



Wireless Point to Point and 3G/4G Rural Networks

Presented by

Jim Whalen

Nevada DOT

Why NDOT Deploys PTP & 3G/4G

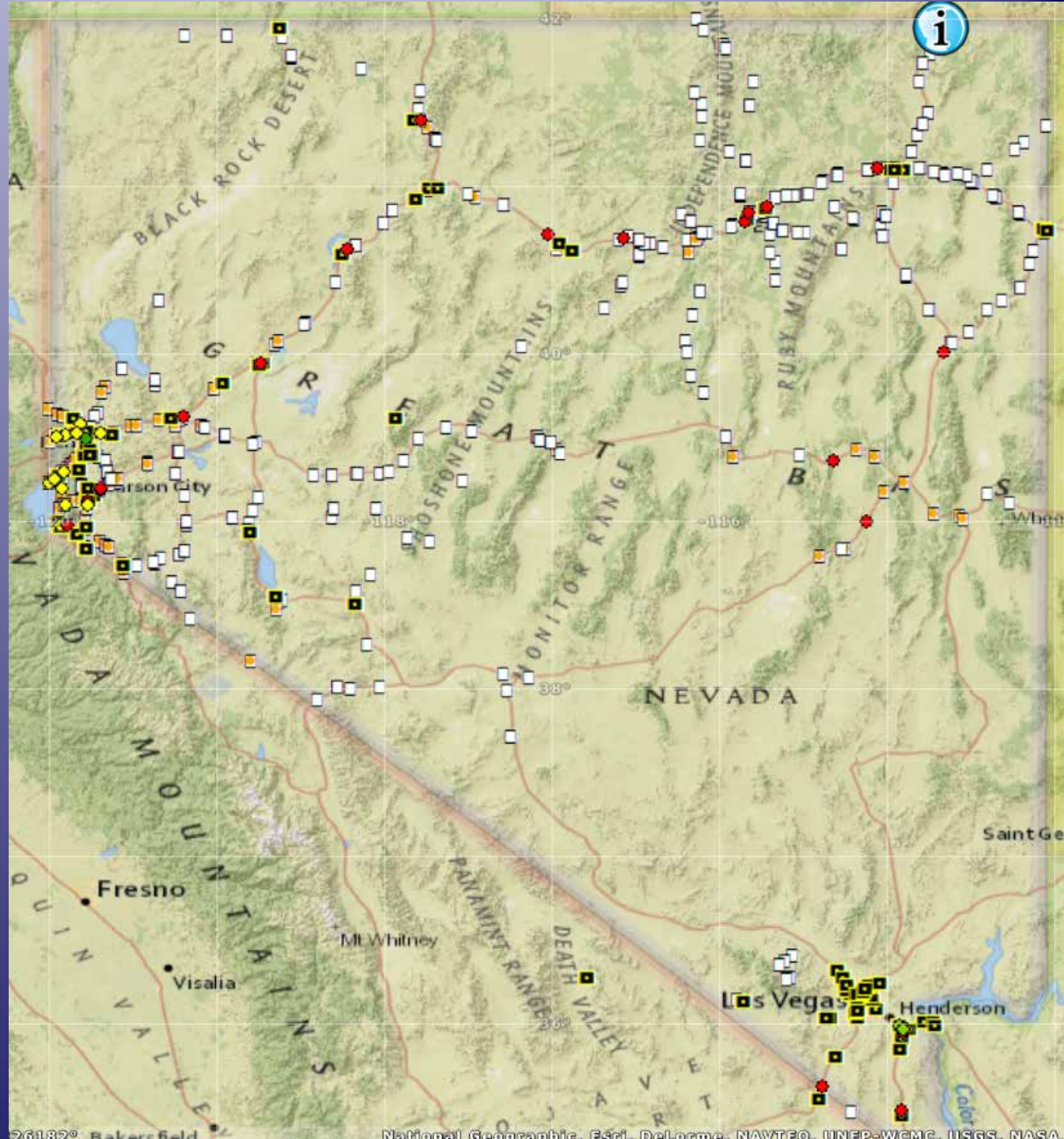
- n The department is responsible for the planning, construction, operation and maintenance of the 5,400 miles of highway and over 1,000 bridges which make up the state highway system.
- n Nevada is predominately a rural state with many roadway devices which need connectivity to the road operation center.
- n State and department infrastructure are initially considered for network connectivity as well as lease services.

Why NDOT Deploys PTP & 3G/4G

- n State Radio System has 109 Mountain top Sites however, the Harris EDACS RDI protocol does not support TCP/IP well.
- n NDOT is not staffed for non-COTS systems.
- n PTP can extend a network where other mediums are not available and is reliable and cost effective.
- n 3G/4G can also extend a network but is not as reliable as other mediums and has recurring costs.



- ◆ Airport Info
- ◆ HAR Weather Info
- ◆ HAR Road Conditions
- ◆ Hoover Dam Detour
- DMS
- Chain up Signs
-





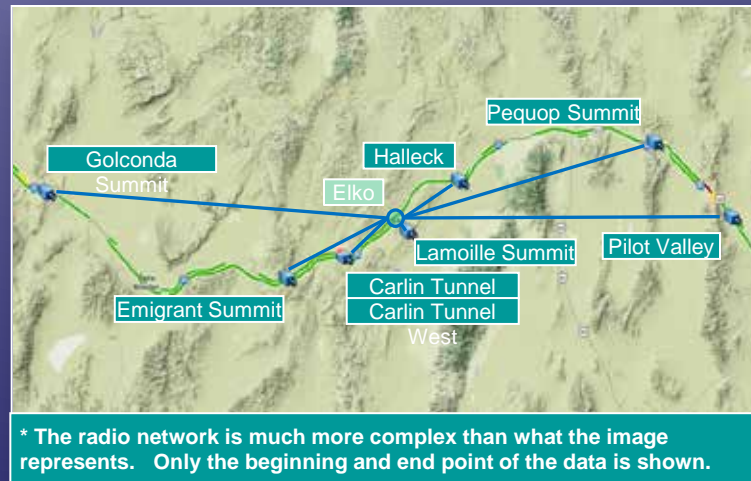
District 3 Point to Point

Existing Point to Point infrastructure

- n Prior to the current point to point system NDOT District III used a combination of 5.8Ghz and 900Mhz to connect various sites. In 2007 NDOT decided to move to 4.9Ghz in the rural areas as the cost comparison between other technologies and licensed 4.9Ghz essentially became the same. Additionally, it was the hope of NDOT to avoid interference from other wireless users as licensed 4.9Ghz is dedicated for Public Safety use only. In the urban area such as Reno and Las Vegas licensed 4.9Ghz has become polluted by other public safety agencies and is no longer used by NDOT.

Existing Point to Point infrastructure

- n **Existing Infrastructure:** Of the 40 Ethernet radio pairs, 28 Ethernet radio pairs are located in D3. Elko accounts for approximately 70%, 195 linear miles, of the total 279 linear miles that NDOT ITS uses for communications. This does not include radios for the Statewide Radio System.



Existing Point to Point infrastructure

- n NDOTs ITS Network
 - n Static network.
 - n Implements Rapid Spanning Tree where need. (Used in Reno and Las Vegas)
 - n VLANs are used to create multiple distinct broadcast domains (20 VLANs for PTP)
 - n Support both unicast and multicast traffic. Multicast is used to support video.
 - n VLANs supporting video are configure with Pim Sparse Mode with rendezvous points at each layer 3 switch. (PIM SM explicitly builds unidirectional shared trees rooted at a *rendezvous point*)

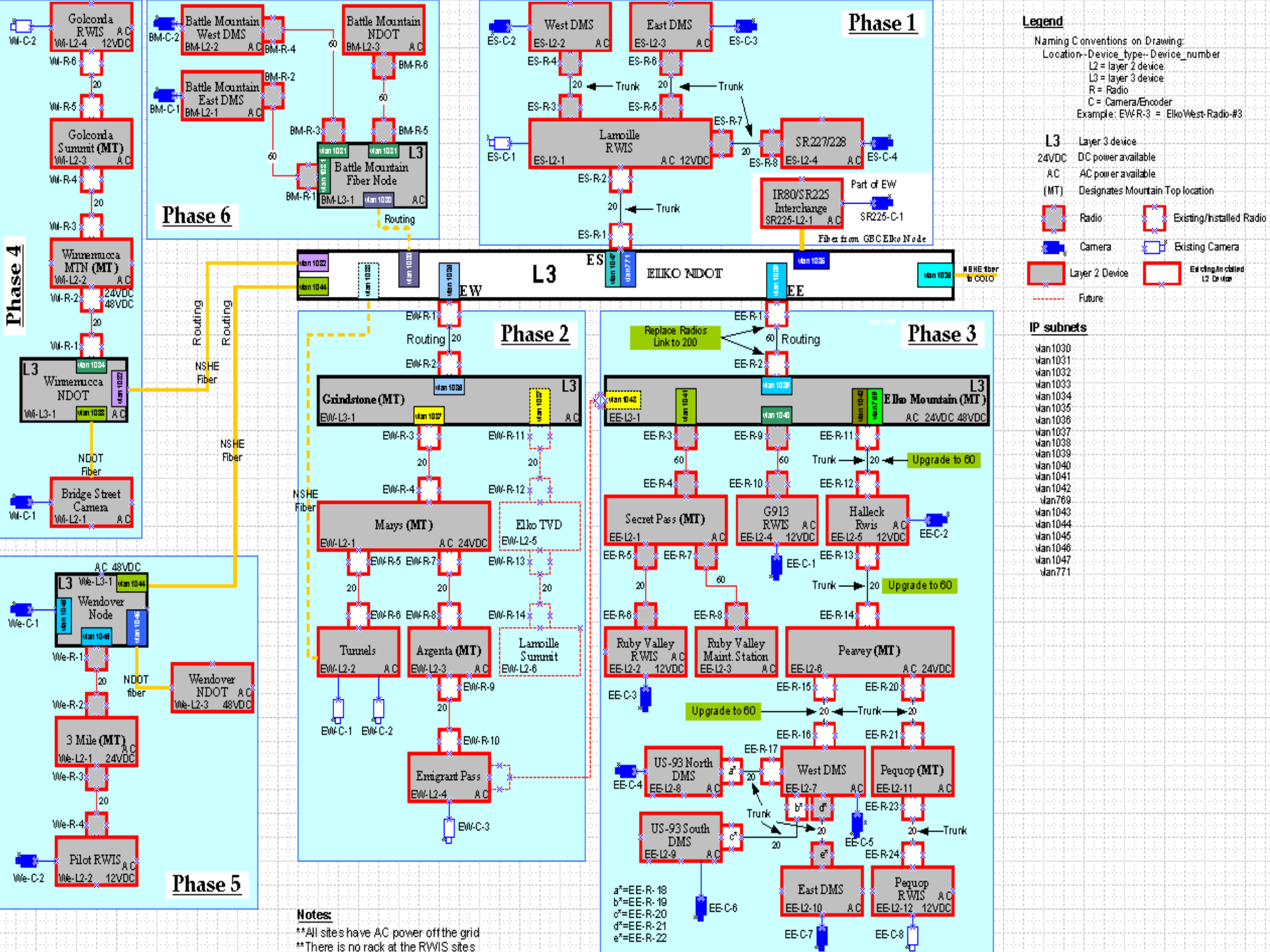
Existing Point to Point infrastructure

n NDOTs ITS Network

- Cambium PTP 600 Series 4.9GHz Licensed Radio
- Channel Size 5,10, or 20 MHZ
- High-speed connectivity and backhaul
 - 5 MHz Channel: Up to 48 Mbps
 - 10 MHz Channel: Up to 100 Mbps
 - 20 MHz Channel: Up to 200 Mbps
- NLOS and long-distance LOS performance
- High interference environments (Built-in diversity)
- VLAN tagging

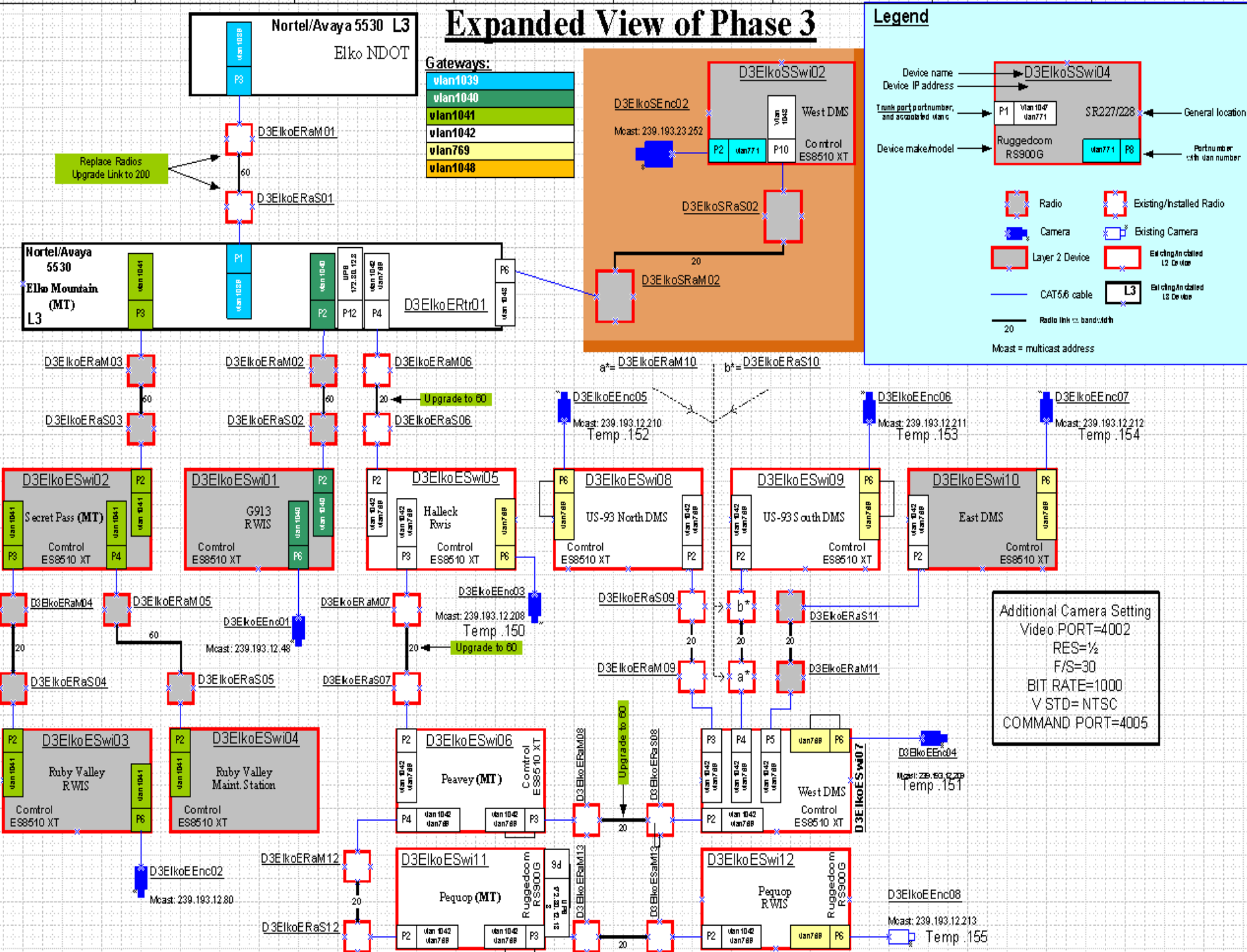
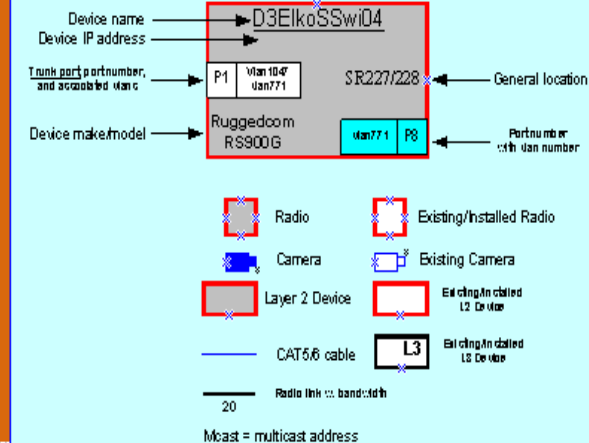
Existing Point to Point infrastructure

- Operating temperature -40 to -60
- Power Source 90–240 VAC, 50–60 Hz / 36-60V DC
- Power Consumption 55 W max
- Network and System Management
 - Web access HTTP & HTTPS
 - In-band and out of band management
 - SNMP v1,v2c, and 3
 - 20 MHz Channel: Up to 200 Mbps
- Cambium provides a PTP link planner tool used for RF path and propagation studies.
- System has been in operation for 4 years with no failures except power.

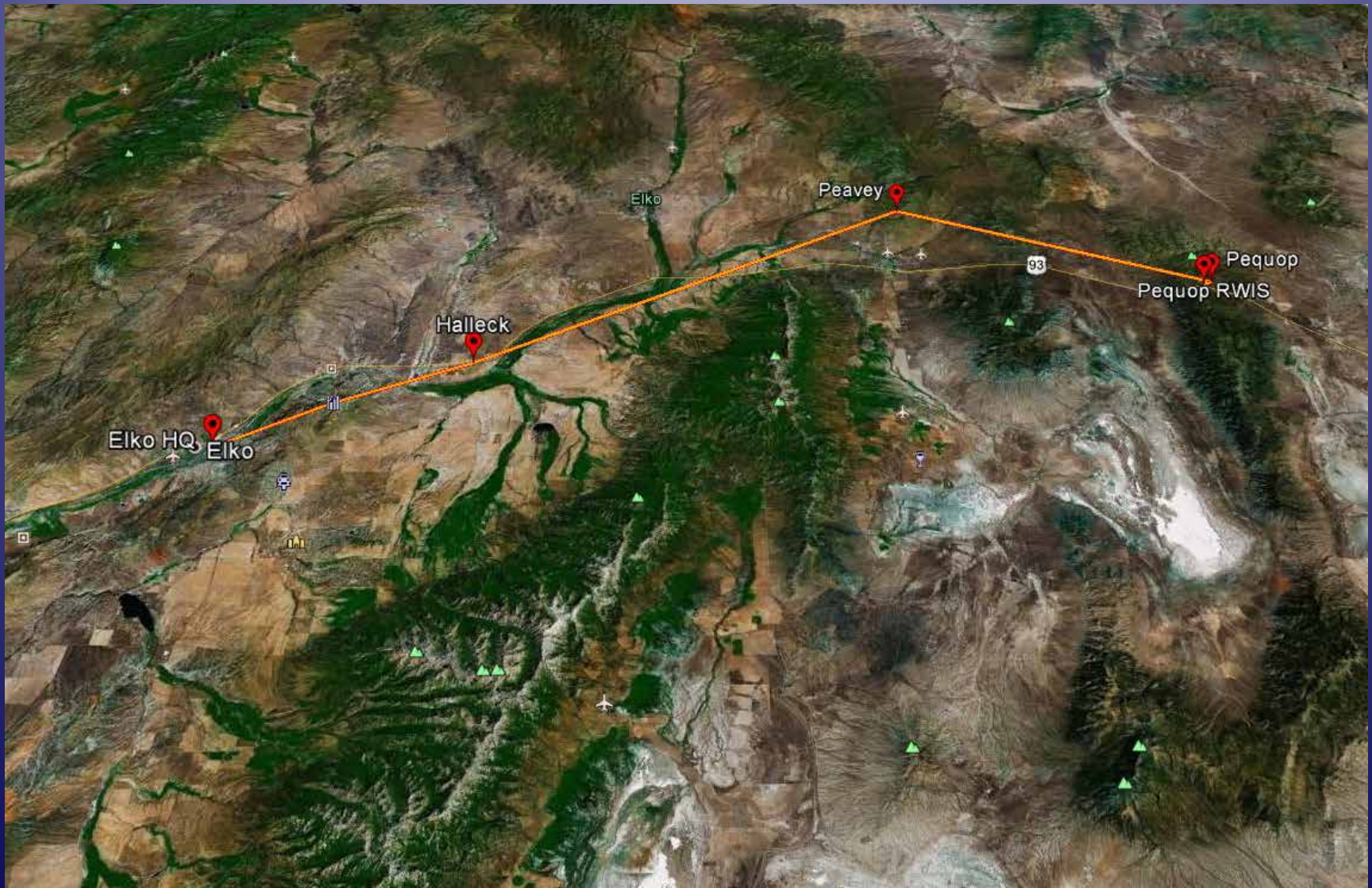


Expanded View of Phase 3

Legend



Point to Point Path Profile



Point to Point Path Profile

Path Profile Name:

Start Location

Location Name: Latitude: Longitude: Antenna Height: Ground Height:

End Location

Location Name: Latitude: Longitude: Antenna Height: Ground Height:

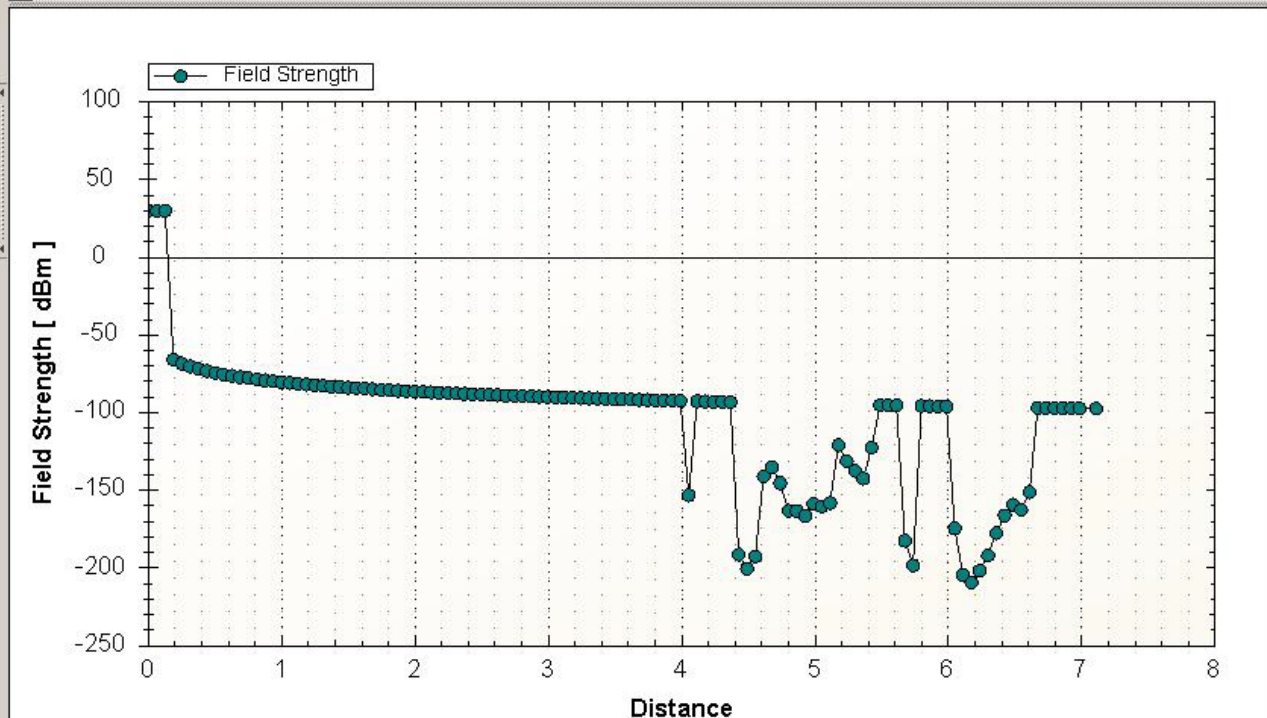
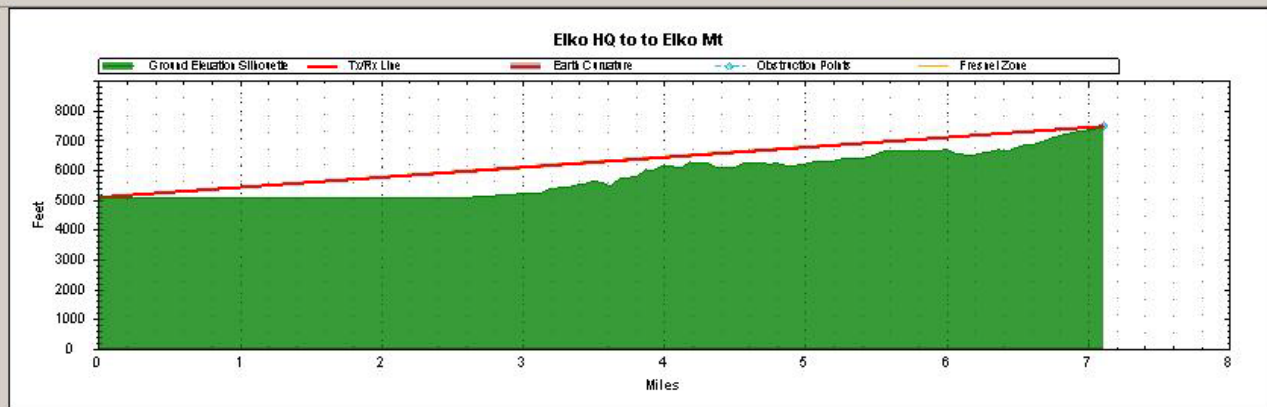
☒ Show FS Graph

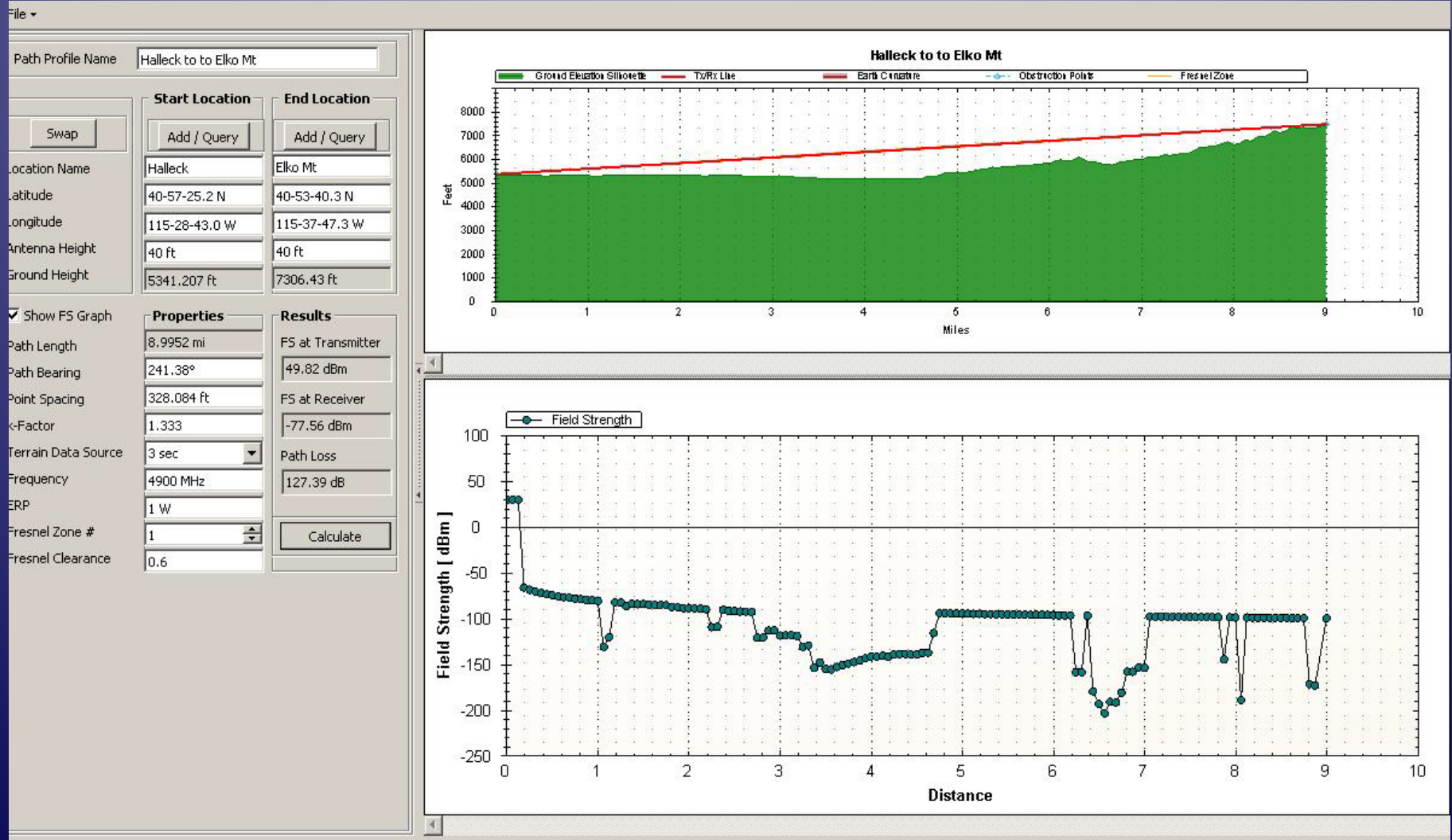
Properties

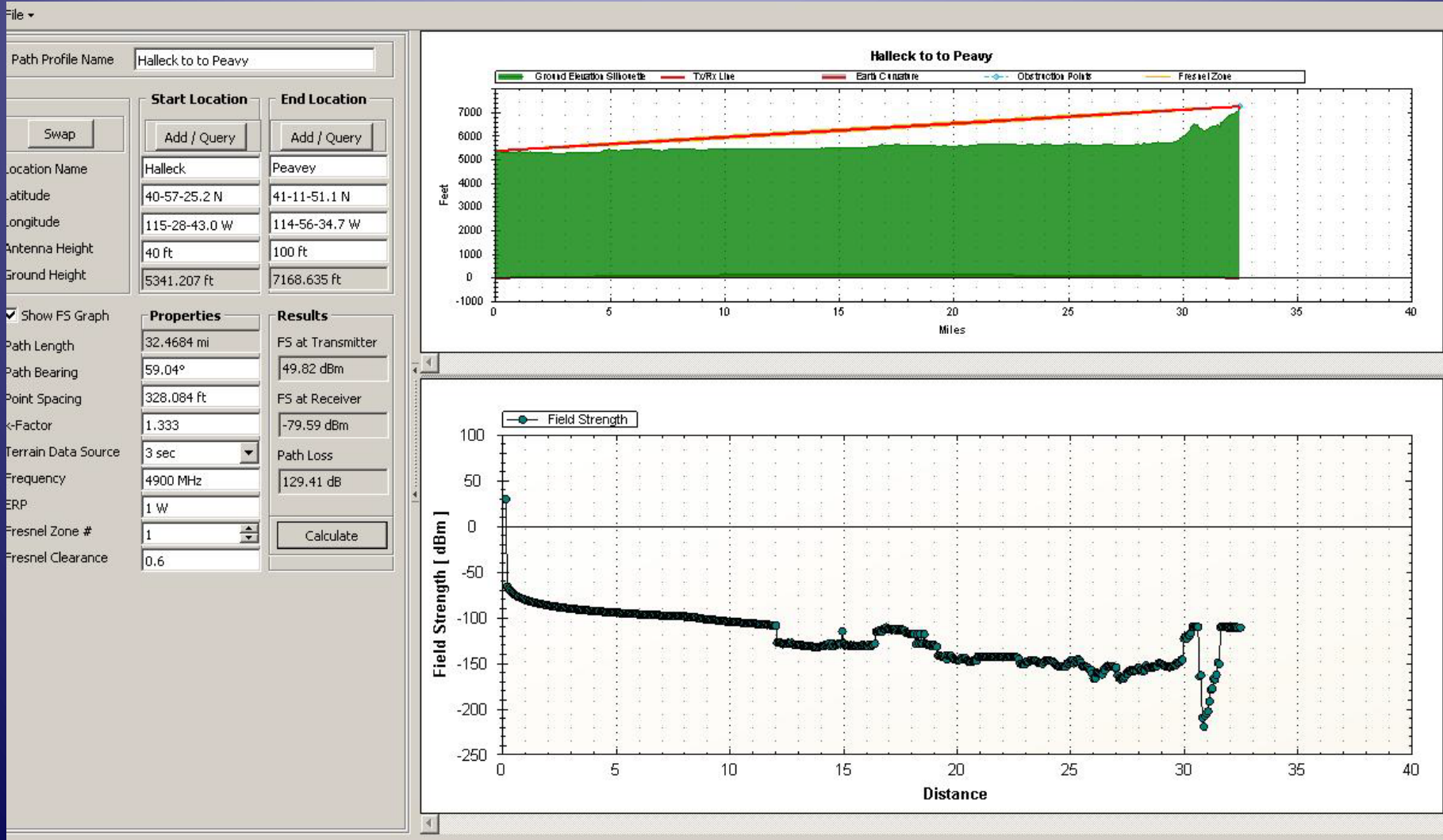
Path Length: Path Bearing: Point Spacing: k-Factor: Terrain Data Source: Frequency: ERP: Fresnel Zone #: Fresnel Clearance:

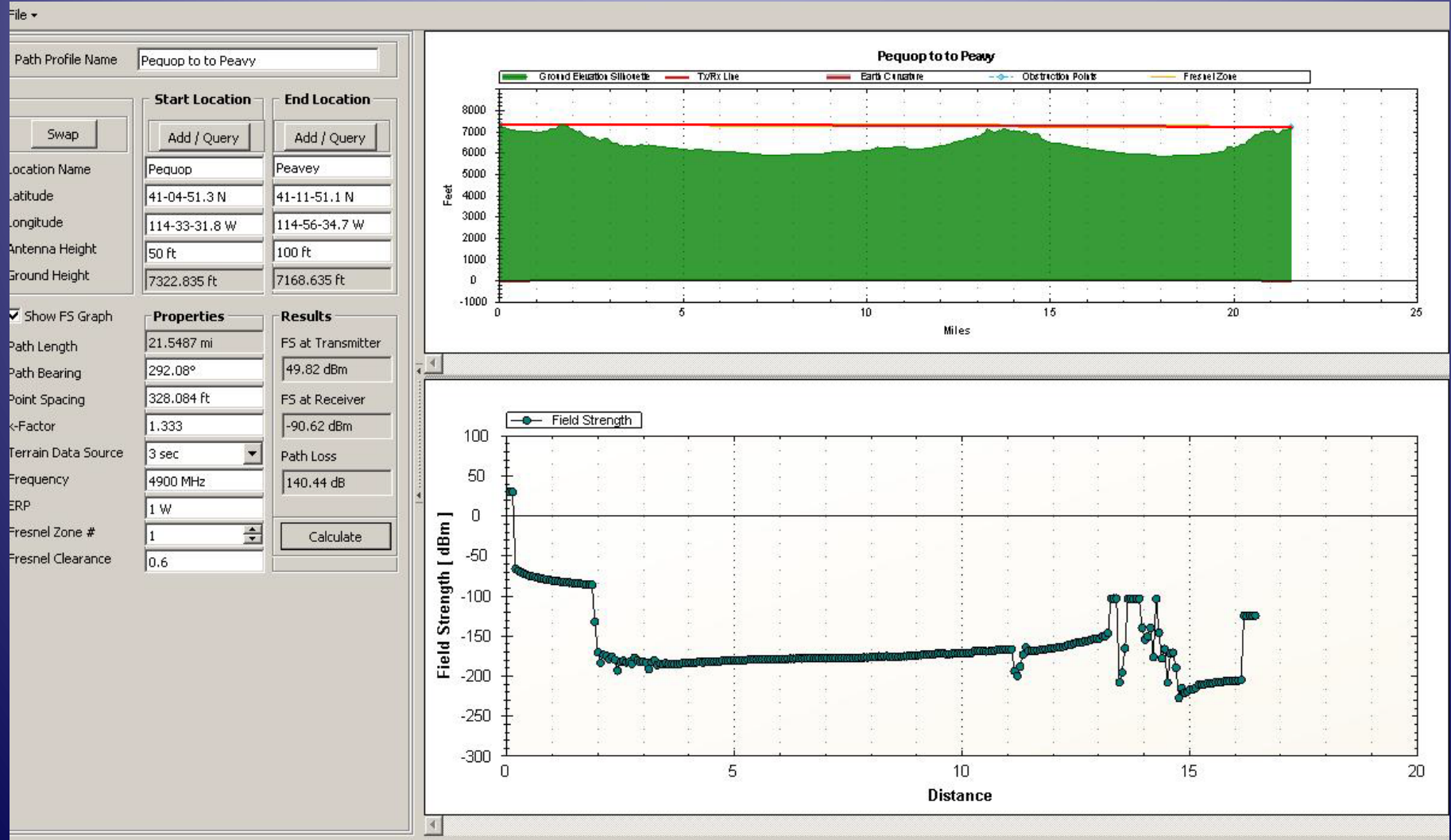
Results

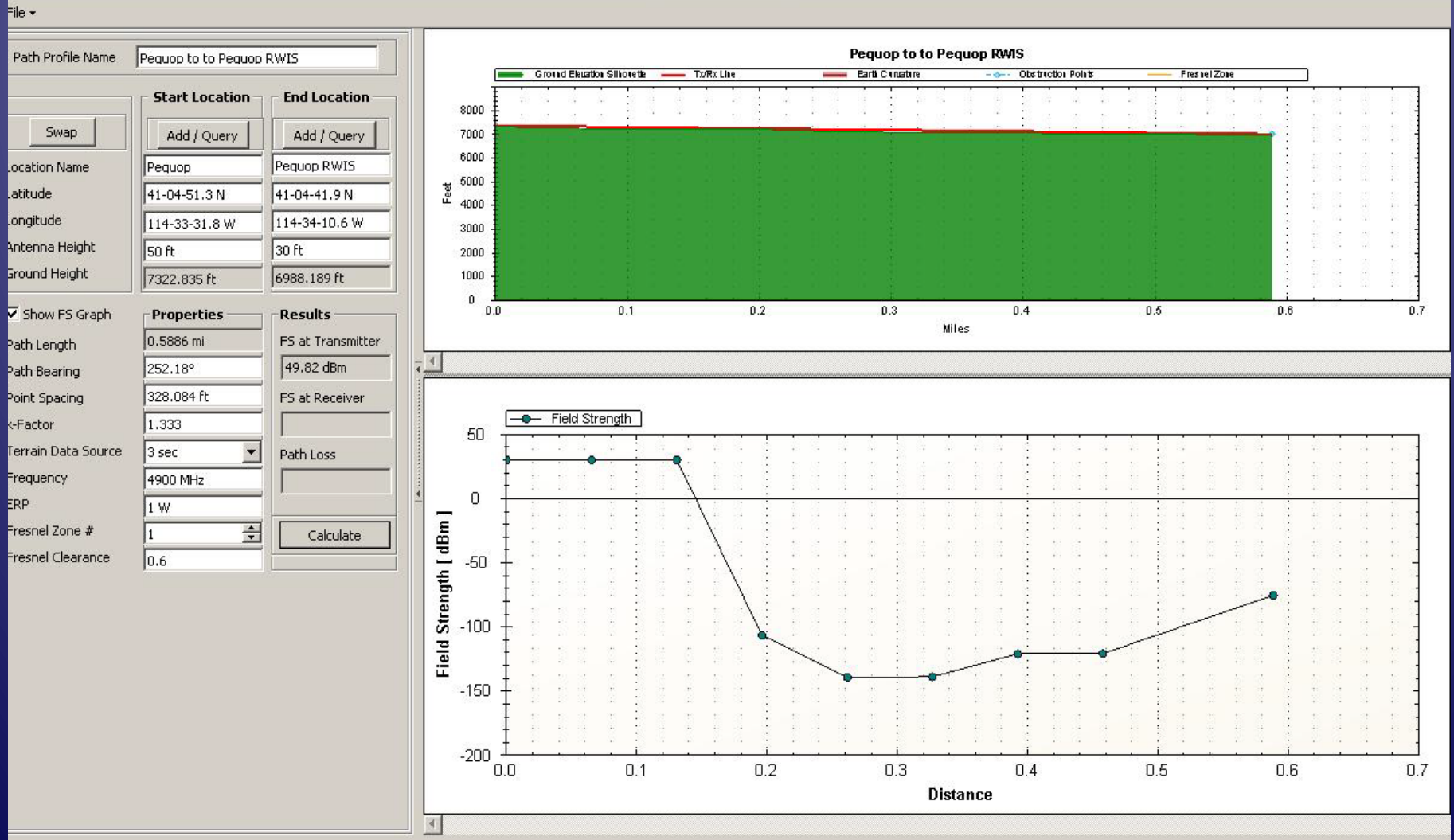
FS at Transmitter: FS at Receiver: Path Loss:











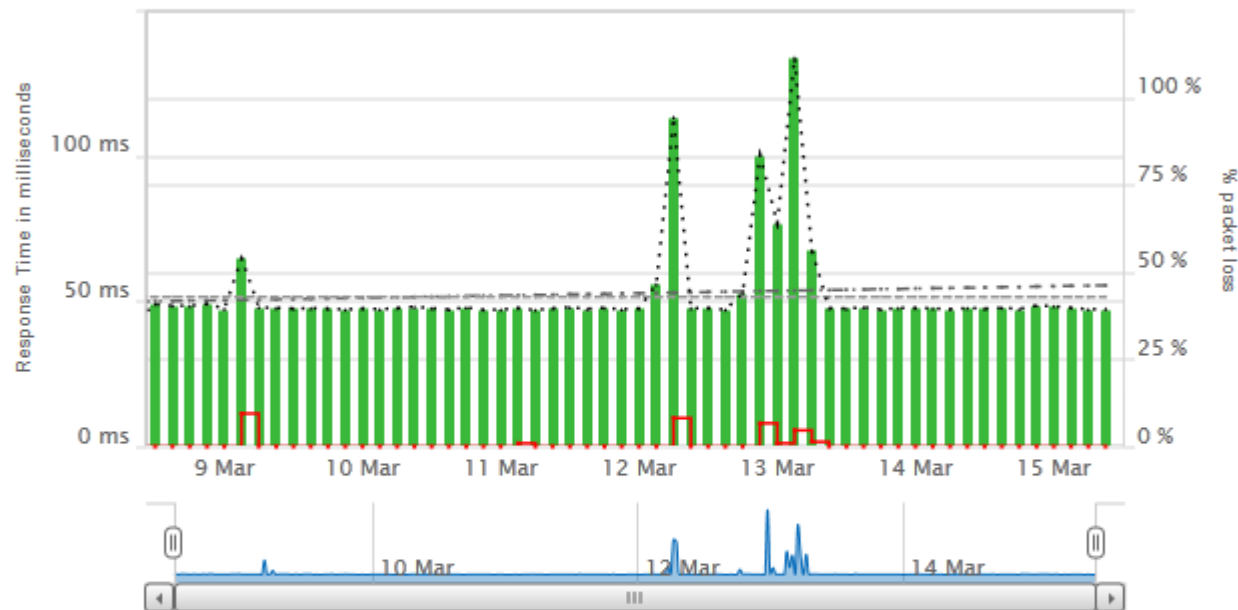
Average Response Time & Packet Loss

EXPORT EDIT HELP

D3ElkoESwi12

Mar 8 2013, 11:56 am - Mar 15 2013, 10:51 am

Zoom 1h 12h 24h



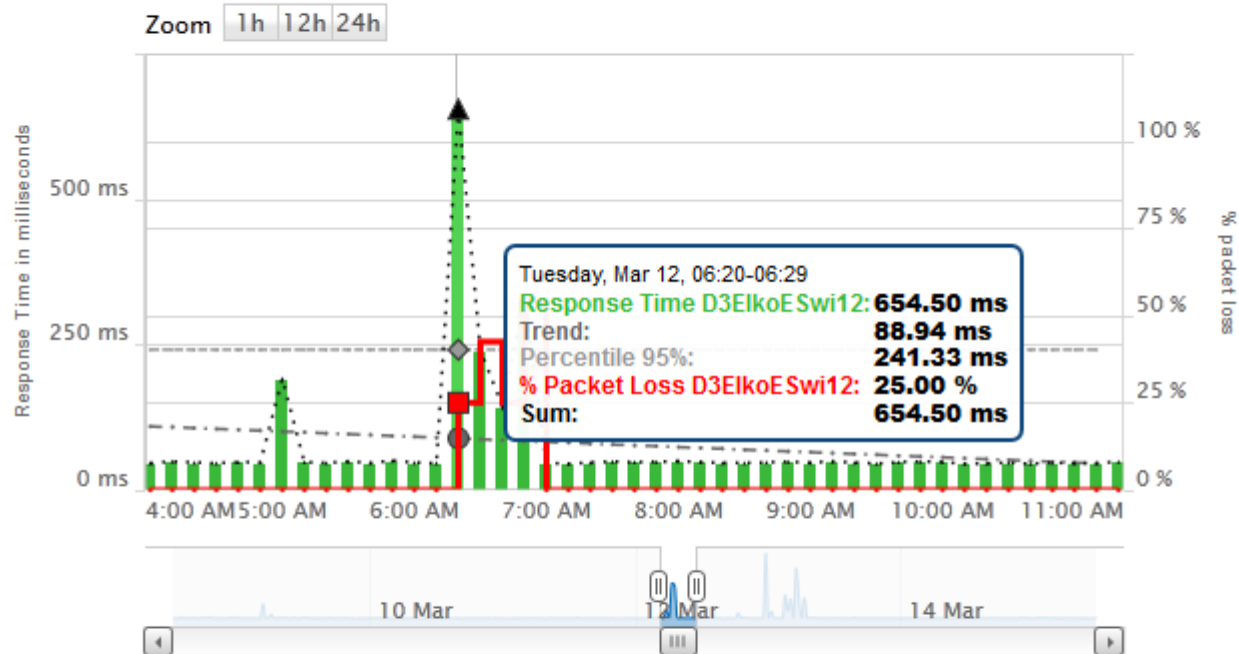
- ☒ Response Time D3ElkoESwi12
- ☒ Trend
- ☒ Percentile 95%
- ☒ % Packet Loss D3ElkoESwi12
- ☒ Sum

Average Response Time & Packet Loss

EXPORT EDIT HELP

D3ElkoESwi12

Mar 12 2013, 4:02 am - Mar 12 2013, 11:17 am



- ☒ Response Time D3ElkoESwi12
- ☒ Trend
- ☒ Percentile 95%
- ☒ % Packet Loss D3ElkoESwi12
- ☒ Sum

District 3 Point to Point system using Cambium PTP radios





Point to Point Configuration



Cambium PTP60049

Configuration can be done with WebUI or CLI

Home

Status

» System Administration

System Status - Master

Equipment

Attributes	Value	Units
Link Name	Peavey to Halleck RWIS	
Link Location	Peavey	
Software Version	49400-09-02	
Hardware Version	D05-R00-C	
Region Code	14	
Elapsed Time Indicator	199 Days 09:26:39	

Ethernet / Internet

Ethernet Link Status	Copper Link Up	
Ethernet Speed And Duplex	100 Mbps Full Duplex	
MAC Address	00:04:56:00:4d:ed	
IP Address	172.30.12.188	
Remote IP Address	172.30.12.187	
Subnet Mask	255.255.255.192	
Gateway IP Address	172.30.12.129	

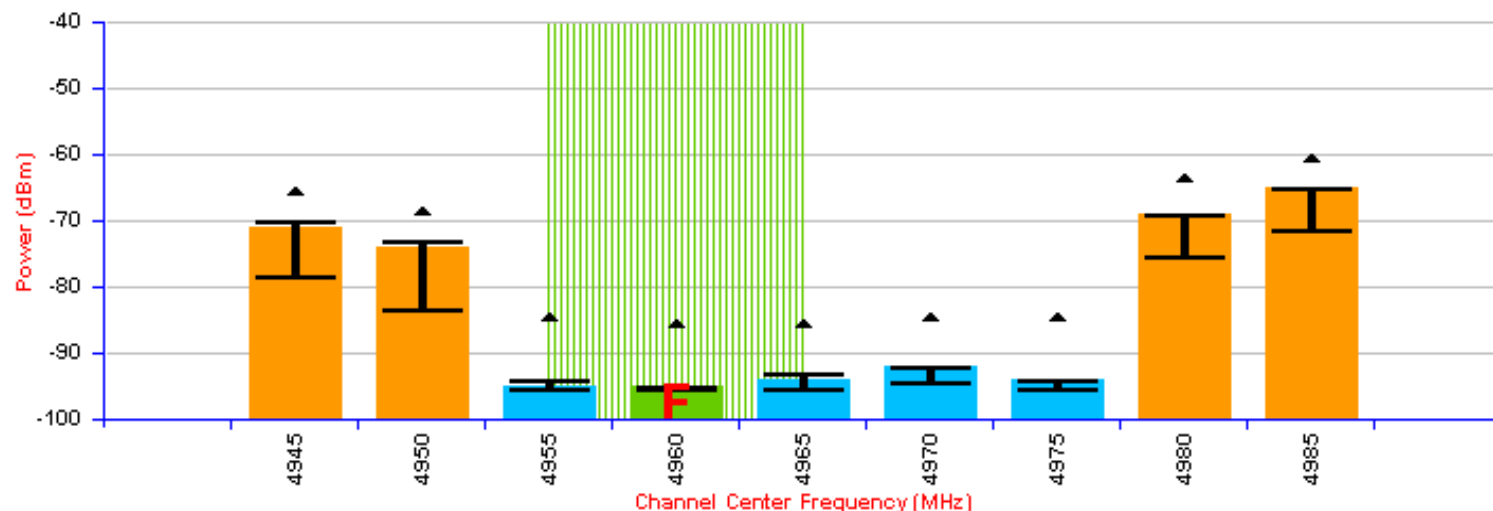
Wireless

Attributes	Value	Units
Wireless Link Status	Up	
Max Receive Modulation Mode	64QAM 7/8	
Maximum Transmit Power	23	dBm
Remote Maximum Transmit Power	23	dBm
Transmit Power	19.0, 19.0, 19.0, 19.0	dBm
Receive Power	-70.3, -71.8, -72.7, -72.3	dBm
Vector Error	-21.0, -25.9, -26.9, -26.1	dB
Link Loss	135.0, 134.8, 133.9, 134.9	dB
Receive Data Rate	8.85, 8.84, 7.59, 8.85	Mbps
Transmit Data Rate	17.70, 17.69, 15.17, 17.70	Mbps
Receive Modulation Mode	64QAM 7/8 (8.85 Mbps)	
Transmit Modulation Mode	64QAM 7/8 (17.70 Mbps)	
Receive Modulation Mode Detail	Running At Maximum Receive Mode	
Range	32.11	miles

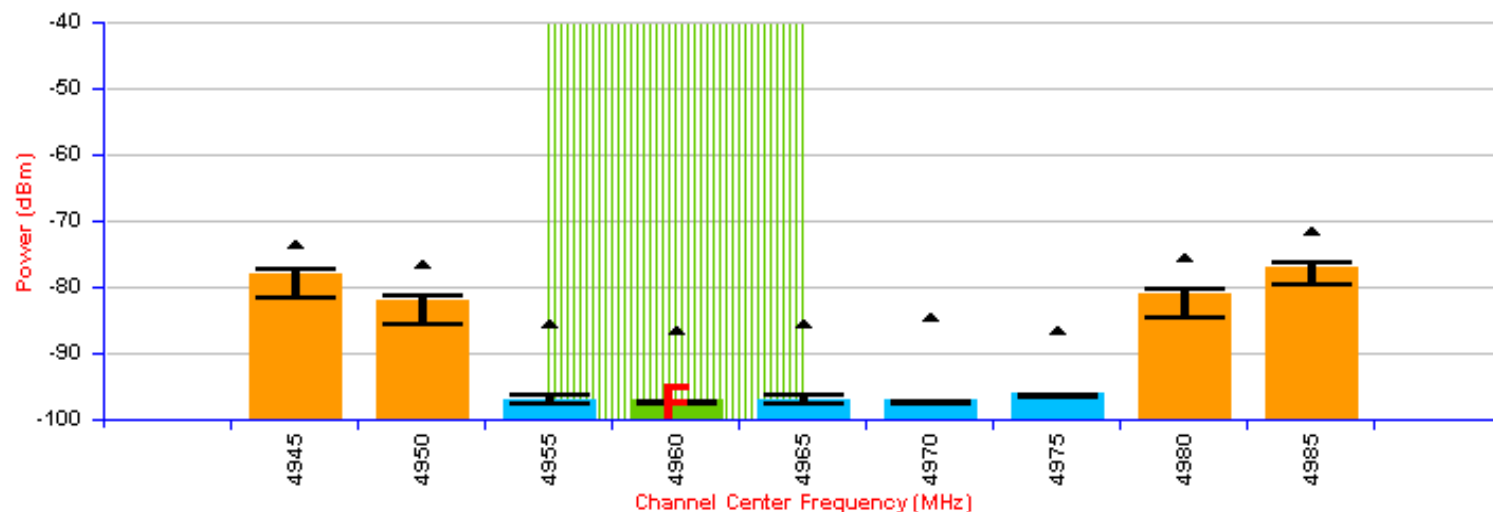
Spectrum Management - Fixed Frequency Mode

Local Channel 4: State=ACTIVE CHANNEL, Mean=-96 dBm, 99.9%=-95 dBm, Peak=-95 dBm, Peak of Peaks=-85 dBm

Local Receive Channel Spectrum



Peer Receive Channel Spectrum



Attributes	Value	Units
Spectrum Management Page Refresh Period	3600	Seconds

Attributes	Value	Units
Interference Threshold	-85	dBm
Submit configuration changes		Reset form



District 2 3G/4G Network



District 2 3G/4G Network



- n NDOT uses Cellular connections in areas where preferred Ethernet transport, such as copper or fiber optics, is not available.
- n NDOT uses Proxicast and Seirra Wireless cellular gateways, both are high-performance, mobile, rugged, commercial-grade 3G cellular router that allows Ethernet-based devices to simultaneously utilize a single cellular data account for primary or backup connectivity.



District 2 3G/4G Network



- n Both vendors support the latest 3G/4G high-speed wireless cellular technologies and provide expanded routing, security and management features.
 - n IPSEC VPN
 - n FTP/TFTP
 - n HTTP/HTTPS
 - n CLI
 - n IP/Routing (DHCP, NAT, Policy/IP routing, and Multicast)



District 2 3G/4G Network



- n Cellular Carriers Support on Sierra Wireless and Proxcast
 - n *Verizon Wireless*
 - n *Sprint PCS*
 - n *Alltel*
 - n *AT&T*
 - n *Cingular*
 - n *T-Mobile*

District 2 3G/4G Network

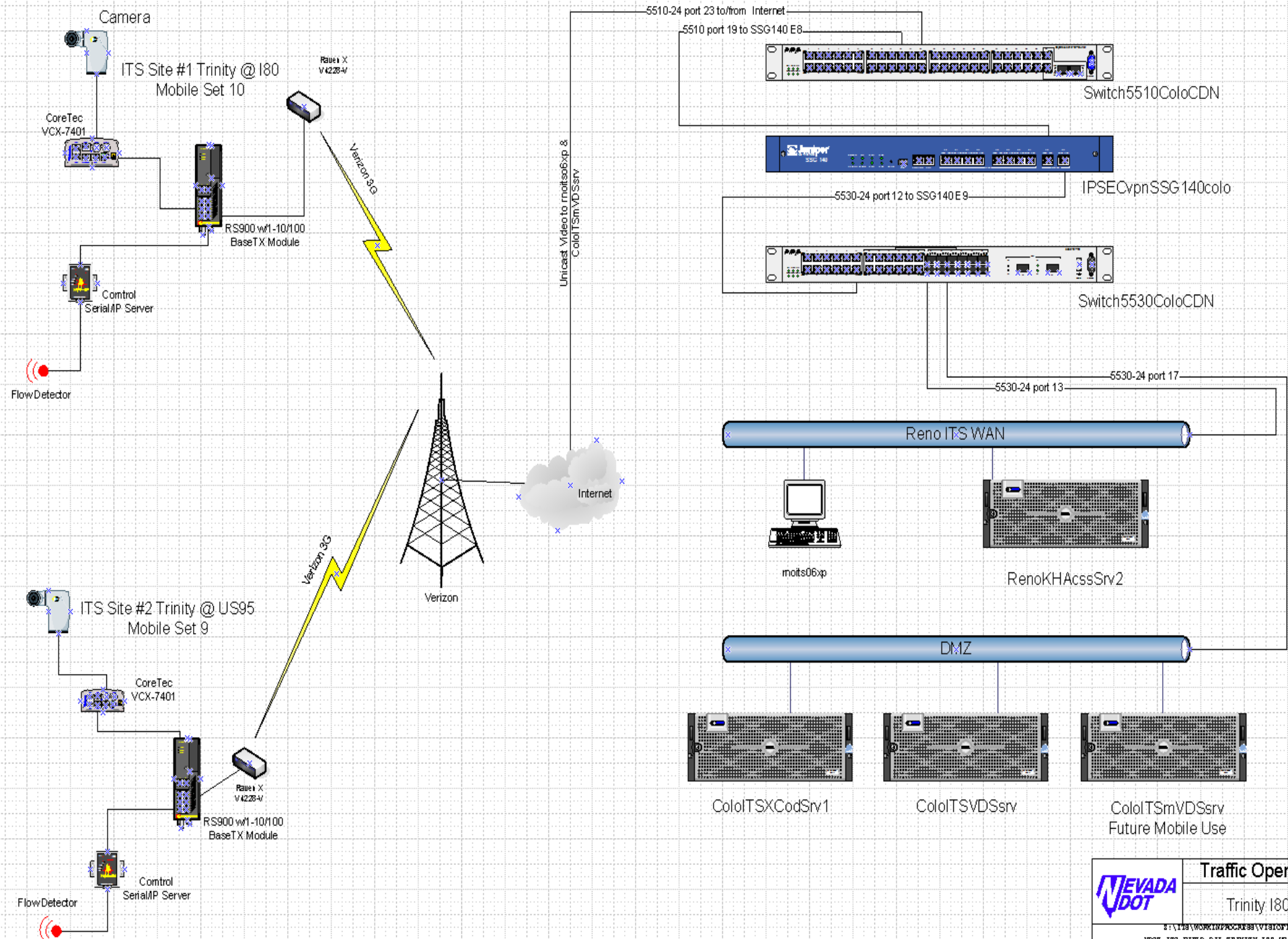
- n NDOT Cellular Network
 - n Static
 - n IPSEC VPN
 - n Unicast
 - n H.264 Video
- n Devices supported on Cellular Network
 - n HAR
 - n RWIS
 - n Flow detector
 - n CCTV

District 2 3G/4G Network

- n Site Considerations
 - n Location of cellular tower
 - n RSSI (-85 db or better)
 - n Antenna type & gain
 - n Power requirements
 - n Grounding
 - n Average Data rate is around 256Kps
 - n Only non-critical systems should be deployed on cellular

District 2 3G/4G Network

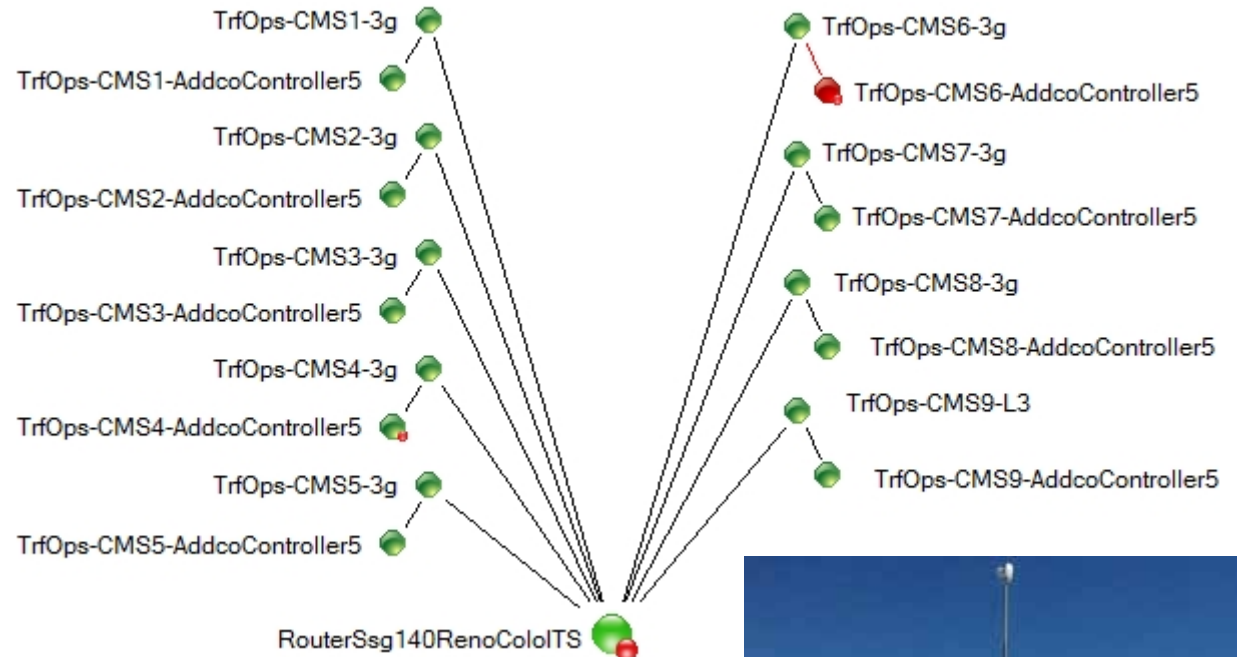
- n Site Considerations
 - n Do not expect 99.999 or 99.99 up time realistic up time is between 80 – 90%
 - n Congestion – Not enough capacity to handle peak time. As more user access the cell site latency and packet loss increase
 - n Fade – insufficient signal strength. A signal strength of less than -85dbm is insufficient for consistent reliability.



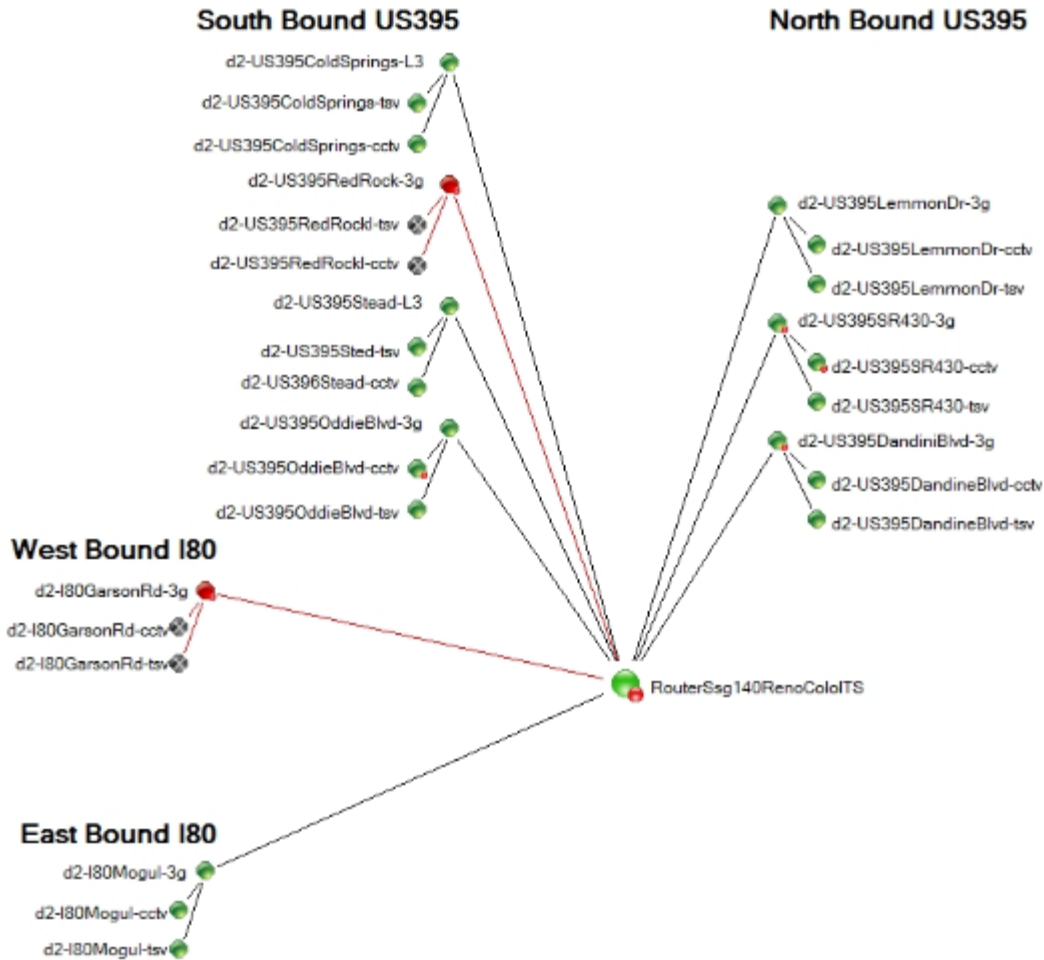
Traffic Oper
Trinity I80

\\128\WORKING\ACQUISITION\VISIOT
MOI 128 FIELD DIT TRINITY I80 US

Cellular VPN



Cellular VPN



Proxicast Lan-Cell 3 EVDO/HSPA 3G/4G Gateway

- + 4G will allow for better data rate
- + inexpensive
- + works with our current Juniper system
- + Passes all traffic thru the VPN tunnel
- 4G not available in rural areas
- Recurring Cost





Proxicast
Lan-Cell 3
Configuration
can be done
with WebUI
or CLI

proxicast

LAN-Cell 3

Name: d2-180GoldRanchA-3g

Serial: 001B3910E580

Status

Setup

Wireless (Wi-Fi)

Security

Applications

QoS

Admin

Logout

Status - Router

Router Information

Model Name

LAN-Cell 3

Firmware Version

5.2.2

Current Time

Fri Dec 31 2010 22:43:07 PST

Running Time

6 hours, 43 mins

WAN (USB Modem)

MAC Address

No MAC Address

Connection Type

wwan

IP Address

166.140.236.229

Subnet Mask

255.255.255.255

Gateway

10.64.64.65

WAN (Ethernet)

MAC Address

00:1B:39:10:E5:85

Connection Type

dhcp

IP Address

0.0.0.0

Subnet Mask

Gateway

LAN

MAC Address

00:1B:39:10:E5:84

IP Address

172.28.250.97

Subnet Mask

255.255.255.248

DHCP Server

Disabled

DHCP Start IP Address

172.28.250.33

DHCP End IP Address

172.28.250.64

Max DHCP Clients

32

STATUS

System Time:

Fri Dec 31 2010 22:44:33 PST

Up Time:

6 hours, 44 mins

Firmware:

5.2.2

WAN (USB Modem)

Status:

Up

Disable

Signal Strength:

0%

IP Address:

166.140.236.229

Provider:

Modem Mfg'r:

Pantech

Modem Model:

UML290

Up Time:

6 hours, 43 mins

WAN(Ethernet)

Status:

Down

Enable

Type:

dhcp

IP Address:

0.0.0.0

Subnet:

0.0.0.0

Up Time:

0

Wi-Fi

Status:

Down

Enable

Role:

Access Point

Mode:

B/G/N Mixed

Channel:

Channel 6 [2.437GHz]

SSID1:

Proxicast01 (Disabled)

Security1:

Disabled

SSID2:

Proxicast02 (Disabled)

Security2:

Disabled

Clients:

0

LAN



Proxicast Lan-Cell 2

Configuration can be done with WebUI or CLI

proxicast®

HOME

NETWORK ☒

WIRELESS ☒

SECURITY ☒

ADVANCED ☒

LOGS

MAINTENANCE

LOGOUT

Automatic Refresh Interval None

System Information

System Name	d2-I80GarsonRd-3g		
Model	LAN-Cell 2		
Bootbase Version	V1.09 07/10/2009		
Firmware Version	V4.02(AQP.6) 01/12/2010		
Up Time	09:05:00		
System Time	2013-05-27	11:07:38	GMT-07:00 DST
Firewall	Enabled		

System Resources

Flash	<div></div>	4/8 MB
Memory	<div></div>	25/32 MB
Sessions	<div></div>	27/3000
CPU	<div></div>	0%

Interfaces	Status	IP/Netmask	IP Assignment	Renew
WAN	Down	0.0.0.0/ 0.0.0.0	DHCP client	<input type="button" value="Renew"/>
Cellular	Up	166.239.33.228/ 255.255.255.255	IPCP client	<input type="button" value="Drop"/>
Dial Backup	Down	0.0.0.0/ 0.0.0.0	N/A	<input type="button" value="Dial"/>
<input checked="" type="checkbox"/> LAN	100M/Full	172.28.250.137/ 255.255.255.248	Static	N/A
<input checked="" type="checkbox"/> WLAN	100M/Full	0.0.0.0/ 0.0.0.0	Static	N/A
<input checked="" type="checkbox"/> DMZ	100M/Full	0.0.0.0/ 0.0.0.0	Static	N/A

Cellular Interface Status [show detail...](#)

Cellular Connection Status	Up (EVDO Rev.A)
Service Provider	Verizon
Roaming Network	Not roaming
Signal Strength	-44 dBm (Poor) <div></div>
Dormant State	Yes

Wi-Fi Information

Wi-Fi status	Disabled
SSID	Proxicast01
Bridge to	LAN
802.11 mode	802.11b+g
Channel	Channel-006 2437MHz
Security mode	None
# of Associated Clients	0

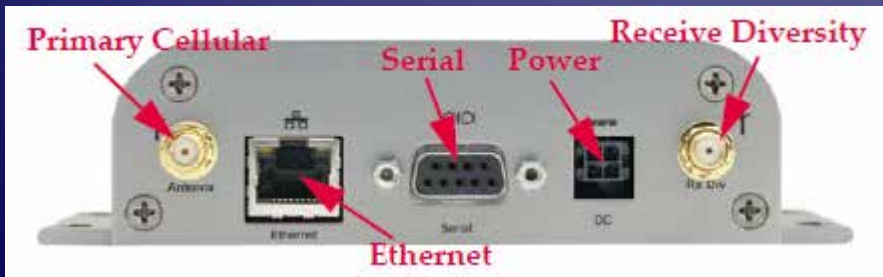
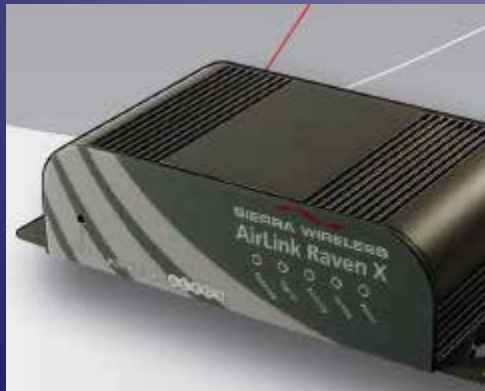
Latest Alerts

Date/Time	Message
2013-05-27 10:57:50	Rule [Tunnel1] Tunnel built successfully
2013-05-27 09:58:07	Rule [Tunnel1] Tunnel built successfully

System Status

Sierra Wireless Raven X EVDO/HSPA 3G Gateway

- + 3G CDMA supports better data rates than GSM
- + inexpensive
- + works with our current Juniper system
- + Supports IPSEC and GRE VPN tunnel
- Supports Split Tunneling all traffic does not go through the tunnel
- Recurring Cost





Sierra Wireless Raven X

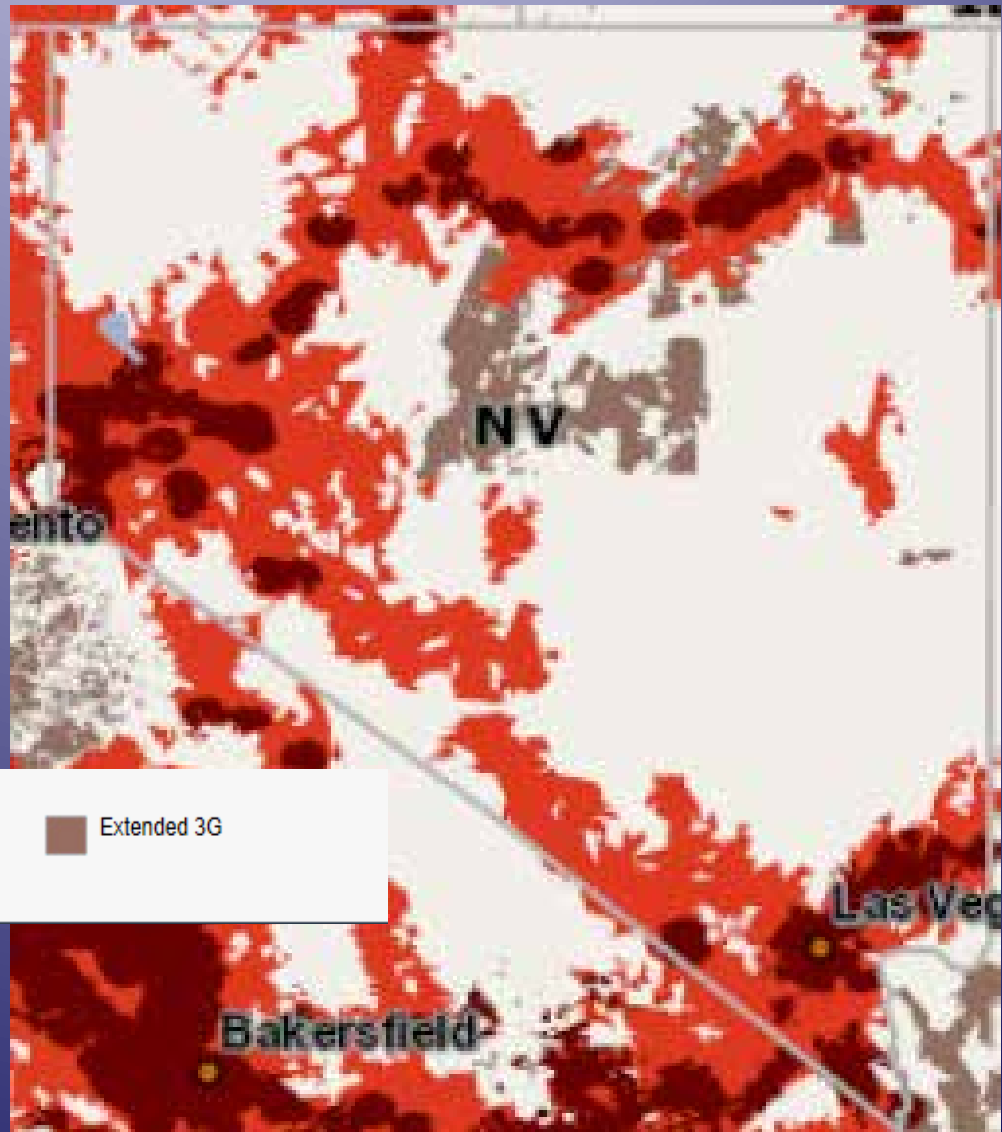
Configuration can be done with WebUI or CLI

[Upload](#) | [Download](#)[Status](#) | [WAN/Cellular](#) | [LAN](#) | [VPN](#) | [Security](#) | [Services](#) | [Report](#) | [Serial](#) | [Applications](#) | [Admin](#)





Last updated time : 05-27-2013 11:21:23

[Apply](#) | [Refresh](#) | [Cancel](#)

Home		
WAN/Cellular	AT Phone Number	17757207021
	AT IP Address	166.130.67.124
LAN	AT Network State	Network Ready
VPN	AT RSSI (dBm)	-94
Security	AT Cell Info	Cell Info: BSIC: 0 TCH: 487 RSSI: -94 LAC: 56891 CellID: 62253
Services	AT Current Network Operator	AT&T, 310410
	AT Network Service Type	HSPA
Serial	AT ALEOS Software Version	H4225_4.0.11.003 Aug 21 2012
Applications	AT ECIO (dB)	-6.5
About	AT Channel	487
	WAN/Cellular Bytes Sent	28035600
	WAN/Cellular Bytes Rcvd	6449624
	AT Device Name	352974027387810

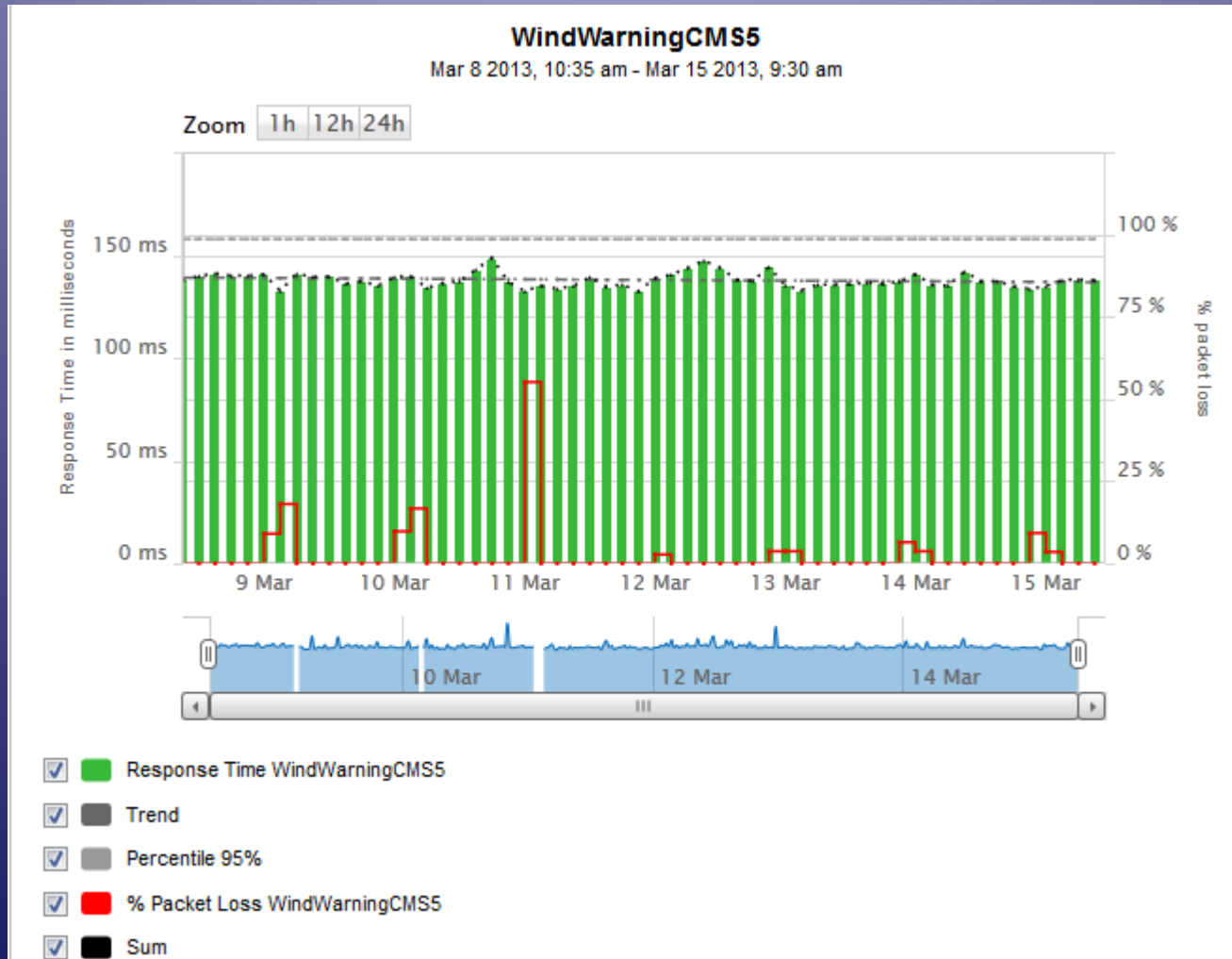


Map Legend

- | | | |
|---|--|---|
|  Verizon 4G LTE * |  Verizon 3G |  Extended 3G |
|  No Service | | |

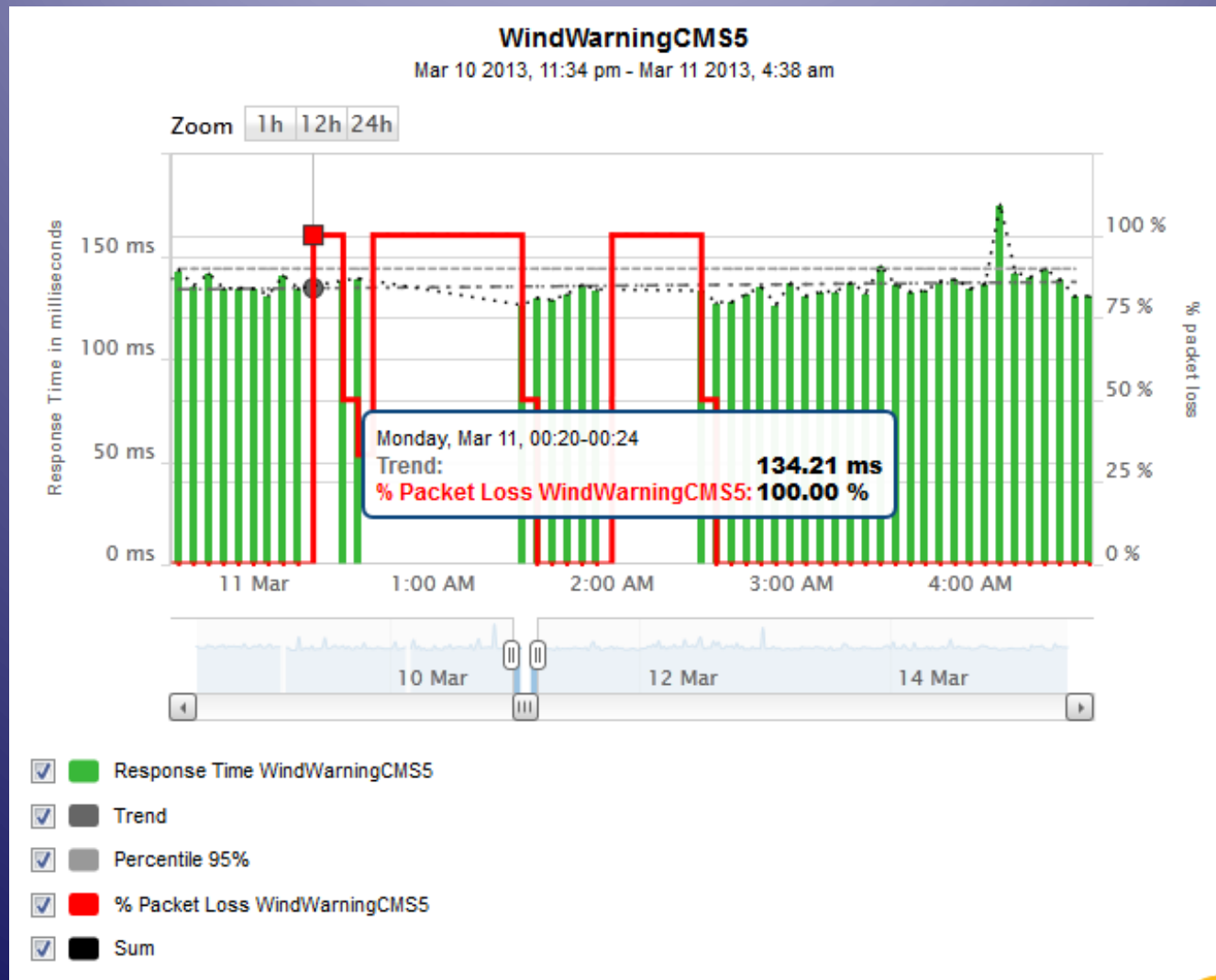
Network Performance Using Proxicast LAN-Cell 2 (3G)EVDO

Average Response Time and Packet loss using SNMP&ICMP Data



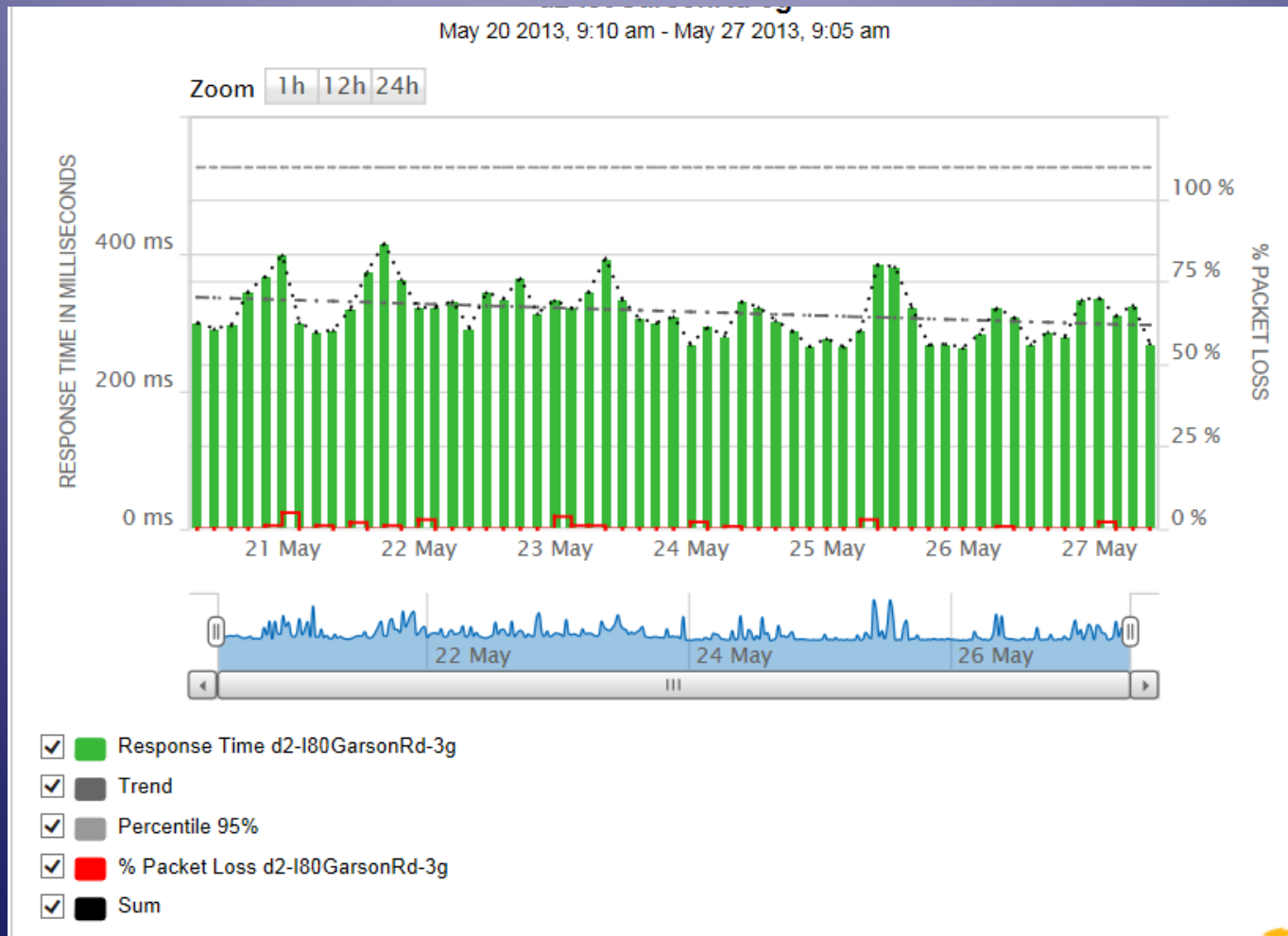
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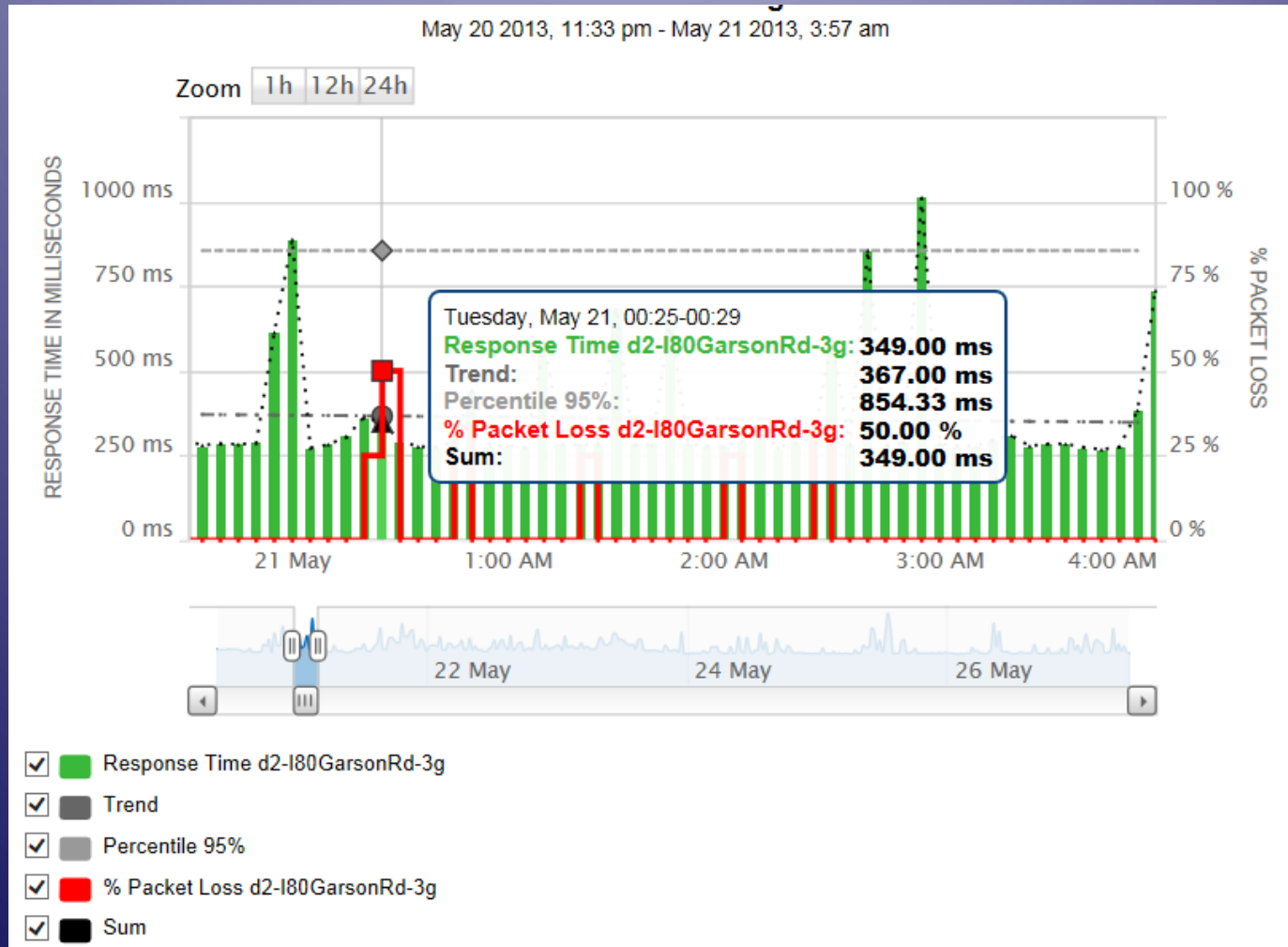
Network Performance Using Proxicast LAN-Cell 3 (4G)CDMA

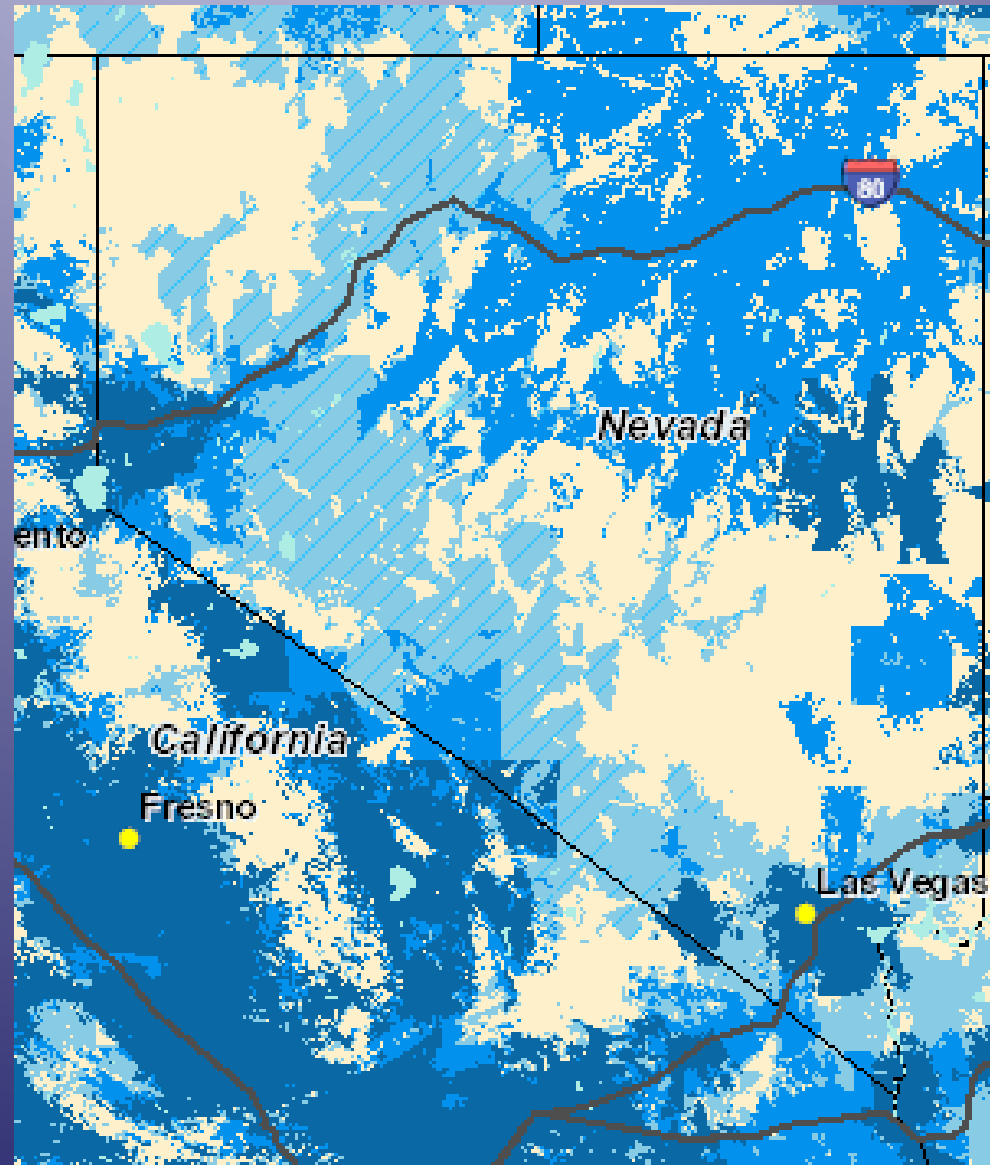
Average Response Time and Packet loss using SNMP&ICMP Data









Network Performance Using Proxicast LAN-Cell 3 (4G)EVDO

Average Response Time and Packet loss using SNMP&ICMP Data



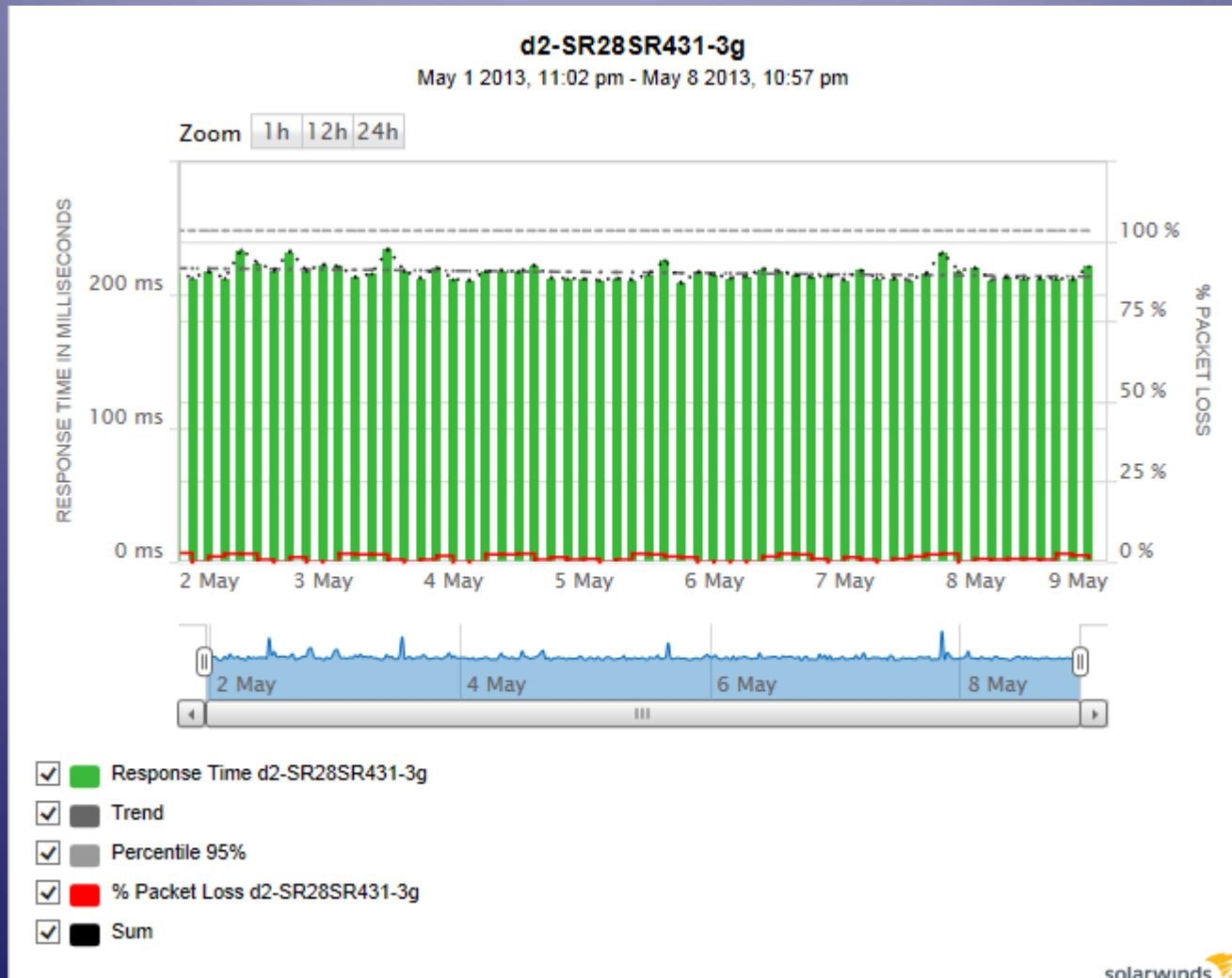


Data Coverage Legend

-  4G LTE * (viewable at 120 miles and closer)
-  4G *
-  3G *
-  Partner 3G *
-  2G (EDGE) *
-  Partner 2G (EDGE and/or GPRS)

Network Performance Using Raven X GSM (3G)

Average Response Time and Packet loss using SNMP&ICMP Data



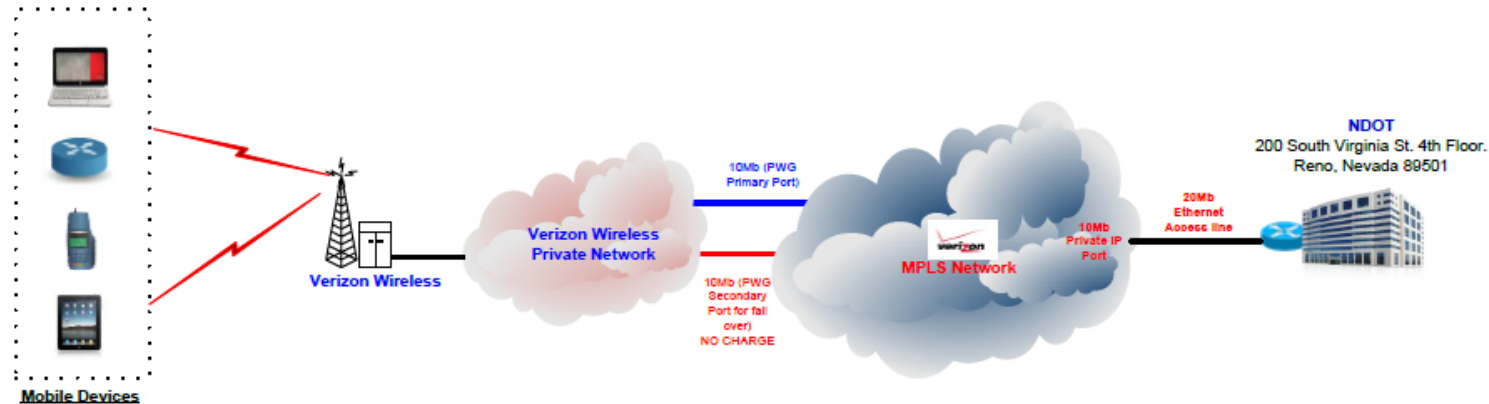
Network Performance Using Raven X GSM (3G)

Average Response Time and Packet loss using SNMP&ICMP Data



Future Plans Dedicated Circuit to reduce Latency

Proposed Verizon Wireless Access and Verizon MPLS Network for NDOT



Router provided, installed and maintained by VzB (for Managed solution) or
Router provided, installed and maintained by Customer (for Un-Managed solution)

Future Plans Point to Multi-Point

- n Reduce 3G/4G usage
- n Use existing state backbone
- n Provide better network response time with little to no packet loss.





Questions?

FOR ADDITIONAL INFORMATION CONTACT
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