



# Broadband Instruments and Systems



## Return Path Troubleshooting

SCTE Cascade Range Chapter



think ahead.



# Seminar Outline

- Return Path Defined
- Network Preparation & Maintenance
- Troubleshooting Ingress
- Signal Leakage
- Return Sweep
- Return Path Monitoring
- Using the Tools





# Return Path Defined



PROPRIETARY • TRILITHIC AND AUTHORIZED CLIENTS ONLY

This document contains proprietary information that shall be distributed or routed only within Trilithic, Inc. and its authorized clients, except with written permission of Trilithic.



# Return Path

- The focus of the cable industry is on making cable networks quality, interactive, and two-way communications pipelines
- Many services are being considered or deployed for the return spectrum including
  - High-speed data
  - Interactive TV applications
  - Telephony
  - Internet TV
  - Video Conferencing
  - And more...





# Return Path

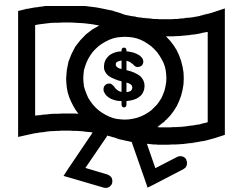
- The problems that operators are having with the return path typically comes from noise and ingress
- Ingress is the most common problem that operators of two-way services are struggling with





# How Testing Helps

- Must be quick to identify, isolate, and solve problems – know system health
- Provides long-term retention
  - Recruiting customers is expensive and is critical to the ROI
  - Loss of voice customer may also mean loss of the rest of the triple-play revenue





# Broadband Instruments and Systems



## Physical Network Preparation & Maintenance



think ahead.



# Enhanced Testing and Maintenance

- Before the service is rolled out
  - Align and test each node to assure operating margin for optimal quality
- Adequate digital video and HSD performance does not guarantee adequate VoIP performance
  - these services are relatively robust
  - able to withstand interference that causes packet loss and jitter





# Alignment & Maintenance Required

- In order to provide the highest quality service and mitigate service calls
- The return path should be swept and balanced
- Verify carrier-to-noise ratio operating margin
- Ingress and impulse noise must be monitored for at least a 24-hour period
  - occurs at various times of the day
  - has a wide variety of causes





# Return Path

- Impact of Noise & Ingress on System Services
  - Noise Funneling
  - Noise Contribution
  - Ingress Contribution
- Required System Maintenance
  - Return Sweeping
  - Ingress Troubleshooting
  - Alternative Maintenance Techniques
- Required Monitoring
  - Monitoring of the Spectrum
  - Correlating Monitoring information with system performance





# Primary sources of return path noise

- Thermal Noise
  - generated in each active component
- Fiber Optic-Noise
  - From the Return Path Laser
  - Fiber Optic Receiver
- Ingress
  - Discrete
  - Broadband
  - System Induced





# System Operating Levels

- C/N Margins may be improved by raising Carrier Levels - But Only to a Point
- Carrier Levels are limited by the Return Laser





# Troubleshooting Ingress

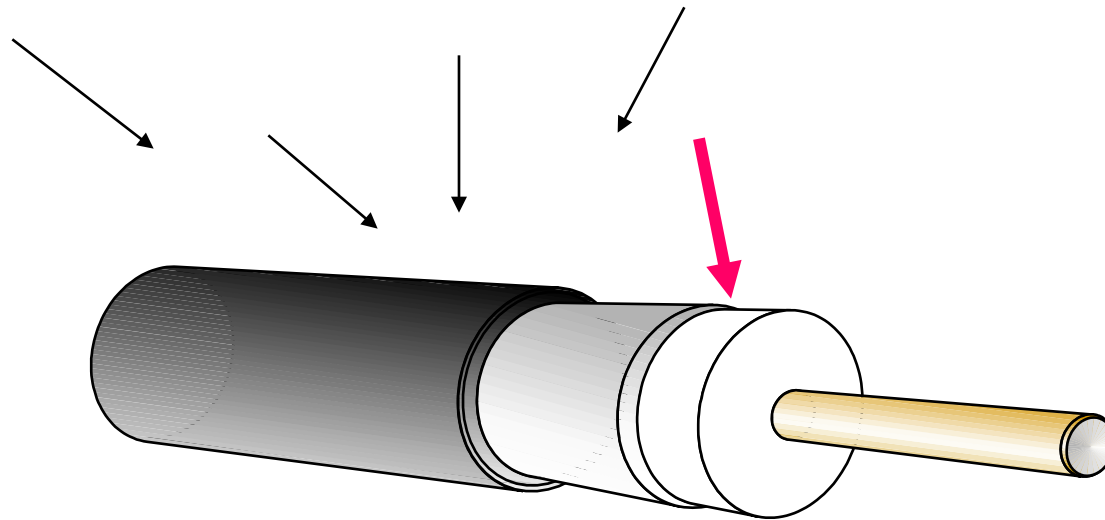


PROPRIETARY • TRILITHIC AND AUTHORIZED CLIENTS ONLY

This document contains proprietary information that shall be distributed or routed only within Trilithic, Inc. and its authorized clients, except with written permission of Trilithic.



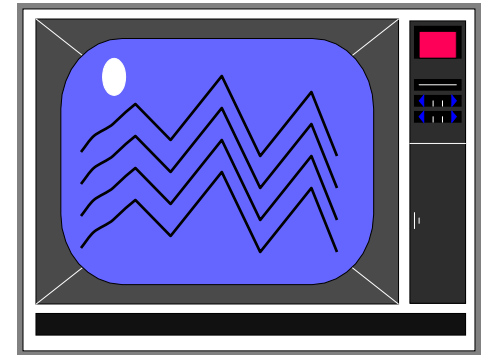
## Ingress





# Ingress on Analog Channels

- Lines in picture
- Ghosting
- Pay-per-view problems
- High speed data problems
- Interference with two-way radio services using the same frequencies
- Repeat Service Calls





# Ingress on Digital Channels

- Macro Blocking (Tiling)
- Freeze Frame
- Picture and Sound go to black
- Robotic Voice
- Data Packet Loss or slower speeds
- Repeat Service Calls

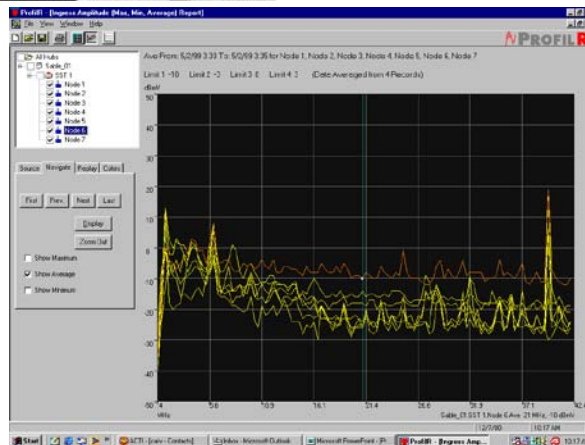
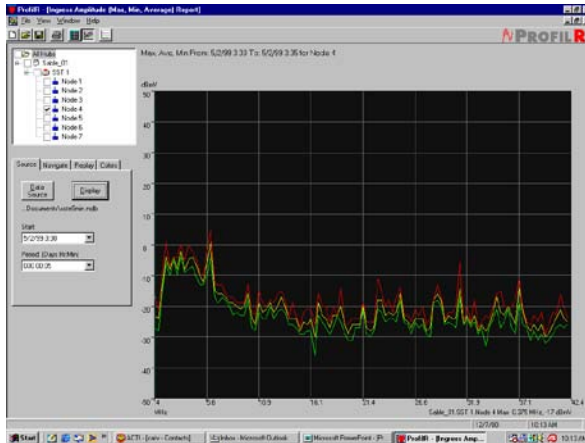


PROPRIETARY • TRILITHIC AND AUTHORIZED CLIENTS ONLY

This document contains proprietary information that shall be distributed or routed only within Trilithic, Inc. and its authorized clients, except with written permission of Trilithic.



# Observations about Ingress



- Ingress levels vary in the return path
  - Over Time
  - From Node to Node
  - Discrete or Broadband
- Ingress Signatures
  - Highest under 15 MHz
- Vary between nodes
  - Noise Floor Node 1  
-25dBmV @ 21 MHz
  - Noise Floor Node 6  
-10dBmV @ 21 MHz



PROPRIETARY • TRILITHIC AND AUTHORIZED CLIENTS ONLY

This document contains proprietary information that shall be distributed or routed only within Trilithic, Inc. and its authorized clients, except with written permission of Trilithic.



# Ingress Monitoring Tools for Maintenance

- Real time access to headend ingress levels via PC or SLM
  - Check ingress levels remotely, saving time traveling to remote locations to troubleshoot ingress that is not longer there
  - Allow comparisons of Ingress levels at the test point and hubsite locations
- Provide documentation of areas in need of maintenance
  - Alarm violations by node
  - Playback spectral information that caused alarm conditions
  - Spectral information by node over time





# Common Sources of Ingress

- Off Air
  - Short Wave Radio (4.75 to 10 MHz)
  - Ham Operators (7, 10, 14, 18, 21, 24 & 28 MHz)
  - CB Radios (27 MHz)
  - Broadband noise (things with electric motors, PCs, etc)
  - Impulse Noise (shorts bursts of Broadband noise)
- Plant Induced
  - Common Path Distortion (6MHz beats across entire spectrum)
  - Transient Hum Modulation
  - Excessive Gain
- Subscriber Induced
  - Direct Pickup
  - Malfunctioning Subscriber Devices
  - Broadband noise from appliances
  - Self Installs





# Ingress Studies

## Where does ingress enter the system?

Hard-line Cable	5%
Tap to Ground Block	25%
Subscriber Wiring	70%



TRILITHIC



# The Daily Routine

- Make a cross reference of service groups (router card/blades) and system nodes
- Compare trouble tickets from HSD, IPPV and Telephony to determine problem nodes
- Use alarm information from status monitoring system to verify if service degradation is due to ingress
- Use remote access through a PC or connect a spectrum analyzer to system test points and verify the problem still exists





# The Daily Routine

- Utilize good installation practices
- Install devices need to be of a good quality
- Conduct pre and post reverse testing on installations
- Monitor and repair signal leakage
- Check the performance of the return path
- Issue the reverse trouble tickets to the techs

***Potentially one bad drop cable or one poor connection can wipe out an entire node for reverse services.***





# Signal Leakage



PROPRIETARY • TRILITHIC AND AUTHORIZED CLIENTS ONLY

This document contains proprietary information that shall be distributed or routed only within Trilithic, Inc. and its authorized clients, except with written permission of Trilithic.



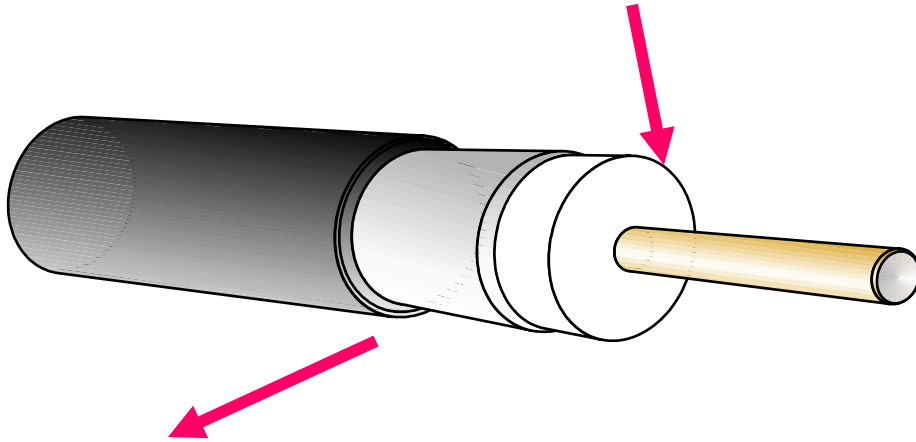
# What is Signal Leakage?

- Definition:
  - Undesired emission of signals out of an HFC network





# Ingress & Egress



- Ingress
  - RF or electrical energy that enters the coaxial environment
- Egress
  - RF signal leaking out of the coaxial environment





# CLI Spectrum Charts

108 MHz

118 MHz

137 MHz

Off-air

Air Navigation

Air Voice Communication

Cable

CH 98

CH 99

CH 14

CH 16

CH 15

144 MHz

162 MHz

174 MHz

Off-air

HAM Operators

Government Mobile

Cable

CH 18

CH 19

CH 20

CH 21

CH 22



PROPRIETARY • TRILITHIC AND AUTHORIZED CLIENTS ONLY

This document contains proprietary information that shall be distributed or routed only within Trilithic, Inc. and its authorized clients, except with written permission of Trilithic.



# Common Causes

- 70% of all leakage is caused by problems between the tap and entry to the house
  - Aging and environmental stress
  - Physical trauma to cables or connectors
  - Loose drop connectors
  - Inferior quality coaxial cable, passives, or connectors
  - Loose hard line connectors





# Other Causes of Leakage

- Improperly installed connectors
- Cracks in the trunk and feeder cable
- Animal chews
- Poorly-shielded drop cable
- Bad connectors at the tap
- Bad/loose port terminator
- Corroded connectors





# Other Causes Continued

- Customer installed equipment
- Damaged amplifier housing or loose amplifier housing lids
- Broken tap ports
- Poor installation of splices and connectors
- Poorly-shielded customer premise equipment





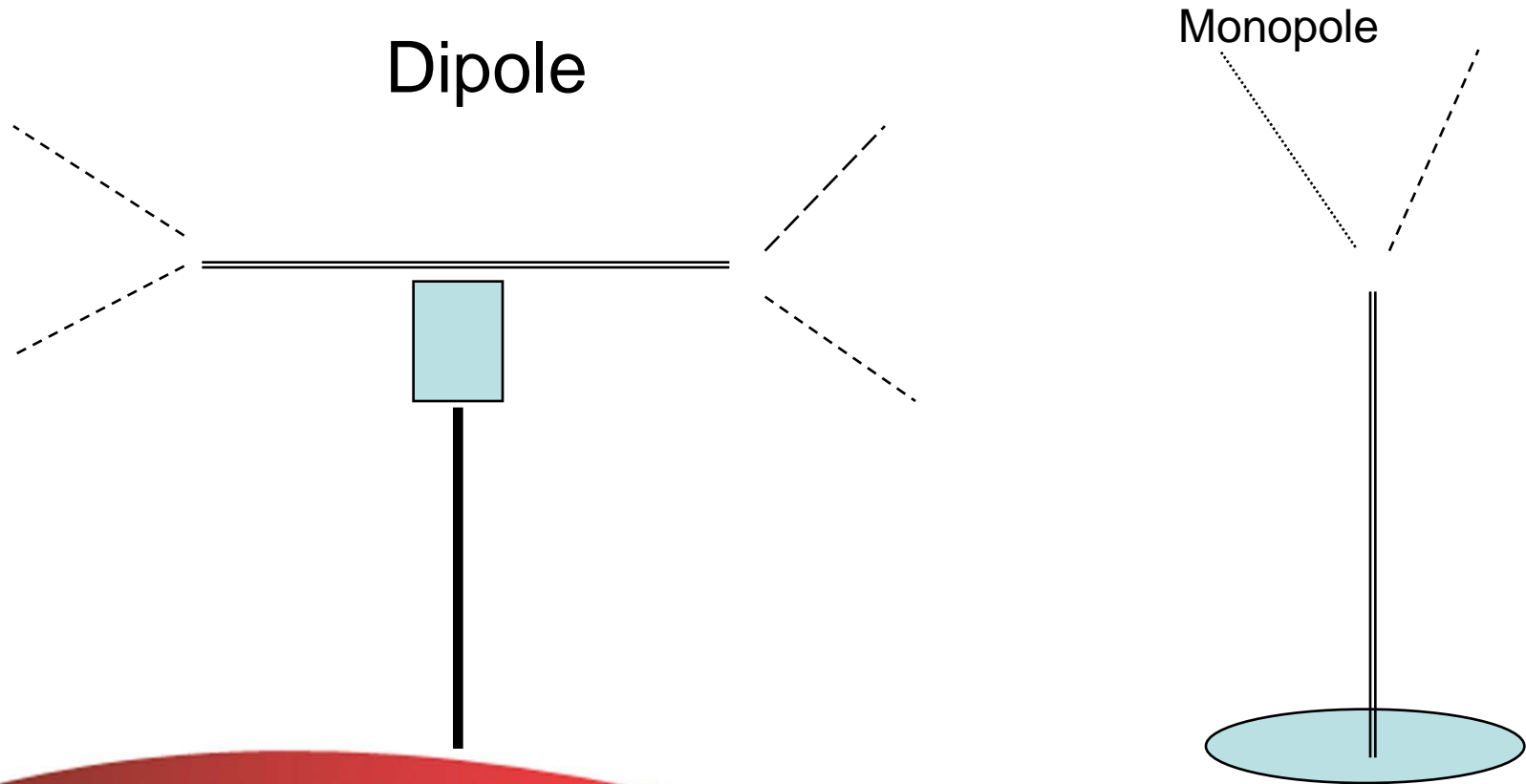
# Acceptable Procedures for Leakage Measurement

- Use a calibrated halfwave dipole antenna
- Antenna must be elevated 3 meters off the ground and positioned 3 meters from the leakage source
- Antenna must be rotated 360° in the horizontal plane for maximum reading
- CLI Fly-over





## Polarization Angle

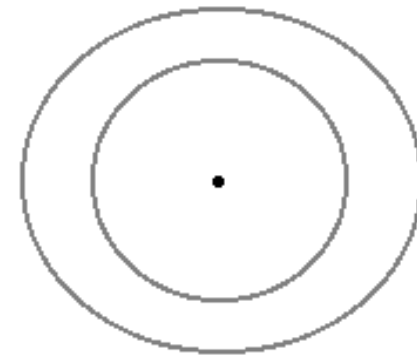
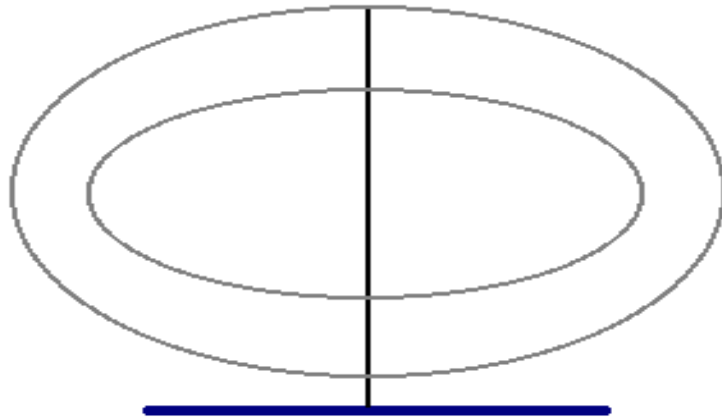


PROPRIETARY • TRILITHIC AND AUTHORIZED CLIENTS ONLY

This document contains proprietary information that shall be distributed or routed only within Trilithic, Inc. and its authorized clients, except with written permission of Trilithic.



# Leakage Antennas-Whip

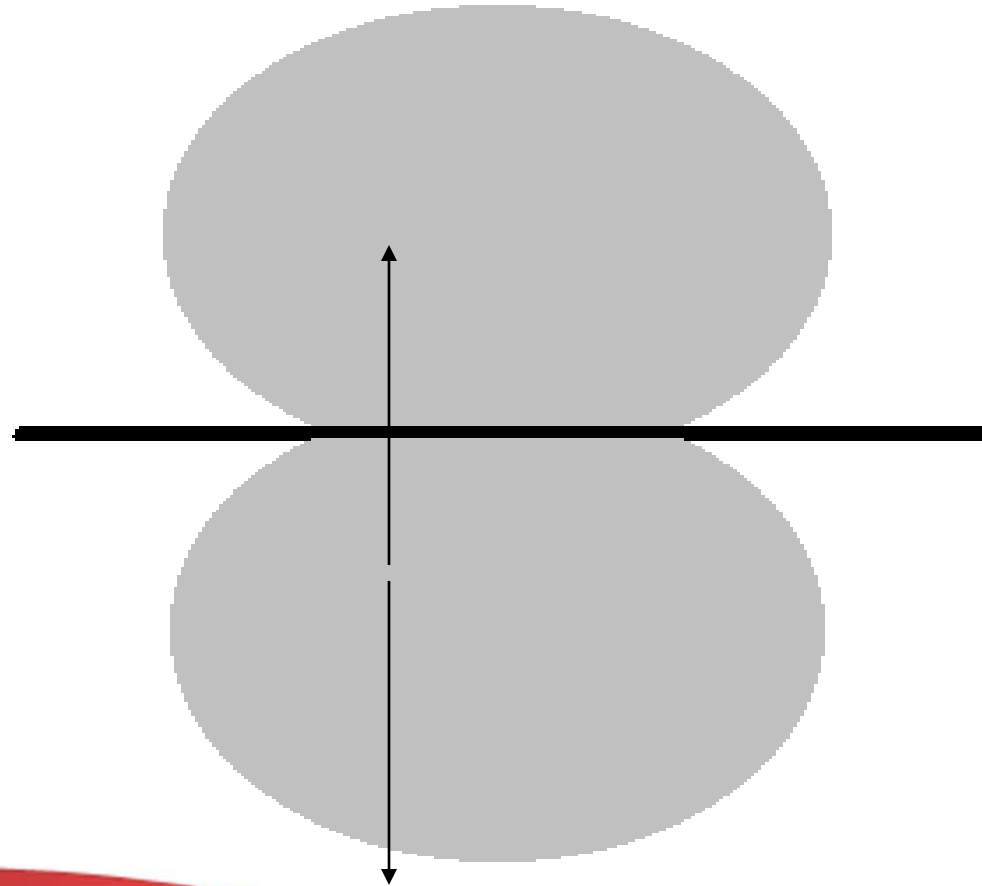


PROPRIETARY • TRILITHIC AND AUTHORIZED CLIENTS ONLY

This document contains proprietary information that shall be distributed or routed only within Trilithic, Inc. and its authorized clients, except with written permission of Trilithic.



# Leakage Antennas-Dipole

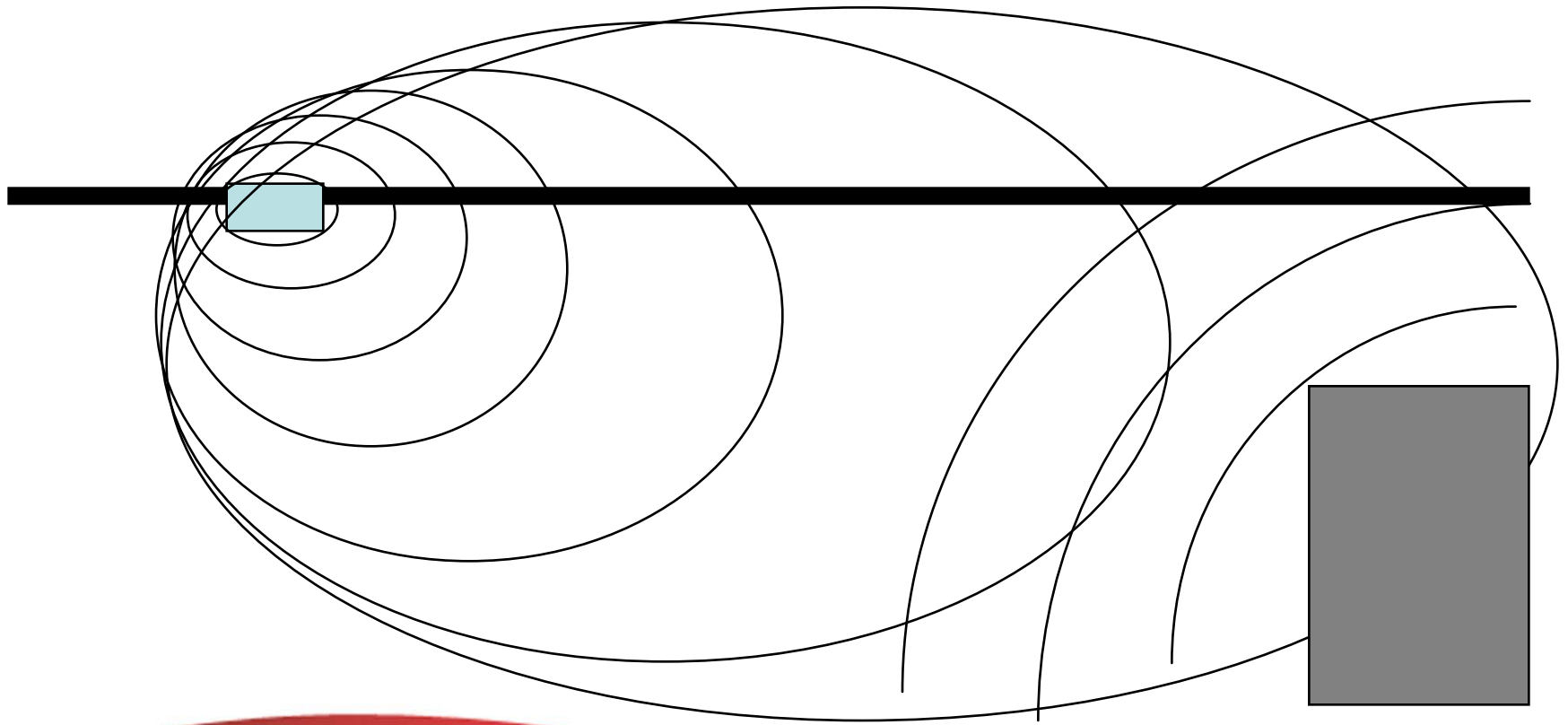


PROPRIETARY • TRILITHIC AND AUTHORIZED CLIENTS ONLY

This document contains proprietary information that shall be distributed or routed only within Trilithic, Inc. and its authorized clients, except with written permission of Trilithic.



## Signal phasing

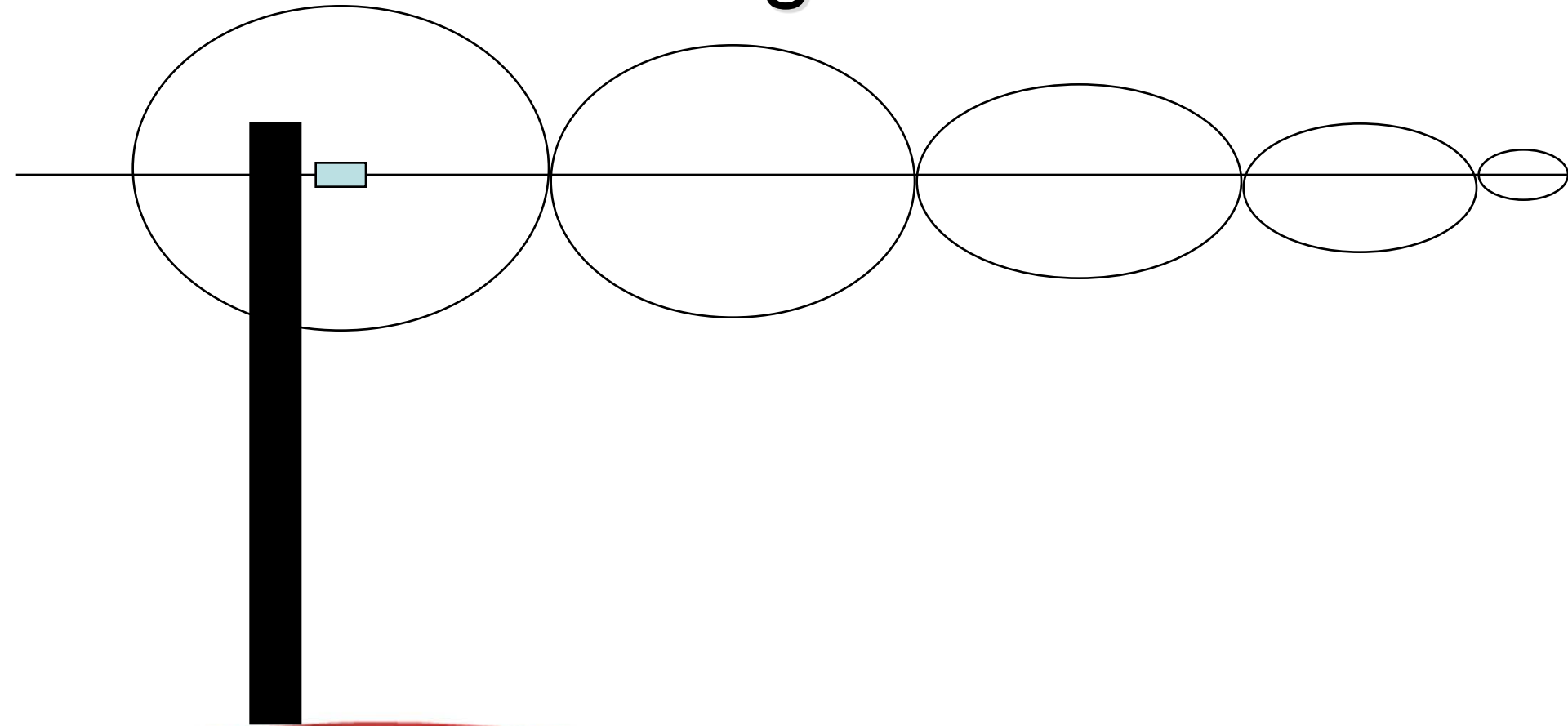


PROPRIETARY • TRILITHIC AND AUTHORIZED CLIENTS ONLY

This document contains proprietary information that shall be distributed or routed only within Trilithic, Inc. and its authorized clients, except with written permission of Trilithic.



# Standing Waves

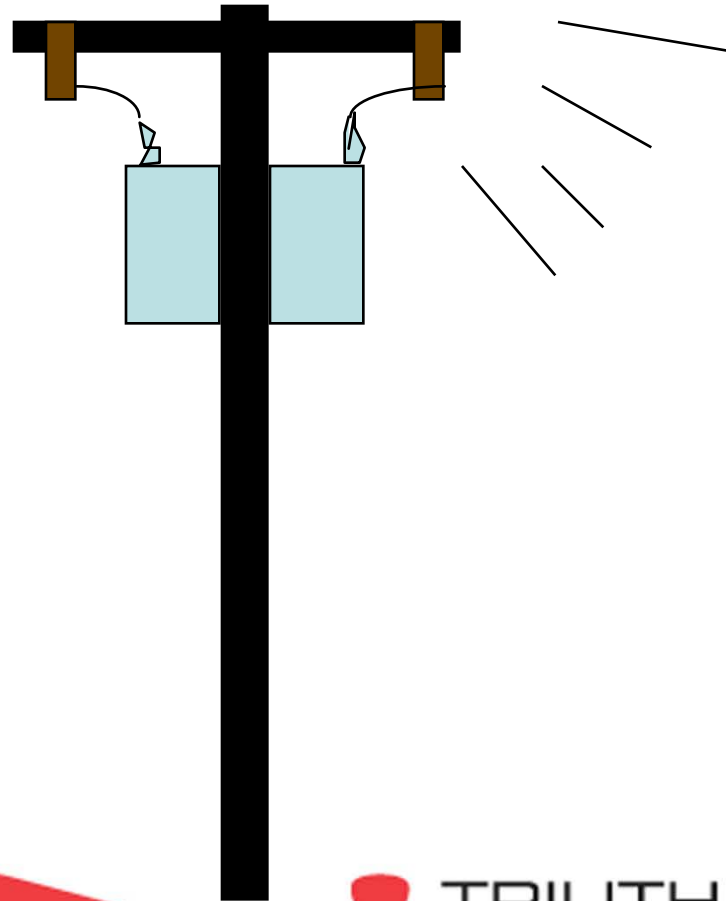


PROPRIETARY • TRILITHIC AND AUTHORIZED CLIENTS ONLY

This document contains proprietary information that shall be distributed or routed only within Trilithic, Inc. and its authorized clients, except with written permission of Trilithic.



# Electrical Noise

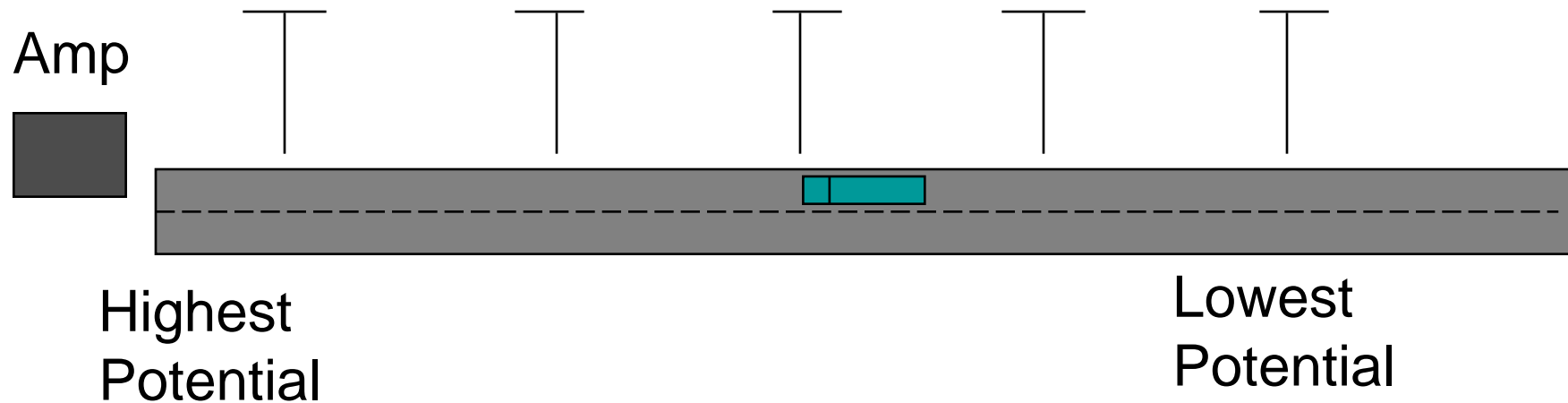


PROPRIETARY • TRILITHIC AND AUTHORIZED CLIENTS ONLY

This document contains proprietary information that shall be distributed or routed only within Trilithic, Inc. and its authorized clients, except with written permission of Trilithic.



# Leakage Field Strength





# Distance Correction

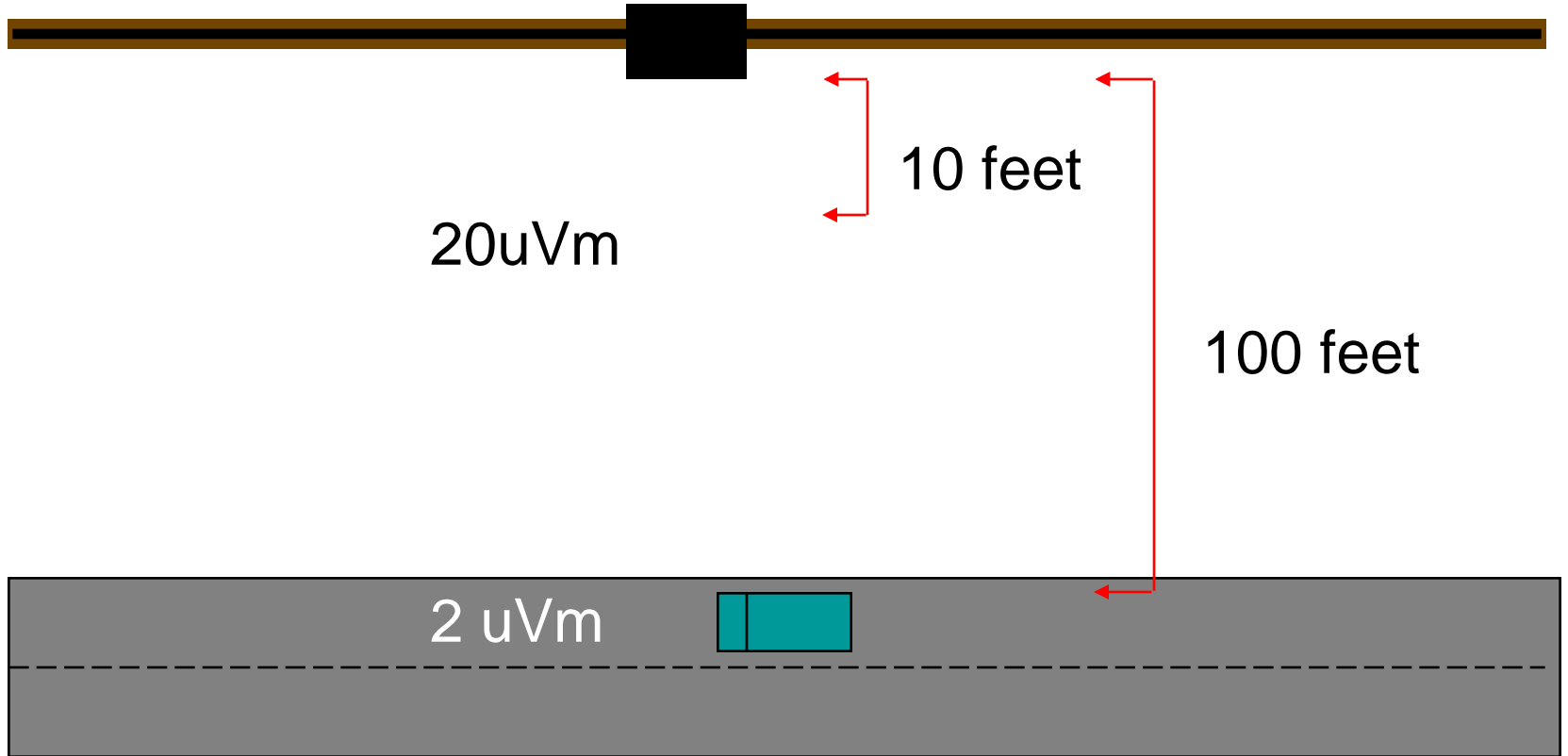
Reading x Distance

$$\frac{\text{-----}}{10} = \text{Corrected Reading}$$



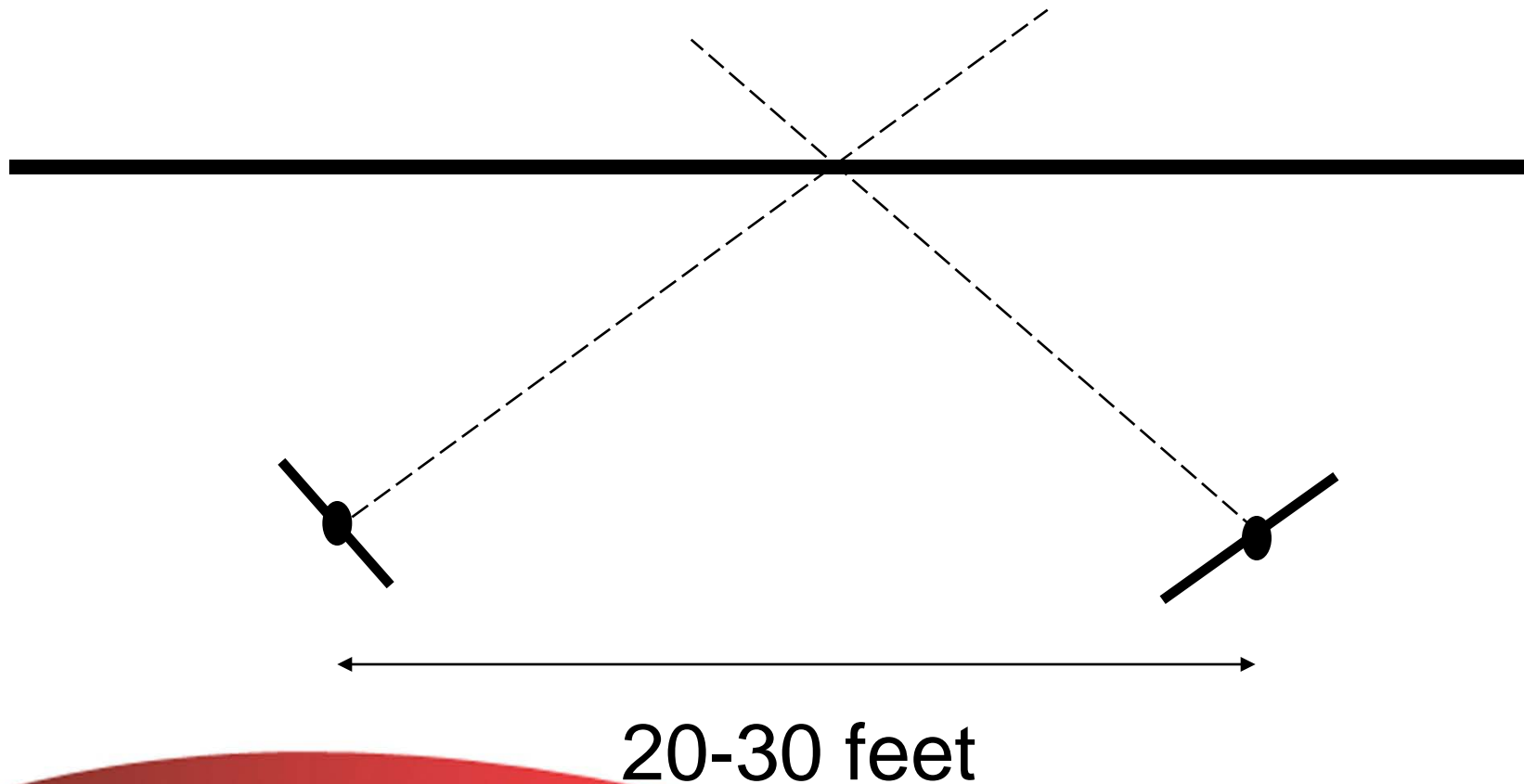


# Patrolling for Leakage





## Walking Out a Leakage Area

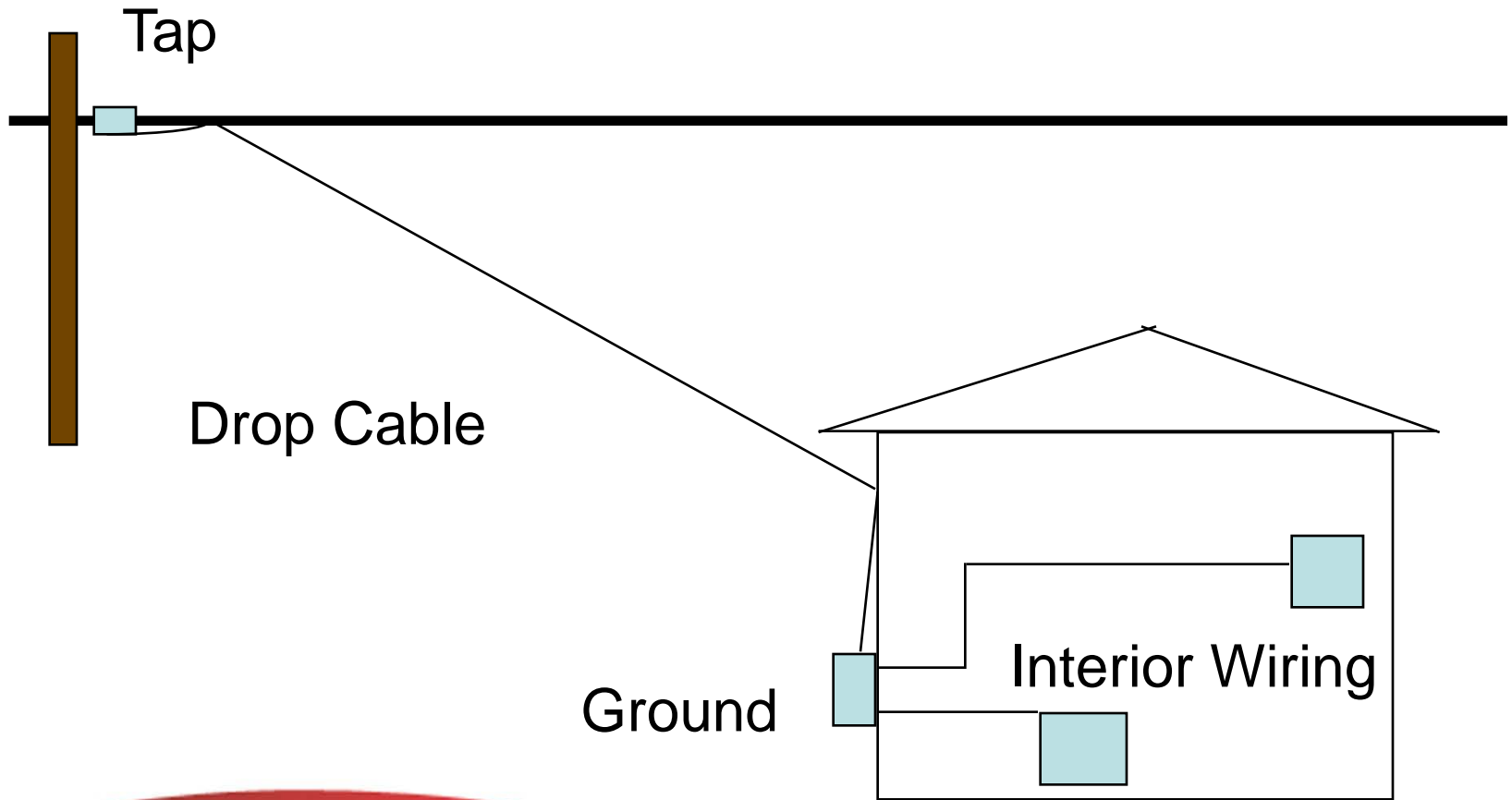


PROPRIETARY • TRILITHIC AND AUTHORIZED CLIENTS ONLY

This document contains proprietary information that shall be distributed or routed only within Trilithic, Inc. and its authorized clients, except with written permission of Trilithic.



# Installation Leakage

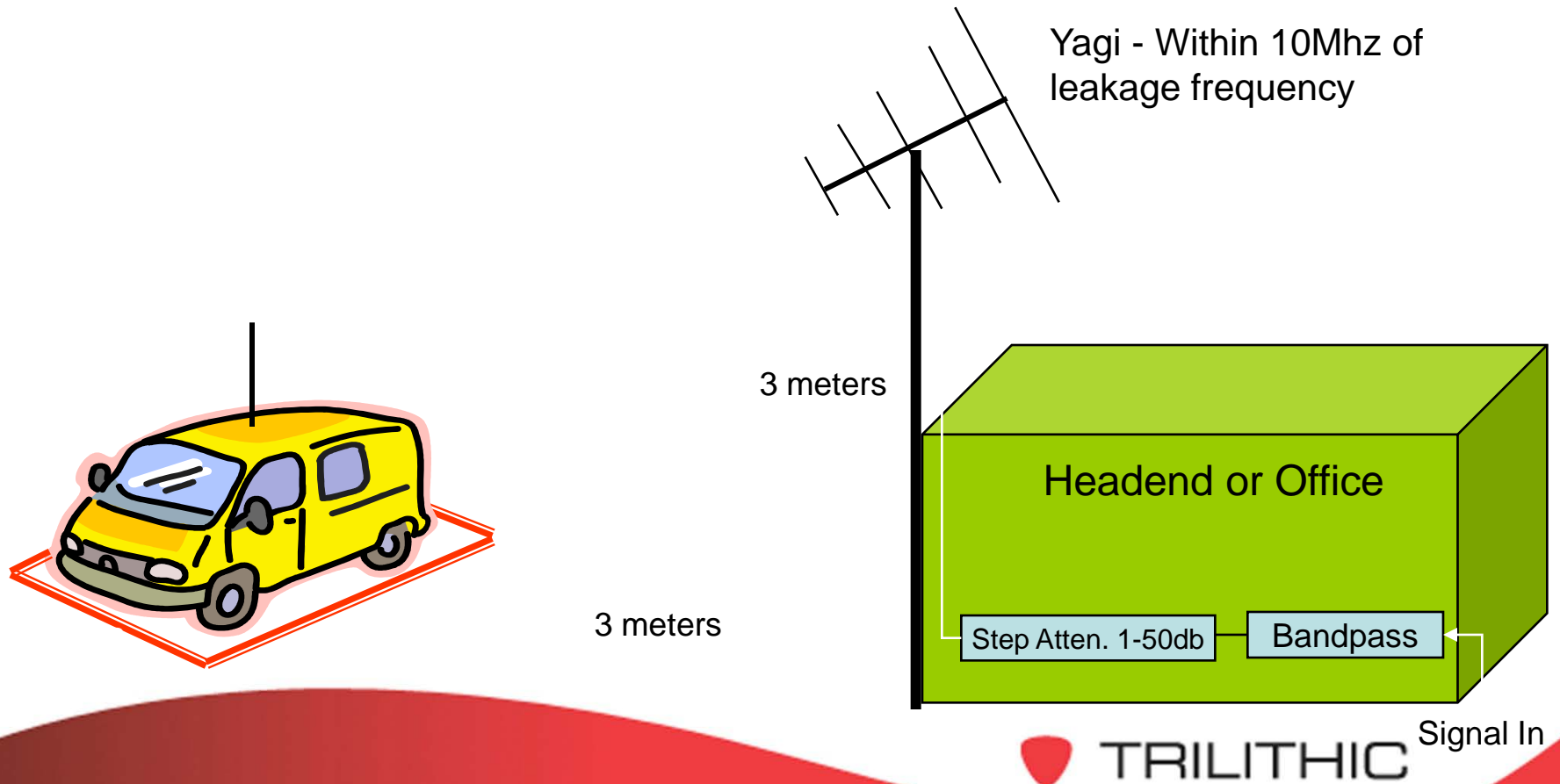


PROPRIETARY • TRILITHIC AND AUTHORIZED CLIENTS ONLY

This document contains proprietary information that shall be distributed or routed only within Trilithic, Inc. and its authorized clients, except with written permission of Trilithic.



## Drive-up Calibration Point



PROPRIETARY • TRILITHIC AND AUTHORIZED CLIENTS ONLY

This document contains proprietary information that shall be distributed or routed only within Trilithic, Inc. and its authorized clients, except with written permission of Trilithic.



# Why and How to Check for Leakage ?



PROPRIETARY • TRILITHIC AND AUTHORIZED CLIENTS ONLY

This document contains proprietary information that shall be distributed or routed only within Trilithic, Inc. and its authorized clients, except with written permission of Trilithic.



- **Public Safety**
  - Potential interference with aircraft communication/navigation
  - The cable system could interfere with off-air signals
- **Quality of Service**
  - Ingress impairs picture quality
  - Ingress/Egress (leakage) usually is a sign of a pending equipment failure





- Increased implementation of services requiring return path activation
  - If a system has egress it will most likely have ingress
  - Ingress brings the viability of two-way services into question
  - VoIP demands higher network reliability





# Common Leakage Sources

- Splices and fittings- Water and weather can result in pulled out, loose or corroding fittings
- Splices at taps, line extenders, splitters, amps and ground blocks
- Illegal hookups involving twin leads, cheap passive devices, house amplifiers, poor or no connectors, and improperly terminated splitters
- 15% jumpers from drops to taps or ground blocks
- 75% of leaks come from subscribers home





# Return Sweep



PROPRIETARY • TRILITHIC AND AUTHORIZED CLIENTS ONLY

This document contains proprietary information that shall be distributed or routed only within Trilithic, Inc. and its authorized clients, except with written permission of Trilithic.



# Return Sweep

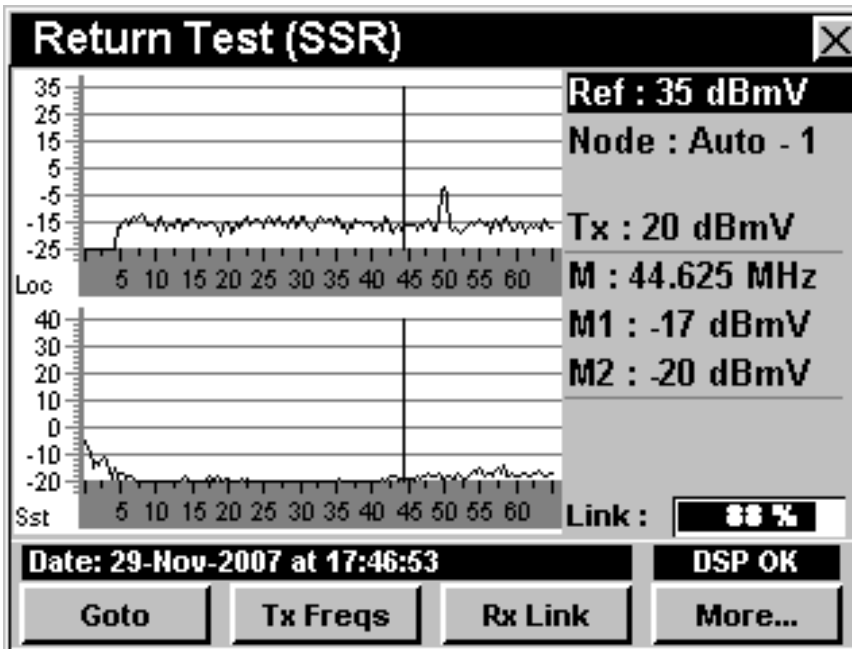
- Proper alignment of the system is critical to service quality and reliability
- Problems uncovered while sweeping can also cause ingress
  - Bad, or loose connections
  - Cable damage
  - Misalignment (can cause laser clipping)



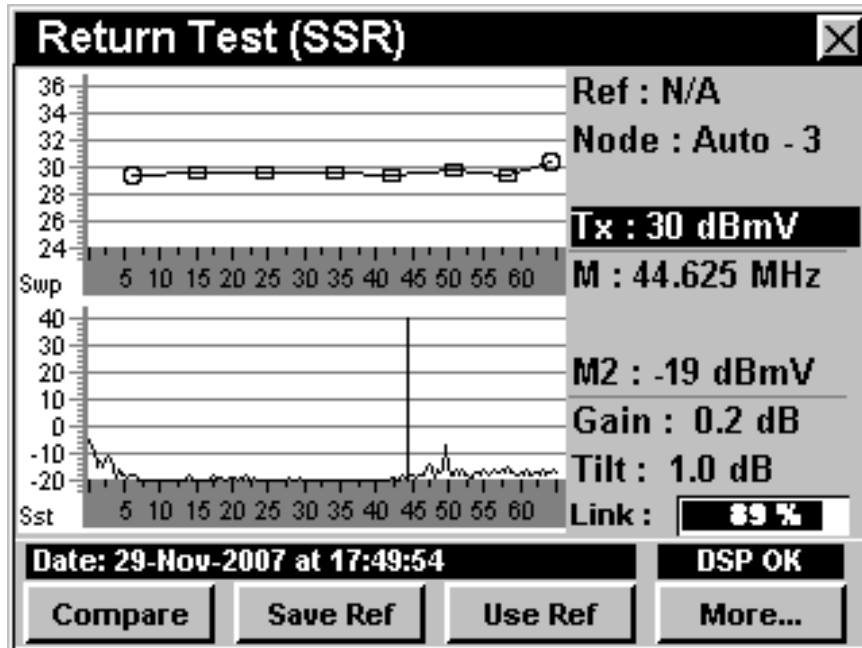


# Field Access

- Return Display
  - Helps in isolating ingress locations by viewing changes in headend ingress levels
  - Cause level fluctuations by
    - pulling pads
    - using wink switches
  - Or Use a headend overlay to deduce the ingress contribution by a leg or span
  - Compare ingress levels without breaking continuity



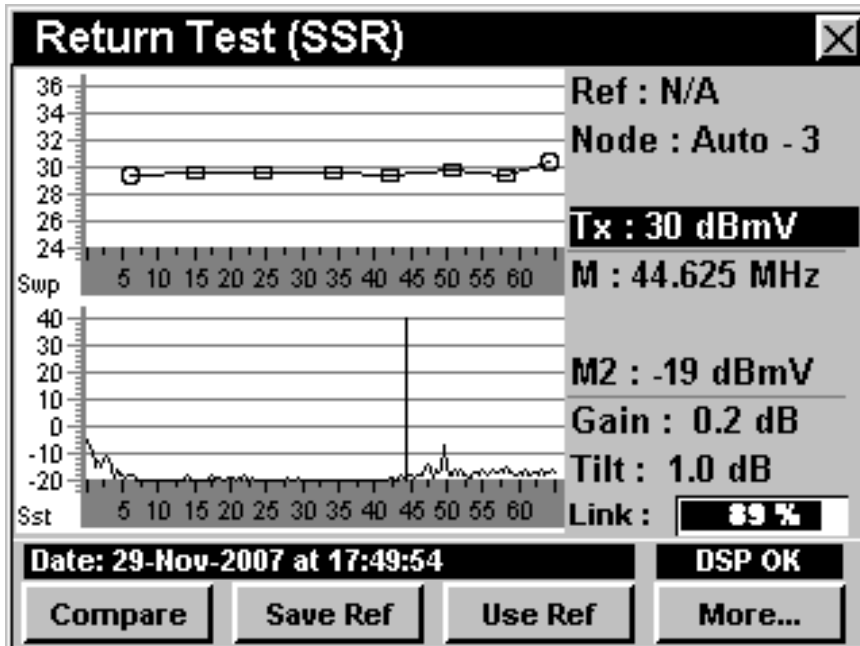
# Return Sweep Mode



- Displays
  - Gain/Tilt
  - Frequency Response
  - Headend Ingress levels
- Gain Information
  - Difference between Headend nominal and sweep carrier level
- Tilt Information
  - Difference between low and high pilots carrier levels
- Pads and Equalizers
  - Gain/Tilt values of 0 are perfect
  - Values other than 0 indicate the change in Pad/EQ necessary to bring the system into alignment



# Return Sweep Mode



- Frequency Response Trace
  - Plots received (Headend) level for each sweep carrier
  - Scale per Division 2 dB
  - Ideal Trace is a flat line
- Impairments to frequency response
  - Damaged Cable
  - Damaged actives or passives
  - High Ingress Levels





# Return Path Monitoring



PROPRIETARY • TRILITHIC AND AUTHORIZED CLIENTS ONLY

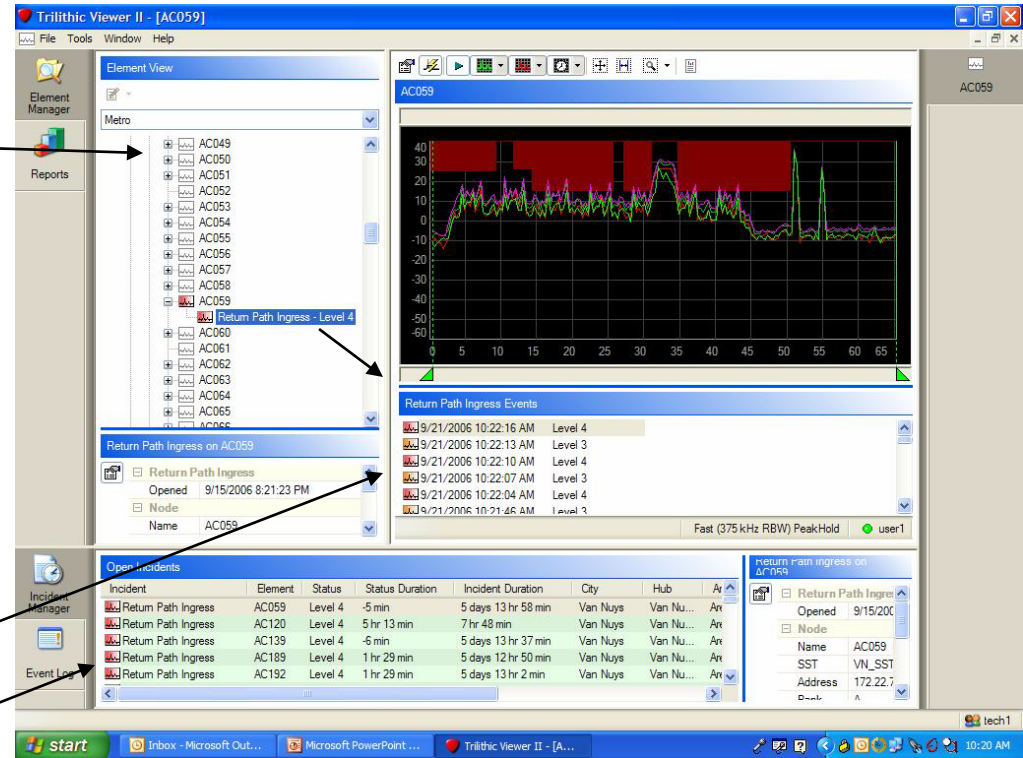
This document contains proprietary information that shall be distributed or routed only within Trilithic, Inc. and its authorized clients, except with written permission of Trilithic.



# Monitoring System User Interface

## Components

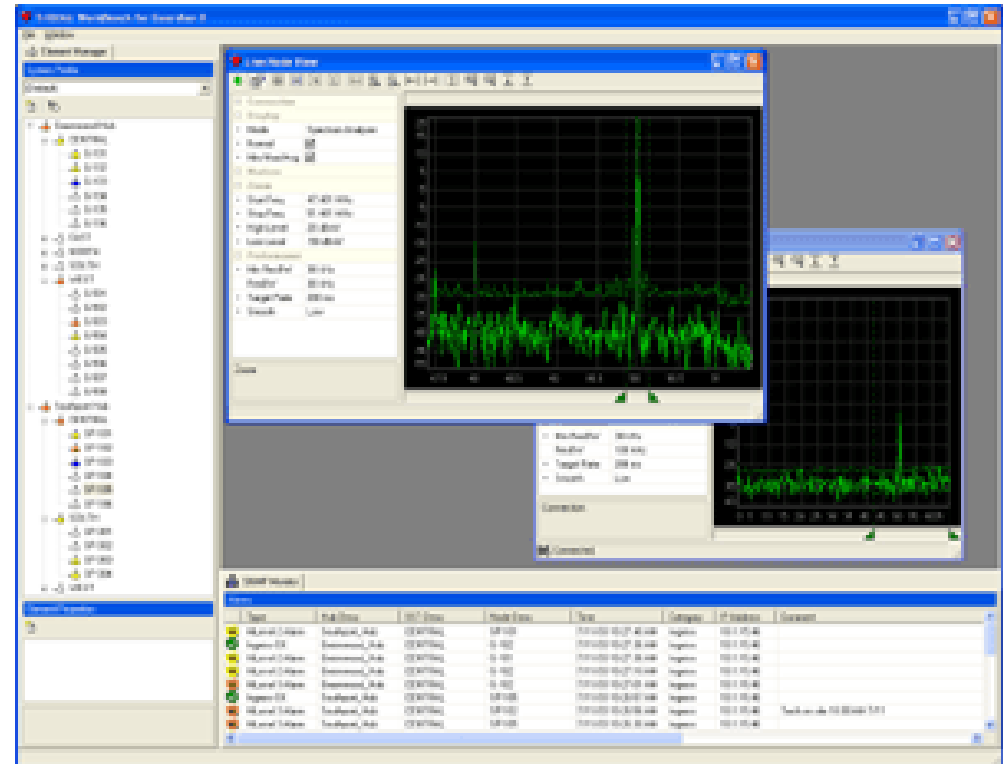
- Status Tree
- Spectrum Display
  - Live trace and trace that triggered alarm
  - Lets tech know if ingress is present at this time
  - Trace signature helps identify cause
- Alarm History
- Incident Log





# Certifying Return Path

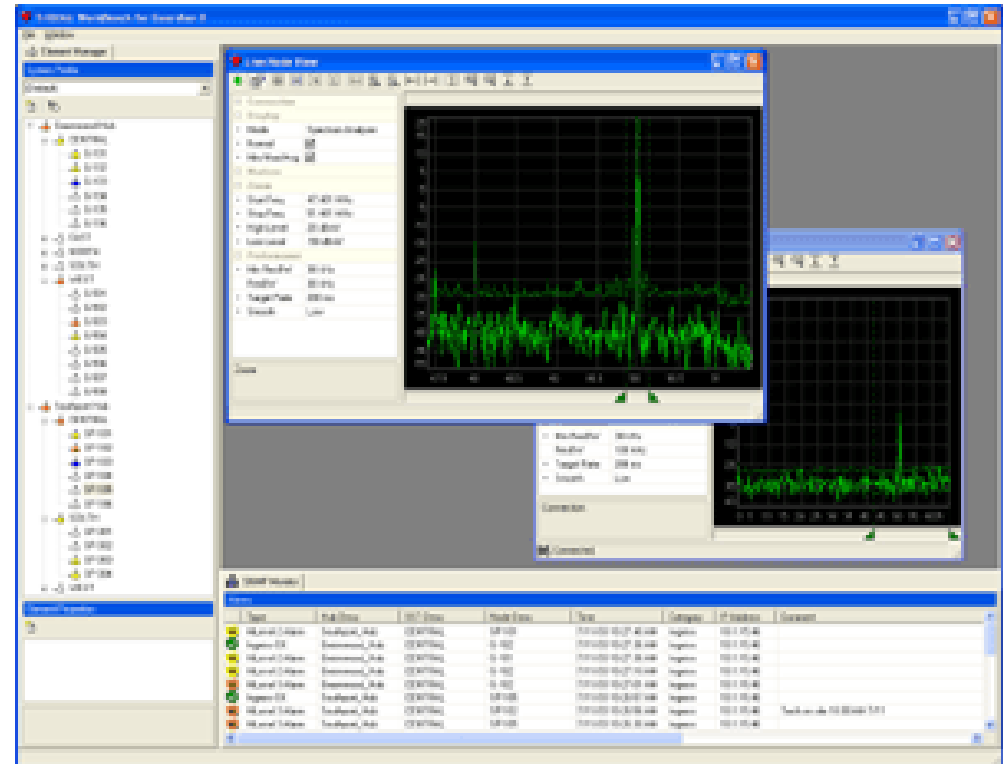
- There have been as many methods and specifications
- Examples include
  - a one-hour max hold
  - ten minutes max hold
- The results are considered to demonstrate that over this period the network would either pass or fail based on the amount of junk viewed





# Certifying Return Path

- Voip is not a 1 hour service
  - 24 hour
  - 7 days a week
- This maximum measurement is also not indicative of the true performance of the network
- The certification process should be at least a twenty-four hour certification
- Should be an on-going figure of merit.





# Using The Tools Tips and Tricks



PROPRIETARY • TRILITHIC AND AUTHORIZED CLIENTS ONLY

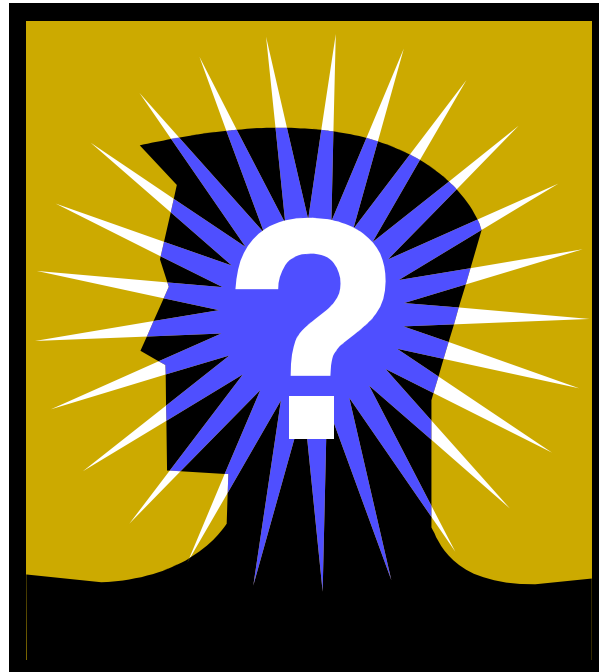
This document contains proprietary information that shall be distributed or routed only within Trilithic, Inc. and its authorized clients, except with written permission of Trilithic.



- Spectrum Analyzer Settings
- Chasing Return Path Noise
- Return Sweep
- Leakage Detectors
- Monitoring for Ingress



# Questions?





# Trilithic Applications Engineering

[support@trilithic.com](mailto:support@trilithic.com)

800-344-2412

317-895-3600

[www.trilithic.com](http://www.trilithic.com)



PROPRIETARY • TRILITHIC AND AUTHORIZED CLIENTS ONLY

This document contains proprietary information that shall be distributed or routed only within Trilithic, Inc. and its authorized clients, except with written permission of Trilithic.