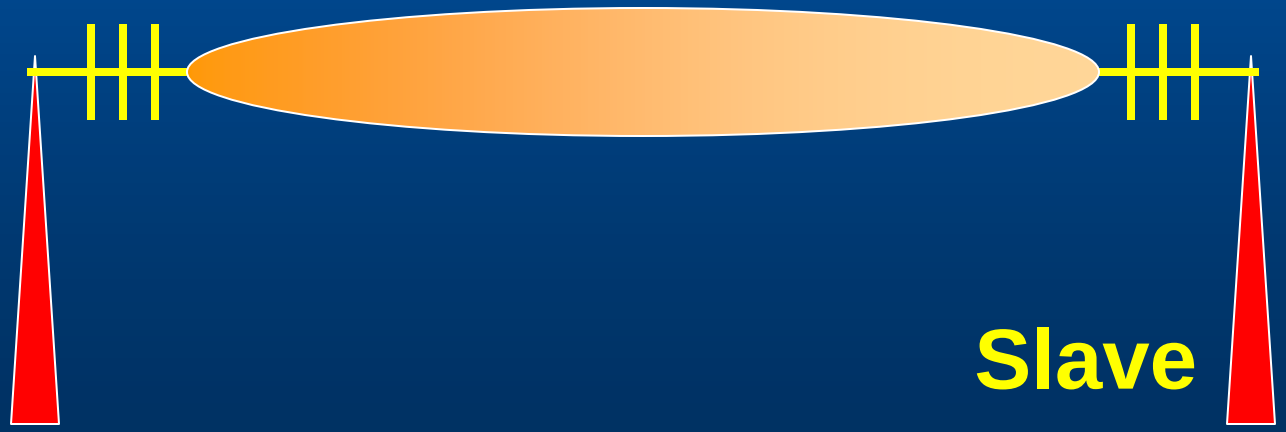
- **Variation in signal level as a result of multi-path or obstacles in the RF signal path results in a condition known as fade.**
- **High speed data communication is specially susceptible to failure caused by fade conditions.**

Wireless Fundamentals

- **FADE MARGIN**
  - **is the difference between received signal strength and the minimum radio sensitivity.**
  - **is a major factor that needs to be considered during initial system design.**
  - **Relation between Communication Reliability and Fade Margin**

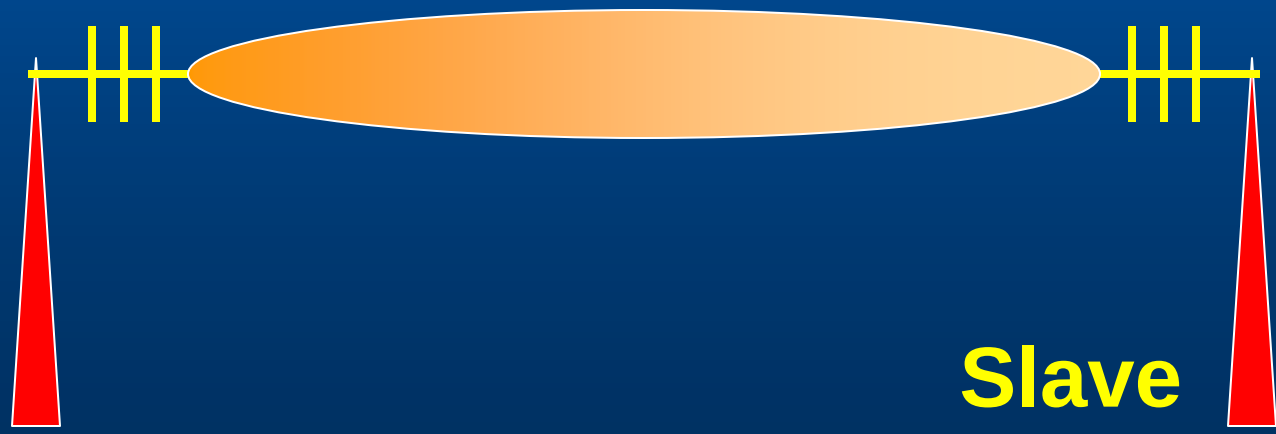
Radio Path

- The term used to describe the route over which the RF Energy must travel from Master to Slave.
- Expressed in dBm. Ie. Path from A to B is –95 dBm



Radio Paths

- **Goal:**
  - **The goal in designing Radio Systems is to maximize the Radio Path as it will maximize the performance of the system**



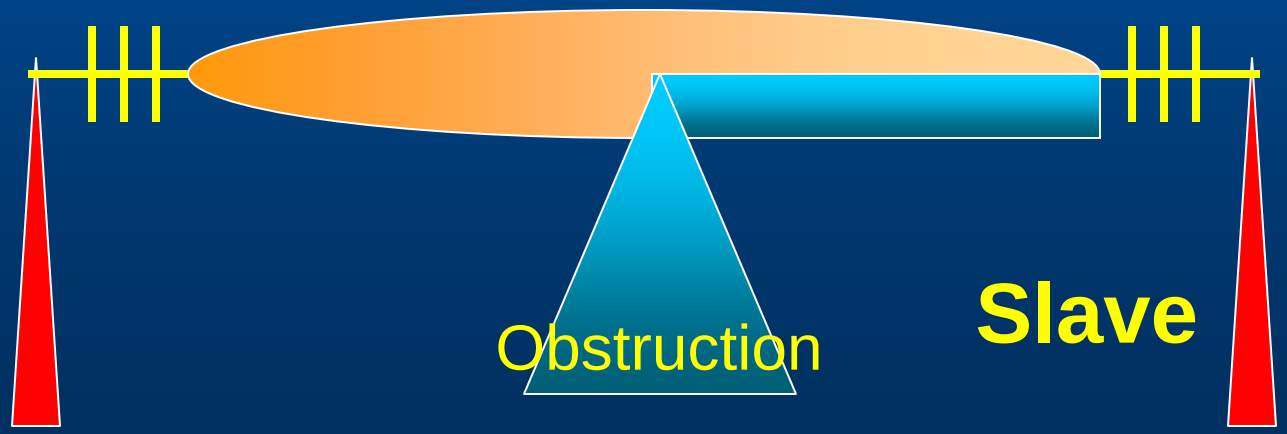
Radio Paths

- **Determining if a Radio Path is Acceptable**
  - **Examine the Receive Sensitivity (RS) of the Radio**
  - **Consider a 20 dBm Fade Margin**
  - **Compare this value with value for Path**
  - **Typical Values range from –60dBm to –110dBm**

Radio Paths

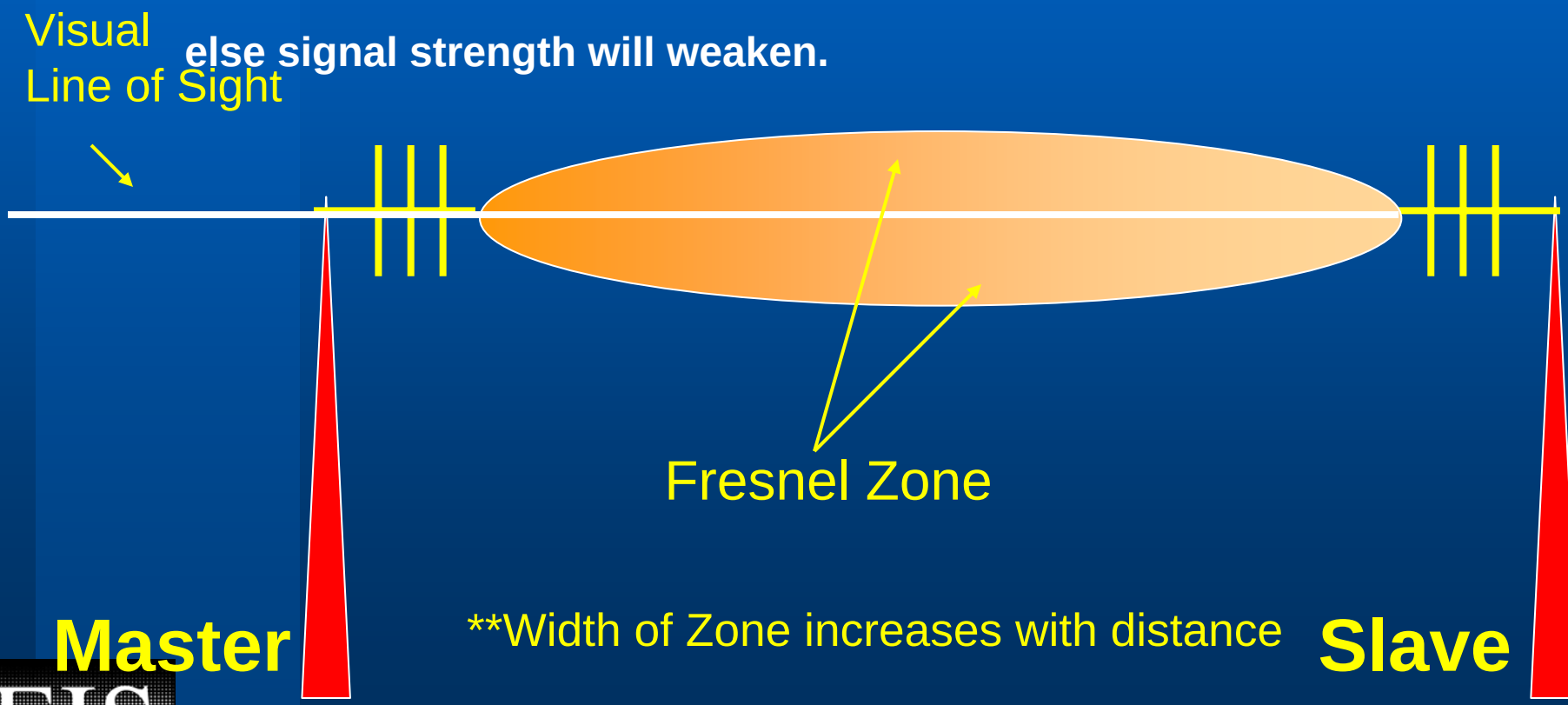
Radio Path Losses

- **Obstructions**
  - **Buildings, Hills, Solid Structures, Vegetation (dense foliage)**
- **Due to Distance**
  - **Signal dispersion weakens it over distance**



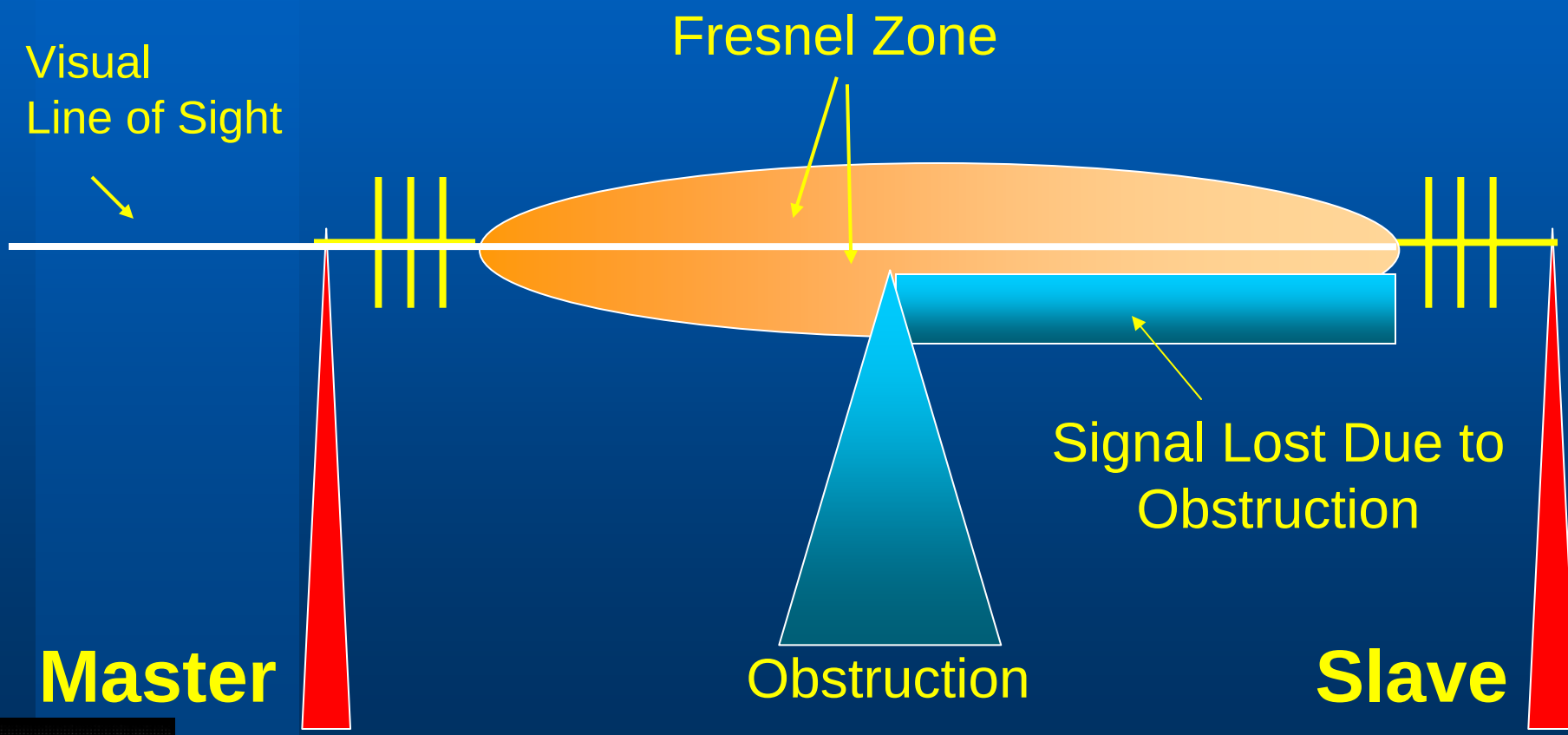
Radio Path

- **The area around the visual line-of-sight that radio waves spread out into after they leave the antenna. This area must be clear or else signal strength will weaken.**



Radio Paths

Obstruction in the Fresnel Zone

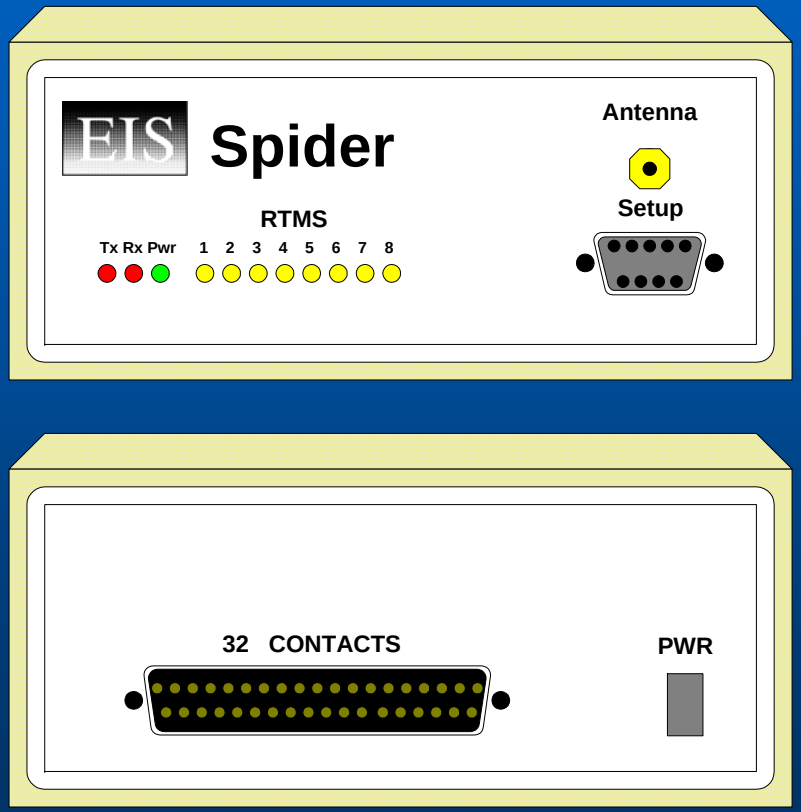


Radio Path

- **Minimizing Path Losses**
- **Avoid Obstructions if possible**
  - **If you can't go around, go OVER top.**
  - **Antenna Height is Critical.**
  - **Remember Freznel Zone.**
    - **As distance increases, zone width increases.**

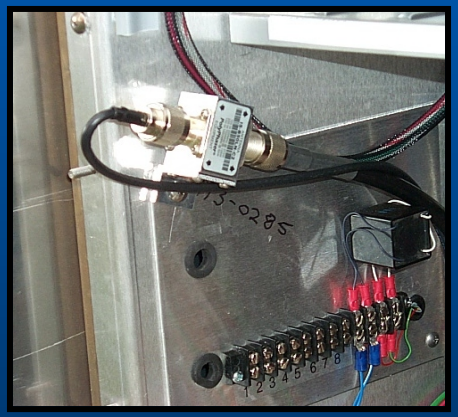
System Components

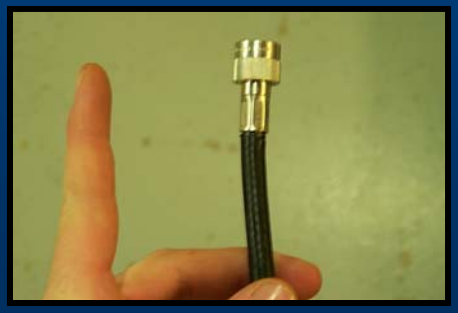
- **SPIDER Controller**
- **shelf mount**
- **12-24V AC or DC - comes with wall cube power supply**
- **37 pin connector supplies dry contacts to controller**



System Components

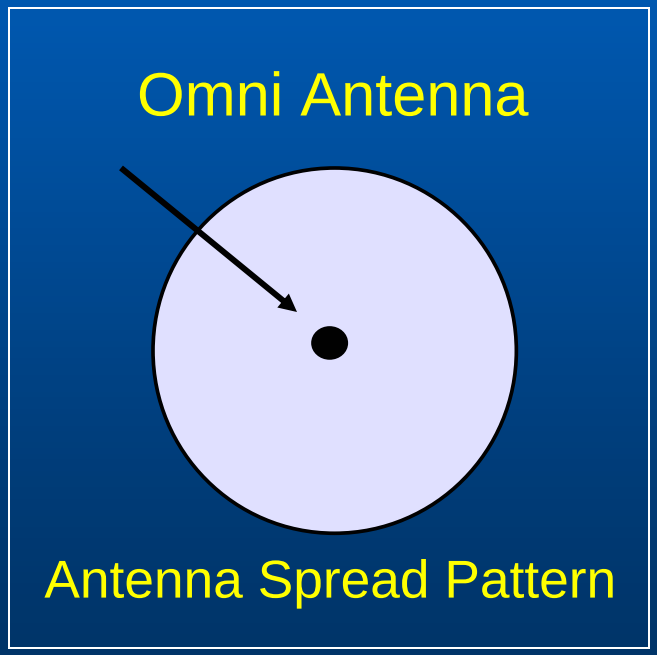
- **RF Jumper**
- **Connects Radio to Lightning arrestor**
- **Lightning arrestor must be grounded**
- **Low loss LMR400 RF cable to connect to antenna**





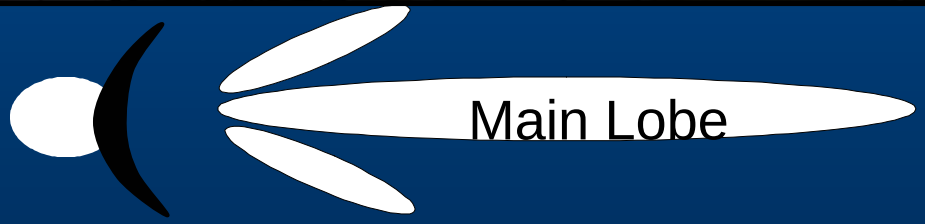
System Components

- **Omni-Directional**
  - **Antenna Gain is equal 360 degrees surrounding antenna**
  - **Increased length creates higher gain antenna**



System Components

- **Yagi Antennas**
  - **More elements on Antenna equals More Gain.**
  - **Length of the elements indicates frequency specification**



Antenna System

- **Antenna Gain Selection**
- **System Performance can drop if High Gain Antennas are used at short range.**
  - **The Receiver Radio can be OVERPOWERED**
  - **More Errors will occur**
  - **Radios may be damaged**
  - **Signal Levels >-50 dBm are too high**

Antenna System

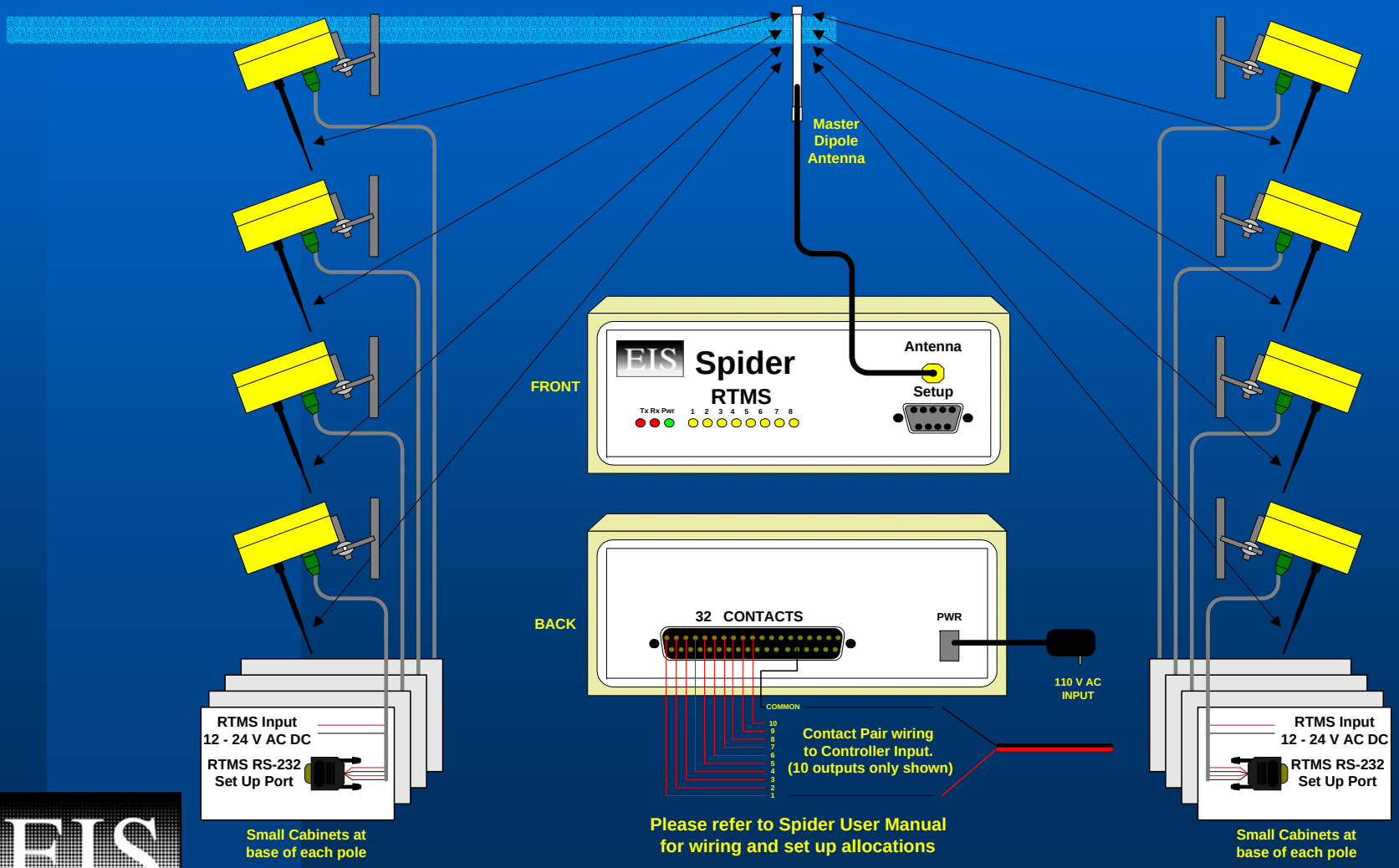
- **The SPIDER system uses low gain omni antennas as the system design is based on short distances with line of sight**
- **an Omni antenna is mounted at 30’ at SPIDER location, small whip antennas are mounted on RTMS units**

Antenna System

- **Antenna Height**
  - **should be mounted as high as possible**
  - **Height becomes more important as the distances between sites increase**
  - **Remember that the higher the Antenna is mounted, the more RF Cable is needed. (adds loss to system)**

System Design

SPIDER Connection



SPIDER System Parameters

- **The SPIDER is set as a “Plug and Play” system by the factory.**
- **It is important to have the following parameters properly assigned to the radios in the system:**
  - **network address**
  - **hopping pattern**
  - **encryption key**

SPIDER System Parameters

- **Network Address:**
  - **This parameter must be the same in the SPIDER Controller Master and ALL RTMS slaves and repeaters. Multiple networks with different network addresses may co-exist in a geographical area without interfering with each other. Range 0 - 65535.**

SPIDER System Parameters

- **Primary Hopping Pattern:**
  - **This parameter identifies the frequency hopping pattern between the slaves and a master. There are 64 patterns (0-63) of which patterns 0-61 are preprogrammed.**

SPIDER System Parameters

- **Encryption Key:**
  - **This parameter provides network security. The Master, slaves and repeaters must have the same encryption key to communicate and will be allocated a range 0 - 65535.**

SPIDER parameters

- **Unit Address:**
  - **Each member of the network is identified by a unique Unit Address number.**
  - **The master is designated Unit #0**
  - **the slaves will be Units #1 to #8 (maximum number of RTMS units per SPIDER is 8)**

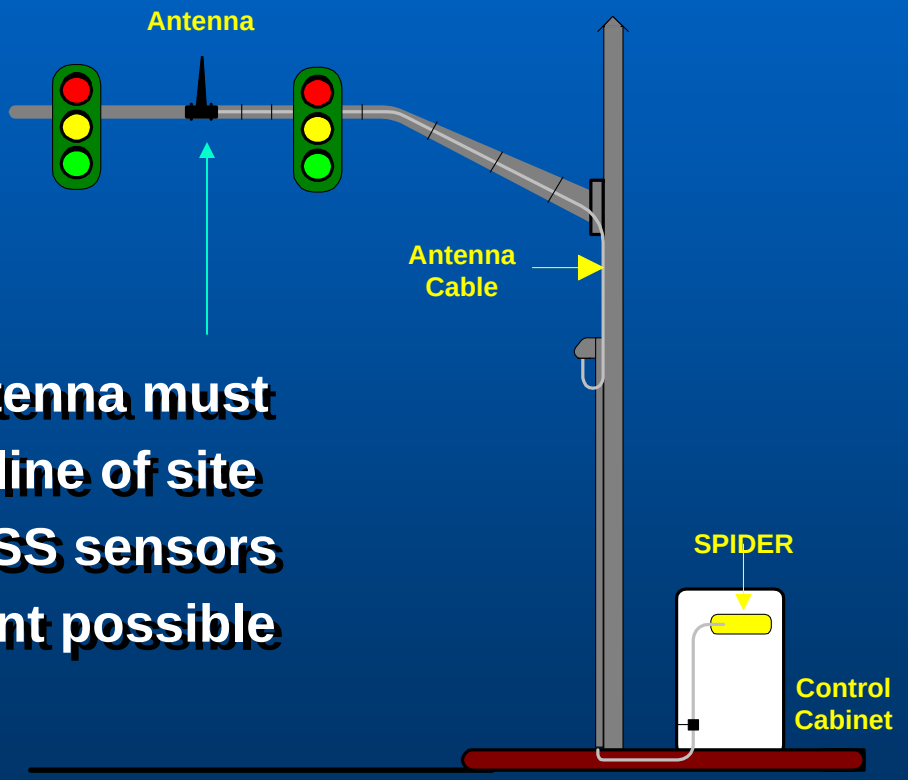
Installation

Site Considerations

Antenna Mounting

- **Is there an Antenna Mast near the cabinet?**
  - **Signal Pole**
  - **Luminaire**
  - **Additional Antenna Mast**

SPIDER Master Antenna



The master dipole antenna must be positioned within line of site of the slave RTMS - DSS sensors and at the highest point possible

Spider Controller requires 12 - 24 AC or DC
Antenna Surge Protector Grounding cable in cabinet

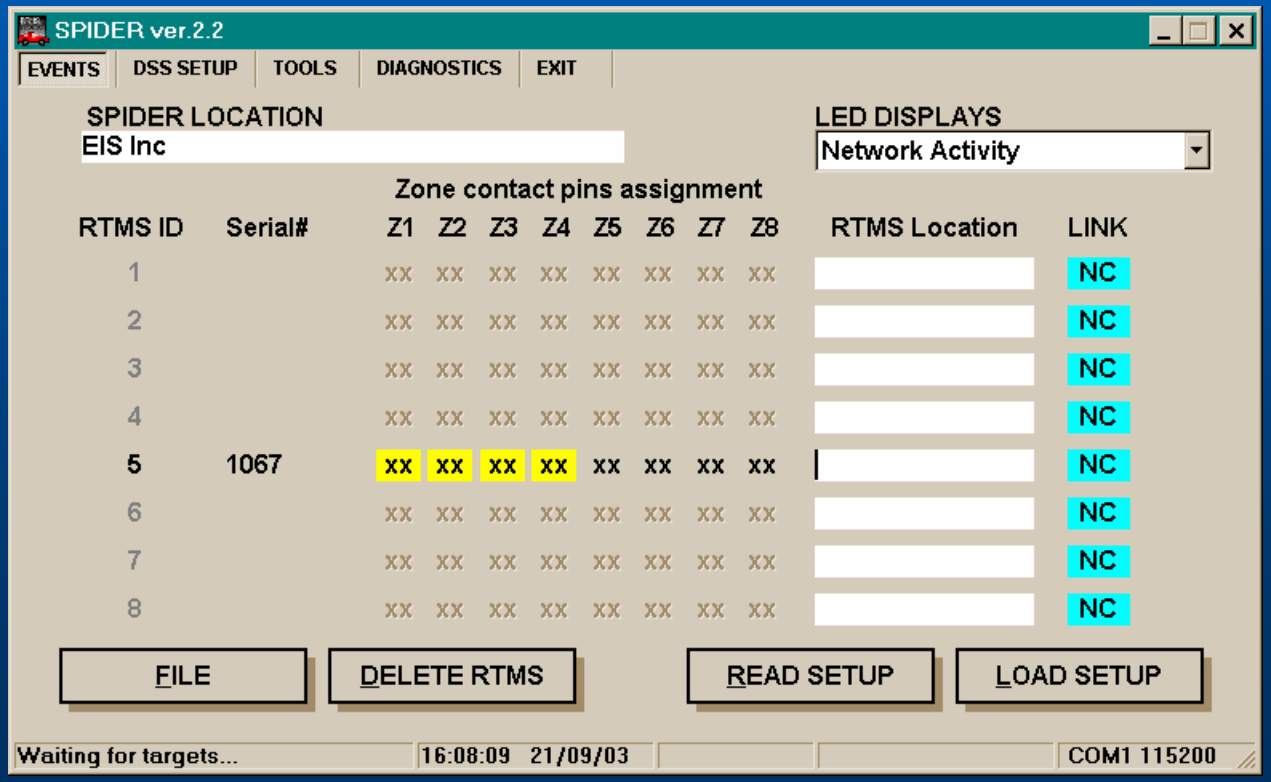
RTMS Locations

- **RTMS units should be mounted as per product specifications**
- **antenna selection will be based upon proximity to SPIDER and line-of-sight**

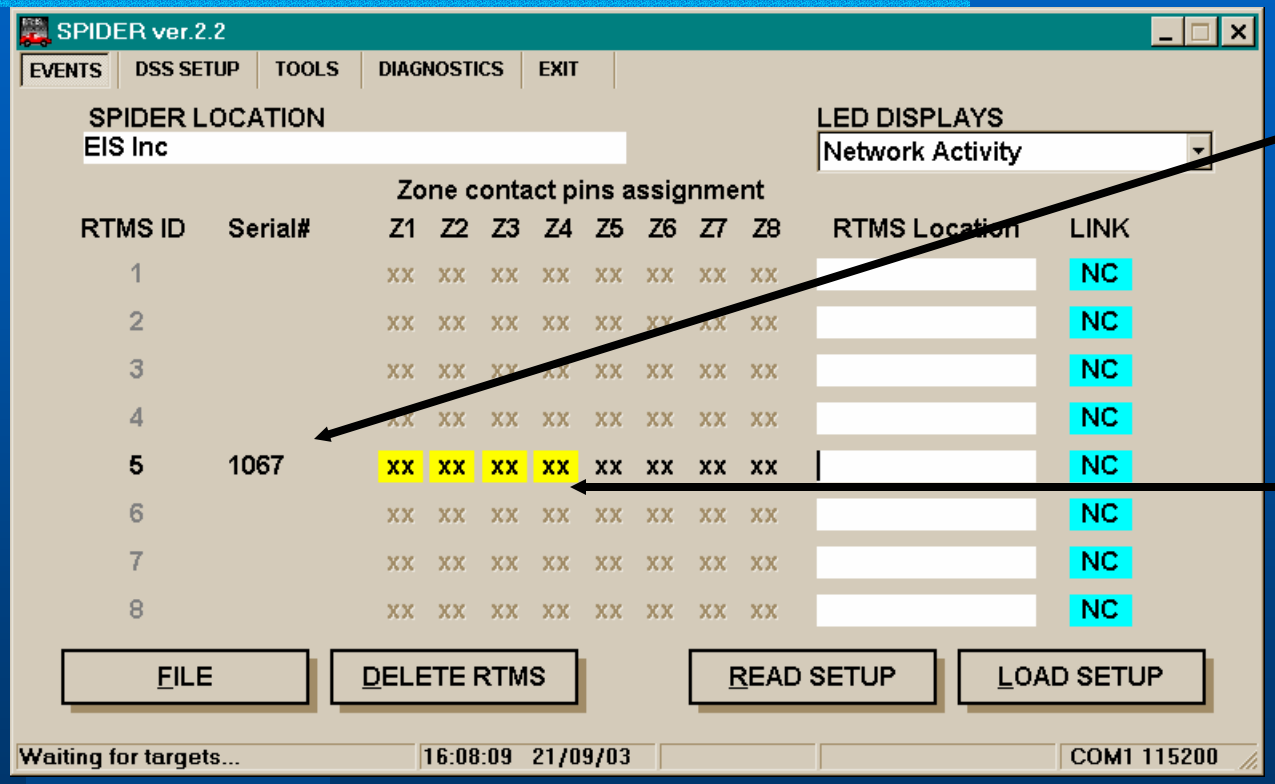
Software Utility

Events Screen

- On opening the SPIDER utility, allow 10 seconds for software to read the controller



The Events Window



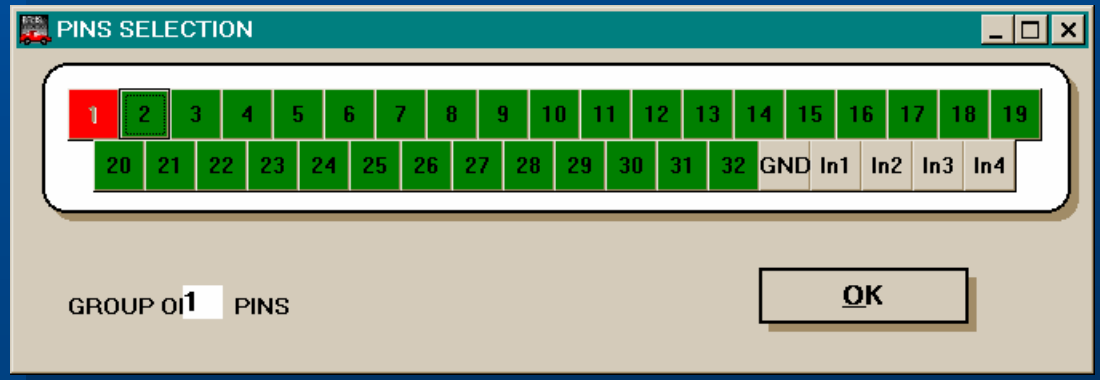
Active RTMS units are listed showing individual serial numbers

Zones programmed into RTMS are displayed - currently are shown as Yellow boxes with XX until pin assignment is given

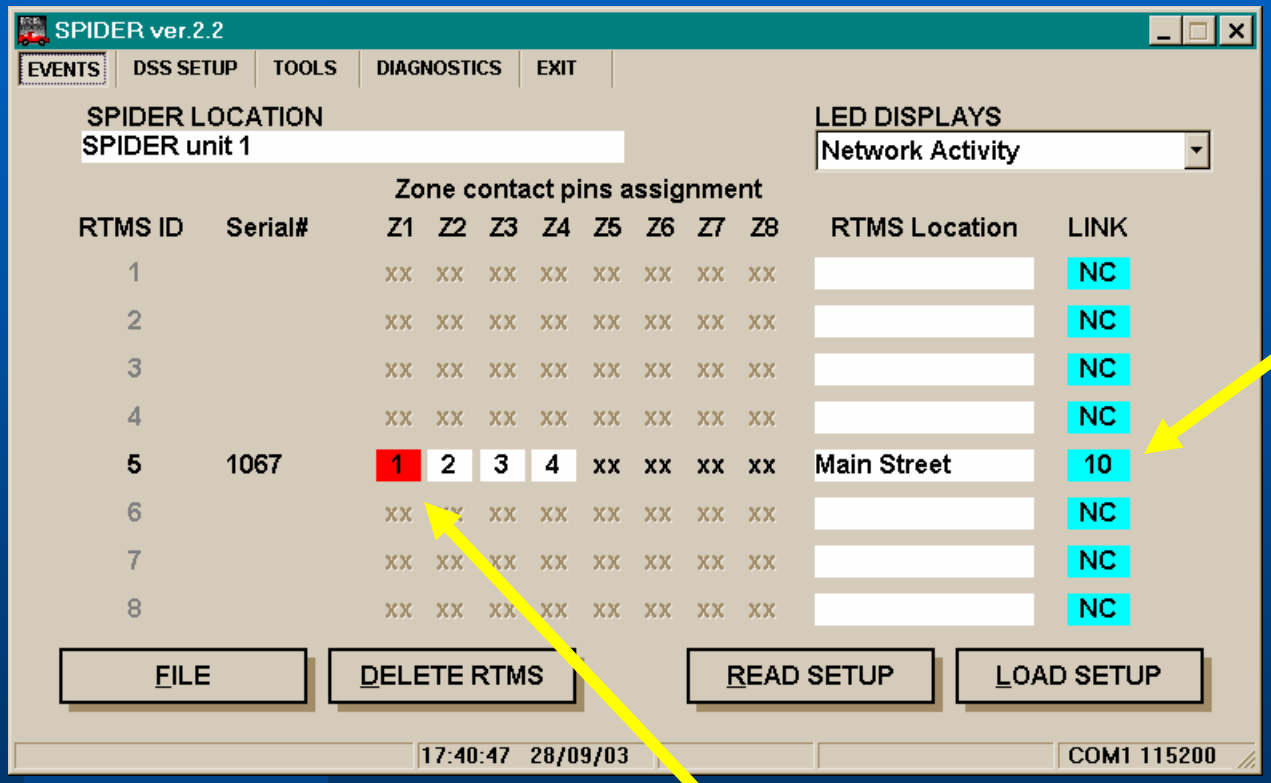
This is the SPIDER main window. It provides visual verification on the operation of an active system

Pins Selection

- click on the yellow zone box to display the selection screen
- The dry relay contacts for each lane of each detector can be programmed
- a total of 32 contacts can be provided



The Events Window



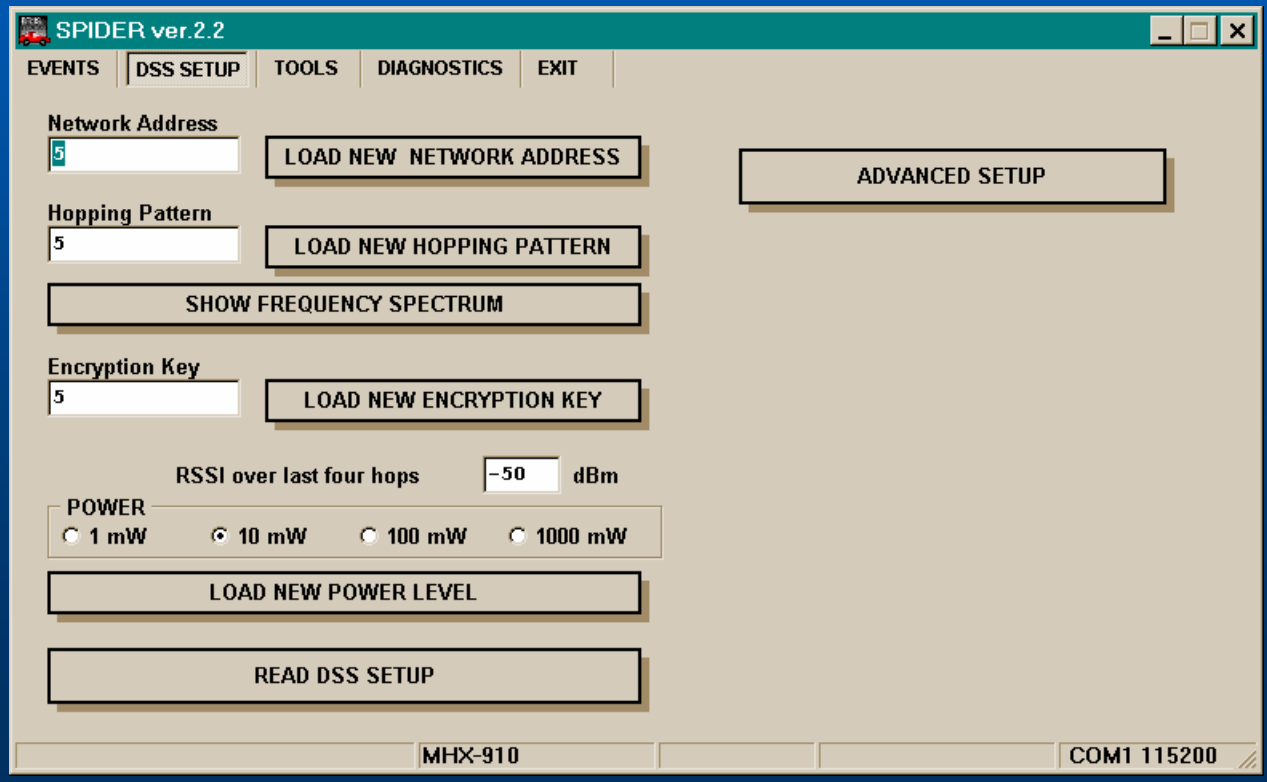
LINK shows synchronization level between the SPIDER and RTMS unit.

A reading of 10 is perfect, a steady reading of 6 or less would require investigation

Vehicle targets are shown in red - only after Pin Assignment is completed and loaded to the SPIDER

DSS Setup

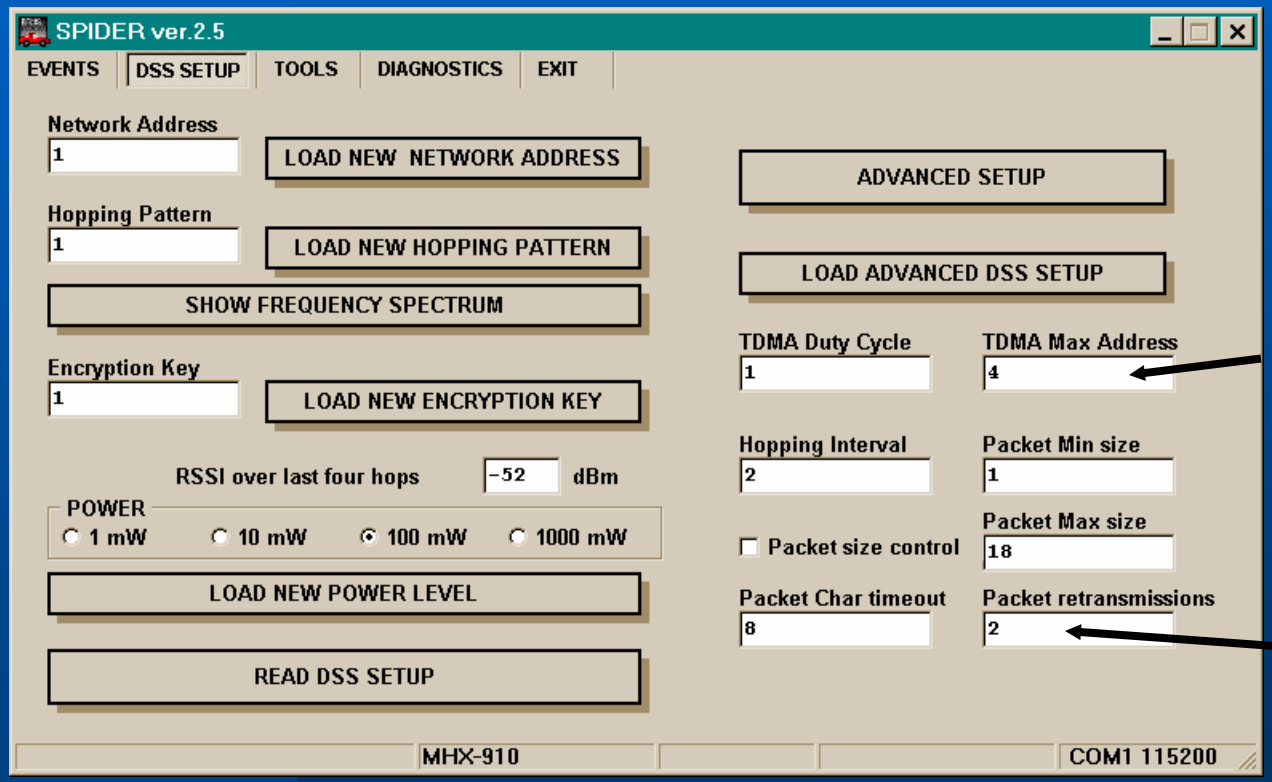
- **Parameters are pre-programmed for system but can be changed by the user**



DSS Setup

- When in the DSS Setup screen the Tx lamp will disappear from the front panel of the SPIDER as you are no longer communicating with the RTMS units.
- If in the DSS Setup for 5 minutes or longer the SPIDER will automatically return to normal operation

DSS Setup - Advanced Setup

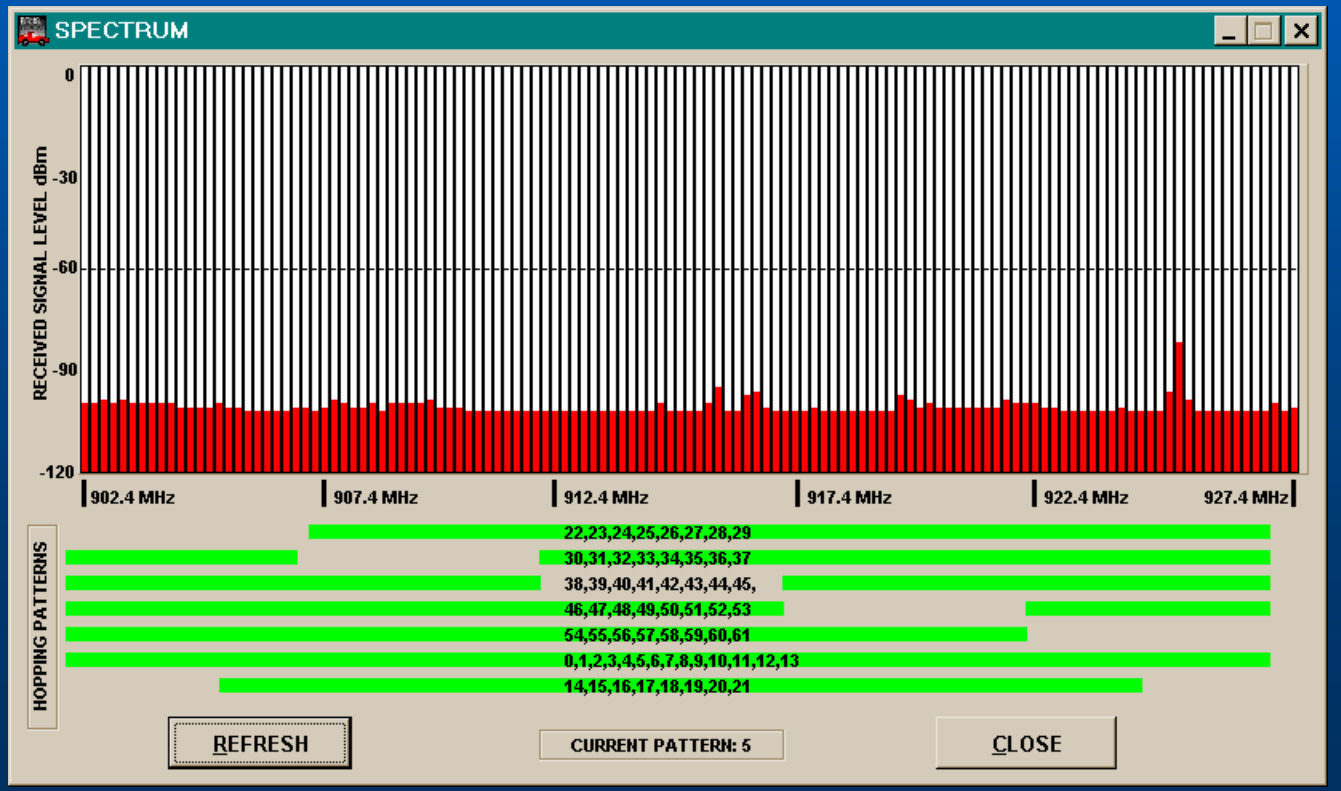


Maximum number of RTMS units in system

# of message retries if comm failed

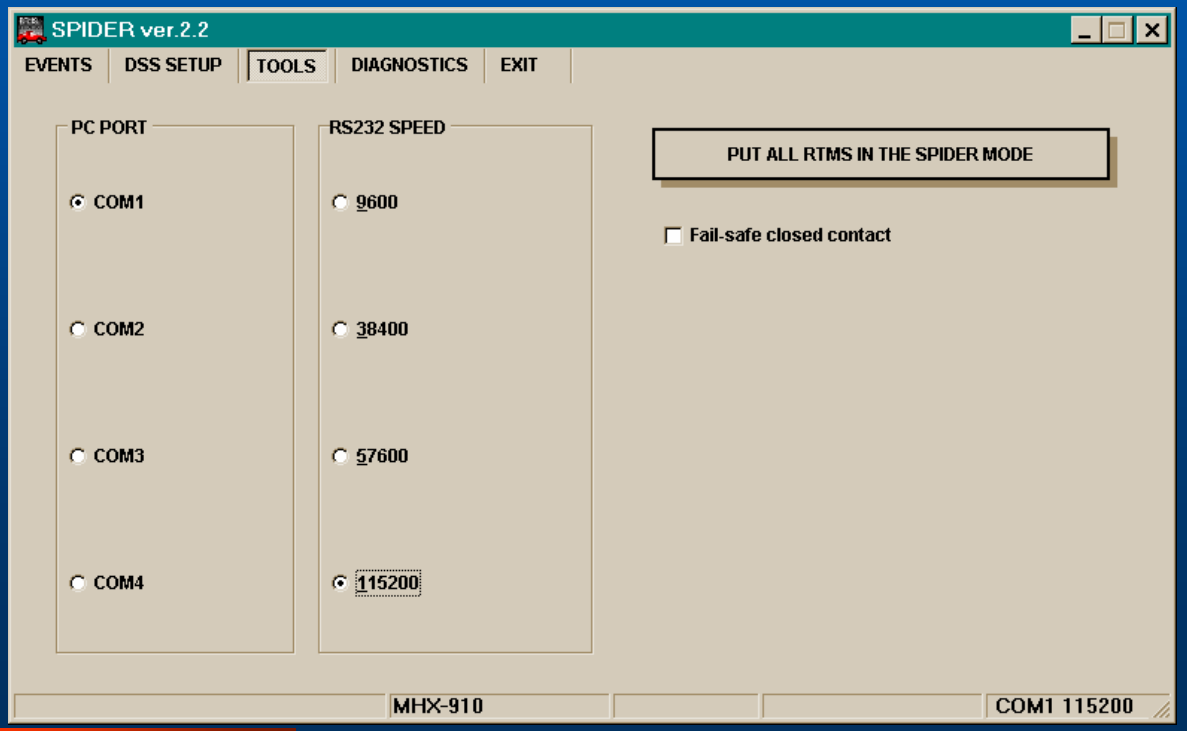
Spectrum

- The spectrum can be analyzed to verify the best hopping pattern



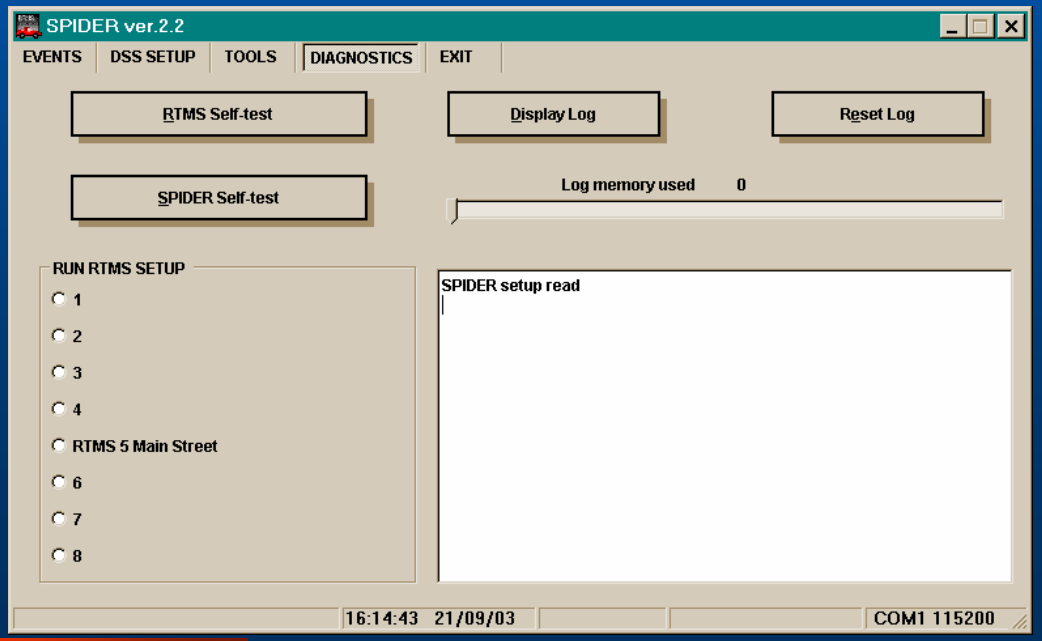
Tools

- If an RTMS is left in normal mode, and still has the same RF parameters, the SPIDER can send a message to put in the SPIDER mode



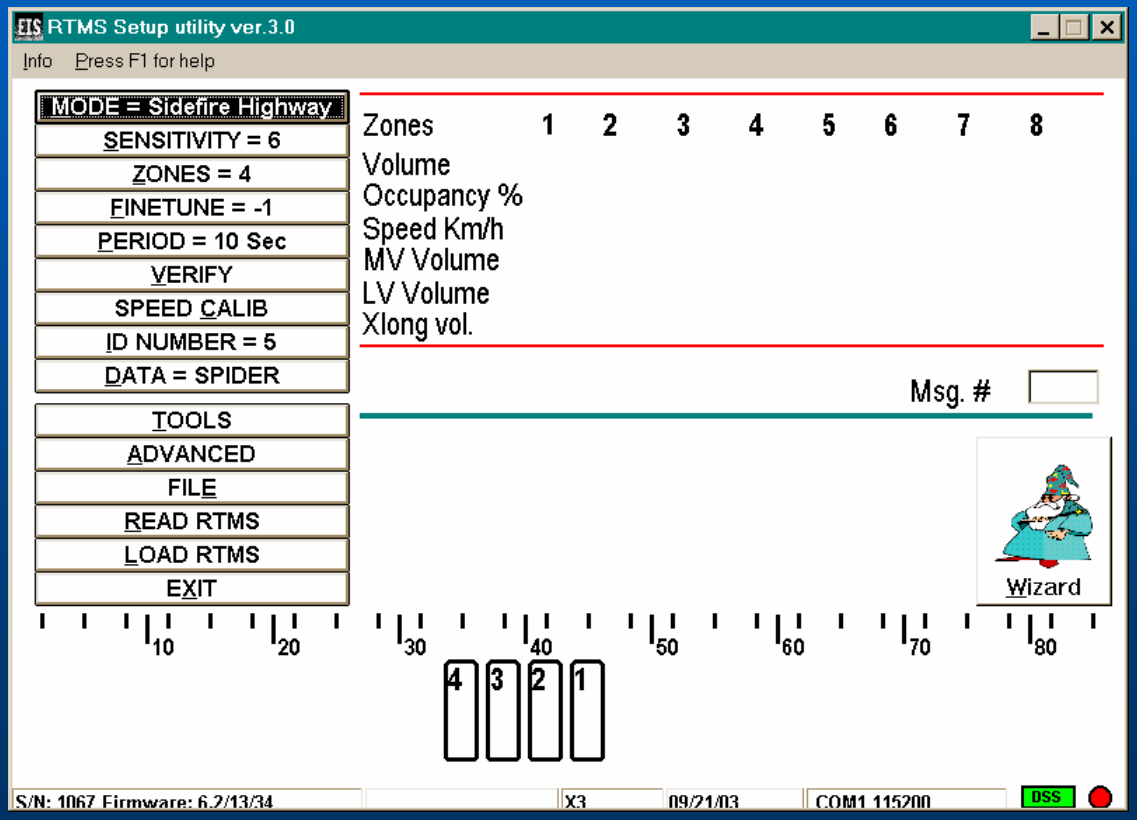
Diagnostics

- **Can check the SPIDER log for any error messages (troubleshooting)**
- **self test for SPIDER and RTMS**
- **communicate via RF to individual RTMS**



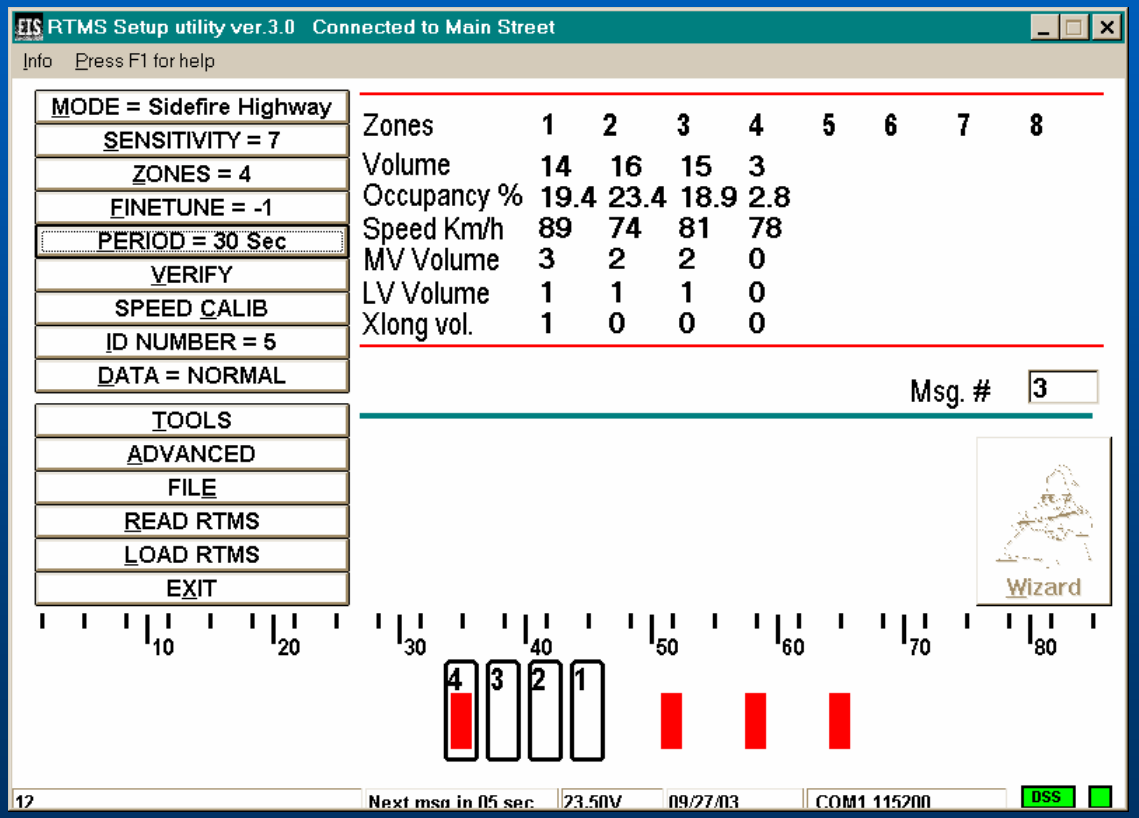
RTMS Setup Utility

- **RTMS units come pre-programmed in SPIDER mode and to communicate to SPIDER RF master**



RTMS - via the SPIDER

- To set up the RTMS unit, the mode needs to change to NORMAL - done automatically when program is opened via the SPIDER
- changes back to SPIDER mode on exit



Troubleshooting

Troubleshooting

- **No RTMS units are displayed on Event Screen or are grayed out**
  - **no power to RTMS**
  - **radio parameters are different between SPIDER and RTMS unit(s) - manual verification of units**
  - **radio path is poor - check antenna connections and RF Spectrum**

Troubleshooting

- **Link number is low - constantly below 6**
  - **indicates multiple message repeats**
  - **radio path is poor - check antenna connections and height - obstacles in antenna path**
  - **radio power is too low - increase**

Troubleshooting

- **SPIDER Log file has messages**
  - **messages are created from communication errors**
  - **if refers to specific RTMS re-establishing contact - may be poor power at RTMS or poor radio path to that RTMS**

Troubleshooting

- **Further troubleshooting assistance is available in the SPIDER User Manual**