Telemetry Redundancy

NetOps XIII

Session Leads
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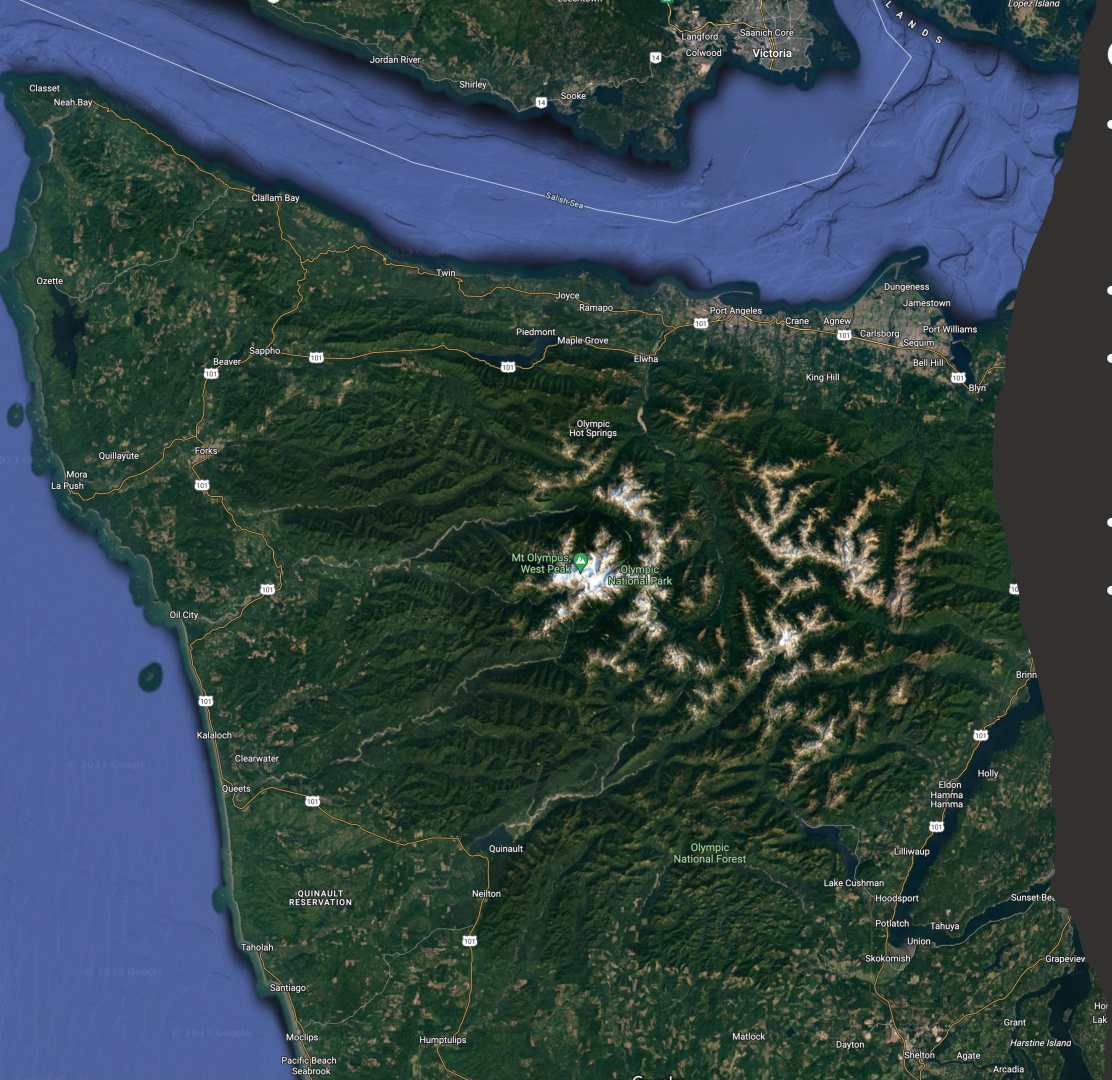
PNSN
Pacific Northwest Seismic Network

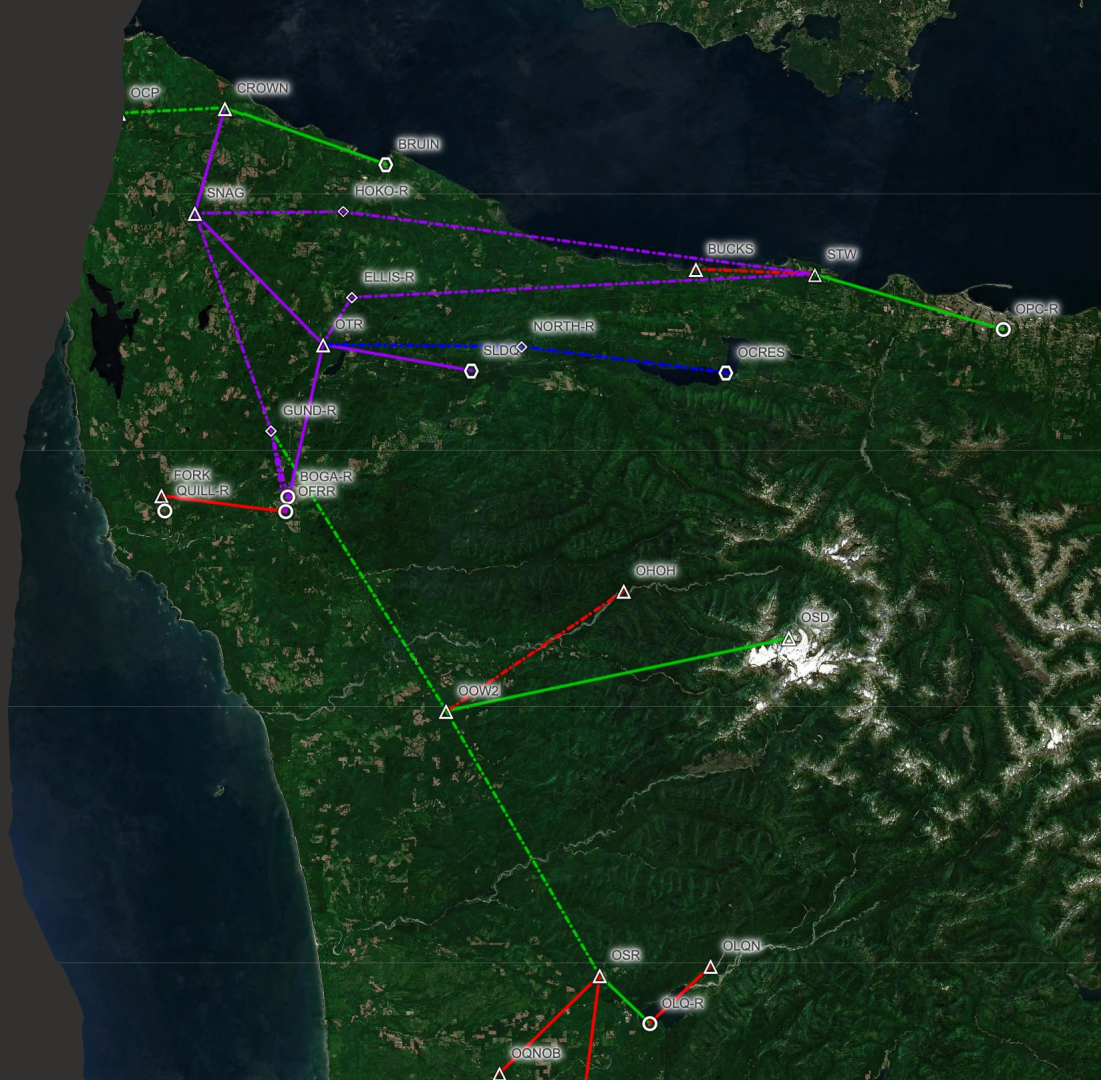


OlympicNet | Regional Challenges

- Limited population and infrastructure
  - 1 city with pop. > 1,000
  - 3 highways with high risk
- Frequent power & network outages
- Nearly uniform land management
  - Large swaths of USFS & NPS
  - Few logging companies own large sq. mileage
- Dense forestation
- Variable topography

OlympicNet | Design

- Radio network with multiple gateways to the internet
- Gateway diversity
  - Carrier type (hard-wire, cell, satellite)
  - Location/infrastructure
- Automatic failover
  - OSPF routing protocol
- Networking autonomy
  - PNSN administered VPN
- Scalability
  - High bandwidth radio links
  - High topographic relief site locations
  - Tower installations



Legend: solid = installed, dashed = planned; color corresponds to radio frequency

OlympicNet | Development Challenges

- Retirement
- Learning curves
- Equipment quirks
  - Radios, networking devices, OS changes
- Firewall intricacies
- Contractors
- Permitting

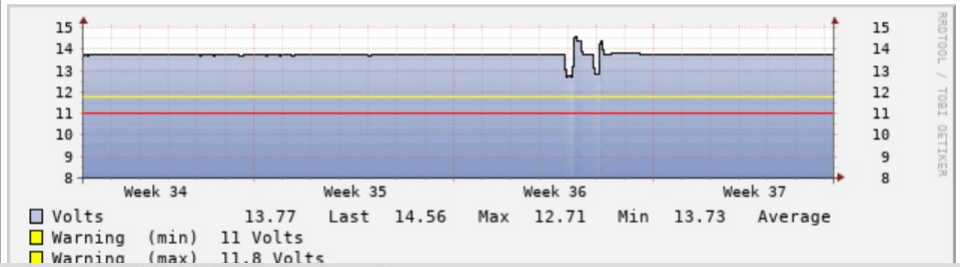
Successes | September 6, 7, 8 2023

Scheduled power outages: Weds, Sept 6th 10pm to Thur Sept 7th 6am, and Thurs, Sept 7th 10pm to Fri. Sept 8th 6am.

Host: BRUIN_ACCESS_XETA9 **Service:** volts

Custom time range 2023-08-20 23:12 - 2023-09-16 06:52

Datasource: Volts

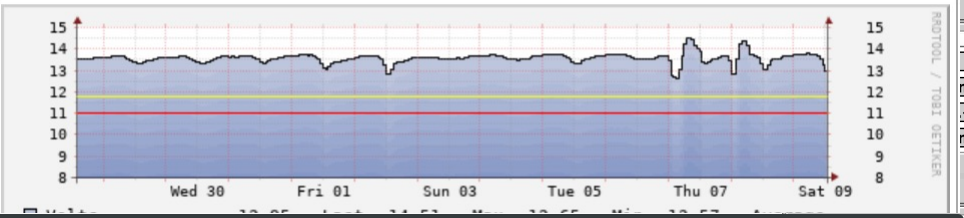


Service details OFR-R_ACCESS_XETA1 -> volts

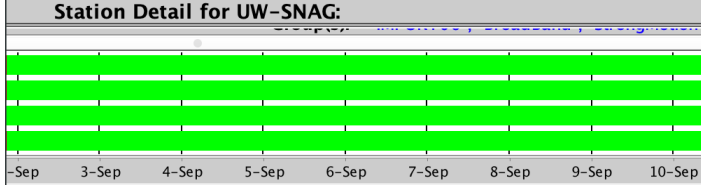
Host: OFR-R_ACCESS_XETA1 **Service:** volts

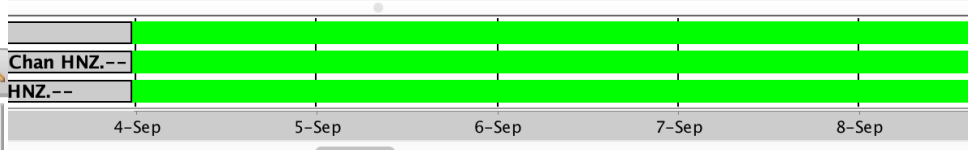
Custom time range 2023-08-28 13:34 - 2023-09-09 12:40

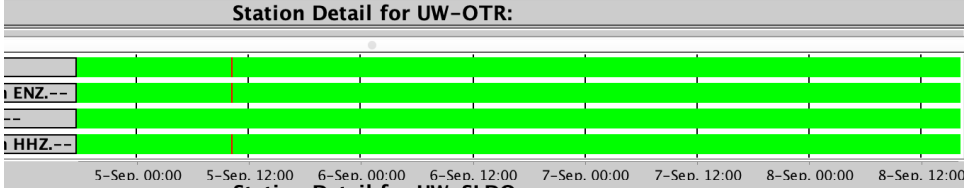
Datasource: Volts

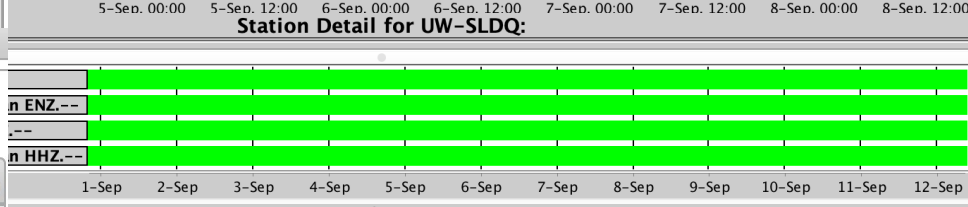


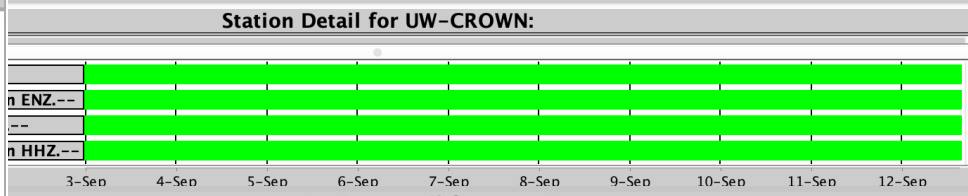
And again on November 30th

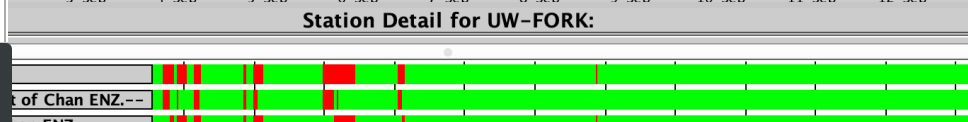












Successes | November 30th 2023

Forks Planned Outage November 30, 2023

November 23, 2023

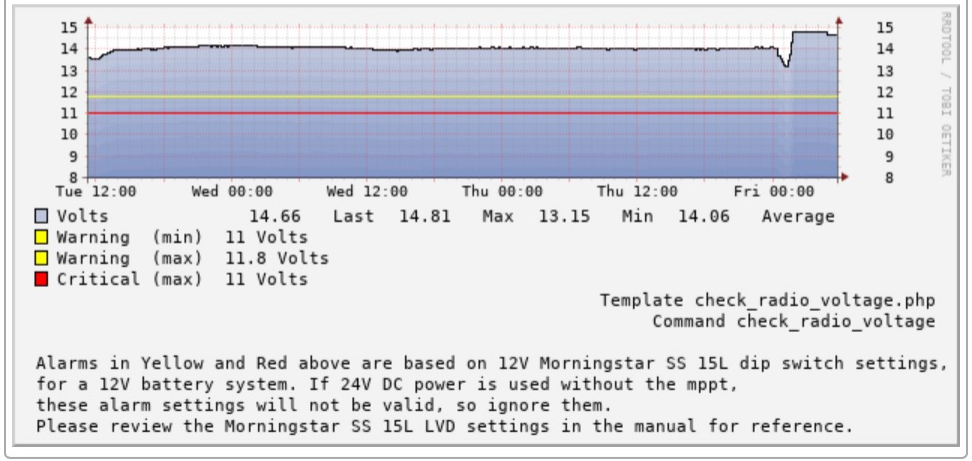
A planned power outage will affect electric service on
Thursday, November 30, 2023beginning at 11:00 pm Thursday evening and lasting until approximately 2:00 am on the morning of Friday, December 1, 2023. The work is required to safely perform substation maintenance.

Service details OFR-R_ACCESS_XETA1 -> volts

Host: OFR-R_ACCESS_XETA1 **Service:** volts

Custom time range 2023-11-28 11:12 - 2023-12-01 05:42

Datasource: Volts



Map Subset UW-FORK UW-SNAG UW-OTR UW-CROWN

Station Detail for UW-FORK:

29-Nov, 12:00 30-Nov, 00:00 30-Nov, 12:00 1-Dec, 00:00 1-Dec, 12:00

ration: 3 days 7:58:11 Out Reset End: Dec 01 2023 23:15:57 GMT

= Fair, Performance Reset Help Close

Station Detail for UW-CROWN:

27-Nov 28-Nov 29-Nov 30-Nov 1-Dec 2-Dec 3-Dec 4-Dec 5-Dec

GMT-7 Z=14.2%] Duration: 9 days 15:45:57 Out Reset End: Dec 05 2023 16:27:31 GMT

ance Map Subset UW-FORK UW-SNAG UW-OTR UW-CROWN

Station Detail for UW-SNAG:

29-Nov 30-Nov 1-Dec 2-Dec 3-Dec 4-Dec

ance Map Subset UW-FORK UW-SNAG UW-OTR UW-CROWN

Station Detail for UW-OTR:

30-Nov, 00:00 30-Nov, 12:00 1-Dec, 00:00 1-Dec, 12:00

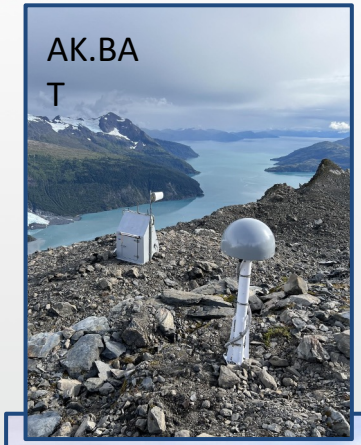
GMT-7 Z=2.8%] Duration: 1 day 22:14:50 Out Reset End: Dec 01 2023 15:53:30 GMT

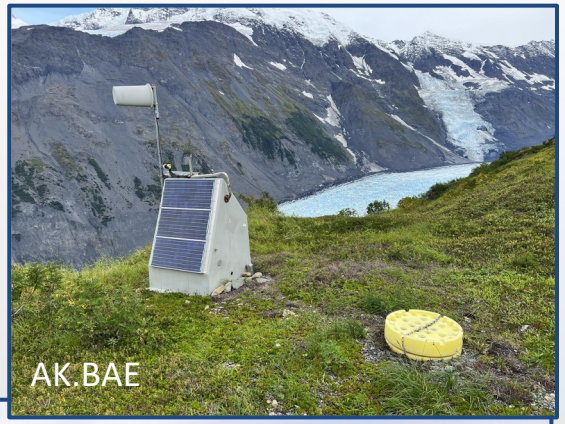
Alaska Earthquake Center

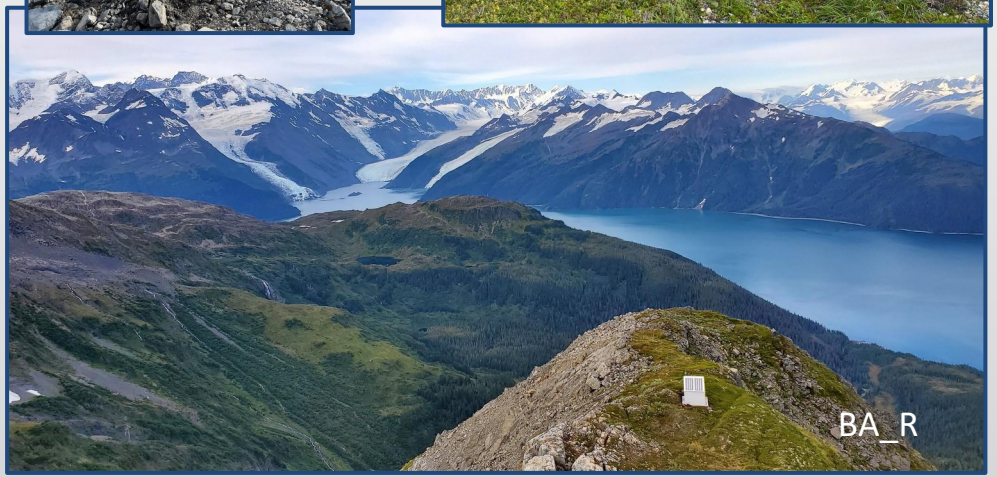
AEC Telemetry Redundancy

- Options limited
  - Multiple internet gateways for a single field subnetwork are rare
  - Locations with multiple internet access options are rare
  - Remote power budges limited for multiple devices

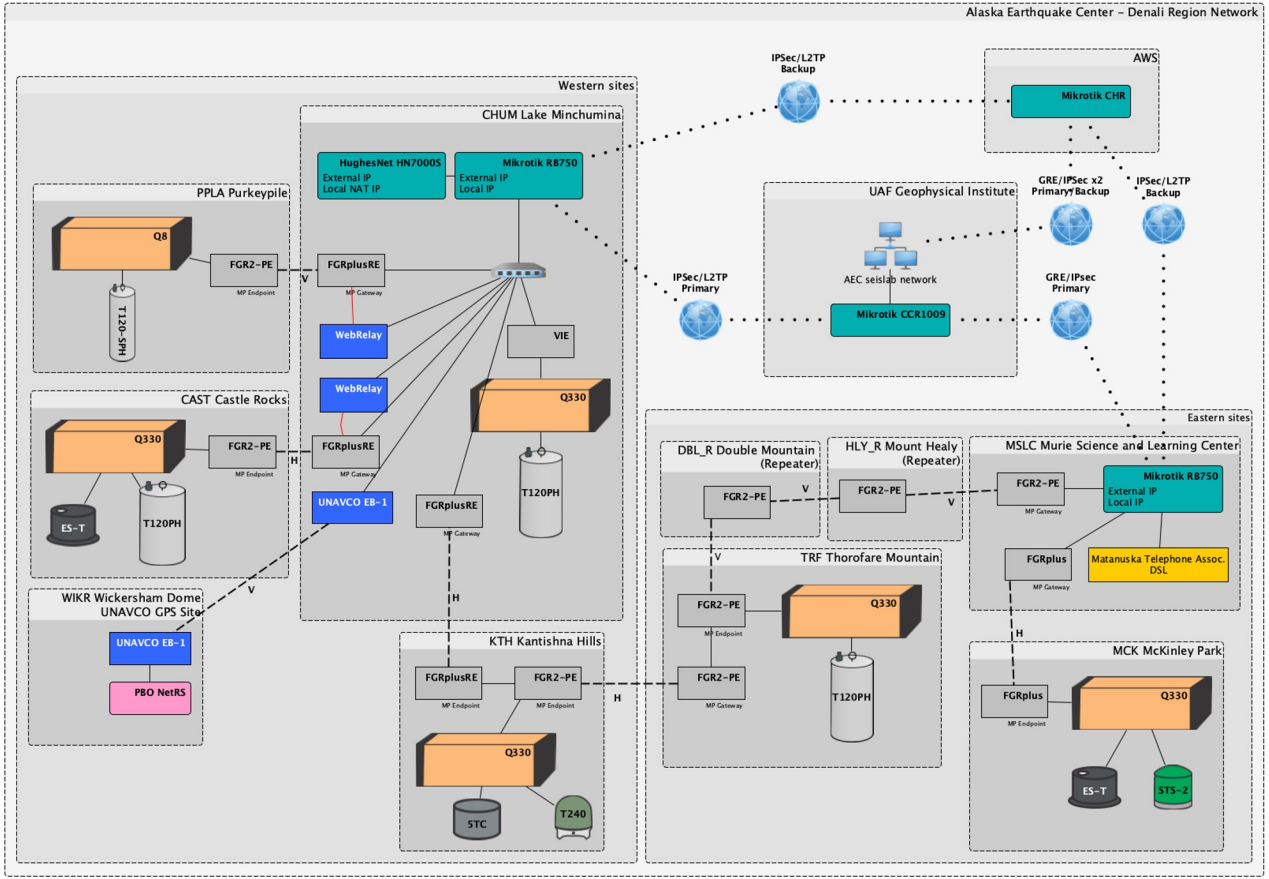
- We do what we can
  - Use multiple internet gateways where possible
    - currently Denali radio network
    - 2024 plans for Bering and Cordova radio networks)
  - WebRelay devices to reboot or turn on/off devices for failovers (still testing)
  - Multiple network paths from the same device
  - Dual cell carriers for critical networks (e.g., Barry Arm)





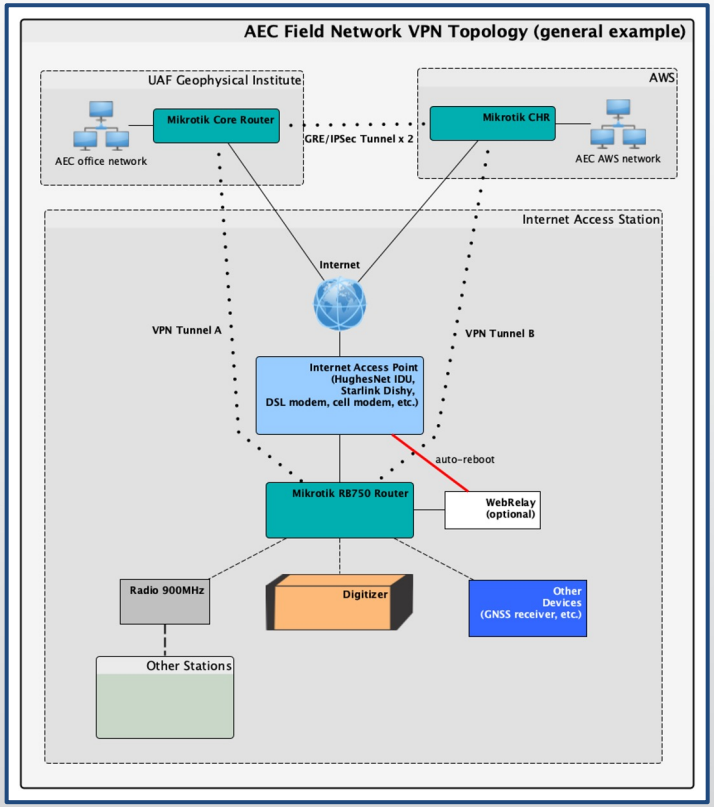


Multiple Gateway Example: Denali Region Network



VPNs and failover telemetry with AWS

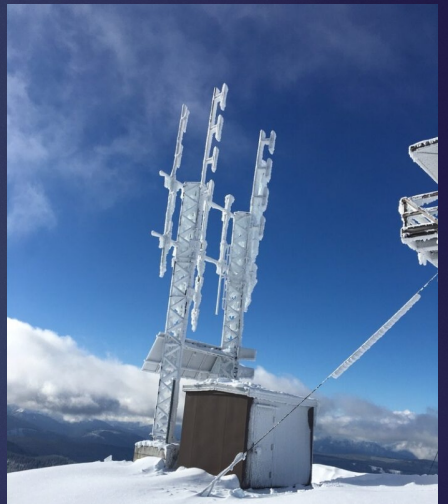
- AEC's primary VPN-based path from field networks is to the AEC VPN concentrator located in the UAF IT center.
- AEC has a limited scope (proof of concept level) backup VPN concentrator on AWS.
  - While limited, it is used for a handful of sites where the primary path to UAF is unreliable.
  - Mikrotik Cloud Hosted Router (CHR) hosted on a t2.micro (free) instance with an Elastic IP.



Cascades Volcano Observatory

Field Telemetry Redundancy

- Challenges - Stations are remote, only single path out, limited infrastructure and power
- As a result, not much field-based telemetry redundancy has been established
- Solutions
  - Backup Telemetry - Same Path
    - Mt. Rainier: Puyallup Lookout to Eatonville
      - Major Repeater; Brings in 8 critical lahar network stations
      - 5.8GHz Primary Link, 900MHz Backup Link; Remote manual switchover
  - Diversification
    - Since field-based redundancy is difficult to establish, focus on network diversification
    - Eliminate single points of failure in the field that can bring down entire network
      - Introduction of cell and Starlink in our networks is making this easier to achieve
    - 900MHz radio, 2.4GHz radio, 5.8GHz radio, cellular, Starlink, internet; different paths out when possible



CVO PLOT Repeater Hosted at WA DNR Puyallup Lookout Tower

Server Redundancy

- Backup Servers
  - Primary seismic import/export server with backup server on hot standby
  - Manual switchover to backup server in case of primary failure
- Multi-Server Virtual Machine Cluster
  - Hosts GNSS, Gas, and Backup Seismic
  - 4 Server Cluster with Virtual Machines
  - If 1 server (node) fails, VM's self-migrate to another node in the cluster
- Future Directions
  - Eventual implementation of AWS cloud hosting services with the establishment of NVEWS and National Volcano Information Service (NVIS)

Nevada Seismological Laboratory

Migration to 11GHz point-to-point radio in Henderson NV

Improving Network Comms

Improved point-to-point radio antennas to upgrade the backbone from Reno to Henderson NV

Starlink

Test on 2 previously untelemetered stations, awaiting to see how power survives winter

Redundancy

Microwave (primary), fiber, cell. Try to have 2-3 paths for data

Advancements

Implemented BFD to provide instant failover for OSPF routing
Wireguard VPN allows OSPF costing of dynamic WAN IP

NEVADA SEISMOLOGICAL LABORATORY