

Cyberinfrastructure meets
Environmental Science:
Connectivity for remote monitoring stations

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The Mackay School of
Earth Sciences and Engineering





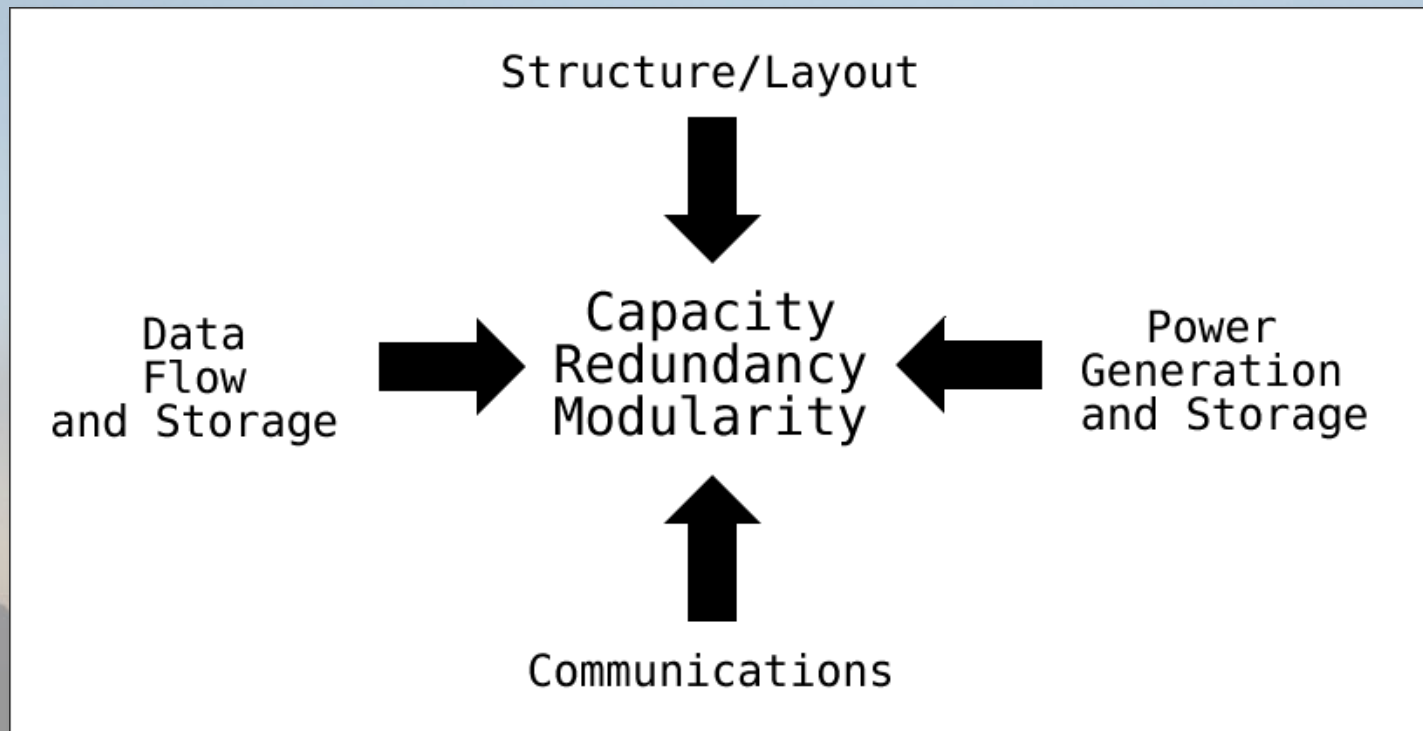
- 1. Why connectivity?*
- 2. What sort of connectivity?*
- 3. How does this advance science?*



1. *Why connectivity?*



As technology enables massive collection of field sensor data, deployments must be designed to minimize field maintenance time.

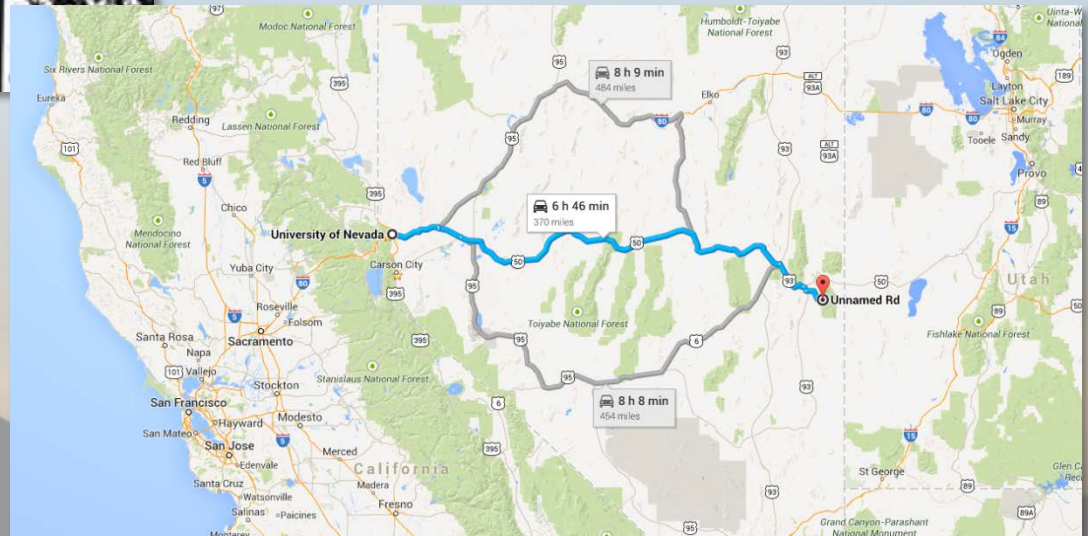


Why think about remote station reliability?



- *Extreme environments*
- *Long term deployment*

- *Distance/expense*
- *Sustainability*



Scale: small unattended observation stations



Challenge: Electrical Power

Sources: grid, **SOLAR**, mechanical/wind, fuel



- *Icing*
- *Wind loading*
- *Shading*
- *Low temperatures*

How can we maximize capacity and reduce downtime?



Challenge: Data Communications

Enables: data transfer, remote control, remote troubleshooting, advanced systems

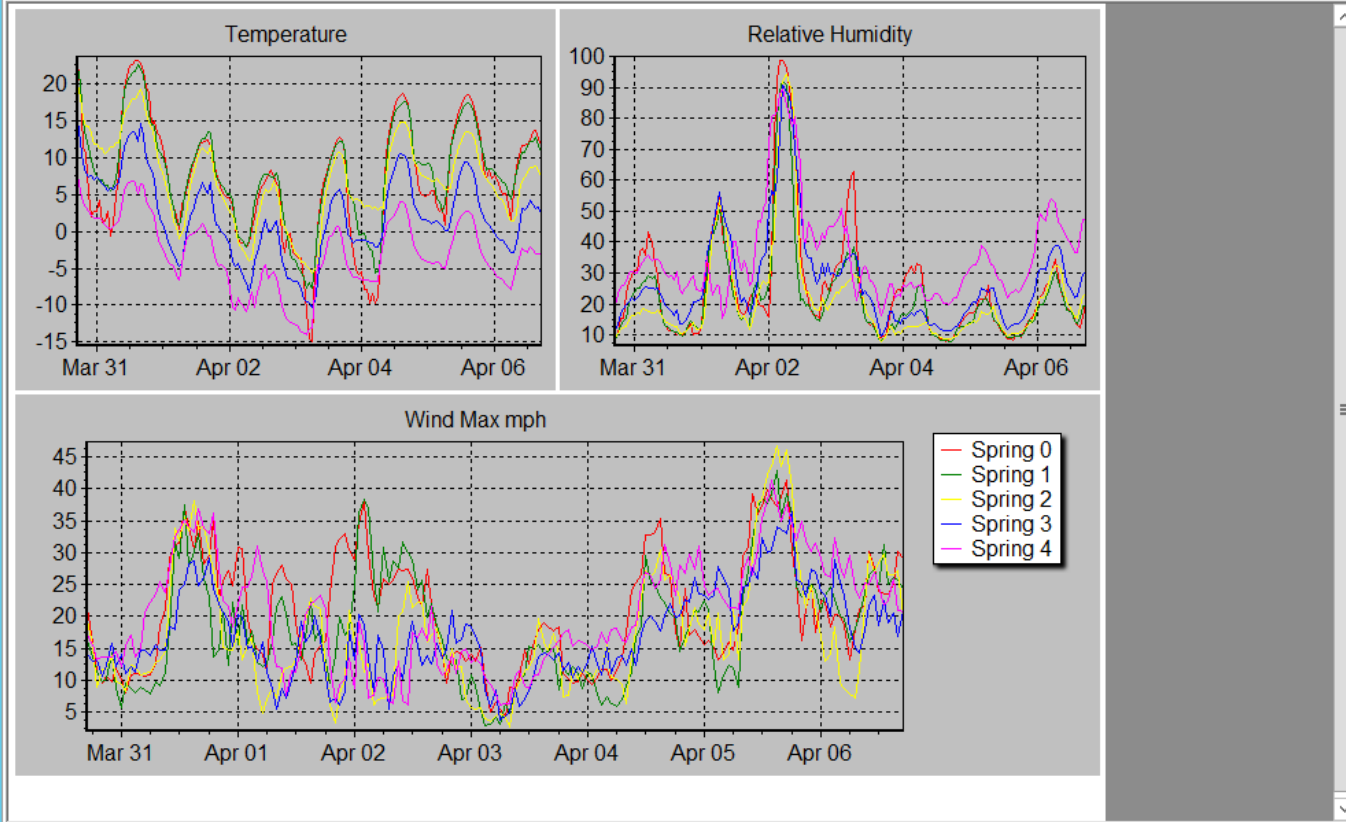


- *Speed/protocol*
- *Power requirements*
- *Hardware expense*
- *Infrastructure*
- *Expertise*

How can we reduce downtime and maximize capacity?

You can either send people out in all seasons to download data and check on the science equipment.....or.....





Connected: Server

loggerNet

- Main
- Program
- Data
- Tools
- Utilities
- Favorites

- Device Config Utility
- Hole Monitor
- CoraScript
- Data Filer
- Data Export
- RWIS Administrator

CAMPBELL SCIENTIFIC
WHEN MEASUREMENTS MATTER

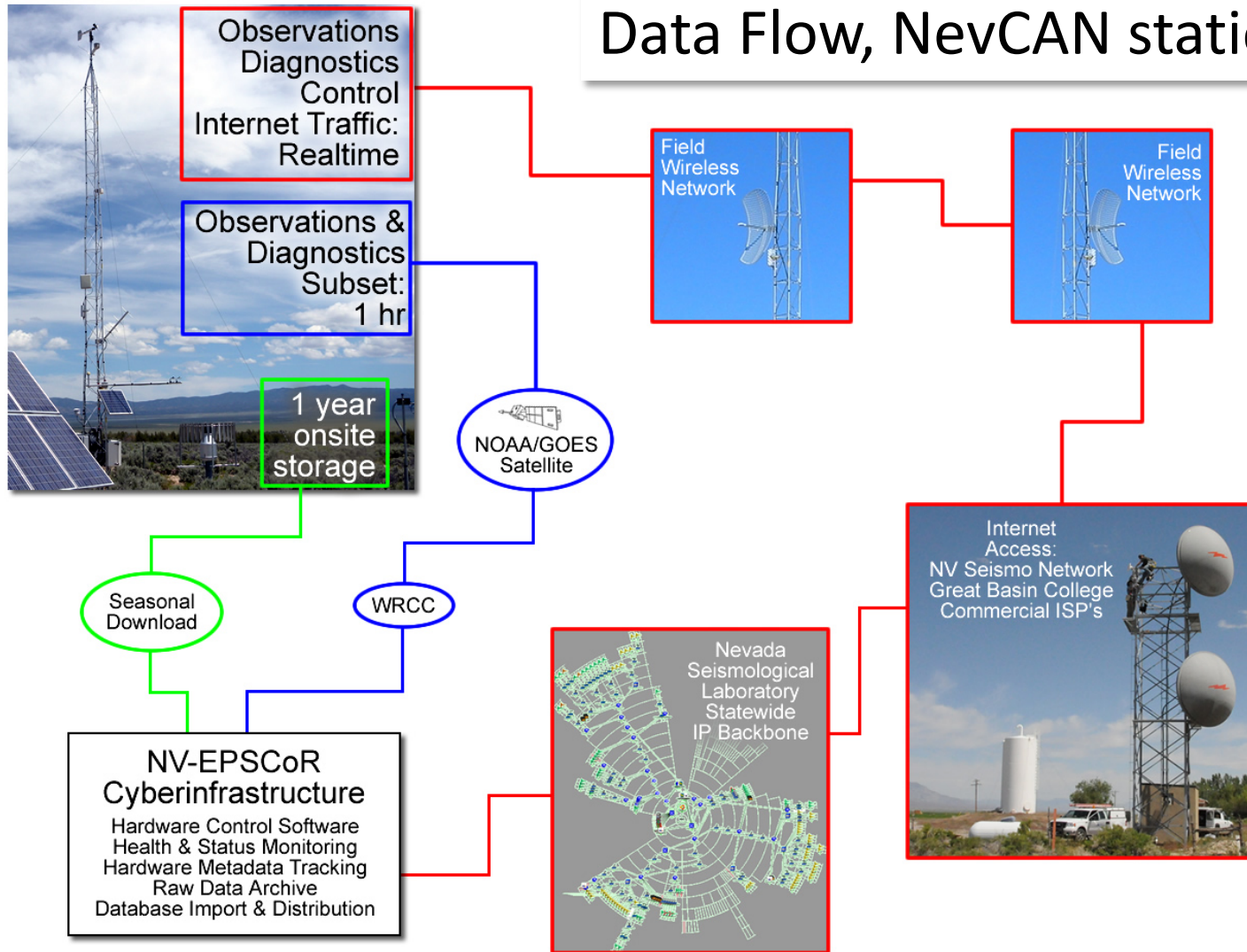
Network Map	Line State
Sheep 1 Met CR3000	off line
Sheep 1 Power CR1000	off line
Sheep 2 Met CR3000	off line
Sheep 2 Power CR1000	off line
Sheep 3 Met CR3000	off line
Sheep 3 Power CR1000	off line
Sheep 4 Met CR3000	off line
Sheep 4 Power CR1000	off line
Spring 1 Met CR3000	off line
Spring 1 Power CR1000	off line
Spring 3 Met CR3000	off line
Spring 3 Veg CR1000	off line
Snake 2 Met CR3000	off line
Snake 2 Power CR1000	off line
Spring 4 Met CR3000	off line
Spring 4 Soils CR1000	off line
Snake 1 Met CR3000	off line
Snake 1 Power CR1000	off line
Spring 2 Met CR3000	off line
Spring 2 Soils CR1000	off line
Snake 3 Met CR3000	off line
Snake 3 Veg CR1000	off line
Spring 3 Soils CR1000	off line
Snake 3 Soils CR1000	off line
Sheep 3 NDVI CR1000	off line
Snake 1 TDP CR1000	off line
Sheep 4 Veg CR1000	off line
Spring 4 Veg CR1000	off line
Spring 4 Veg2 CR1000	off line
Snake 1 SSMA CR1000	off line
SV6_CR5000	off line
Spring 0 Met CR3000	off line
Spring 0 Power CR1000	off line
Rockland-1-Met-CR3000	off line
Pole Adit CR1000	off line
LNF Well CR1000	off line

Free space: 22,475,689,984 bytes 20.9 GB
 Server Time 1:38:57 AM Pause Schedule

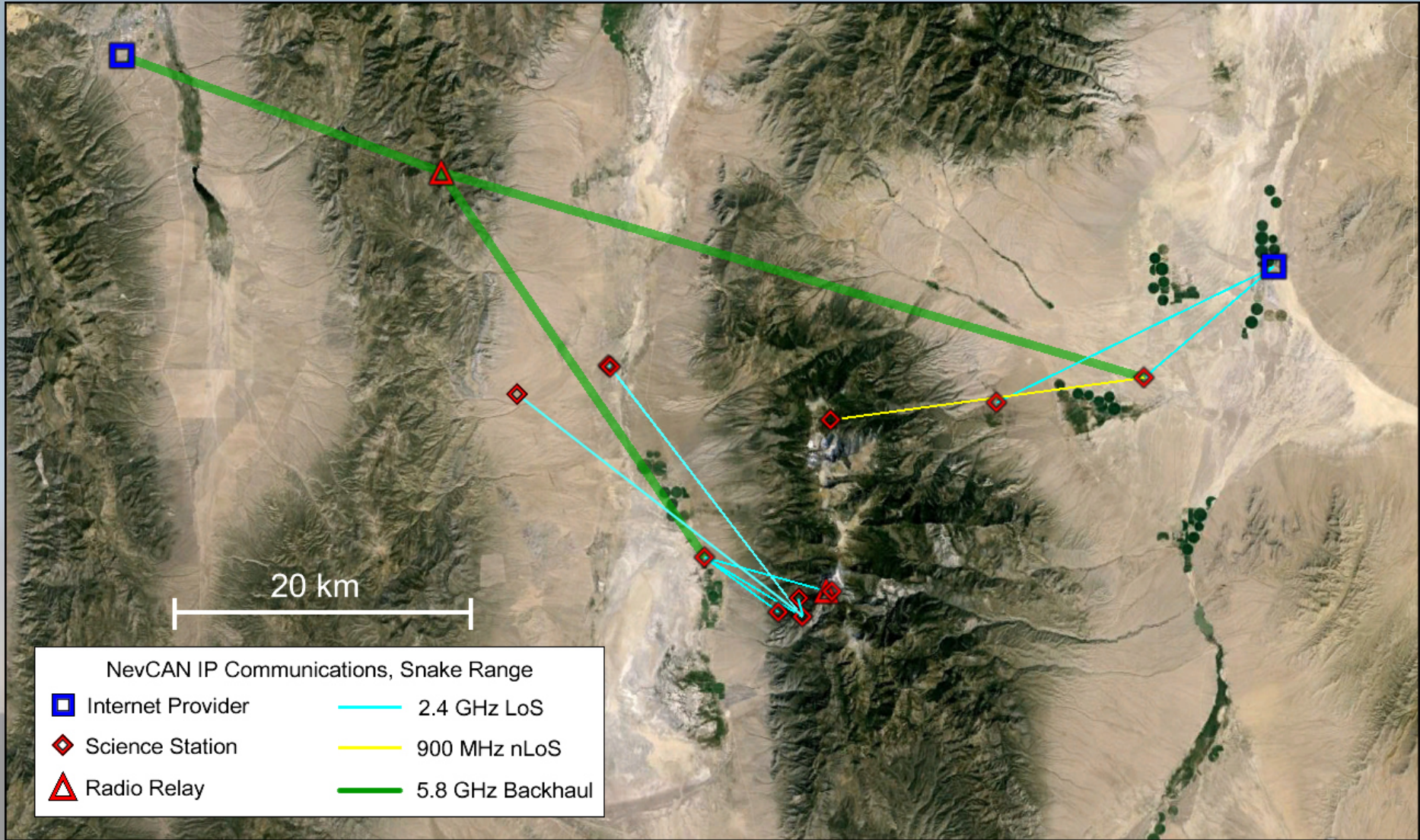
2. *What sort of connectivity?*



Data Flow, NevCAN stations

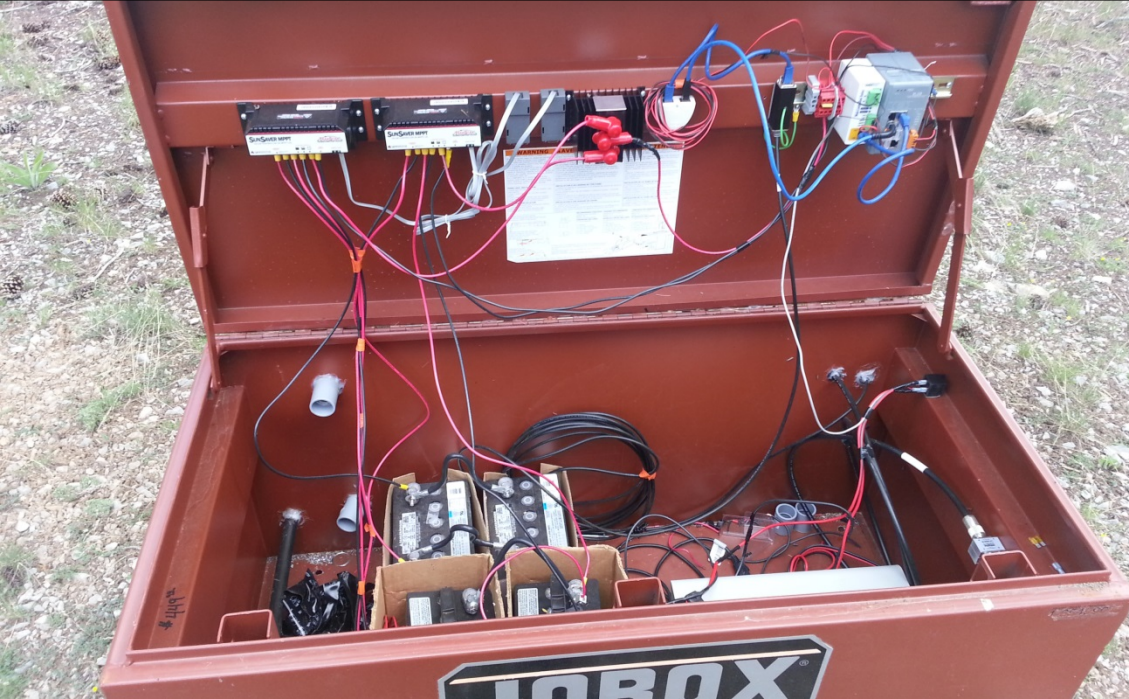
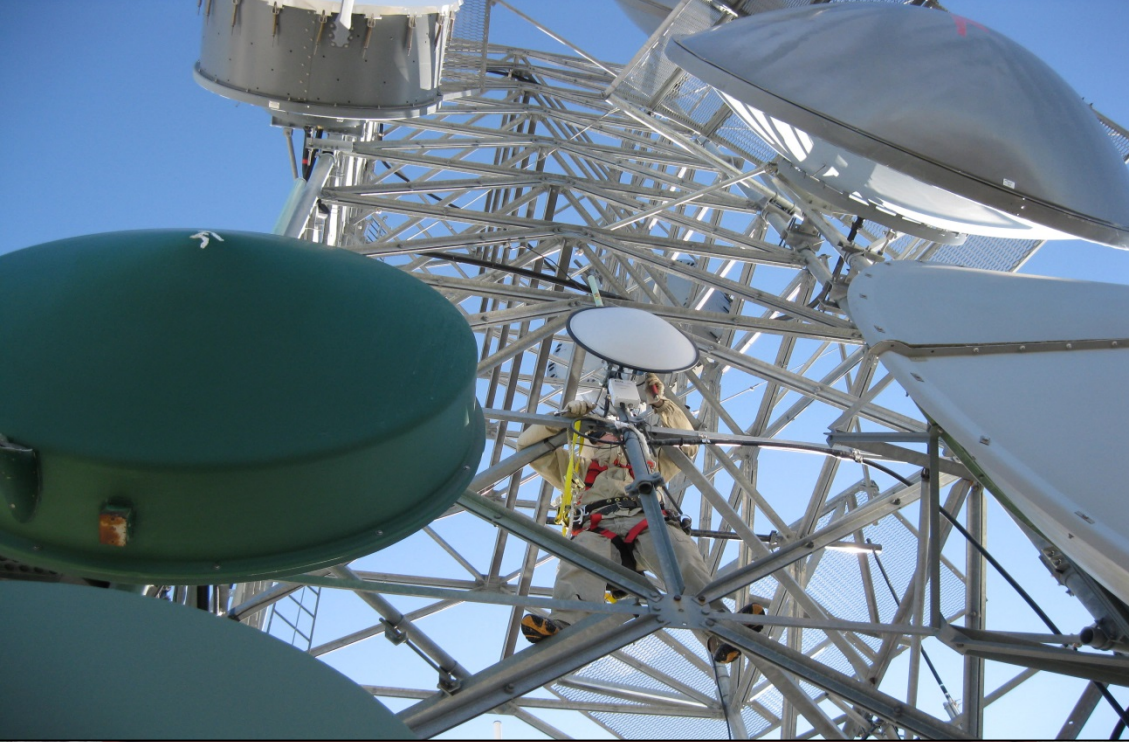


Field TCP/IP Networking

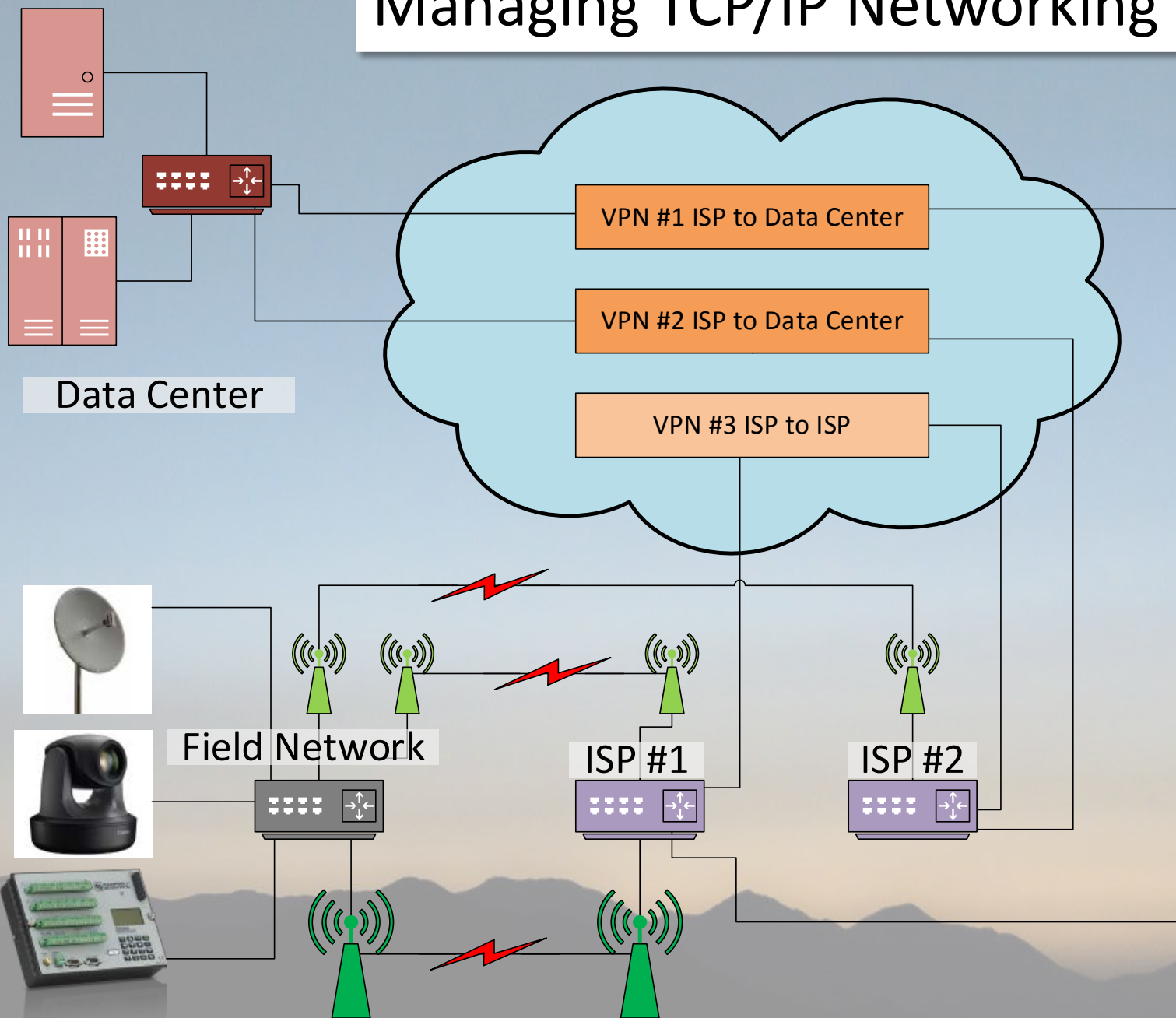


100 km

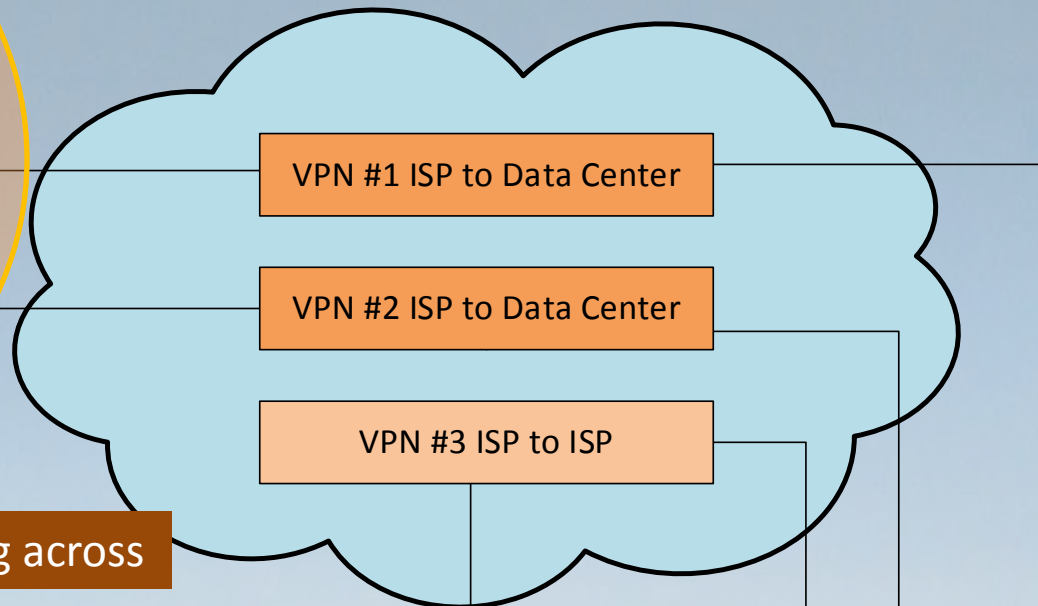
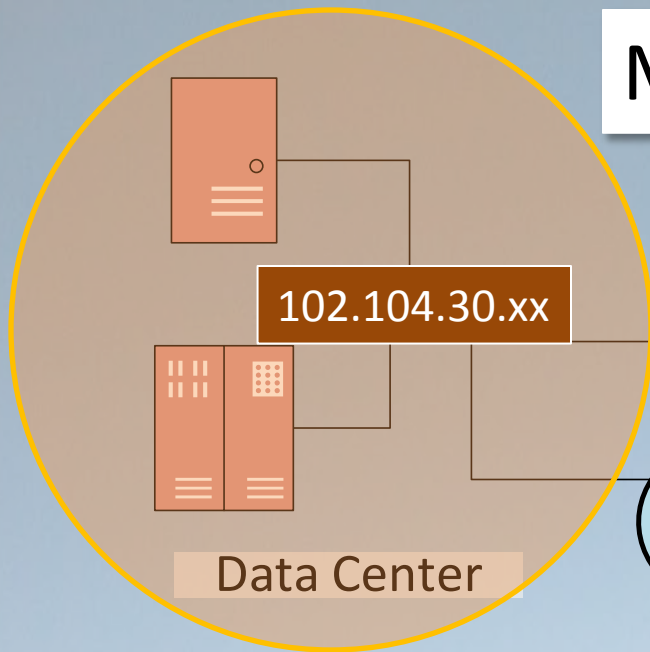




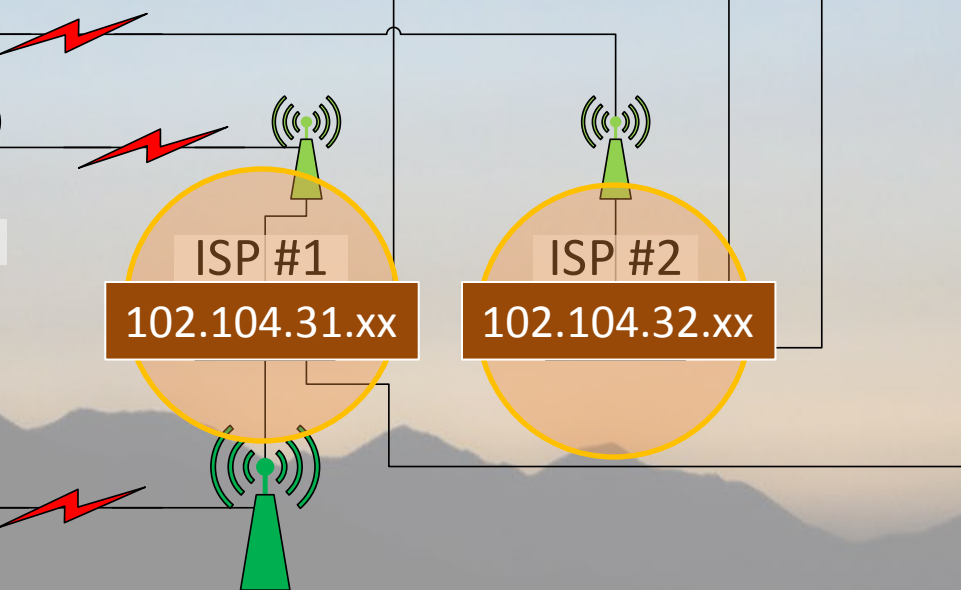
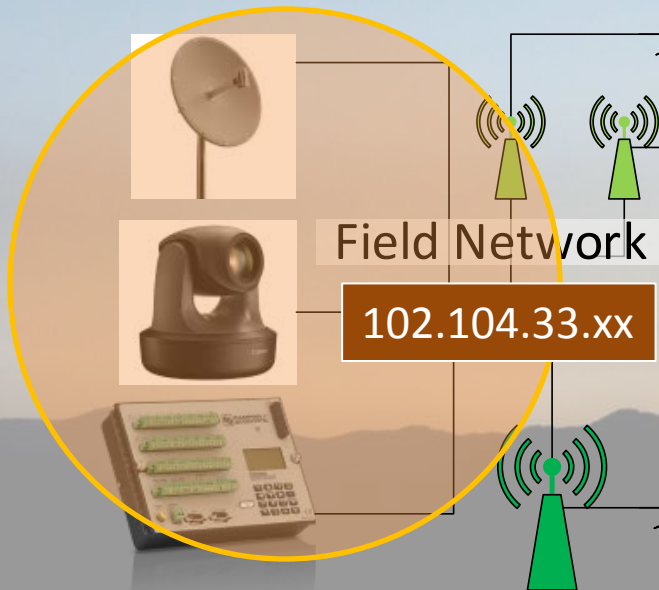
Managing TCP/IP Networking



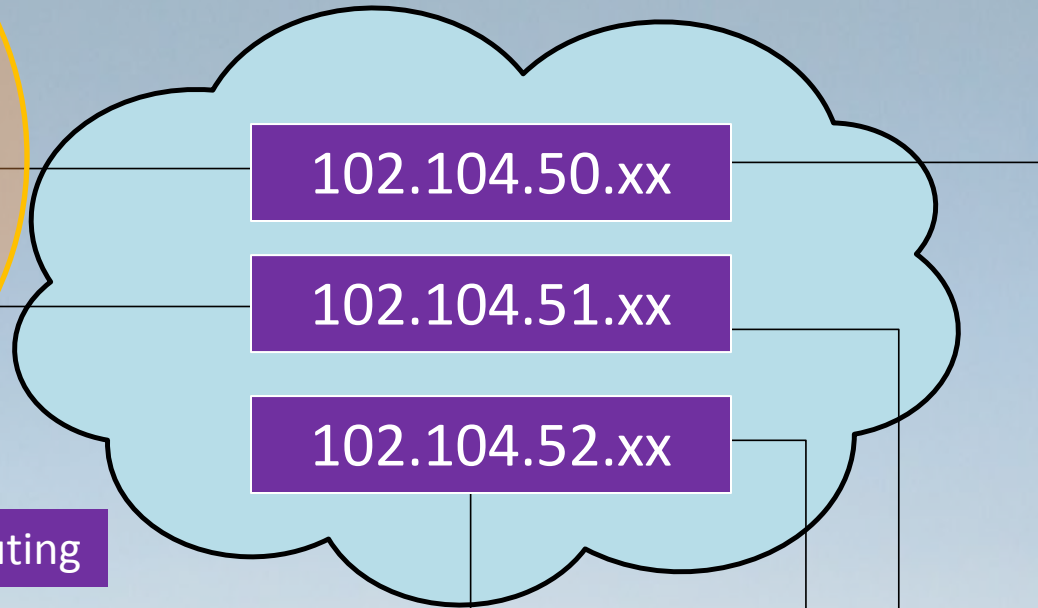
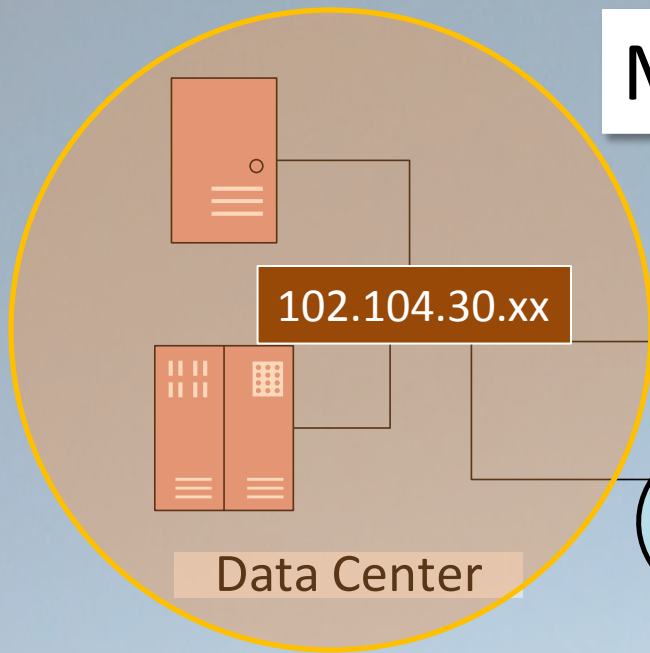
Managing TCP/IP Networking



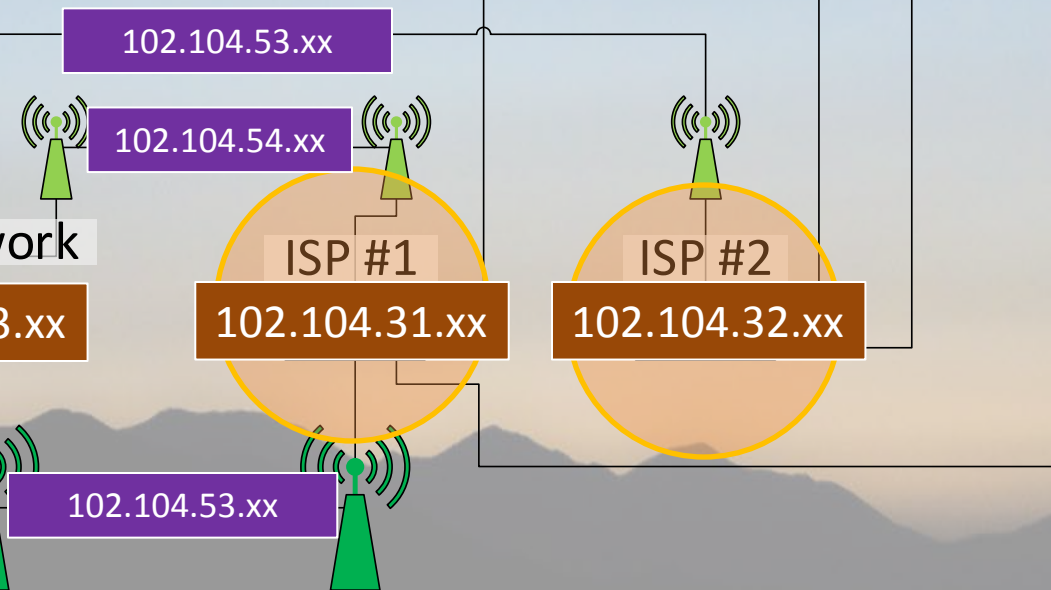
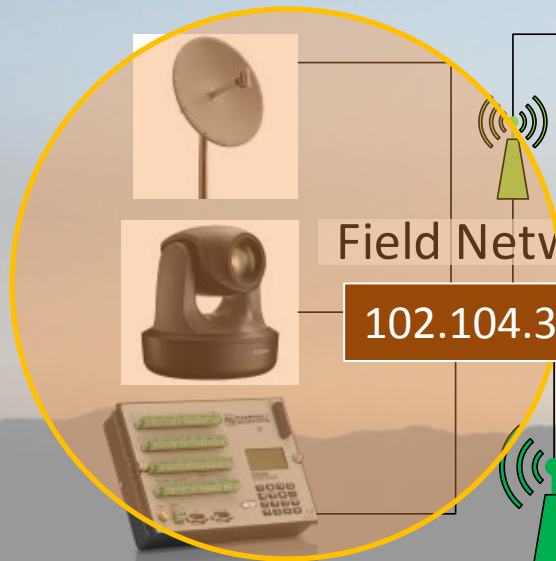
Private subnets: general routing across



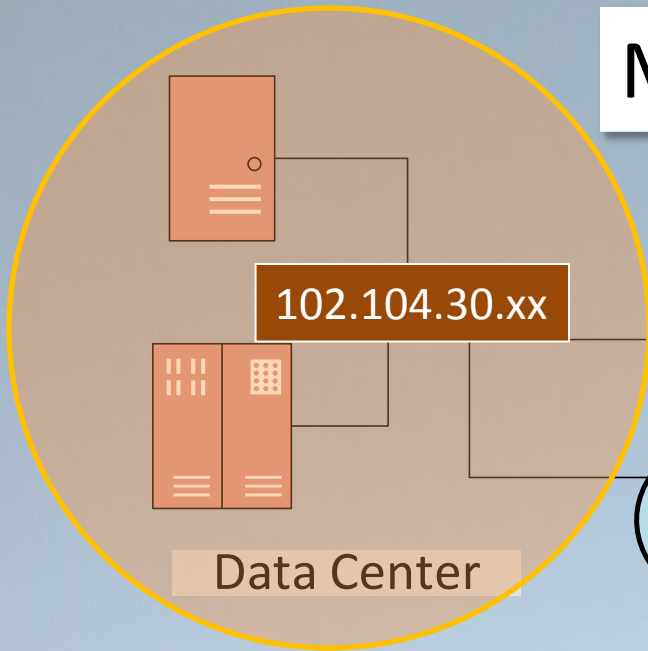
Managing TCP/IP Networking



Transport subnets: limited routing



Managing TCP/IP Networking



Tools:
Interior Routing Protocol OSPF
Monitoring via SNMP
Radio links via ISM bands

102.104.51.xx

102.104.52.xx

Transport subnets: limited routing



102.104.53.xx

102.104.54.xx

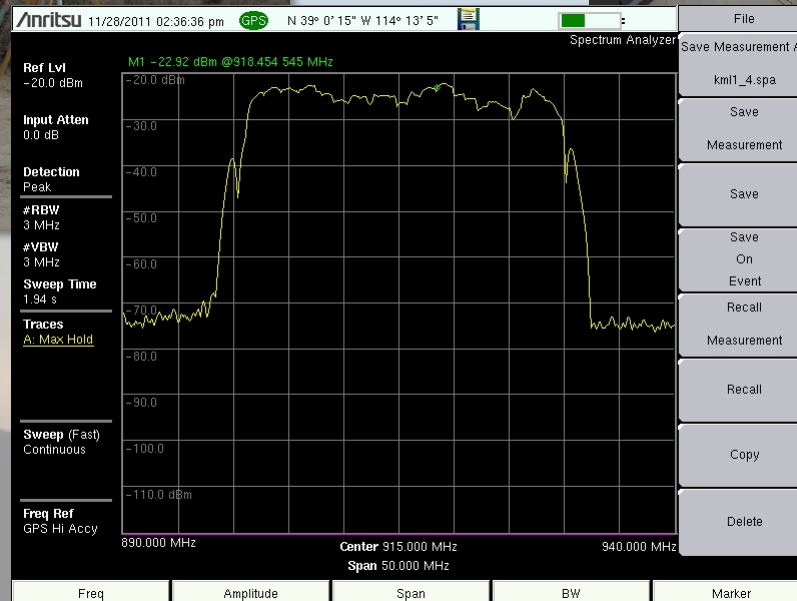
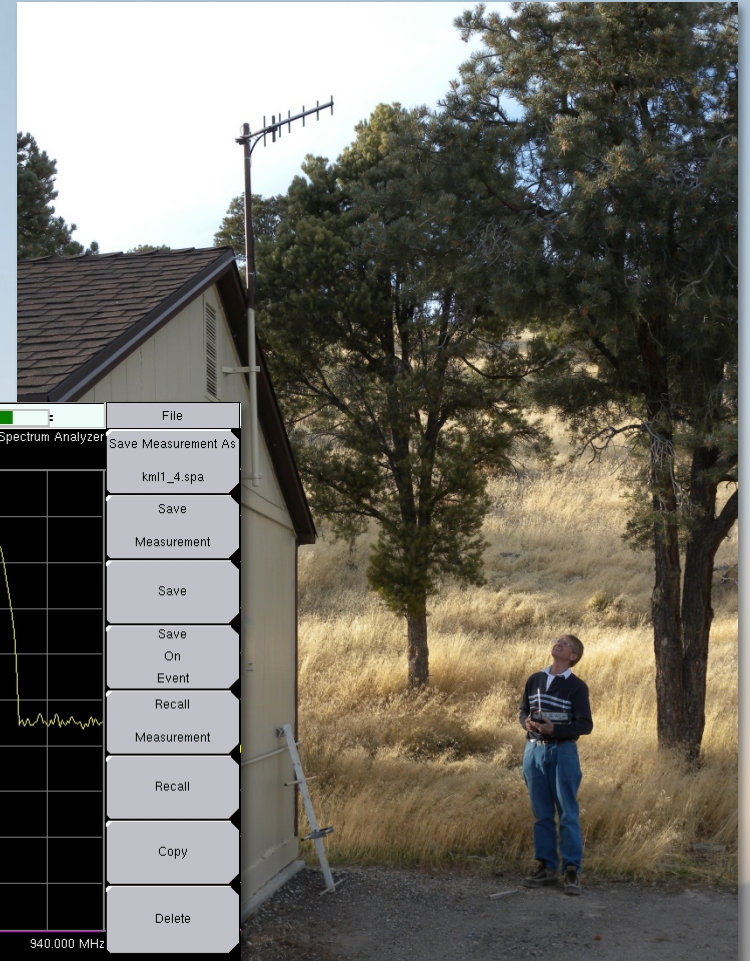
ISP #1
102.104.31.xx

ISP #2
102.104.32.xx

102.104.53.xx

Potential Problems

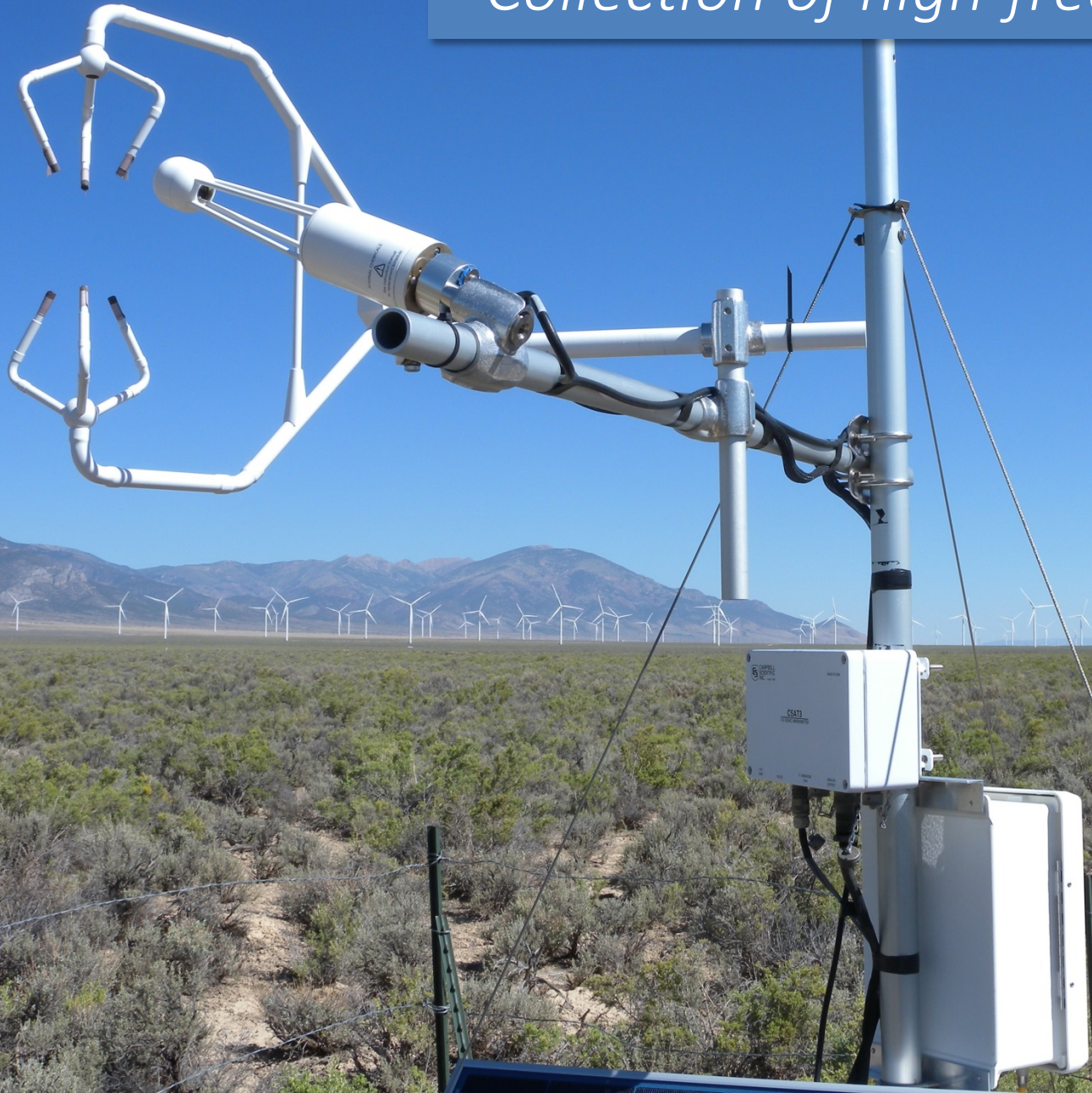
- *Radio interference*
- *Routing conflicts*



3. How does this advance science?



Collection of high-frequency data



Evaluation of ongoing experiments

12/04/2014 13:03:04 PST



Visualizing environmental processes



Real-time information



Latest Webcam Image: South Spring Valley

4/6/2015, 5:04:10 PM

SNAKE RANGE SUBALPINE: WEST

Last recorded: 4/6/2015, 7:45:00 PM

Last Recorded

Temperature	22.9 °F -5.1 °C
Wind Speed	6.9 mph 3.1 m/s
Wind Direction	240.3 °North
Relative Humidity	49.8 %

Last 6 Hours

Barometric Pressure Change	+0.01 in Hg +0.31 mbar
Average Wind Direction	223.7 °North

Last 24 Hours

High Temperature	29.6 °F -1.4 °C
Low Temperature	17.4 °F -8.1 °C
Maximum Wind Gust	34.9 mph 15.6 m/s
Accumulated Precipitation	0.0 inch 0.0 mm



Real-time information



NWS Salt Lake City @NWSSaltLakeCity · Apr 5

Wind gusts reported across the state as of 4 PM. Gusting up to 44 mph SW Utah. #utwx pic.twitter.com/GGA712im9U

↩️ ↻️ 3 ★ 1 ⋮



Scotty Strachan

@scottysci

[@NWSSaltLakeCity](#) last hour Max wind gusts in Snake Valley near Baker, [@GreatBasinNPS](#) at 44 & 45 MPH from two separate research stations

↩️ ↻️ ★ ⋮

RETWEETS

2



3:49 PM - 5 Apr 2015



Reply to [@NWSSaltLakeCity](#) [@GreatBasinNPS](#)



NWS Salt Lake City @NWSSaltLakeCity · Apr 5

[@scottysci](#) [@GreatBasinNPS](#) Thanks for the info! [@NWSEiko](#)

↩️ ↻️ ★ 1 ⋮

Internets in the middle of nowhere!



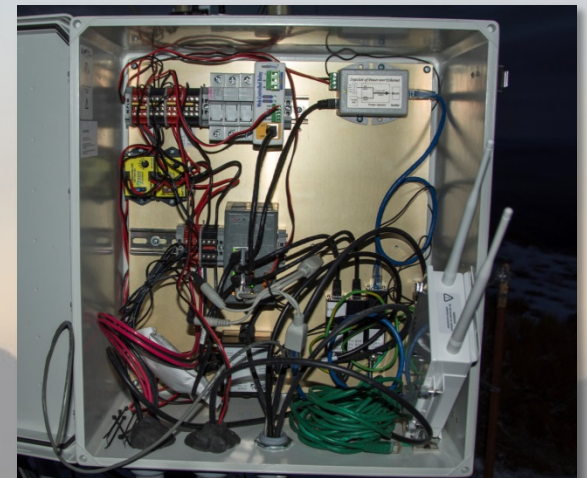


How can you enable connectivity?



Learn about:

- *radio/RF engineering*
- *packet-based networks*
- *enterprise routing*
- *electrical power systems*
- *outdoors installation (!)*
- *staying flexible ...*



Acknowledgements

The authors would like to thank the following for their contributions and support

*National Science Foundation grants BCS-1230329,
EPS-0814372, IIA-1301726
University of Nevada, Reno College of Science Dean's Office*



http://wiki.esipfed.org/index.php/EnviroSensing_Cluster

