

# Field Element Network Design for a Rural Transportation Management Center

## "Part One"

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Caltrans, District 2



# What is different about Rural TMCs and their associated Field Element Networks?





# Harsh Field Conditions





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- Heavy snowfall, winter temperatures of – 30 degrees F in some locations and summer temperatures of +118 degrees F in the Sacramento Valley
- The field conditions can be as challenging as anywhere in the West



# Harsh Field Conditions



Looking Down at the Top of a 334  
Cabinet on SR 89 at Snowman Summit  
January 2008



# Harsh Field Conditions

A photograph of a snowy mountain landscape. In the foreground, a chain-link fence is partially buried under a deep layer of snow. Behind the fence, there are snow-covered evergreen trees and a small structure, possibly a building or a shed, also covered in snow. The sky is overcast and grey.

RWIS Site on SR 89 at Snowman Summit  
January 2008



# Telecommunications





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- District 2 is served by a total of eight different telcos of varying size and capability
- Many areas of the district have no designated telephone company

OREGON

OREGON  
LATA

405

NEW PINE  
CREEK

CAL-ORE

CAL-ORE

LATA 1

SISKIYOU  
TELEPHONE

AT&T

NO TELCO

FRONTIER

NO TELCO

NO TELCO

FRONTIER

VERIZON

AT&T

FRONTIER

LATA 2

NO TELCO

HAPPY VALLEY  
TELEPHONE

AT&T

NO TELCO

FRONTIER

DUCOR

NO TELCO

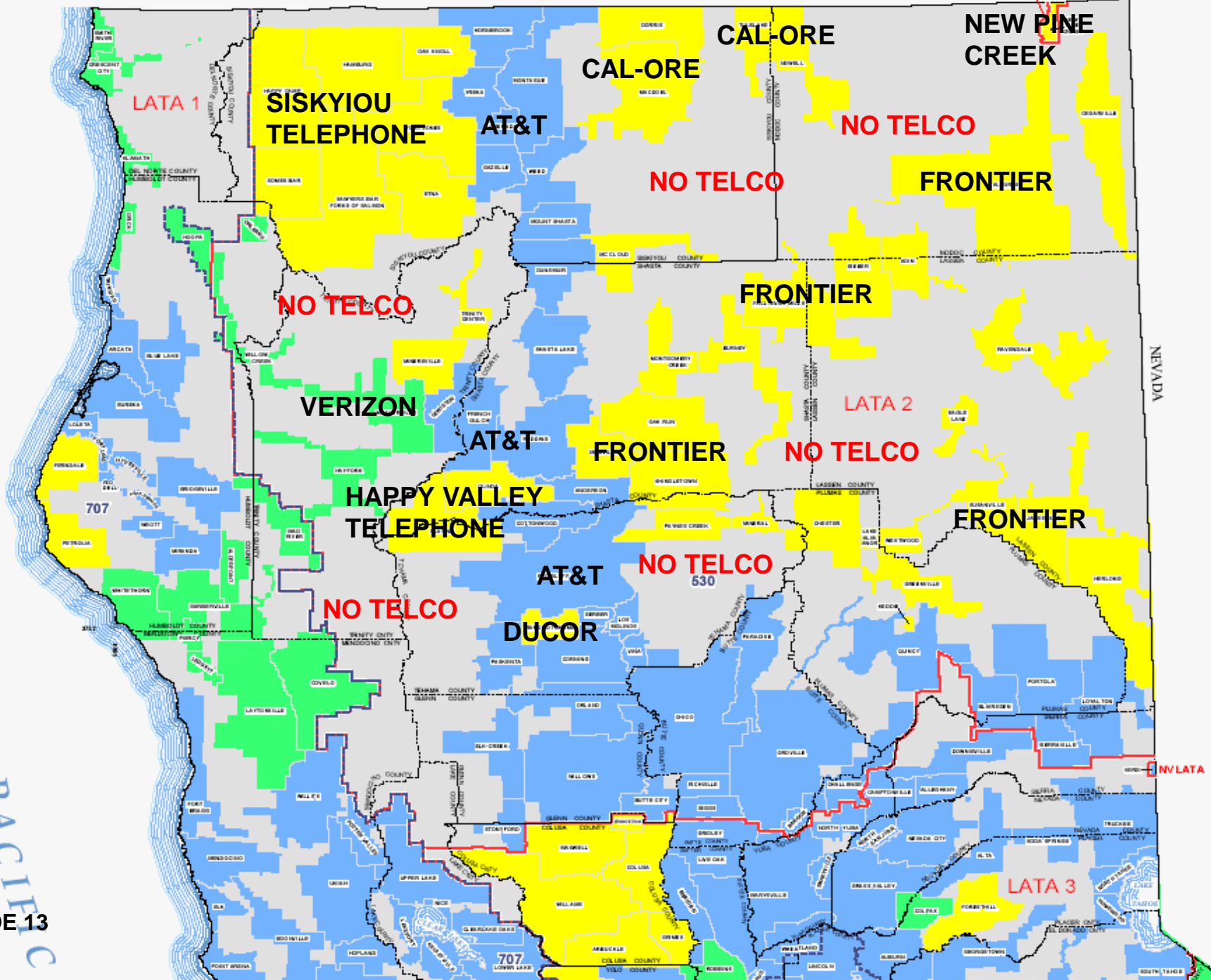
NEVADA

NV LATA

LATA 3

SLIDE 13

PACIFIC





# Telecommunications

- District 2 is generally limited to:
  - POTS
  - ISDN (AT&T service area only)
  - Private Microwave
  - DSL (limited)
  - GPRS (limited)



# Size, Scope and Operations





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- Rural TMCs often must focus on events that occur over large geographic areas with low population densities
- Winter Operations
- Wildfires
- Floods
- Major Freight Corridor Incidents



# Size, Scope and Operations

Rural TMCs are physically smaller than their urban cousin



# Size, Scope and Operations

- Rural TMCs are physically smaller than their urban cousin
- They are generally not staffed 24/7 unless there is an event or during winter operations



# Size, Scope and Operations





# Size, Scope and Operations

- The Rural TMC gathers road condition information from various sources:





# Size, Scope and Operations

- The Rural TMC gathers road condition information from various sources:
  - Closed Circuit Television (RoadCams)
  - Roadway Weather Information Systems
  - Maintenance Radio Dispatch
  - California Highway Patrol
  - National Weather Service



MOTT RD  
PRESET 1



VOLLMERS  
PRESET 3



I5-SR89  
PRESET 1



SNOWMAN  
PRESET 1



ABRAMS LAKE  
PRESET 1



DUNSMUIR  
PRESET 1





PINE GROVE



SLIDE 27

LAKE BLVD





# Size, Scope and Operations





# Size, Scope and Operations

- The RTMC then controls and coordinates en-route Traveler Information through various ITS field elements on the field element network:



# Size, Scope and Operations

- The RTMC then controls and coordinates en-route Traveler Information through various ITS field elements on the field element network:
  - Changeable Message Signs
  - Highway Advisory Radios
  - World Wide Web
  - Media Releases



# Size, Scope and Operations

- All of this requires a robust technical architecture that will support reliable operation during the most severe conditions.



# D2 Rural TMC Technical Architecture





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- Field video will be monitored exclusively on the video wall
- Workstations will be used exclusively to control the field elements



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- Workstations will be used for all administrative computing (web, email, etc.)
- Room and video wall control will be facilitated with a multi-media control system using a wireless touch panel as the instrument of control (Crestron)



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- All RTMC cabling will use a standards based, structured cabling approach
- All RTMC technical systems will be independent of district office power and telecommunications

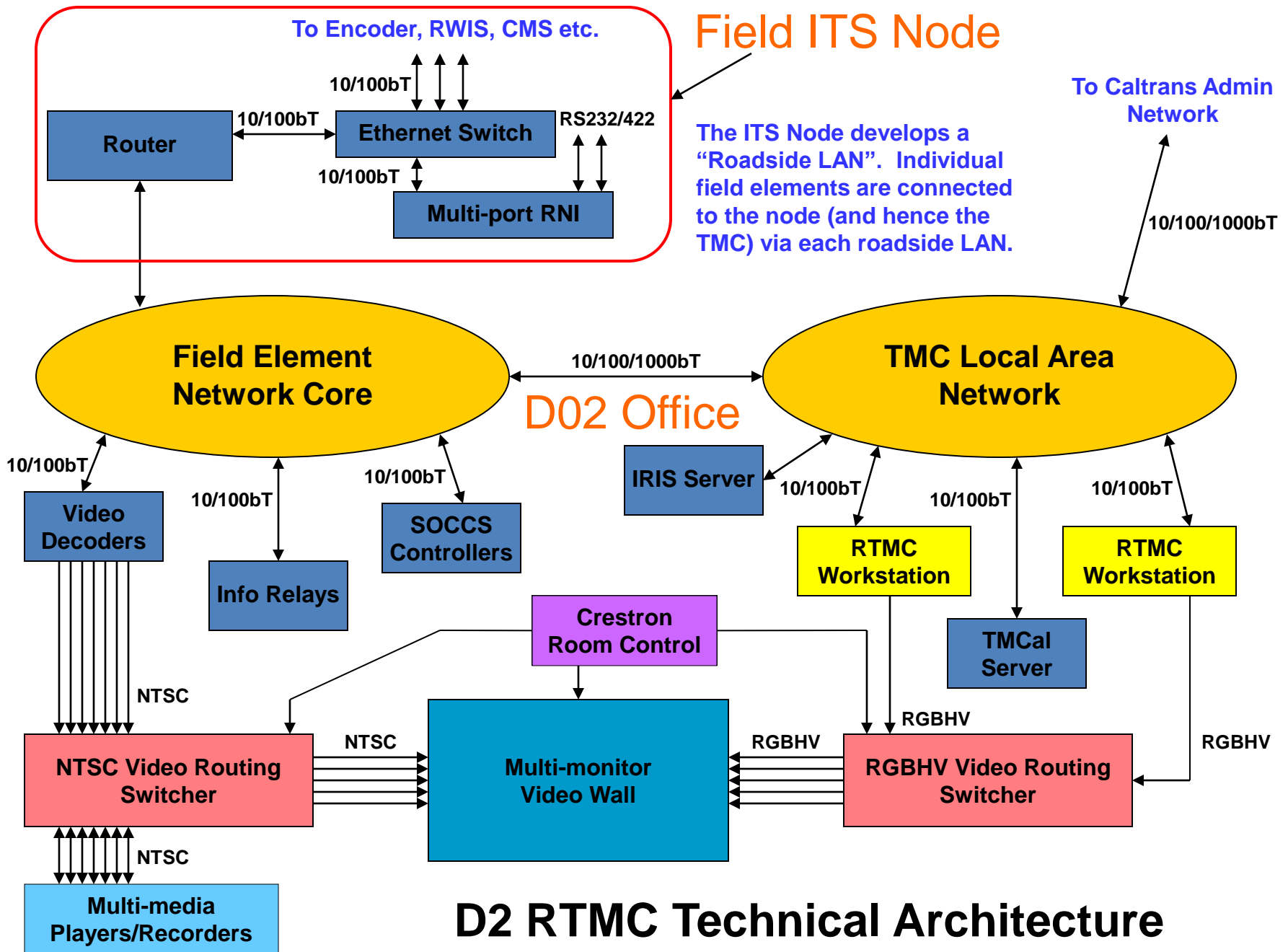
# D2 Rural TMC Technical Architecture

The background image shows a person from behind, sitting at a desk in a control room. They are facing a large video wall made of many monitors. The monitors display various images of roads, some with snow, and some with data or maps. The person is wearing a red jacket. The room has large windows on the left side, showing a view of the outside world.

- The close proximity of the operators to the video wall facilitates their ability to effectively see and use the many monitors for road condition monitoring
- This approach reduces the clutter and congestion on the workstation desktop without compromising the ability to clearly see and utilize the video streams

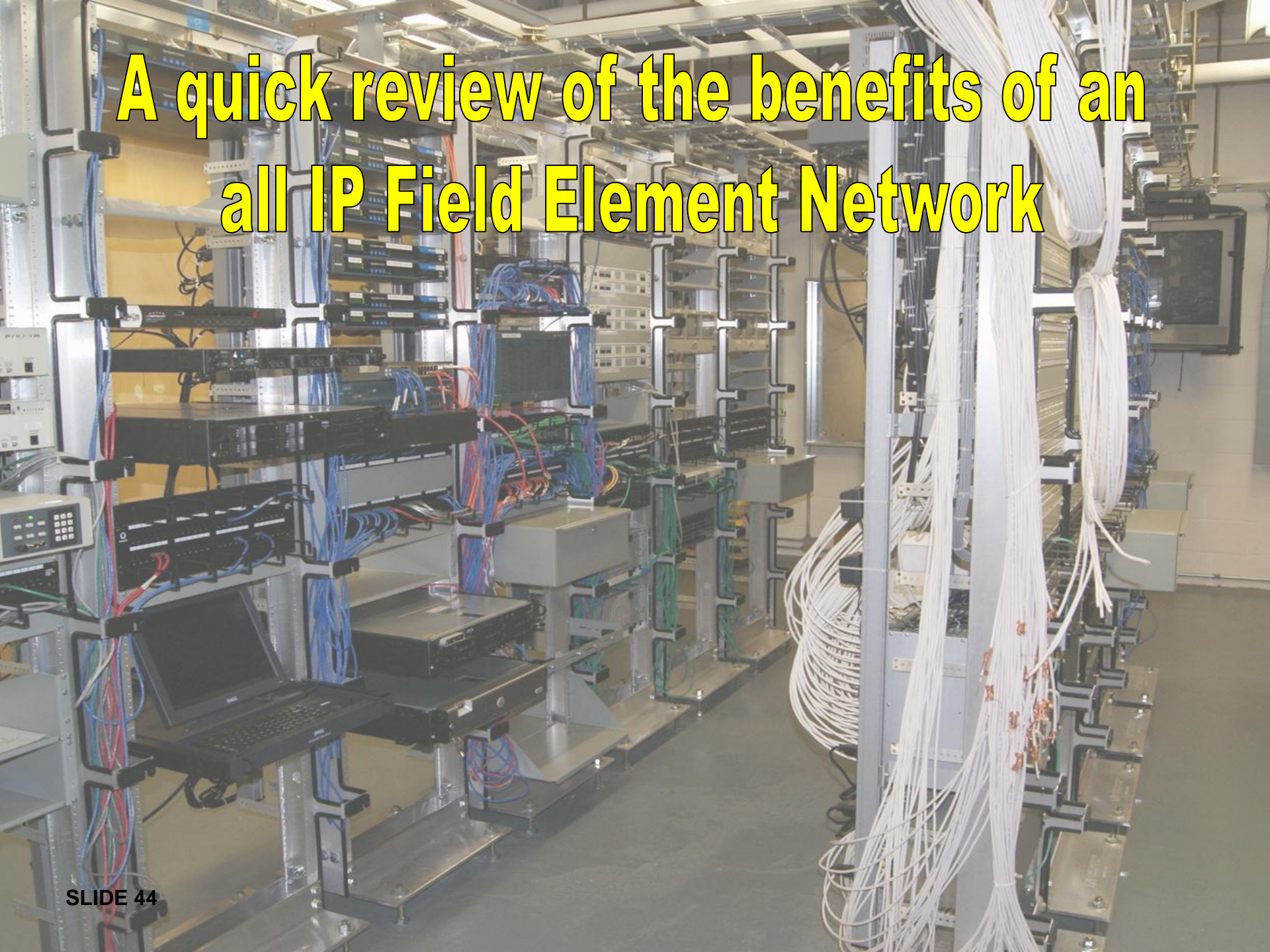








# A quick review of the benefits of an all IP Field Element Network

A photograph of a server room with multiple racks of network equipment. The racks are filled with various electronic components, including switches and routers. A large bundle of white cables hangs from the top of the racks, and many blue and red cables are visible connecting the equipment. The room has a clean, industrial appearance with metal racks and a concrete floor.

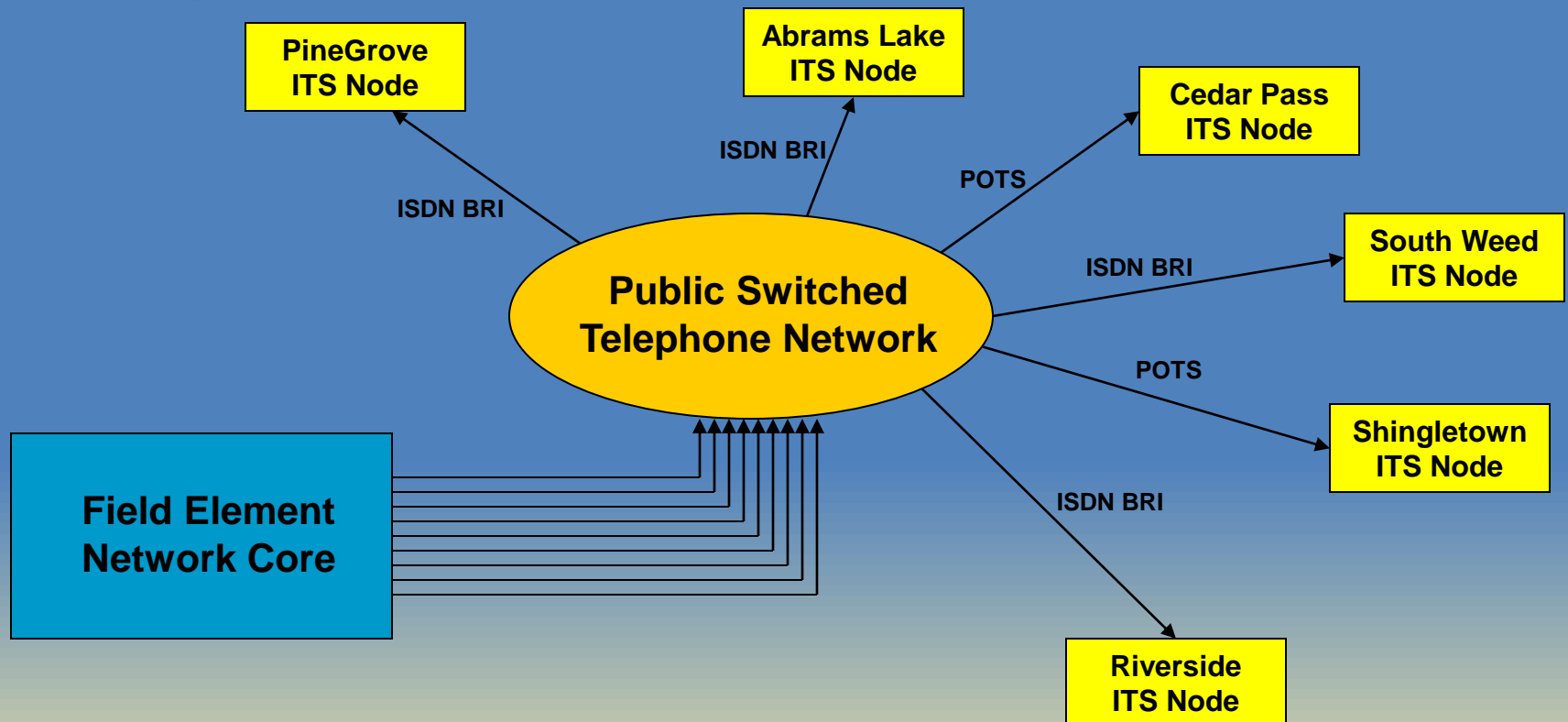
# A quick review of the benefits of an all IP Field Element Network

- Layered approach to communications



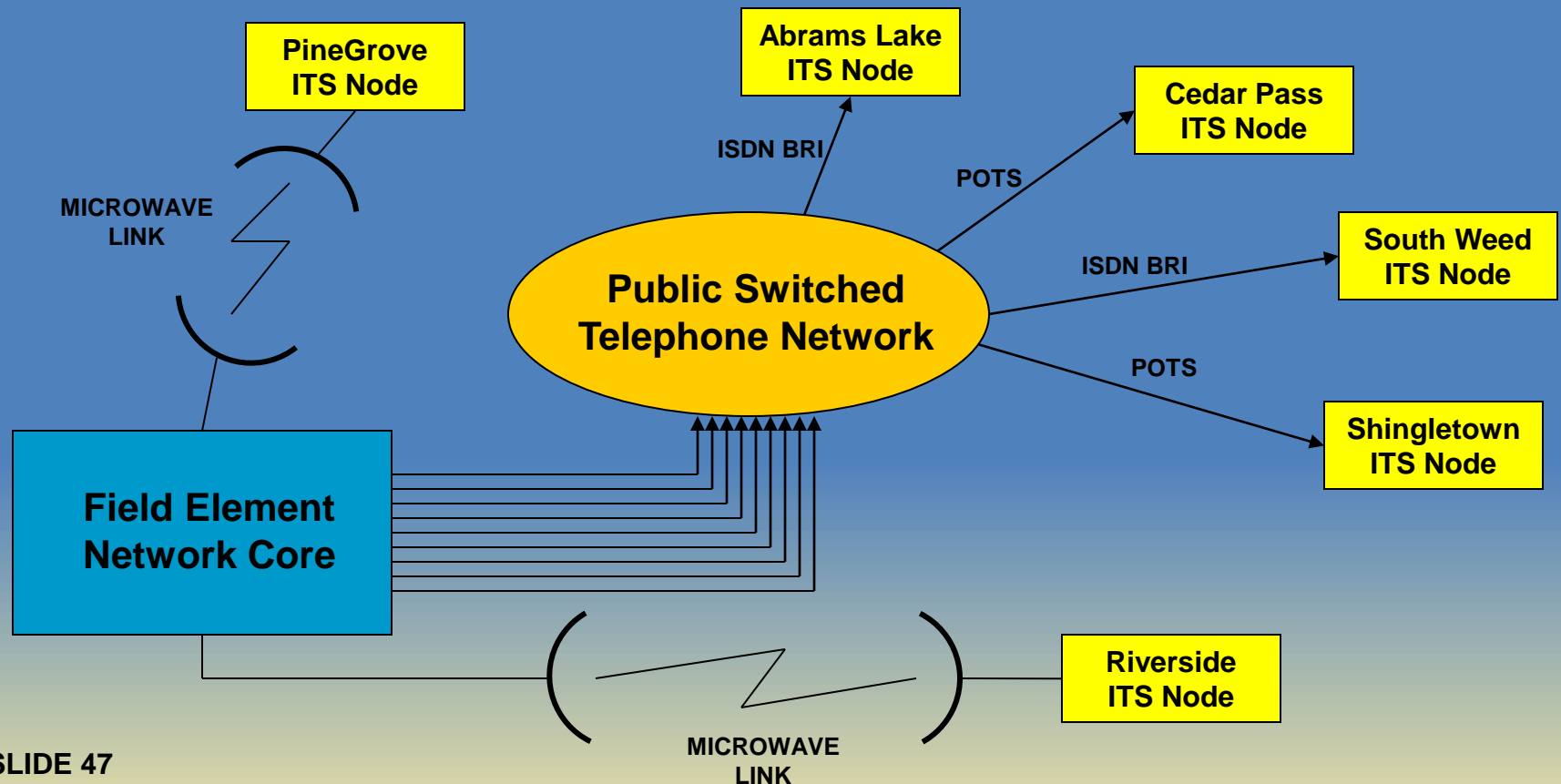
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- Layered approach to communications
- Good interoperability between communications equipment manufacturers
- Very expandable and scalable - when properly designed
- Excellent troubleshooting and testing diagnostics, features and utilities
- Off-the-shelf equipment is “quickly” deployable



# District 2 Field Element Network Communications Subtypes

- Dial-on Demand (DDR) POTS

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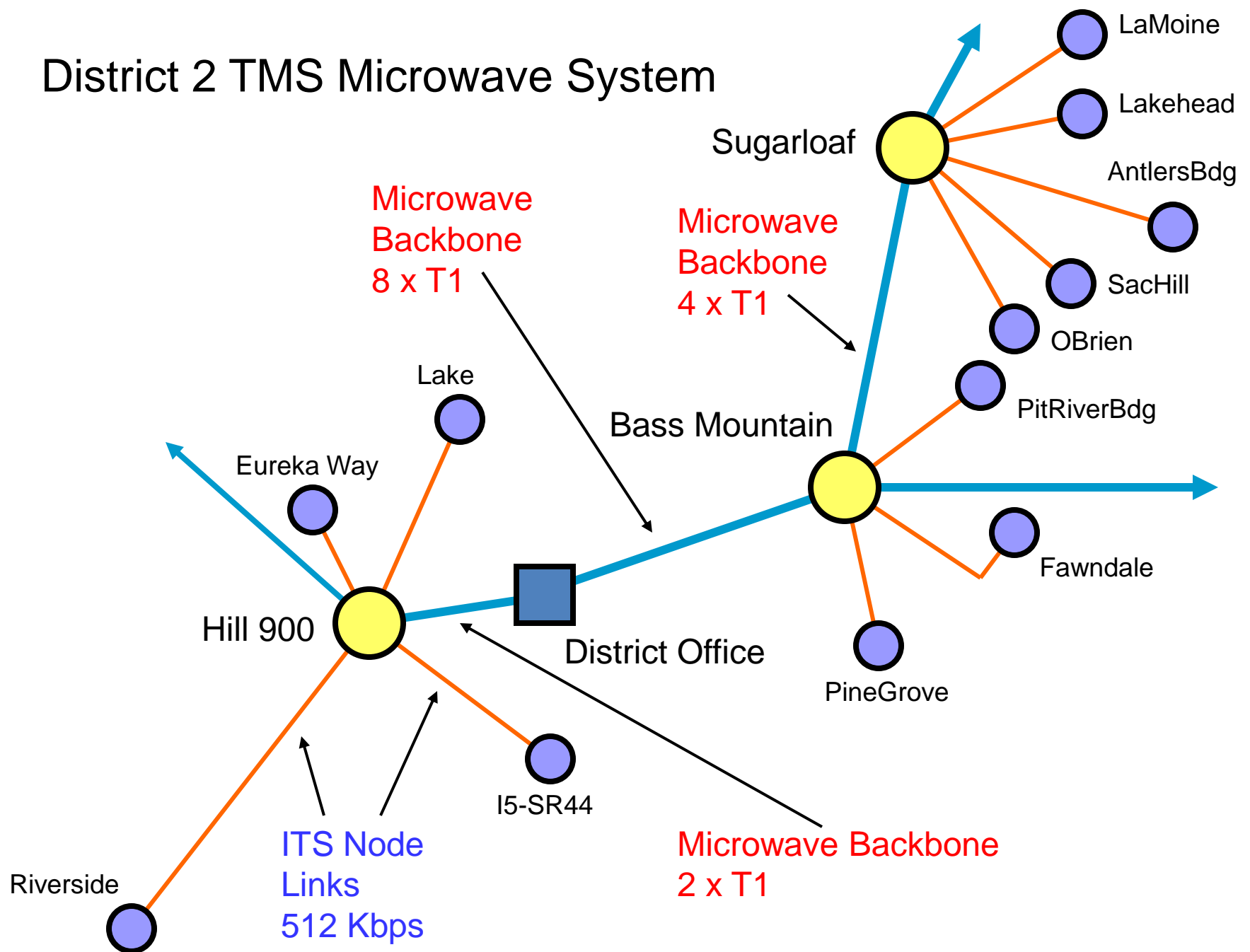
- Dial-on Demand (DDR) POTS
- Dial-on Demand (DDR) ISDN



# District 2 Field Element Network Communications Subtypes

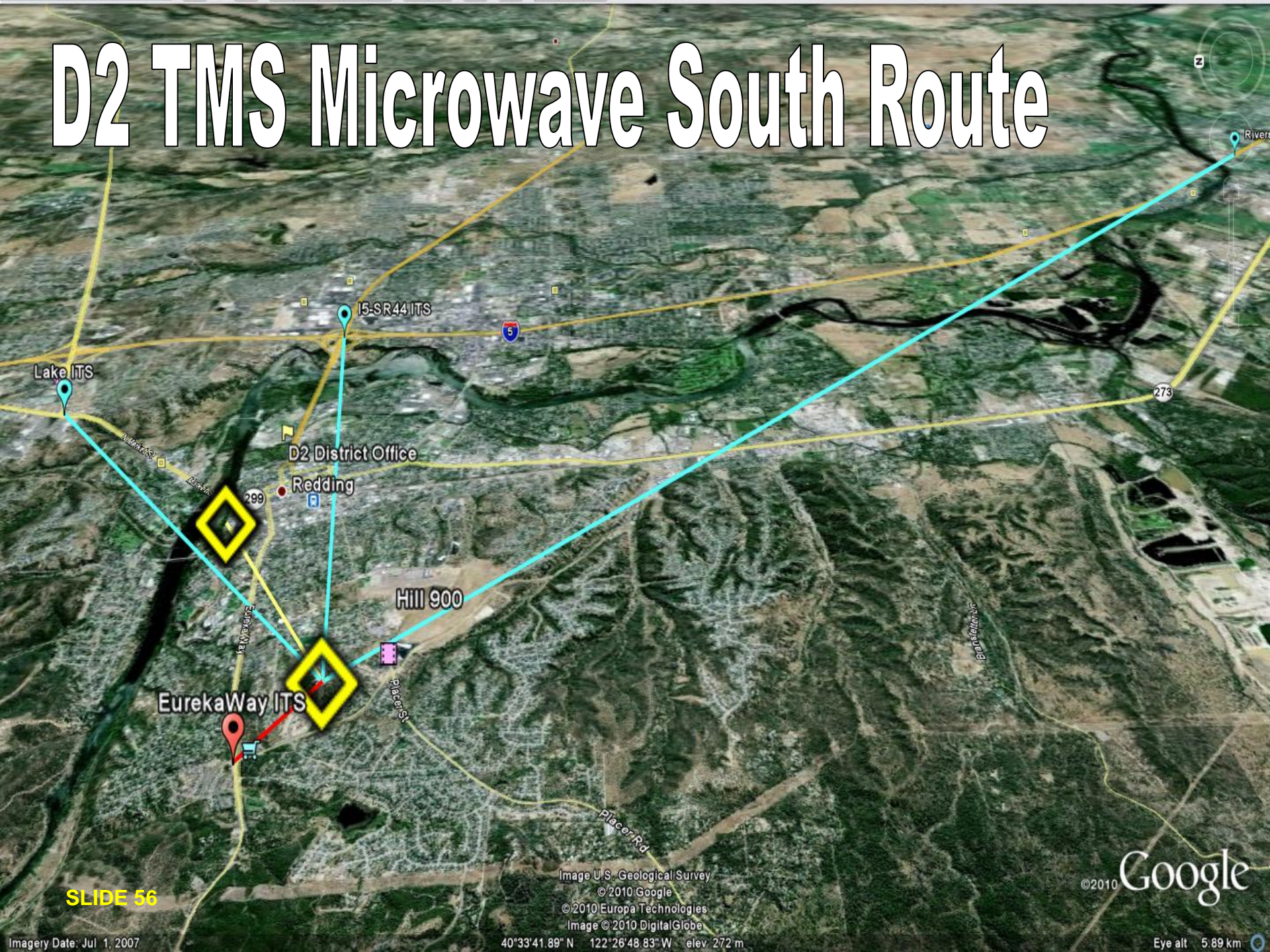
- Dial-on Demand (DDR) POTS
- Dial-on Demand (DDR) ISDN
- Private Microwave Network

# District 2 TMS Microwave System





# D2 TMS Microwave South Route





# D2 TMS Microwave North Route



SLIDE 57





# Bass Mountain ITS Radio Site

SLIDE 58





# Fawndale Passive Repeater

SLIDE 59



# District 2 Field Element Network Subtypes

- Dial-on Demand (DDR) POTS
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- General Packet Radio Service (GPRS)

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- Fiber in the Redding Urban Area (in construction)





# Redding Area Fiber Project

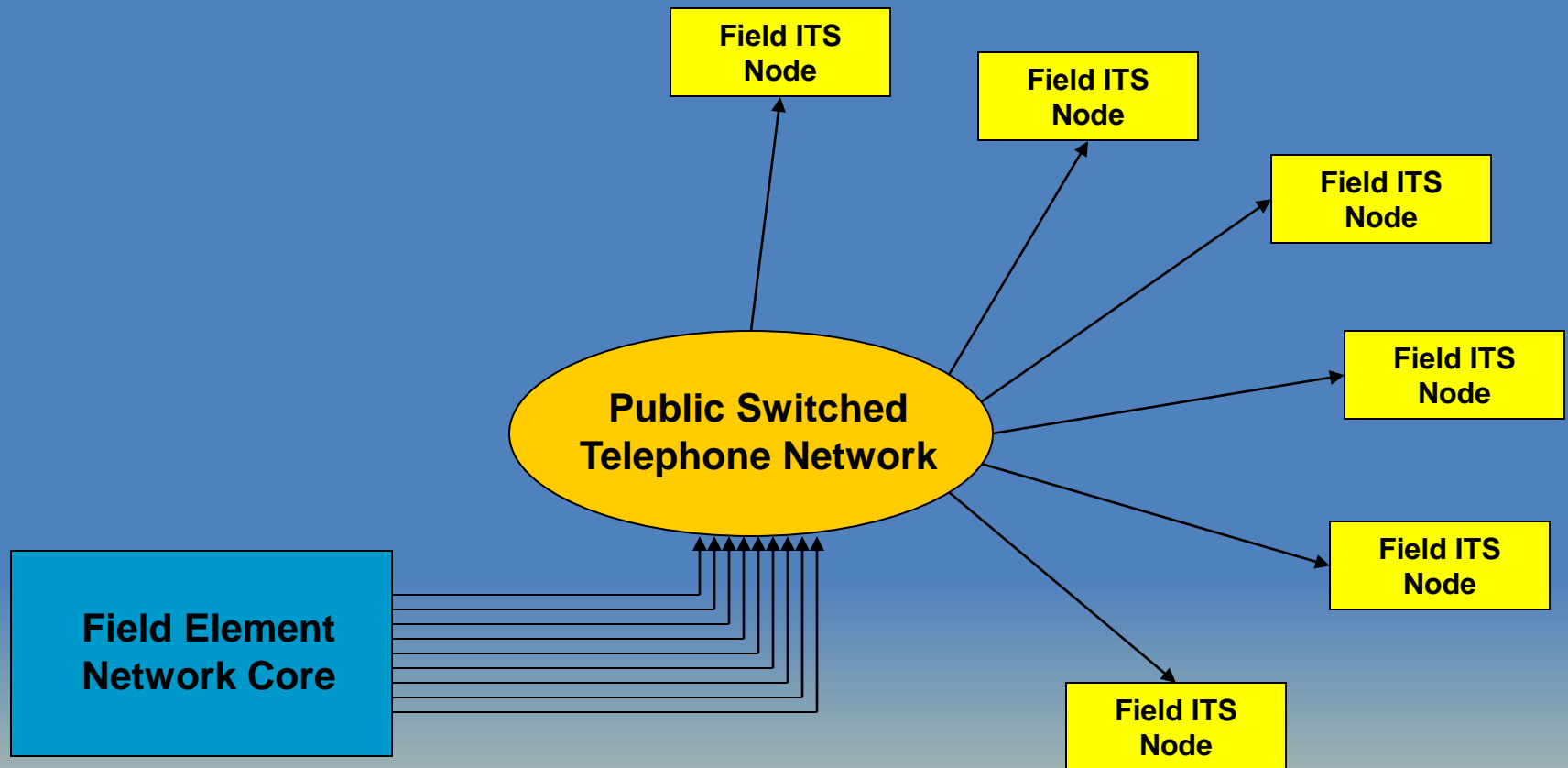
SLIDE 62

# District 2 Field Element Network Subtypes

- Dial-on Demand (DDR) POTS
- Dial-on Demand (DDR) ISDN
- Private Microwave Network
- General Packet Radio Service (GPRS)
- Fiber in the Redding Urban Area (in construction)
- Digital Subscriber Line (DSL – in design)



# Why use a one-to-many DDR Network Core approach?



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- It is very scalable with proper system design, but care must be taken to carefully control bandwidth usage
- Charges are only accrued when the site is connected

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# Why use a one-to-many DDR Network Core approach?

- Caltrans as an organization can “easily” deal with installing a new telephone service (POTS or ISDN) as part of the construction contract
- This allows the site to be turned-up and operational within a couple of weeks from the end of construction
- The site is then migrated to ISM band microwave (unlicensed) as that system is built out in the area (could be years later)



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- Then the ISM band equipment is moved out to the edge to expand the system
- This process repeats and eventually the system arrives at a complete build out

# Why use a one-to-many DDR Network Core approach?

- Strategy Summary:



# Why use a one-to-many DDR Network Core approach?

- Strategy Summary:
  - First – DDR
  - Second – ISM Band Microwave
  - Third – Licensed Microwave
  - Fourth – Move ISM Band equipment out to the edge and expand the network

# Why use a one-to-many DDR Network Core approach?

- Same strategy is applied to other communications subtypes that are not easily installed during construction



# Why use a one-to-many DDR Network Core approach?

- Same strategy is applied to other communications subtypes that are not easily installed during construction
- Some field sites will remain DDR for their entire life if no other communications subtypes are available or practical

# One-to-Many DDR architecture scales well

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO.	TOTAL SHEETS

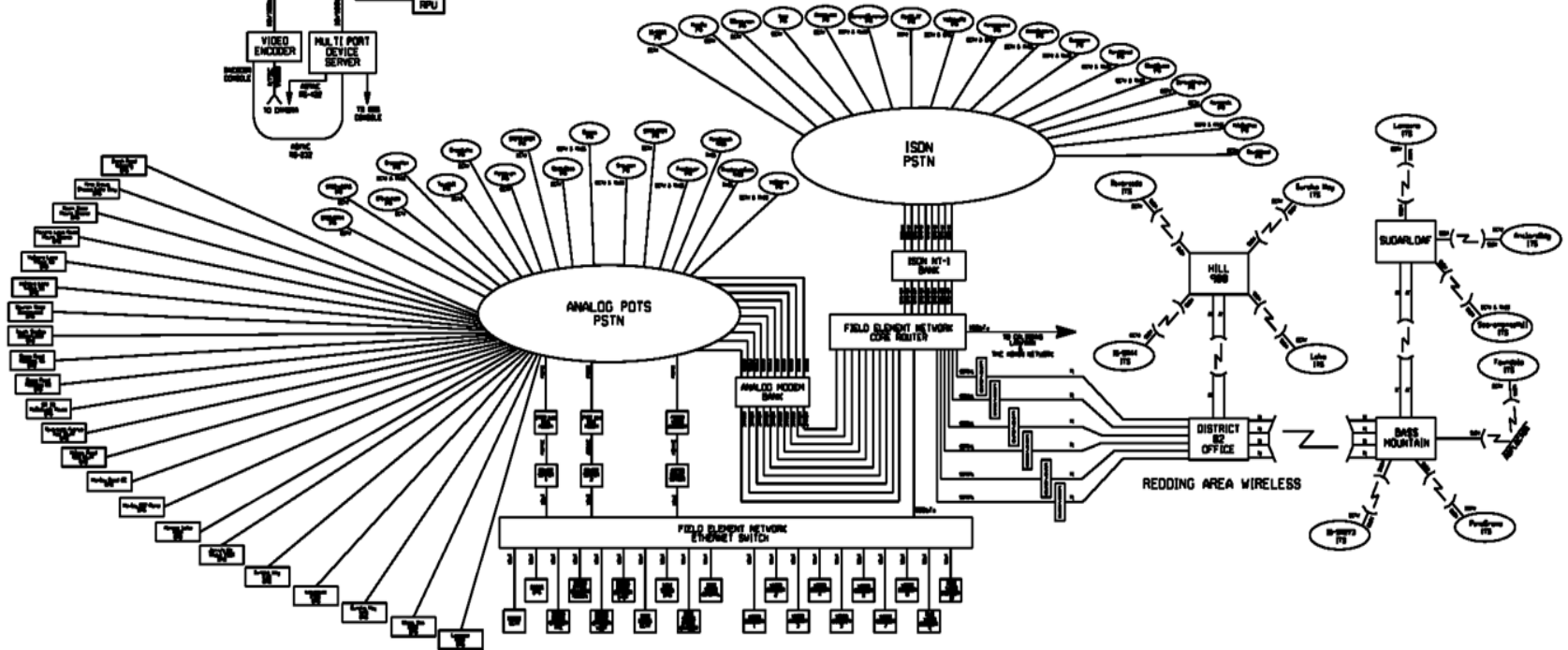
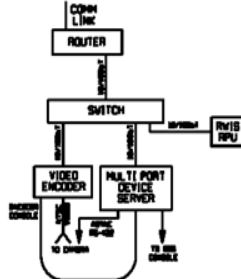
REGISTERED CIVIL ENGINEER \_\_\_\_\_

PLANS APPROVAL DATE \_\_\_\_\_

The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.

REGISTERED PROFESSIONAL ENGINEER  
CIVIL  
STATE OF CALIFORNIA

TYPICAL ITS NODE SITE



SYSTEM DIAGRAM  
DISTRICT 02  
FIELD ELEMENT NETWORK

NOTE: DISTRICT 02 HAR AND HAR FLASHER NETWORK ARE DIRECT DIAL AND NOT SHOWN

REVISOR  
DATE  
DESIGNED BY  
CHECKED BY

PROJECT ENGINEER

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION  
TRAFFIC OPERATIONS - ITS

00-00-00



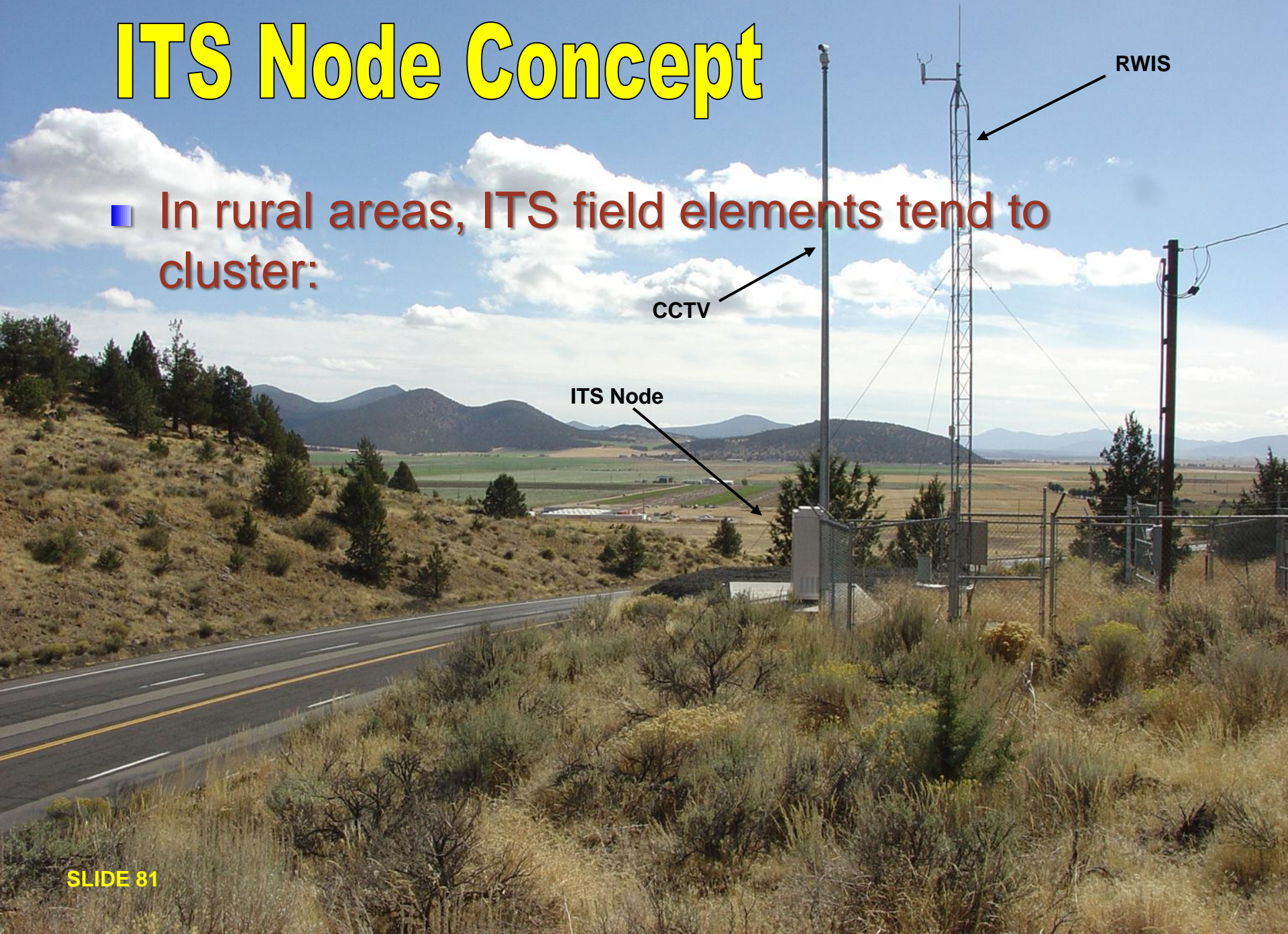
# ITS Node Concept





# ITS Node Concept

- In rural areas, ITS field elements tend to cluster:





# ITS Node Concept

- In rural areas, ITS field elements tend to cluster:

- Chain-On / Chain-Off Areas
- Mountain Passes
- Junctions
- Detour Points
- Only available power and communications in the area

CCTV

ITS Node

RWIS

# ITS Node Concept

- The ITS Node develops a Field Element Network presence along the roadside



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- This provides a communications gateway back to the TMC

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- This provides a communications gateway back to the TMC
- A Roadside LAN is created at the ITS Node and allows the easy interconnection of individual IP enabled field elements (CCTV, RWIS, CMS, etc.) to the Field Element Network



# ITS Node Concept

- The Roadside LAN is usually 10/100bT Ethernet (on underground rated Cat5 cable)

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- But can also utilize other typical LAN technologies depending on distance to the element (100bFX Ethernet, P-to-P Ethernet Radios, Secured WiFi, LRE/xDSL, etc.)
- A typical ITS Node in District 2 consists of a CCTV and RWIS connected via Ethernet

# ITS Node Concept

- Stable power is critical in order to keep field element reliable



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- Stable power is critical in order to keep field element reliable
- Rural utility power is usually very unreliable
- To remedy this, each ITS Node has a robust Battery Back-up System (BBS) as part of the standard configuration
- The BBS also powers the field elements that are on the roadside LAN (except CMS)

# Typical ITS Node Site (Hatchet Mtn ITS Node)

CCTV Camera

RWIS

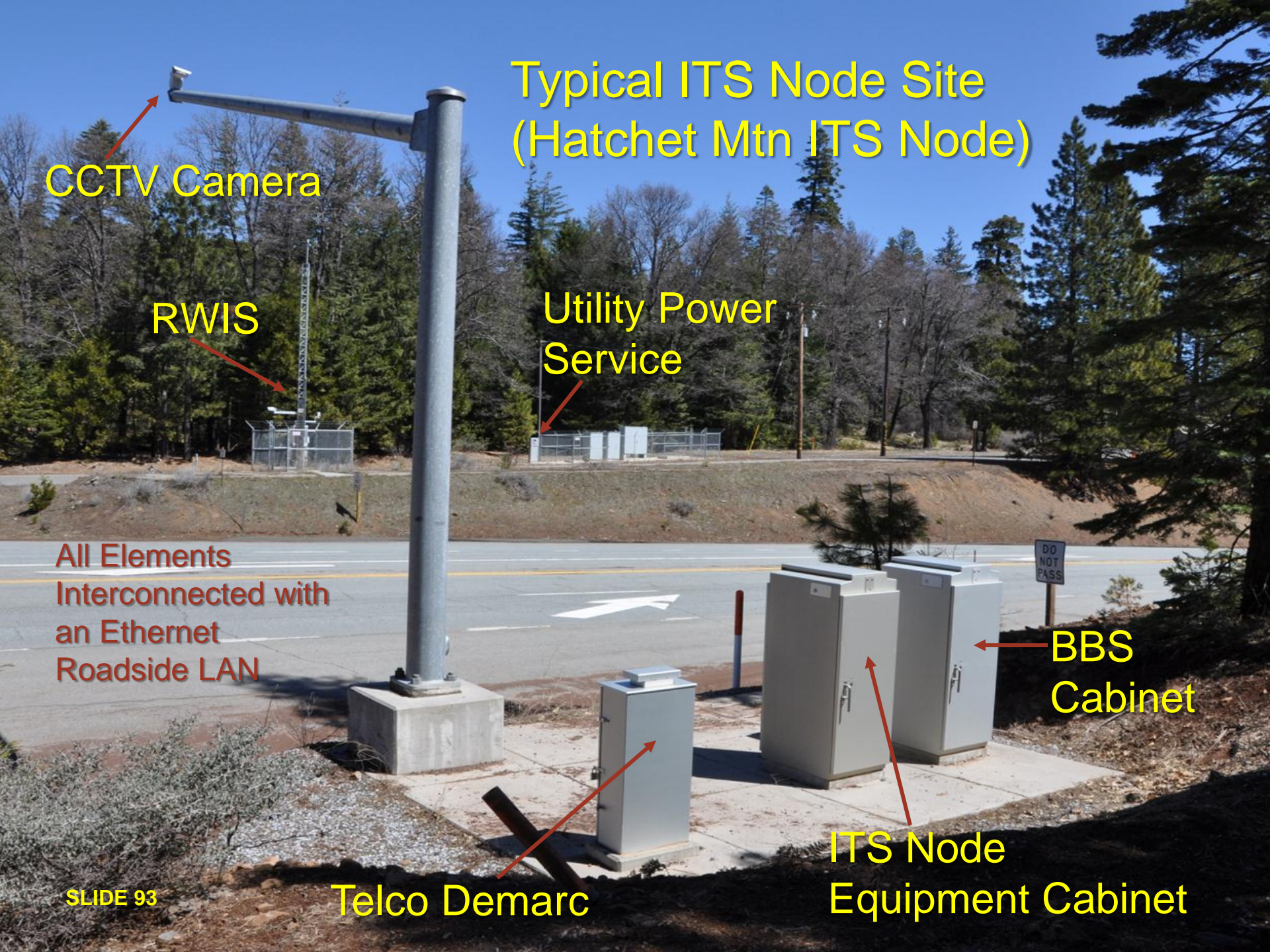
Utility Power  
Service

All Elements  
Interconnected with  
an Ethernet  
Roadside LAN

BBS  
Cabinet

ITS Node  
Equipment Cabinet

Telco Demarc





# Typical ITS Node Equipment Cabinet

Omnitron iConverter  
Ethernet Switch

Moxa Nport  
6650-8 RNI

Cisco 2509-ET  
Router

MultiTech  
MT5634IND  
Modem

District 2 ITS Node  
PDA

Axis 241S  
Video Encoder



# Typical ITS Node BBS Cabinet

Alpha NOVUS  
FXM BBS Unit

District 2 ITS Node  
PDA

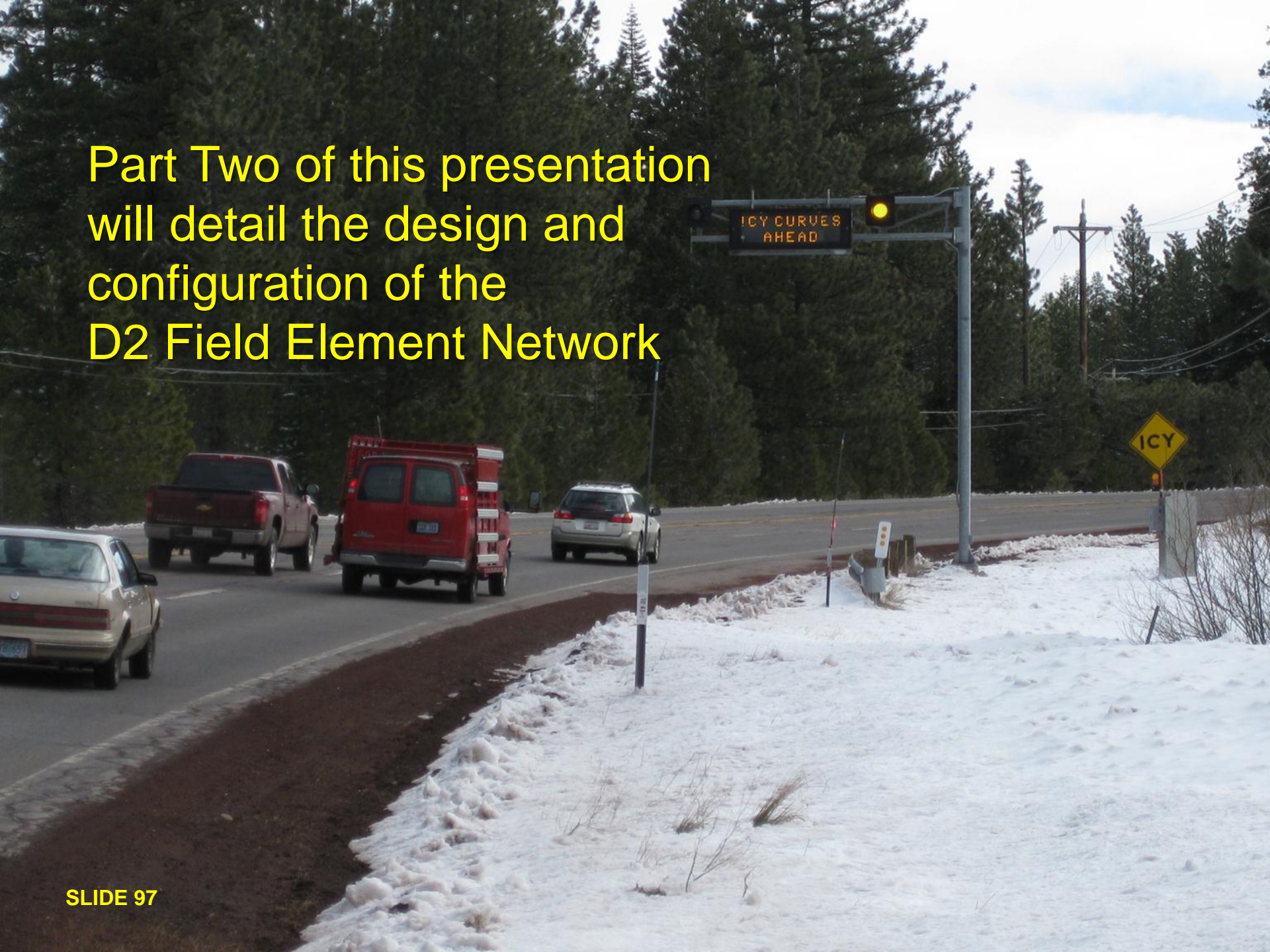
District 2 Slide-  
Out Battery Tray

C&D Technologies  
UPS 12-270FR,  
VR-AGM, 75 AH  
Batteries (for UPS  
service)





Part Two of this presentation  
will detail the design and  
configuration of the  
D2 Field Element Network





# Any Questions?

