Designing A Radio-Based Data Network

presented by

Steve Aberle – WA7PTM

CN85rq12

December Membership (Virtual) Meeting

Oro Valley Amateur Radio Club

Outline

- Disaster Communications
- National Level Exercises
- Amateur Radio Speeds
- A Radio-Based Data Network
- Where is HamWAN?
- What can a Radio-Based Data Network do for ESF #2?
- Network Design Elements
- Equipment Costs

Disaster Communications

- People talking to each other on the radio
  - Analog Voice (FM, SSB)
  - Digital Voice (DMR, D-Star, C4FM)
    - several competing digital formats
- Computers exchanging data via radio
  - Digital Data
    - over 100 formats

Disaster Communications

- Use of Digital Data Modes:
  - Compliments voice communications
  - Capable of transmitting images
  - More accurate, especially for lengthy messages
  - Typically faster *(given proficient operators)*
  - Provides an automatic record of the information exchanged
  - Less prone to eavesdropping by news media and the general public during operations

Disaster Communications

- Where Do Local Jurisdictions Need to Communicate?
  - Internally {*Intra-jurisdiction*}
    - Within the community, county, tribe, state
  - With their neighbors {*Inter-jurisdiction*}
    - Community to community, county to county, tribe to tribe, state to state
  - With the next larger jurisdiction
    - Community to county, county to state, tribe/state to FEMA/DHS

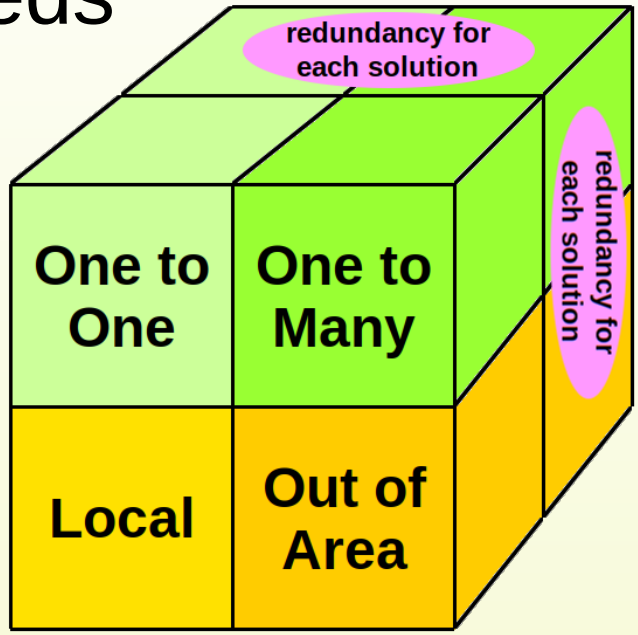
Disaster Communications

- Which Digital Mode(s) Should I Use?
  - Whichever ones are required to fulfill the "*intra-jurisdiction*," "*inter-jurisdiction*," and "*next larger jurisdiction*" communications needs of the served agency
  - No, there is not a single "best" mode to use
    - You should always have a redundant solution
    - The most important part is to be compatible with the digital station at the other end

Disaster Communications

- Plan Your Communications Needs
  - *For <u>both</u> voice and data*

		Primary		Backup	
		One to One	One to Many	One to One	One to Many
Local	Voice	√	√	√	√
	Digital Data	√	√	√	√
Regional / National	Voice	√	√	√	√
	Digital Data	√	√	√	√



FEMA

Search

Prepare for Disasters | Apply for Assistance | Get Flood Insurance

Disasters & Assistance | Grants | Floods & Maps | **Emergency Management** | About | Work With Us

National Level Exercise

The National Level Exercise (NLE) is the nation's cornerstone exercise for validating progress toward achieving the national culture of preparedness required to prepare for and respond to catastrophic events. NLEs are a progressive build of preparedness activities over the two-year cycle of the National Exercise Program, which culminate in a full-scale exercise.

The NLE is an opportunity for all levels of government, the private sector, nongovernmental organizations, and community groups to test operational capabilities, evaluate policies and plans, familiarize personnel with roles and responsibilities, and foster meaningful interaction and communication across the nation. Scenarios for the NLE range from natural disasters to man-made attacks and address the specific types of threats and hazards that pose the greatest risk to the nation.

https://www.youtube.com/watch?v=zTBNu0hdcsA&feature=youtu.be

ASL Video **Audio Description Video**

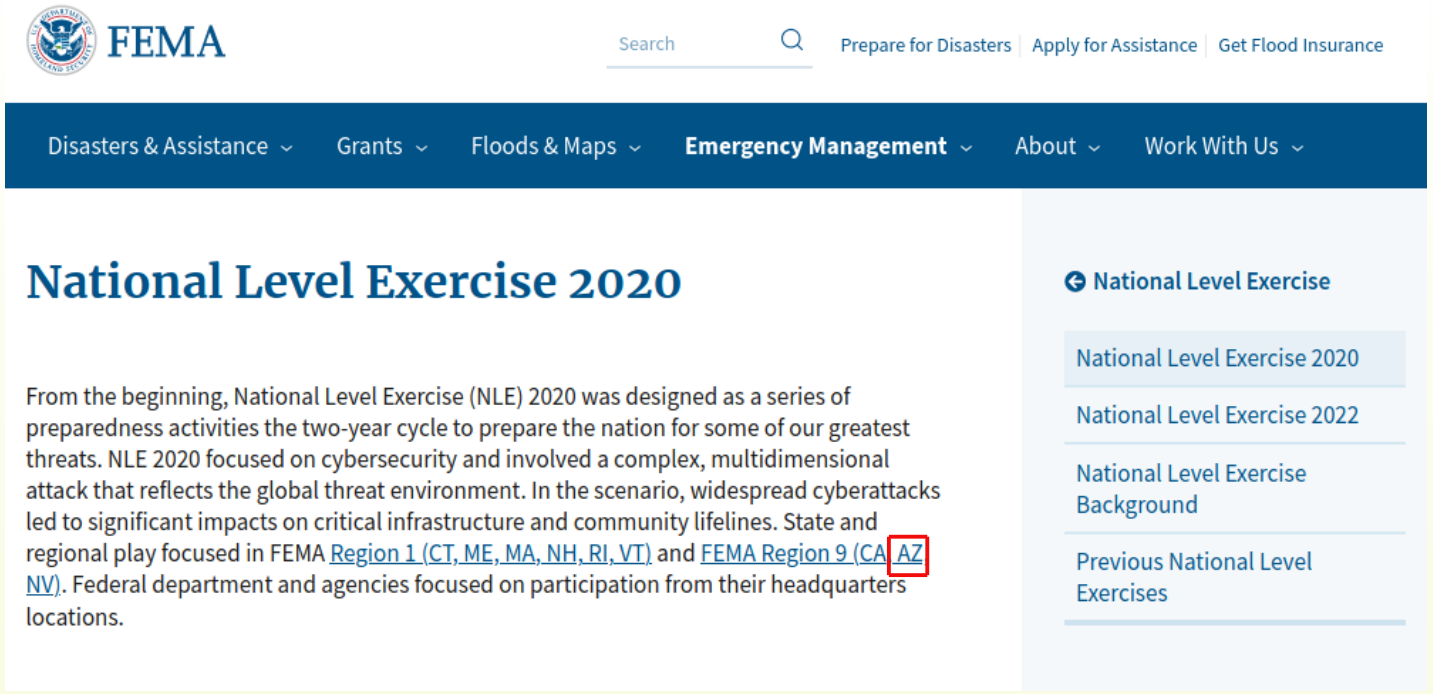
Exercises

- National Level Exercise
  - National Level Exercise 2020
  - National Level Exercise 2022
  - National Level Exercise Background
  - Previous National Level Exercises
- Exercise and Preparedness Tools
- National Exercise Program
- Homeland Security Exercise and Evaluation Program

https://www.fema.gov/emergency-managers/national-preparedness/exercises/national-level-exercise

18 December 2020

WA7PTM



https://www.fema.gov/emergency-managers/planning-exercises/nle/2020

National Level Exercises

Looking Back …

- “Cascadia Rising” June 7-10, 2016
- Cascadia Subduction Zone (CSZ) Catastrophic Earthquake and Tsunami
- FEMA Region X: Oregon, Washington, Idaho
  - Parallel exercise in British Columbia (Pacific Quake '16)

What did the After Action Reports say?

National Level Exercises

Cascadia Rising 2016 Exercise

Cascadia Subduction Zone (CSZ) Catastrophic Earthquake and Tsunami

Functional Exercise: June 7-10, 2016

Joint Multi-State After-Action Report

September 6, 2016

Observation 1.3: Area for Improvement: Many jurisdictions were unable to overcome the challenges posed by a degraded communications environment.

Analysis: Several jurisdictions instituted communications outages throughout the exercise to simulate the degraded communications environment that will result from a Cascadia Subduction Zone (CSZ) rupture. Most EOCs relied solely on internet and telephones as their means of communication; when those services were interrupted by communications outages, there was limited capacity to communicate with outside partners. For example, there was a widespread lack of satellite phone communications inside the EOCs, as staff members had to physically exit the building in order to obtain a satellite connection. In many cases, staff members realized that they did not have basic contact information for their partner agencies' backup or alternate communications equipment, such as satellite phone numbers and radio frequencies. Other key partners, including hospitals, lacked amateur radio capacity entirely. Further, Wireless Priority Service (WPS) access and Government Emergency Telecommunications Service (GETS) cards were not made available to several EOC staff members. Additionally, many EOCs lacked sufficient wireless network capacity to support the influx of personnel into their facilities. These deficiencies rendered many jurisdictions and agencies unable to send or receive information, resulting in a lack of regional situational awareness.

Within the public messaging function, EOCs were often reactive instead of proactive in seeking out alternate forms of communication to reach the public. Few alternate communication strategies were developed in anticipation of widespread

National Level Exercises

Many jurisdictions were unable to overcome the challenges posed by a degraded communications environment.

Observation 1.3: Area for Improvement: Many jurisdictions were unable to overcome the challenges posed by a degraded communications environment.

Analysis: Several jurisdictions instituted communications outages throughout the exercise to simulate the degraded communications environment that will result from a Cascadia Subduction Zone (CSZ) rupture. Most EOCs relied solely on internet and telephones as their means of communication; when those services were interrupted by communications outages, there was limited capacity to communicate with outside partners. For example, there was a widespread lack of satellite phone communications inside the EOCs, as staff members had to physically exit the building in order to obtain a satellite connection. In many cases, staff members realized that they did not have basic contact information for their partner agencies' backup or alternate communications equipment, such as satellite phone numbers and radio frequencies. Other key partners, including hospitals, lacked amateur radio capacity entirely. Further, Wireless Priority Service (WPS) access and Government Emergency Telecommunications Service (GETS) cards were not made available to several EOC staff members. Additionally, many EOCs lacked sufficient wireless network capacity to support the influx of personnel into their facilities. These deficiencies rendered many jurisdictions and agencies unable to send or receive information, resulting in a lack of regional situational awareness.

Within the public messaging function, EOCs were often reactive instead of proactive in seeking out alternate forms of communication to reach the public. Few alternate communication strategies were developed in anticipation of widespread

National Level Exercises

Most EOCs relied solely on internet and telephones as their means of communication; when those services were interrupted by communications outages, there was limited capacity to communicate with outside partners.

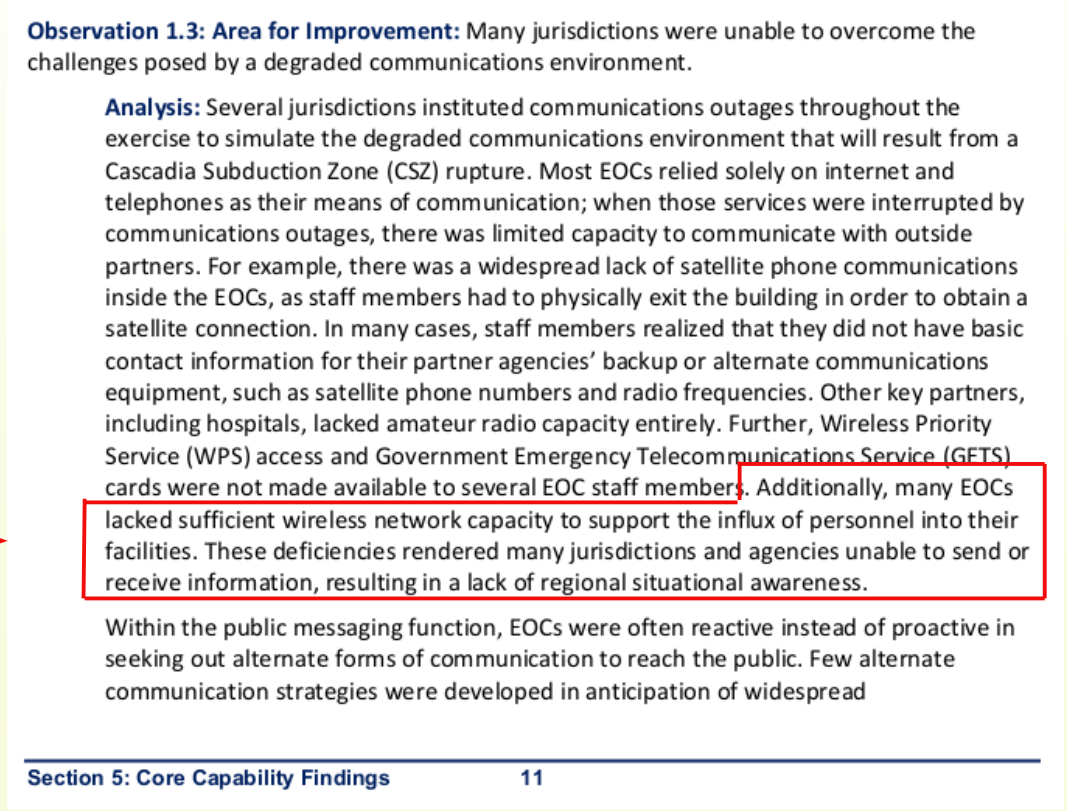
Observation 1.3: Area for Improvement: Many jurisdictions were unable to overcome the challenges posed by a degraded communications environment.

Analysis: Several jurisdictions instituted communications outages throughout the exercise to simulate the degraded communications environment that will result from a Cascadia Subduction Zone (CSZ) rupture. Most EOCs relied solely on internet and telephones as their means of communication; when those services were interrupted by communications outages, there was limited capacity to communicate with outside partners. For example, there was a widespread lack of satellite phone communications inside the EOCs, as staff members had to physically exit the building in order to obtain a satellite connection. In many cases, staff members realized that they did not have basic contact information for their partner agencies' backup or alternate communications equipment, such as satellite phone numbers and radio frequencies. Other key partners, including hospitals, lacked amateur radio capacity entirely. Further, Wireless Priority Service (WPS) access and Government Emergency Telecommunications Service (GETS) cards were not made available to several EOC staff members. Additionally, many EOCs lacked sufficient wireless network capacity to support the influx of personnel into their facilities. These deficiencies rendered many jurisdictions and agencies unable to send or receive information, resulting in a lack of regional situational awareness.

Within the public messaging function, EOCs were often reactive instead of proactive in seeking out alternate forms of communication to reach the public. Few alternate communication strategies were developed in anticipation of widespread

National Level Exercises

Additionally, many EOCs lacked sufficient wireless network capacity to support the influx of personnel into their facilities. These deficiencies rendered many jurisdictions and agencies unable to send or receive information, resulting in a lack of regional situational awareness.



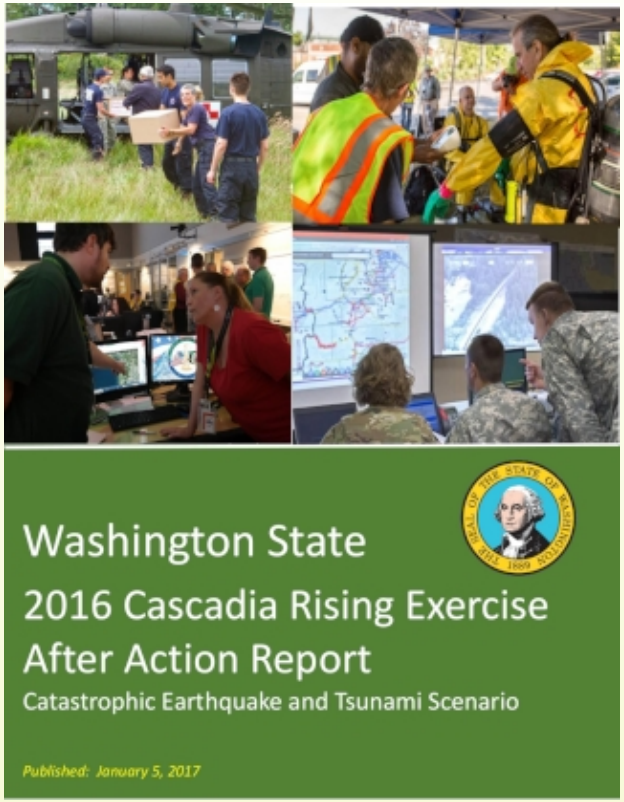
Observation 1.3: Area for Improvement: Many jurisdictions were unable to overcome the challenges posed by a degraded communications environment.

Analysis: Several jurisdictions instituted communications outages throughout the exercise to simulate the degraded communications environment that will result from a Cascadia Subduction Zone (CSZ) rupture. Most EOCs relied solely on internet and telephones as their means of communication; when those services were interrupted by communications outages, there was limited capacity to communicate with outside partners. For example, there was a widespread lack of satellite phone communications inside the EOCs, as staff members had to physically exit the building in order to obtain a satellite connection. In many cases, staff members realized that they did not have basic contact information for their partner agencies' backup or alternate communications equipment, such as satellite phone numbers and radio frequencies. Other key partners, including hospitals, lacked amateur radio capacity entirely. Further, Wireless Priority Service (WPS) access and Government Emergency Telecommunications Service (GETS) cards were not made available to several EOC staff members. Additionally, many EOCs lacked sufficient wireless network capacity to support the influx of personnel into their facilities. These deficiencies rendered many jurisdictions and agencies unable to send or receive information, resulting in a lack of regional situational awareness.

Within the public messaging function, EOCs were often reactive instead of proactive in seeking out alternate forms of communication to reach the public. Few alternate communication strategies were developed in anticipation of widespread

Section 5: Core Capability Findings 11

National Level Exercises



Recommendations:

a) Continue training and exercising the professional and volunteer community on alternate communication systems, forms and procedures.

b) Amateur Radio: Emergency management agencies and their amateur radio support teams need to establish a habitual relationship and engage with each other on how amateur radio networks can support in both activations and drills. For a few jurisdictions, this engagement merely needs to be sustained. For most jurisdictions, this is an area of improvement. This engagement can be improved through several initiatives: communications training and drills should integrate EOC operational managers with technical performance by the ARES/RACES teams. Emergency managers should provide appropriate data, requests, spot reports and direction of response activities as material to be used for radio messages.

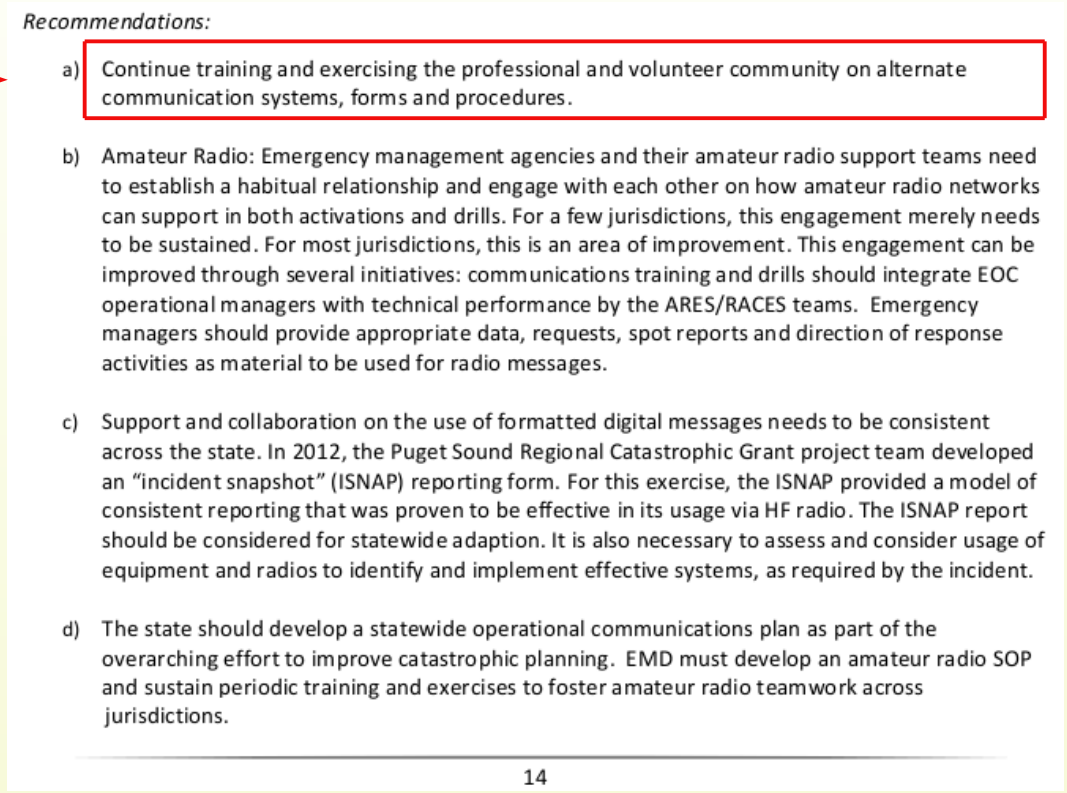
c) Support and collaboration on the use of formatted digital messages needs to be consistent across the state. In 2012, the Puget Sound Regional Catastrophic Grant project team developed an "incident snapshot" (ISNAP) reporting form. For this exercise, the ISNAP provided a model of consistent reporting that was proven to be effective in its usage via HF radio. The ISNAP report should be considered for statewide adaption. It is also necessary to assess and consider usage of equipment and radios to identify and implement effective systems, as required by the incident.

d) The state should develop a statewide operational communications plan as part of the overarching effort to improve catastrophic planning. EMD must develop an amateur radio SOP and sustain periodic training and exercises to foster amateur radio teamwork across jurisdictions.

14

National Level Exercises

Continue training and exercising the professional and volunteer community on alternate communication systems, forms and procedures.



Recommendations:

a) Continue training and exercising the professional and volunteer community on alternate communication systems, forms and procedures.

b) Amateur Radio: Emergency management agencies and their amateur radio support teams need to establish a habitual relationship and engage with each other on how amateur radio networks can support in both activations and drills. For a few jurisdictions, this engagement merely needs to be sustained. For most jurisdictions, this is an area of improvement. This engagement can be improved through several initiatives: communications training and drills should integrate EOC operational managers with technical performance by the ARES/RACES teams. Emergency managers should provide appropriate data, requests, spot reports and direction of response activities as material to be used for radio messages.

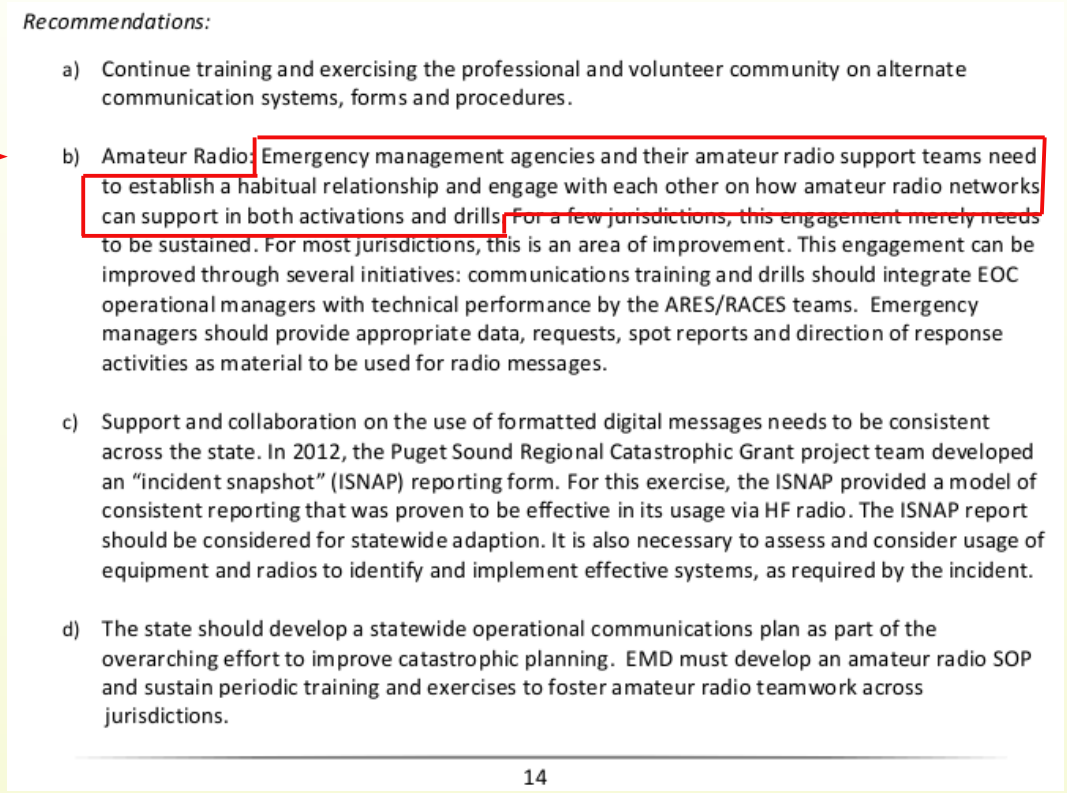
c) Support and collaboration on the use of formatted digital messages needs to be consistent across the state. In 2012, the Puget Sound Regional Catastrophic Grant project team developed an "incident snapshot" (ISNAP) reporting form. For this exercise, the ISNAP provided a model of consistent reporting that was proven to be effective in its usage via HF radio. The ISNAP report should be considered for statewide adaption. It is also necessary to assess and consider usage of equipment and radios to identify and implement effective systems, as required by the incident.

d) The state should develop a statewide operational communications plan as part of the overarching effort to improve catastrophic planning. EMD must develop an amateur radio SOP and sustain periodic training and exercises to foster amateur radio teamwork across jurisdictions.

14

National Level Exercises

Emergency management agencies and their amateur radio support teams need to establish a habitual relationship and engage with each other on how amateur radio networks can support in both activations and drills.



Recommendations:

a) Continue training and exercising the professional and volunteer community on alternate communication systems, forms and procedures.

b) Amateur Radio: Emergency management agencies and their amateur radio support teams need to establish a habitual relationship and engage with each other on how amateur radio networks can support in both activations and drills. ~~For a few jurisdictions, this engagement merely needs~~ to be sustained. For most jurisdictions, this is an area of improvement. This engagement can be improved through several initiatives: communications training and drills should integrate EOC operational managers with technical performance by the ARES/RACES teams. Emergency managers should provide appropriate data, requests, spot reports and direction of response activities as material to be used for radio messages.

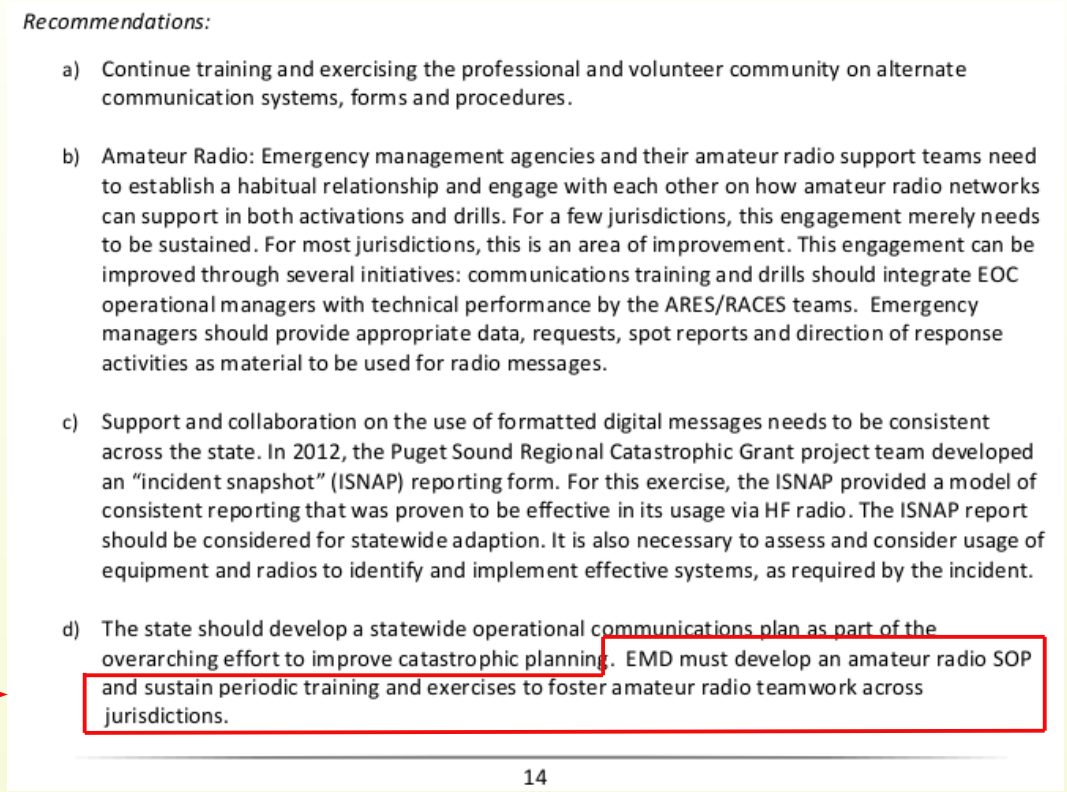
c) Support and collaboration on the use of formatted digital messages needs to be consistent across the state. In 2012, the Puget Sound Regional Catastrophic Grant project team developed an "incident snapshot" (ISNAP) reporting form. For this exercise, the ISNAP provided a model of consistent reporting that was proven to be effective in its usage via HF radio. The ISNAP report should be considered for statewide adaption. It is also necessary to assess and consider usage of equipment and radios to identify and implement effective systems, as required by the incident.

d) The state should develop a statewide operational communications plan as part of the overarching effort to improve catastrophic planning. EMD must develop an amateur radio SOP and sustain periodic training and exercises to foster amateur radio teamwork across jurisdictions.

14

National Level Exercises

EMD must develop an amateur radio SOP and sustain periodic training and exercises to foster amateur radio teamwork across jurisdictions.



Recommendations:

a) Continue training and exercising the professional and volunteer community on alternate communication systems, forms and procedures.

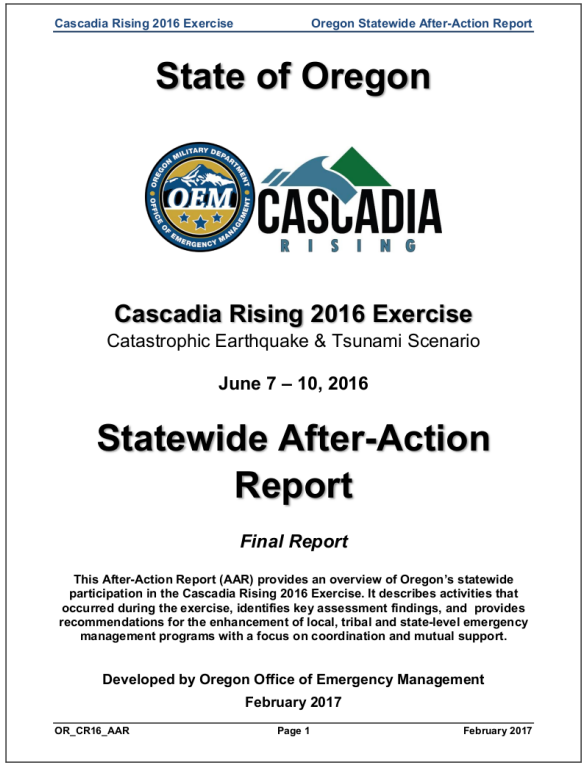
b) Amateur Radio: Emergency management agencies and their amateur radio support teams need to establish a habitual relationship and engage with each other on how amateur radio networks can support in both activations and drills. For a few jurisdictions, this engagement merely needs to be sustained. For most jurisdictions, this is an area of improvement. This engagement can be improved through several initiatives: communications training and drills should integrate EOC operational managers with technical performance by the ARES/RACES teams. Emergency managers should provide appropriate data, requests, spot reports and direction of response activities as material to be used for radio messages.

c) Support and collaboration on the use of formatted digital messages needs to be consistent across the state. In 2012, the Puget Sound Regional Catastrophic Grant project team developed an "incident snapshot" (ISNAP) reporting form. For this exercise, the ISNAP provided a model of consistent reporting that was proven to be effective in its usage via HF radio. The ISNAP report should be considered for statewide adaption. It is also necessary to assess and consider usage of equipment and radios to identify and implement effective systems, as required by the incident.

d) The state should develop a statewide operational communications plan as part of the overarching effort to improve catastrophic planning. EMD must develop an amateur radio SOP and sustain periodic training and exercises to foster amateur radio teamwork across jurisdictions.

14

National Level Exercises



Cascadia Rising 2016 Exercise — Oregon Statewide After-Action Report

State of Oregon

Cascadia Rising 2016 Exercise
Catastrophic Earthquake & Tsunami Scenario

June 7 – 10, 2016

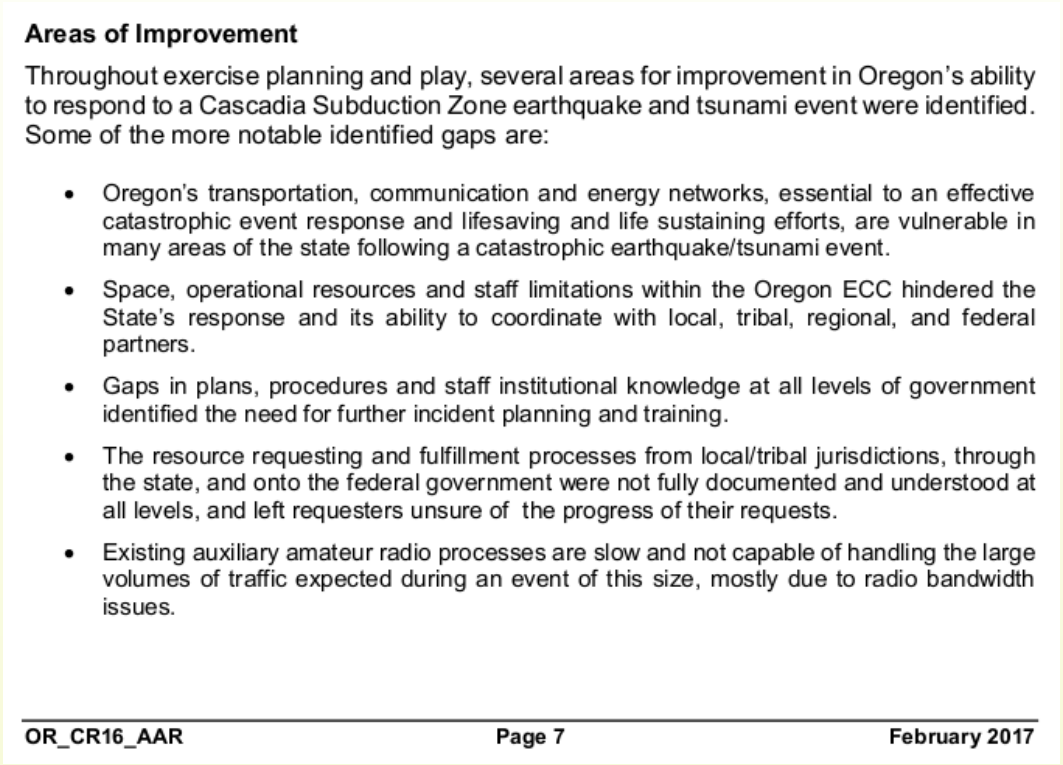
Statewide After-Action Report

Final Report

This After-Action Report (AAR) provides an overview of Oregon's statewide participation in the Cascadia Rising 2016 Exercise. It describes activities that occurred during the exercise, identifies key assessment findings, and provides recommendations for the enhancement of local, tribal and state-level emergency management programs with a focus on coordination and mutual support.

Developed by Oregon Office of Emergency Management
February 2017

OR_CR16_AAR Page 1 February 2017



Areas of Improvement

Throughout exercise planning and play, several areas for improvement in Oregon's ability to respond to a Cascadia Subduction Zone earthquake and tsunami event were identified. Some of the more notable identified gaps are:

- Oregon's transportation, communication and energy networks, essential to an effective catastrophic event response and lifesaving and life sustaining efforts, are vulnerable in many areas of the state following a catastrophic earthquake/tsunami event.
- Space, operational resources and staff limitations within the Oregon ECC hindered the State's response and its ability to coordinate with local, tribal, regional, and federal partners.
- Gaps in plans, procedures and staff institutional knowledge at all levels of government identified the need for further incident planning and training.
- The resource requesting and fulfillment processes from local/tribal jurisdictions, through the state, and onto the federal government were not fully documented and understood at all levels, and left requesters unsure of the progress of their requests.
- Existing auxiliary amateur radio processes are slow and not capable of handling the large volumes of traffic expected during an event of this size, mostly due to radio bandwidth issues.

OR_CR16_AAR Page 7 February 2017

National Level Exercises

Existing auxiliary amateur radio processes are slow and not capable of handling the large volumes of traffic expected during an event of this size, mostly due to radio bandwidth issues.

Areas of Improvement

Throughout exercise planning and play, several areas for improvement in Oregon's ability to respond to a Cascadia Subduction Zone earthquake and tsunami event were identified. Some of the more notable identified gaps are:

- Oregon's transportation, communication and energy networks, essential to an effective catastrophic event response and lifesaving and life sustaining efforts, are vulnerable in many areas of the state following a catastrophic earthquake/tsunami event.
- Space, operational resources and staff limitations within the Oregon ECC hindered the State's response and its ability to coordinate with local, tribal, regional, and federal partners.
- Gaps in plans, procedures and staff institutional knowledge at all levels of government identified the need for further incident planning and training.
- The resource requesting and fulfillment processes from local/tribal jurisdictions, through the state, and onto the federal government were not fully documented and understood at all levels, and left requesters unsure of the progress of their requests.
- Existing auxiliary amateur radio processes are slow and not capable of handling the large volumes of traffic expected during an event of this size, mostly due to radio bandwidth issues.

Amateur Radio Speeds

The Oregon report pointed out <u>what we all know</u>!

- We, as radio amateurs, need to:
  - Be aware of the perception by governmental entities of the capabilities of amateur radio
    - Especially with respect to (lack of) message speed
  - Re-think what we have to offer to the Emergency Management community
  - Step up to meet that challenge
    - Educating our “served agencies” as we improve our capabilities

Amateur Radio Speeds

What Emergency Managers are likely used to (in the greater Tucson market):

- 10 Mbps Cox Cable (lowest speed offered)
- 20 Mbps CenturyLink VDSL2 (lowest speed offered)
- 36 Mbps Cellular 4G LTE (typical download)
- 288 Mbps 802.11n WiFi (4x4 MIMO at 20 MHz)
- 400 Mbps Xfinity Cable (lowest speed offered)
- 1+ Gbps [several vendors] (highest speed offered)

Amateur Radio Speeds

Comparison of Technologies

Megabits per Second	Times faster than a 9600 baud TNC	Technology
0.0003		ham radio, §97.307(f)(3) speed limit, 2200 thru 12 meters
0.0012		ham radio, §97.307(f)(4) speed limit, 10 meters
0.0012		ham radio, BBS systems and Winlink RMS nodes (at 1200 baud)
0.0050		ham radio, PACTOR III
0.0096		ham radio, §97.307(f)(4) speed limit, 6 meters and 2 meters
0.0096		ham radio, BBS systems and Winlink RMS nodes (at 9600 baud)
0.0252	3	ham radio, VARA FM (v4.0.0)
0.0380	4	ham radio, Kantronics 9612+ TNC (design maximum)
0.0560	6	ham radio, §97.307(f)(5) speed limit, 125 centimeters and 70 centimeters
0.0560	6	telecommunications, v.92 dial-up modem

Amateur Radio Speeds

At this point, you should be saying to yourself:

"I feel the need … the need for speed"

Are you entering a golf cart in a NASCAR race?

Amateur Radio Speeds

Comparison of Technologies

Megabits per Second	Times faster than a 9600 baud TNC	Technology
0.384	40	telecommunications, video conferencing (3 bonded ISDN B Channels)
0.947	99	cellular phone, GSM EDGE Evolution
1.544	161	telecommunications, T-1 protocol
1.800	188	cellular phone, CDMA EV-DO Rev. B
3.300	344	telecommunications, ADSL2+M protocol
11.000	1,146	WiFi, 802.11b
14.400	1,500	HamWAN, WA7PTM (client node) to Larch Mtn. (on 17-Sep-2020) – 13.4 miles
16.000	1,667	cellular phone, UMTS-TDD
22.000	2,292	cellular phone, UMTS W-CDMA HSPA+
29.200	3,042	HamWAN, Wash. DOT (client node) to Larch Mtn. (on 3-Sep-2020) – 13.3 miles

Amateur Radio Speeds

Comparison of Technologies

Megabits per Second	Times faster than a 9600 baud TNC	Technology
36.000	3,750	HamWAN, Seattle Westin Bldg. to Gold Mtn. (on 16-Dec-2020) – 21.4 miles
44.736	4,660	telecommunications, DS-3 protocol
54.000	5,625	WiFi, 802.11a and 802.11g
72.200	7,521	HamWAN, Beacon Hill (Seattle) to Mt. Baldi (on 16-Dec-2020) – 33.7 miles
86.400	9,000	cellular phone, LTE
86.600	9,021	HamWAN, Larch Mtn. to Boistfort Peak (on 16-Dec-2020) – 69.1 miles
100.000	10,417	wired data network, 100Mb Ethernet
115.500	12,031	HamWAN, Capitol Peak to Gold Mtn. (on 16-Dec-2020) – 43 miles
115.500	12,031	HamWAN, Mt. McDonald (BC) to Cube Datacenter (BC) (on 16-Dec-2020) – 8.4 miles
130.000	13,542	HamWAN, Mt. McDonald (BC) to Triangle Mtn. (BC) (on 16-Dec-2020) – 2.7 miles

Amateur Radio Speeds

Comparison of Technologies

Megabits per Second	Times faster than a 9600 baud TNC	Technology
130.000	13,542	HamWAN, Seattle EOC (client node) to Gold Mtn. (on 16-Dec-2020) – 21.7 miles
130.000	13,542	HamWAN, Snohomish DEM to East Tiger Mtn. (on 16-Dec-2020) – 33.1 miles
144.400	15,042	HamWAN, Capitol Peak to Boistfort Peak (on 16-Dec-2020) – 33.8 miles
144.400	15,042	HamWAN, Snohomish DEM to Lookout Mtn. (on 16-Dec-2020) – 53 miles
148.608	15,480	telecommunications, OC-3 protocol
173.300	18,052	HamWAN, Snohomish DEM to Gold Mtn. (on 16-Dec-2020) – 36.2 miles
288.800	30,083	WiFi, 802.11n with 4x4 MIMO at 20 MHz
300.000	31,250	HamWAN, Beacon Hill (Seattle) to Haystack Mtn. (on 16-Dec-2020) – 30.4 miles
866.700	90,281	WiFi, 802.11ac
1,000.000	104,167	wired data network, gigabit Ethernet

Amateur Radio Speeds

How do we increase speed?

- Audio: talk faster
  [Auctioneer training begins next month]
- Data: use a different technology
  on the amateur microwave bands
  [for example: 5.650 to 5.925 GHz]

A Radio-Based Data Network

Two common designs:

- Ad Hoc (mesh) network example: AREDN
  - Simple to configure
  - Clients can come and go easily
  - Scalability is a concern
    - Network signaling overhead can bog down the network as it grows

A Radio-Based Data Network

Two common designs:

- IP-based routed network example: HamWAN
  - Uses well-established Wide Area Network protocols
  - Somewhat complex and tedious to configure
  - Can be used to connect groups of ad hoc clients

A Radio-Based Data Network

Which is better, AREDN or HamWAN?

- Neither … they compliment each other
- HamWAN offers a very solid data network backbone
- AREDN offers an easily deployable small network for emergency management
  - Temporary installation at an EOC, ICP, incident support venue
  - Node clusters can be connected to HamWAN for transport

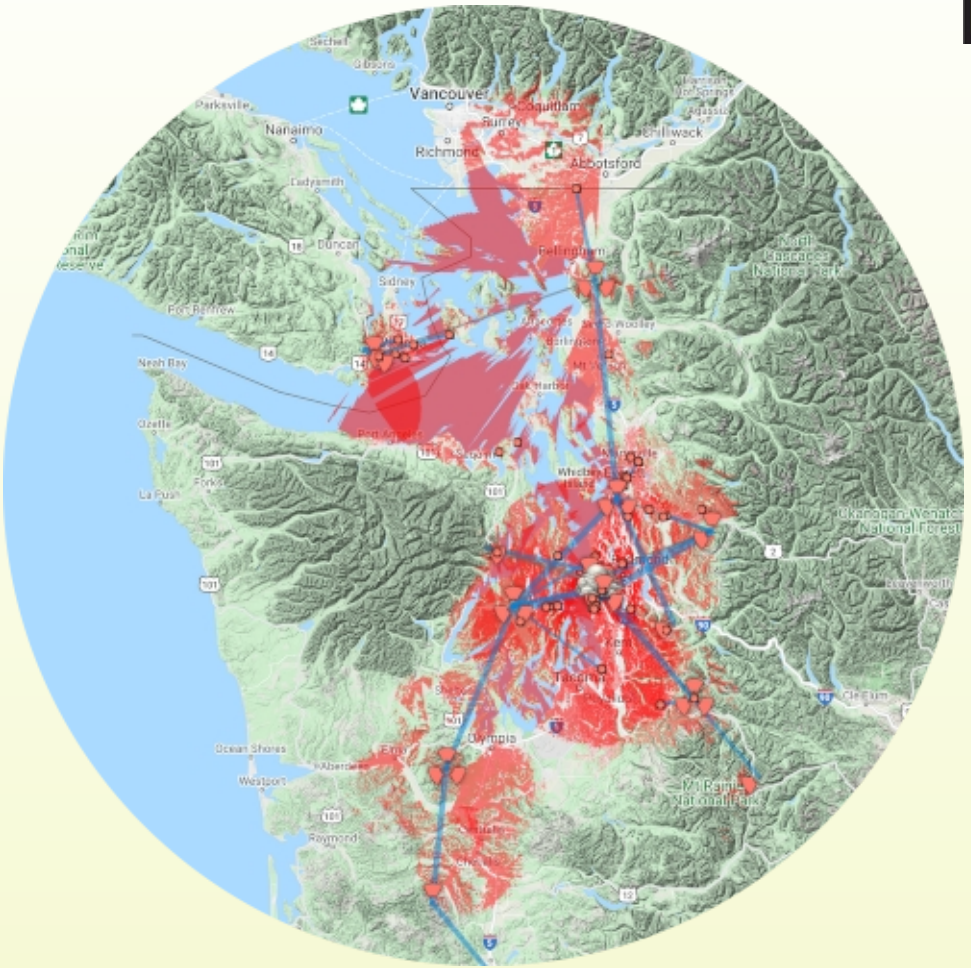
Where is HamWAN?

2013

Puget Sound

Washington

HamWAN



18 December 2020

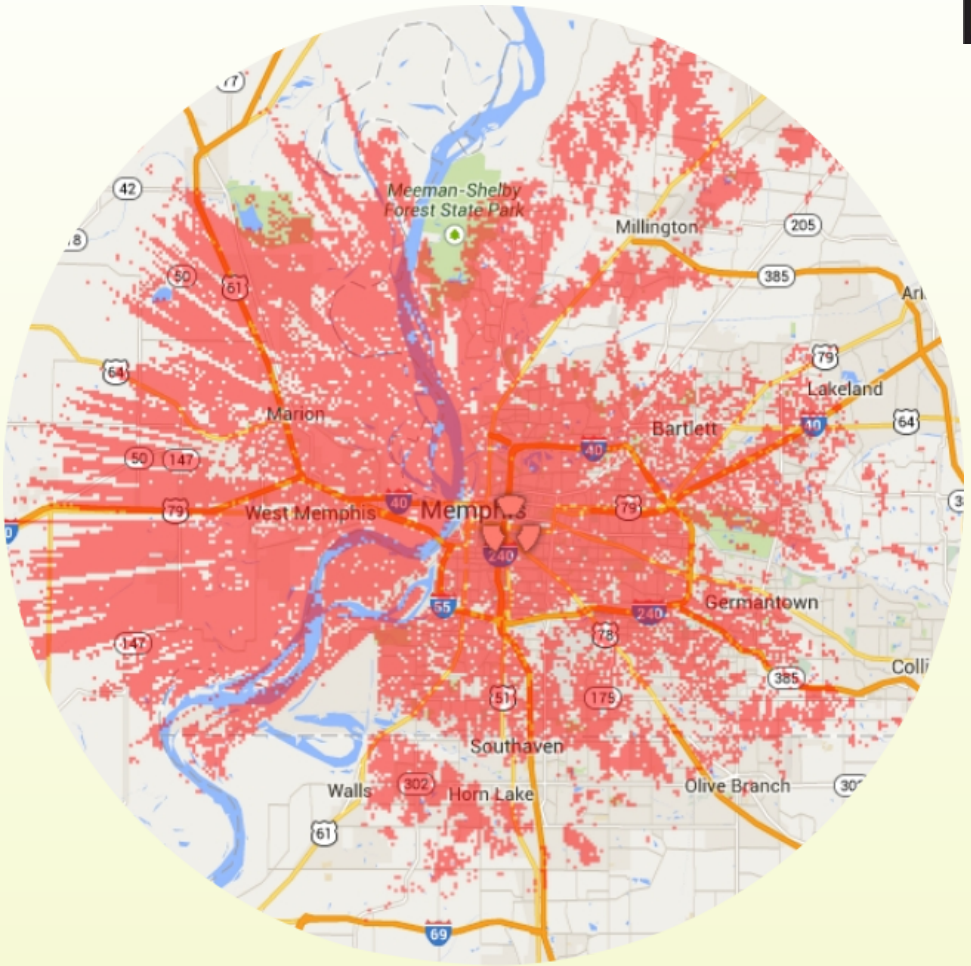
WA7PTM

Where is HamWAN?

2014

Memphis

Tennessee



18 December 2020

WA7PTM

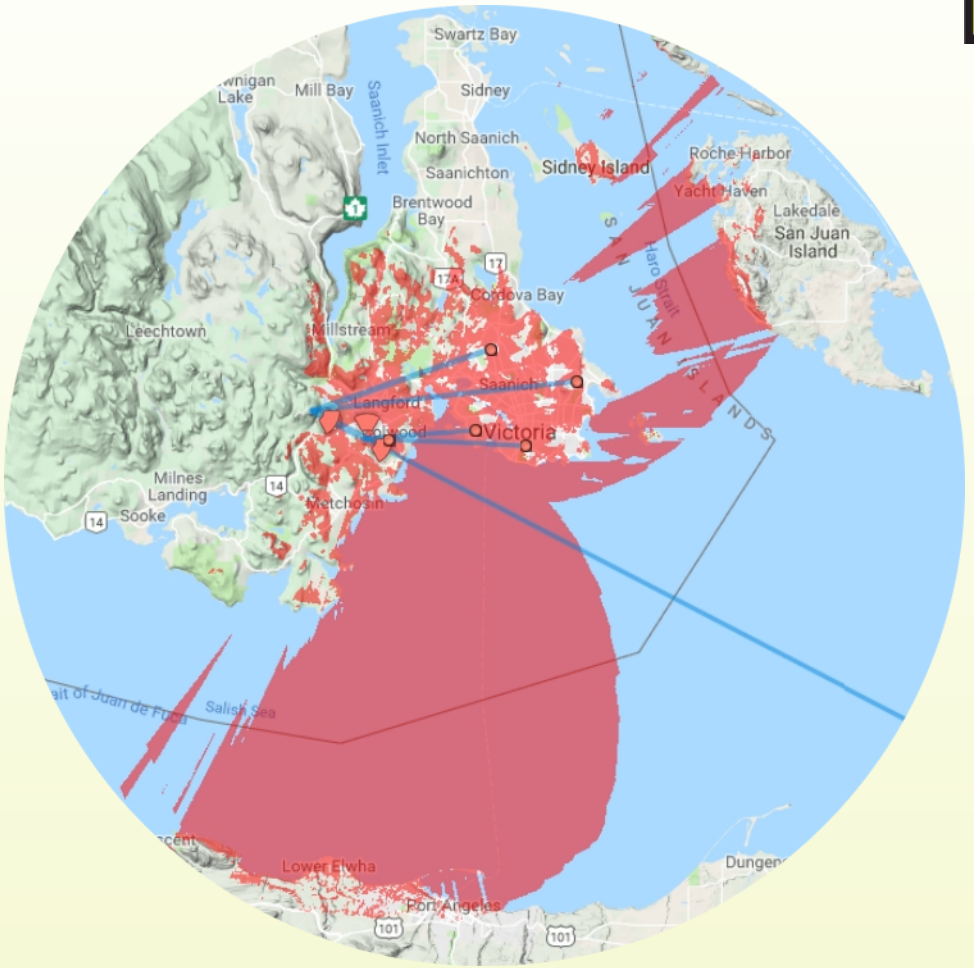
Where is HamWAN?

2016

Victoria

British Columbia

(*attached to Puget Sound*)



18 December 2020

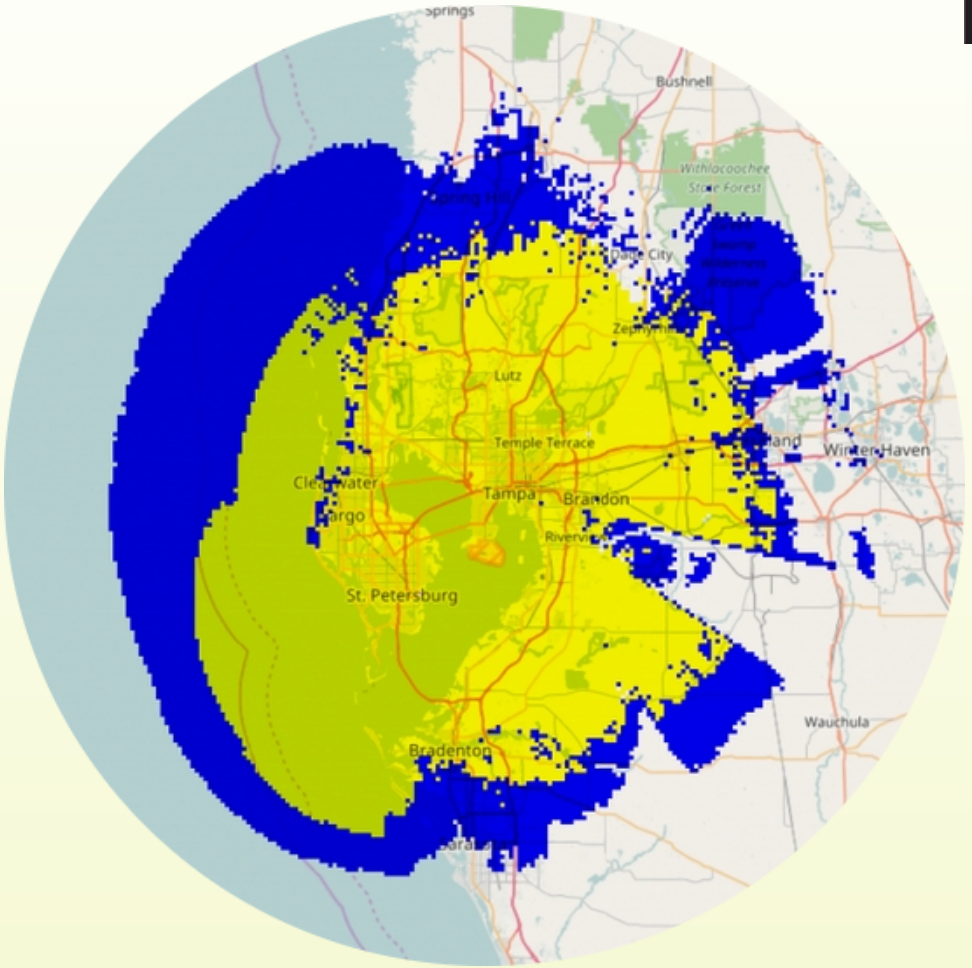
WA7PTM

Where is HamWAN?

2016

Tampa Bay

Florida



18 December 2020

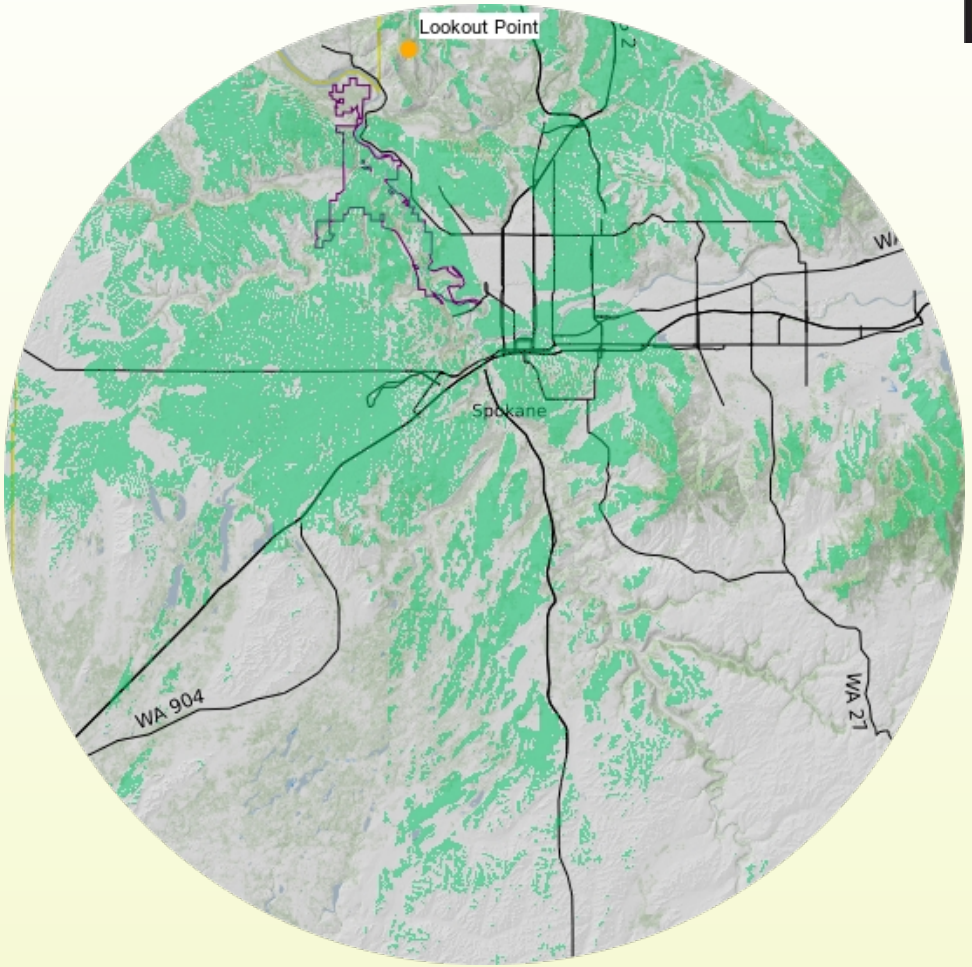
WA7PTM

Where is HamWAN?

2018

Spokane County

Washington



18 December 2020

WA7PTM

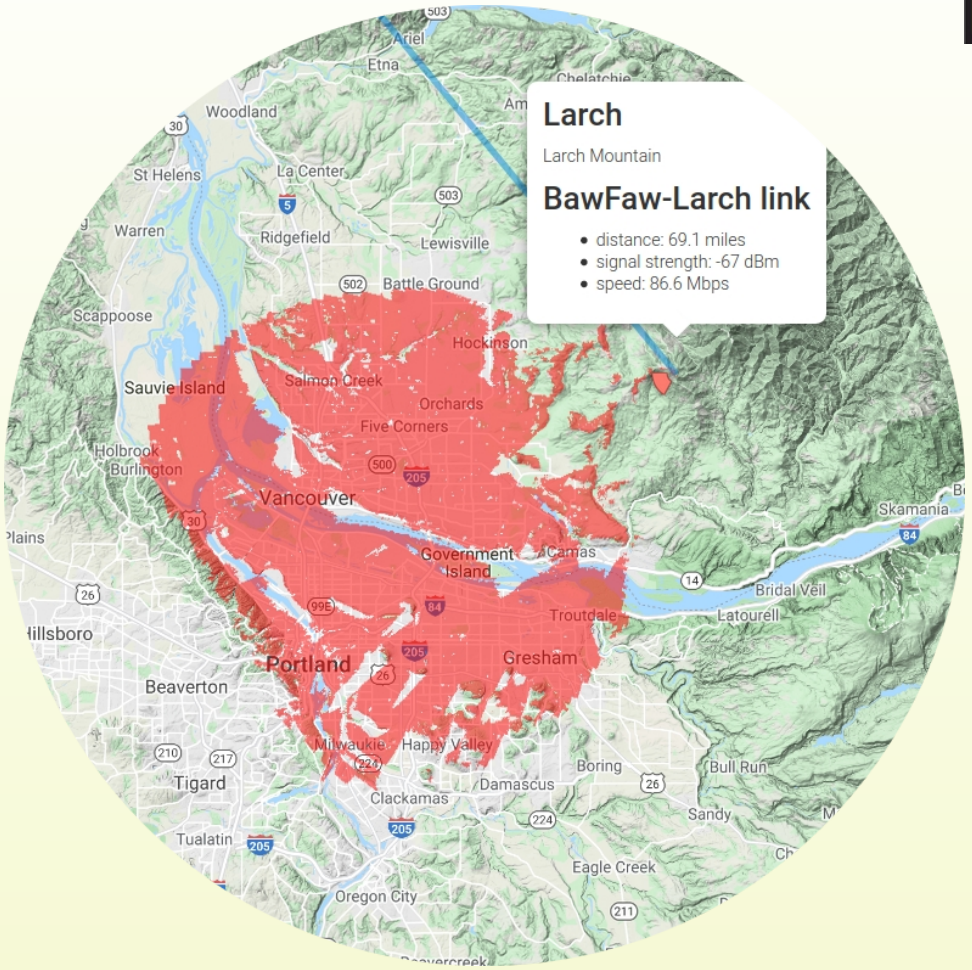
Where is HamWAN?

2018

Clark County

Washington

(*attached to Puget Sound*)



18 December 2020

WA7PTM

What can a Radio-Based Data Network do for ESF #2?

When other systems fail or are overloaded:

- Quickly transfer files to/from the Arizona State Emergency Operations Center (as easy as dropping a file into a shared folder):
  - Emergency Declaration(s)
  - Situation Report Forms
  - ICS-213 (general message form)
  - ICS-213 RR (resource request)
  - Complex/technical information:
    - Medicine lists

What can a Radio-Based Data Network do for ESF #2?

When other systems fail or are overloaded:

- Serve as a transport layer for other services and systems:
  - Email
  - DMR (Digital Mobile Radio)
  - APRS IGate
  - Winlink
  - Packet BBS networks
- Transfer video recorded during UAS (drone) flights

What can a Radio-Based Data Network do for ESF #2?

When other systems fail or are overloaded:

- Depending on system management, can become a backup for remote database connections such as:
  - WebEOC
  - Hospital bed count tracking
  - Data aggregation software (examples from https://appallicious.com):
    - Community Resilience Platform (CRP)
    - Disaster Assessment and Assistance Dashboard (DAAD)
    - Shelter Management System (SMS)

What can a Radio-Based Data Network do for ESF #2?

When other systems fail or are overloaded:

- VoIP (Voice over IP) phone calls
- Portable microwave client systems can be deployed to support emerging communications requirements:
  - Evacuation shelters
  - Live video situation reports
  - Weather monitoring
- Data input to GIS databases

Network Design Elements

High-level “link” sites:

- Point-to-point radios/antennas [to/from other link sites]
- 1 to 3 sector radio(s)/antenna(s) [for client connections]
- Other items:
  - PTZ camera (optional)
  - Misc: data switch, PSU(s), ethernet cable, RJ-45 connectors, cable clamps and cushions, unistrut, pipe clamps, u-bolts, etc.

Network Design Elements

Client connections:

- Integrated radio/antenna
  - Dish or flat panel
- Ethernet cable
- Firewall
- Computer

[to/from a link site sector]

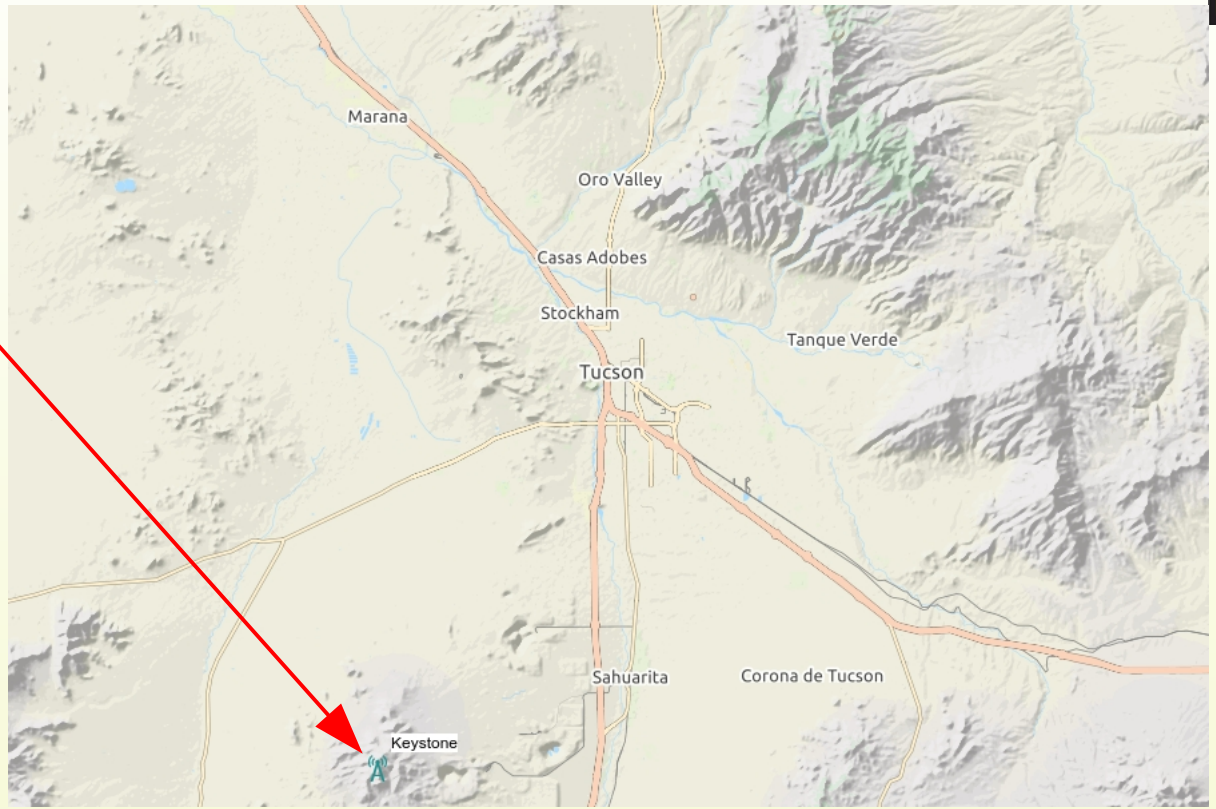
[depending on distance]

Network Design Elements

Keystone Peak

31.8773°, -111.2154°

[*suggested by AK2L*]

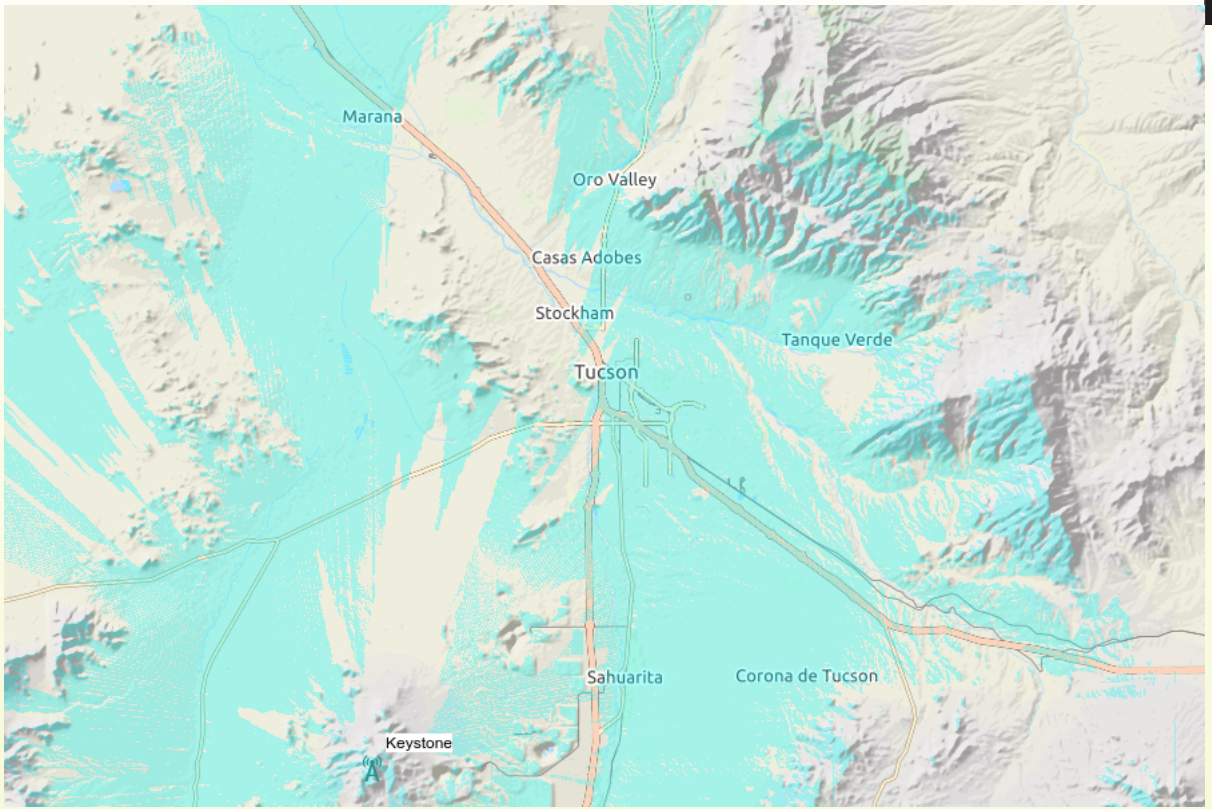


Network Design Elements

Keystone Peak

31.8773°, -111.2154°

[*suggested by AK2L*]



18 December 2020

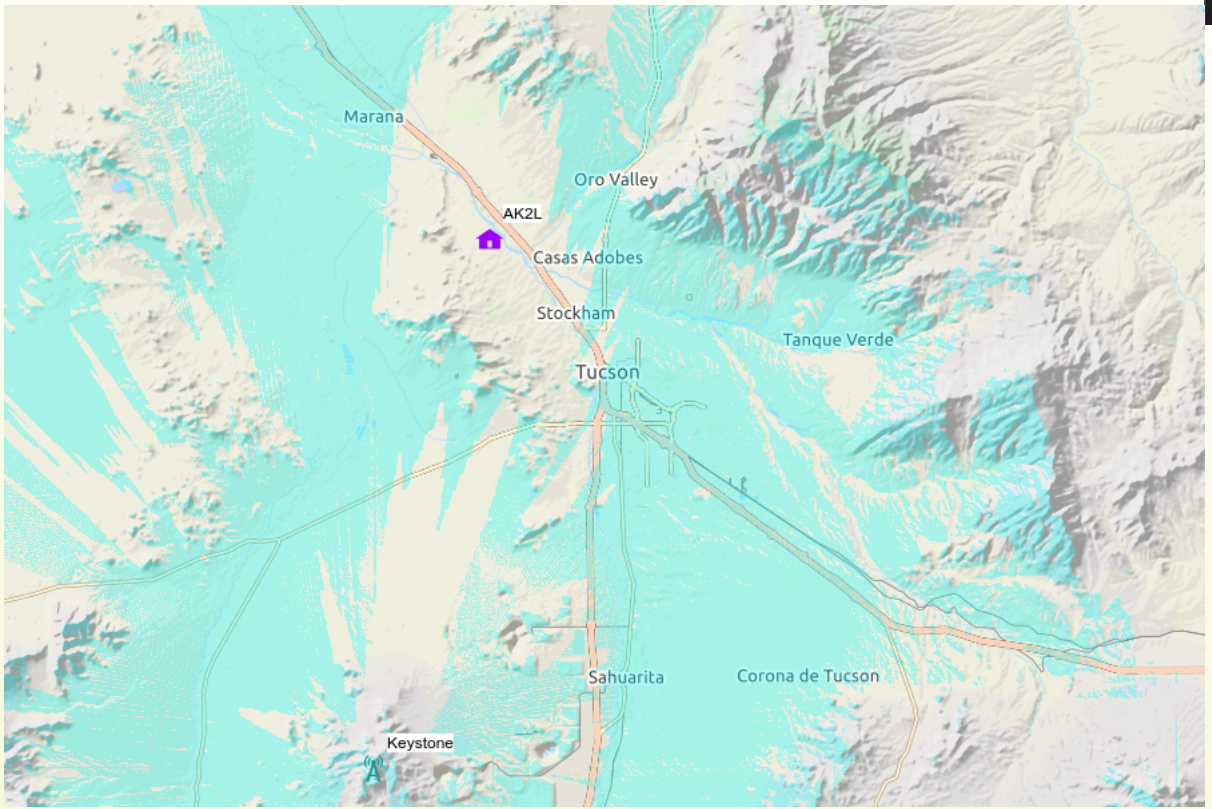
WA7PTM

Network Design Elements

Keystone Peak

31.8773°, -111.2154°

[*suggested by AK2L*]



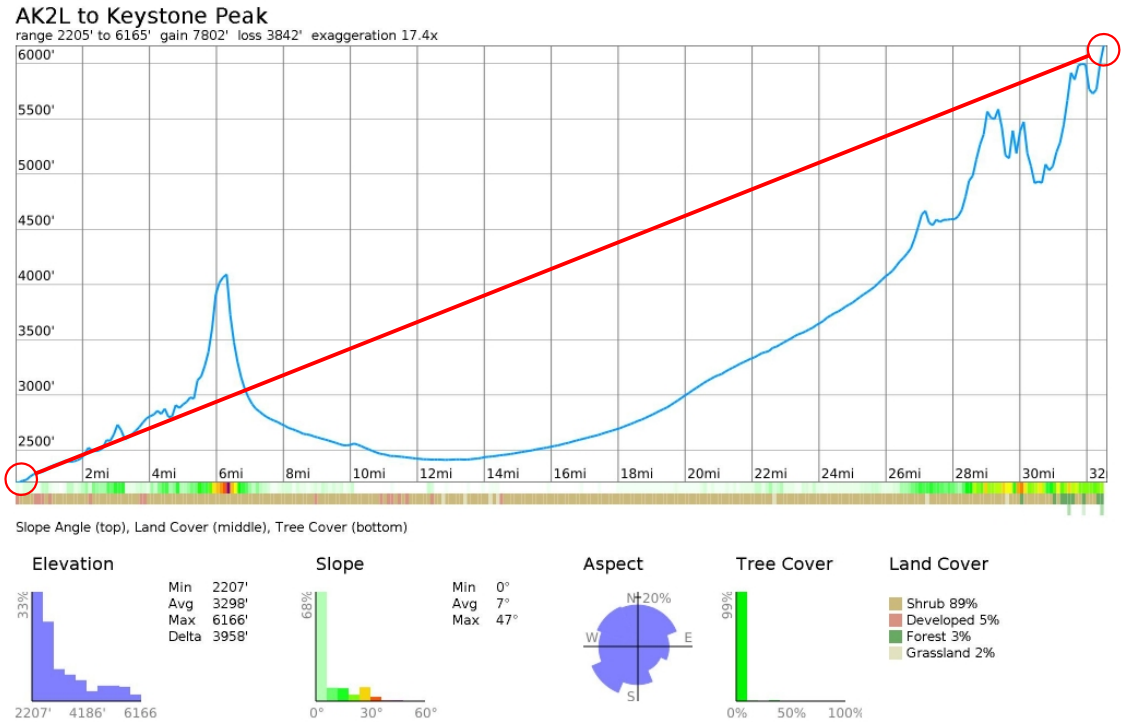
Network Design Elements

Keystone Peak

31.8773°, -111.2154°

[*suggested by AK2L*]

Obviously, this isn't going to work out too well as microwaves need line-of-sight



18 December 2020

WA7PTM

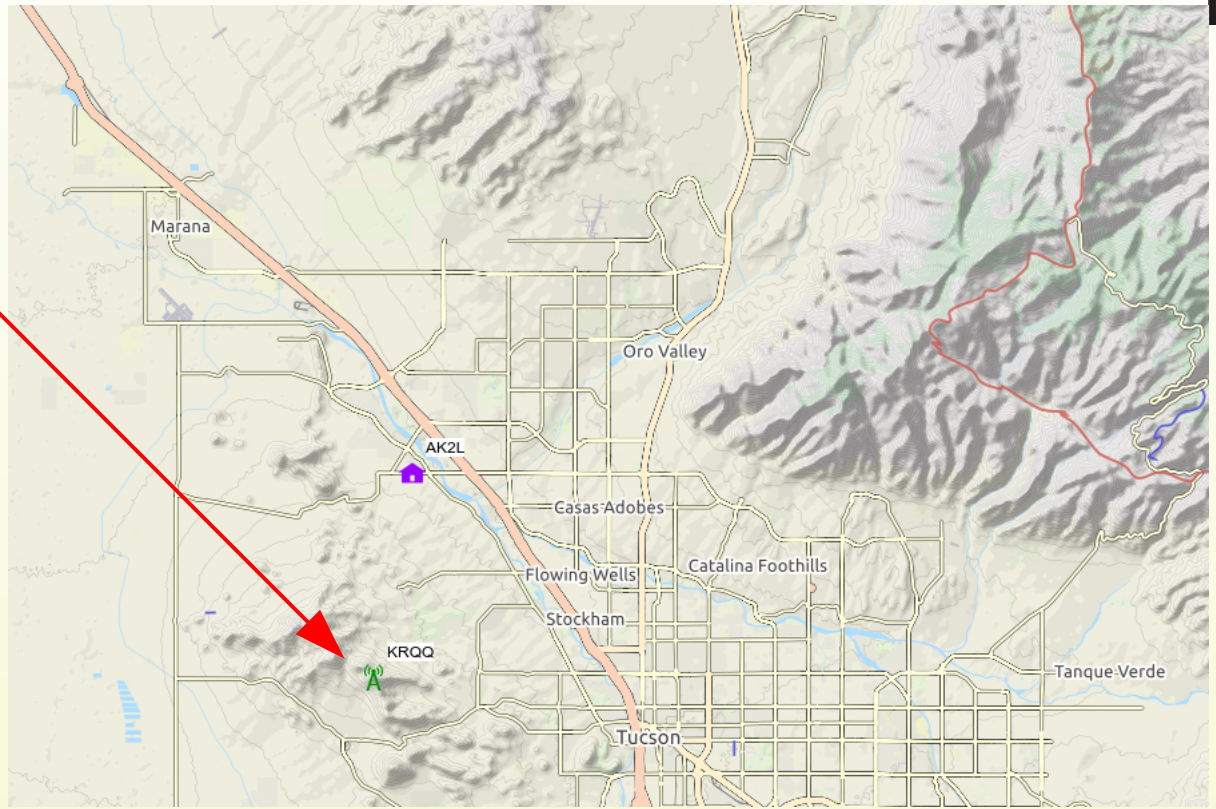
Network Design Elements

7120 West Hidden Canyon Dr.

{ site of 5 commercial antenna towers }

32.2491°, -111.1167°

[*much closer than Keystone Peak*]



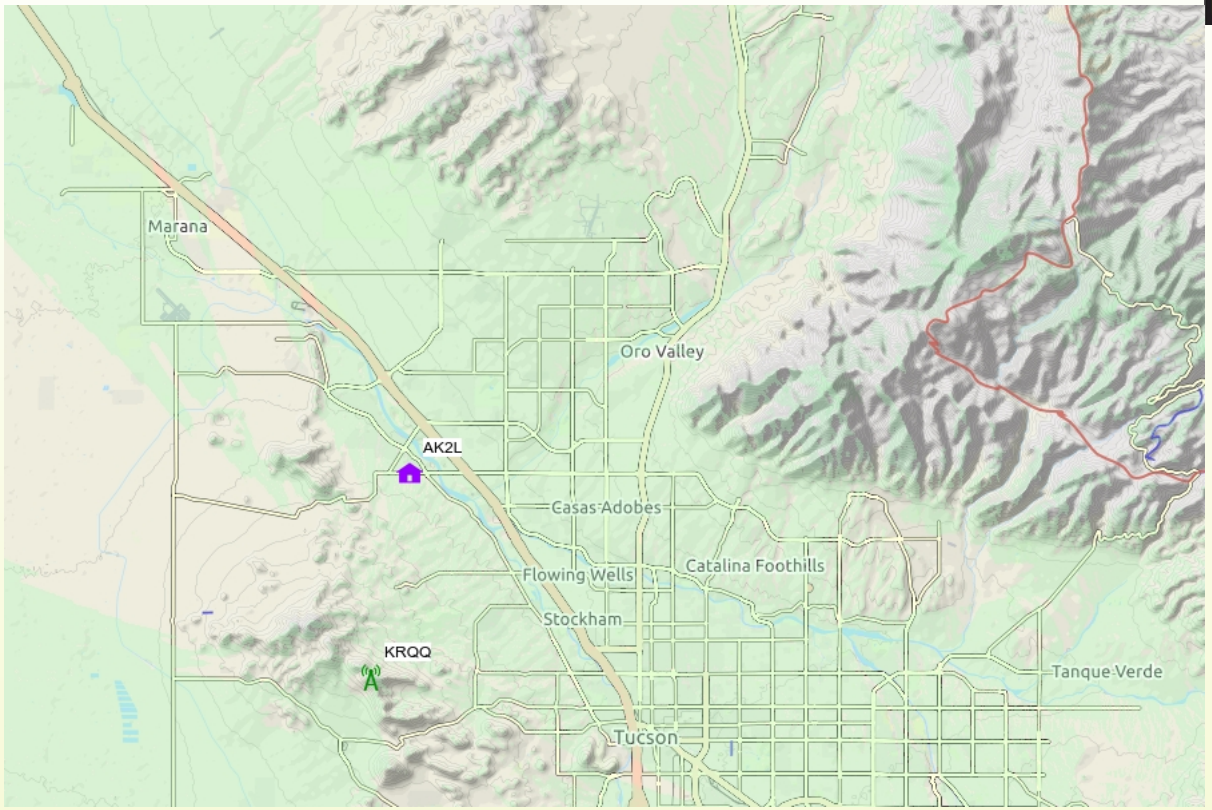
Network Design Elements

7120 West Hidden Canyon Dr.

{ site of 5 commercial antenna towers }

32.2491°, -111.1167°

[*much closer than Keystone Peak*]



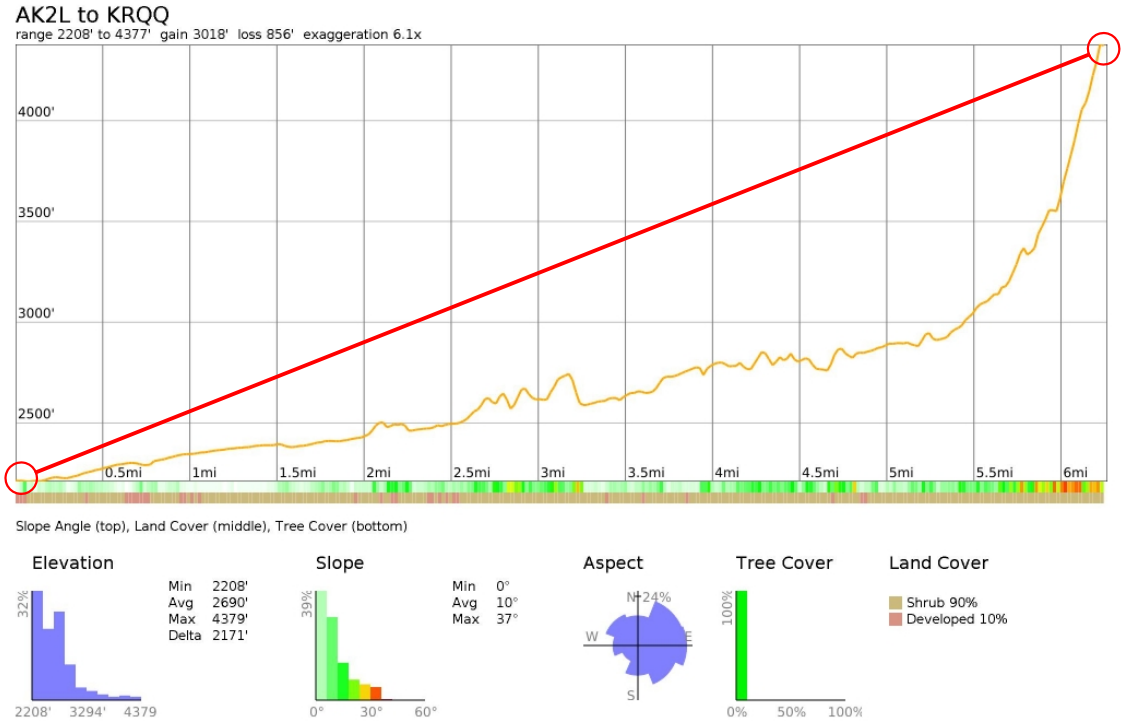
Network Design Elements

7120 West Hidden Canyon Dr.

{ site of 5 commercial antenna towers }

32.2491°, -111.1167°

[*much closer than Keystone Peak*]



18 December 2020

WA7PTM

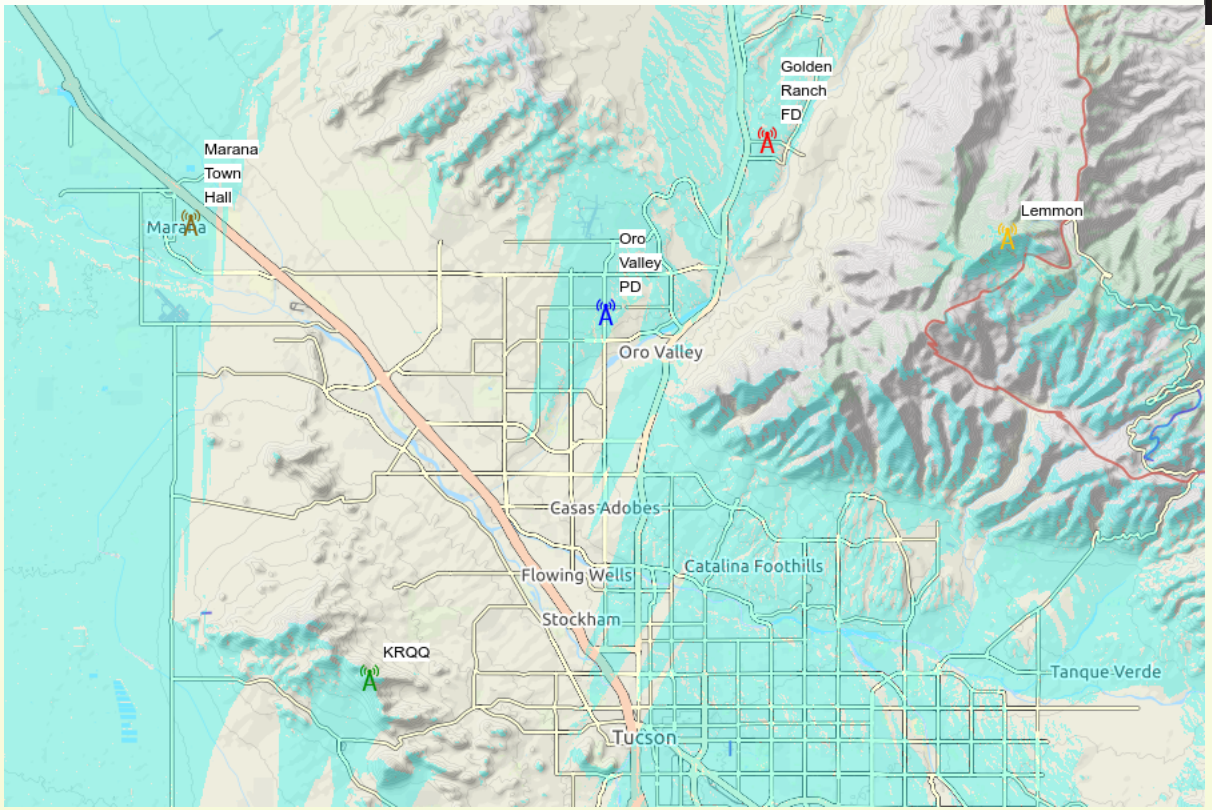
Network Design Elements

Keystone Peak

31.8773°, -111.2154°

Coverage of:

- Oro Valley PD
- Golden Ranch FD
- Marana Town Hall



18 December 2020

WA7PTM

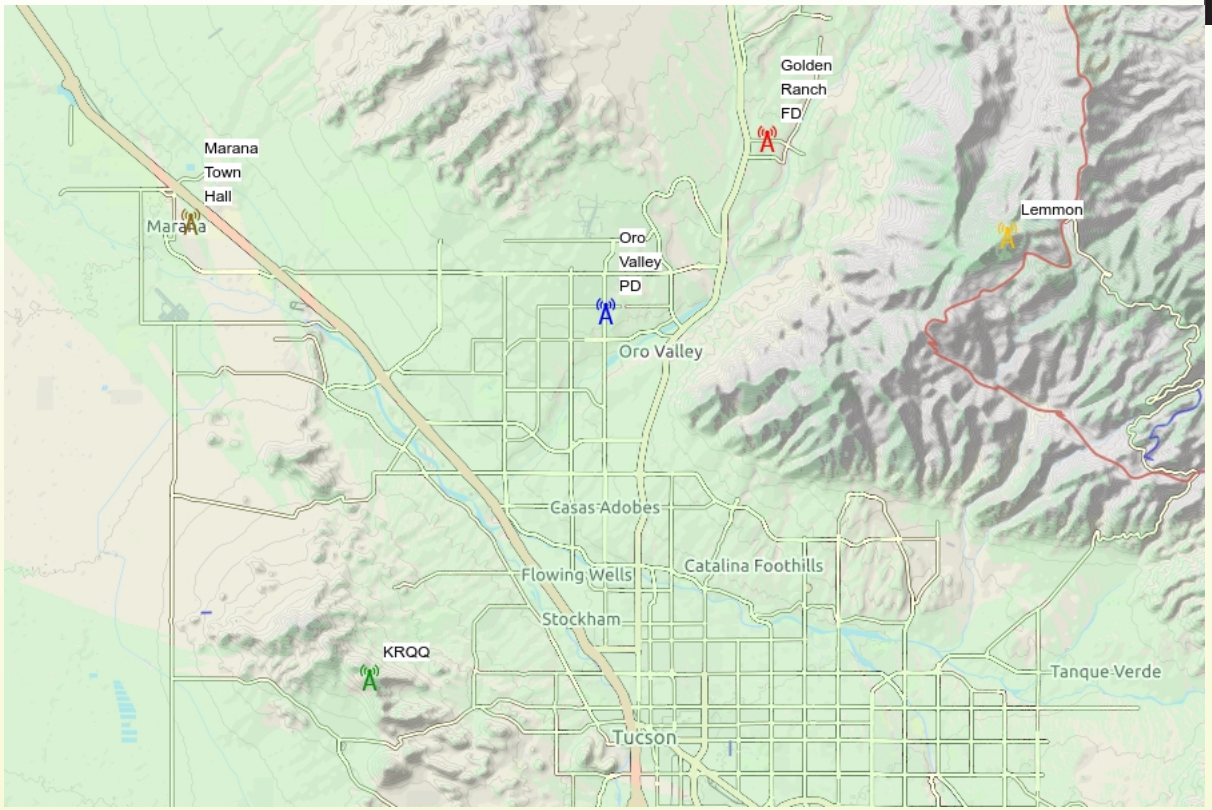
Network Design Elements

7120 West Hidden Canyon Dr.

32.2491°, -111.1167°

Coverage of:

- Oro Valley PD
- Golden Ranch FD
- Marana Town Hall



18 December 2020

WA7PTM

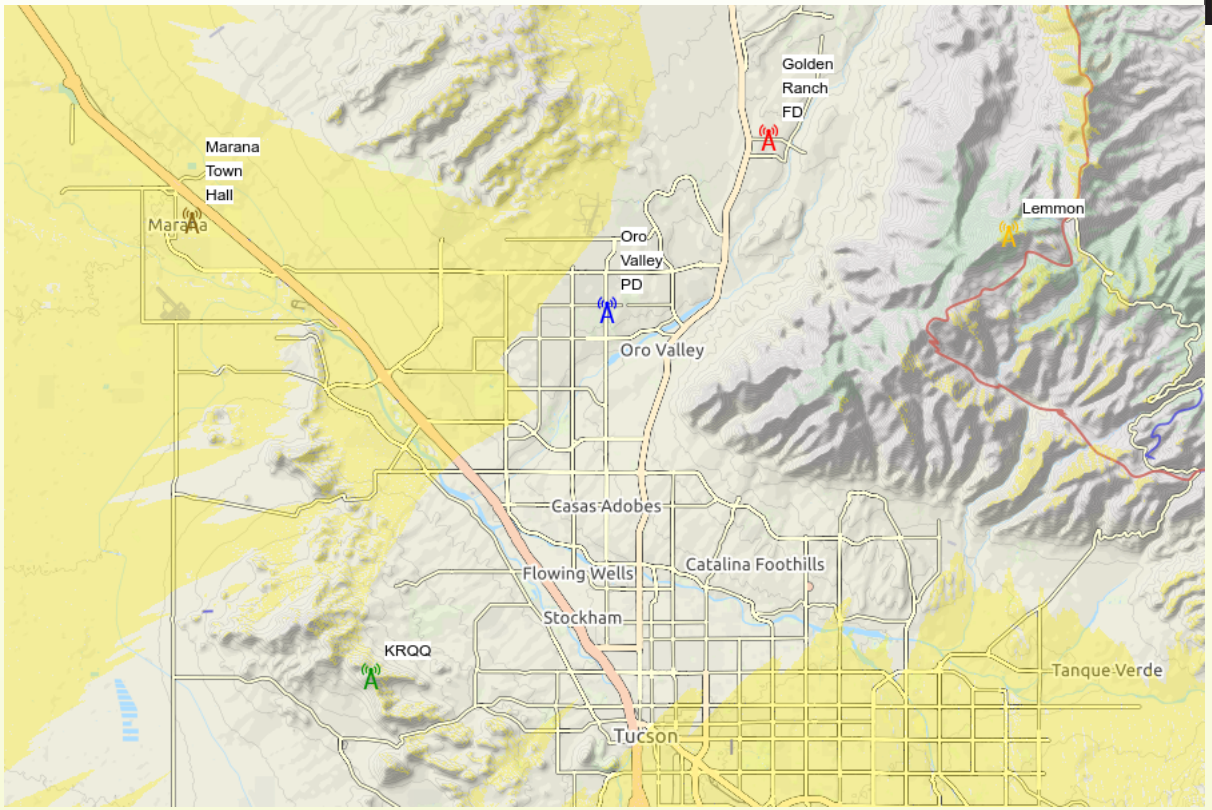
Network Design Elements

Mt. Lemmon

32.4407°, -110.7881°

Coverage of:

- Oro Valley PD
- Golden Ranch FD
- Marana Town Hall



18 December 2020

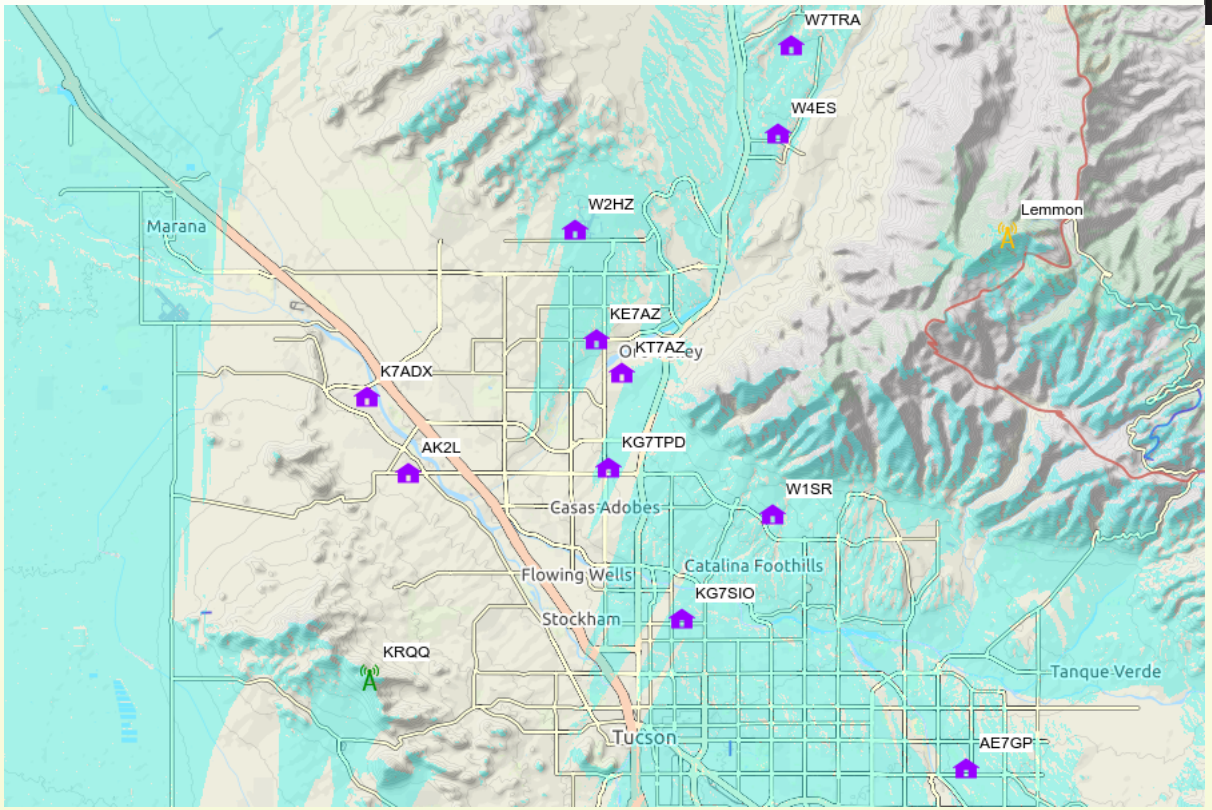
WA7PTM

Network Design Elements

Keystone Peak

31.8773°, -111.2154°

Potential Member Coverage



18 December 2020

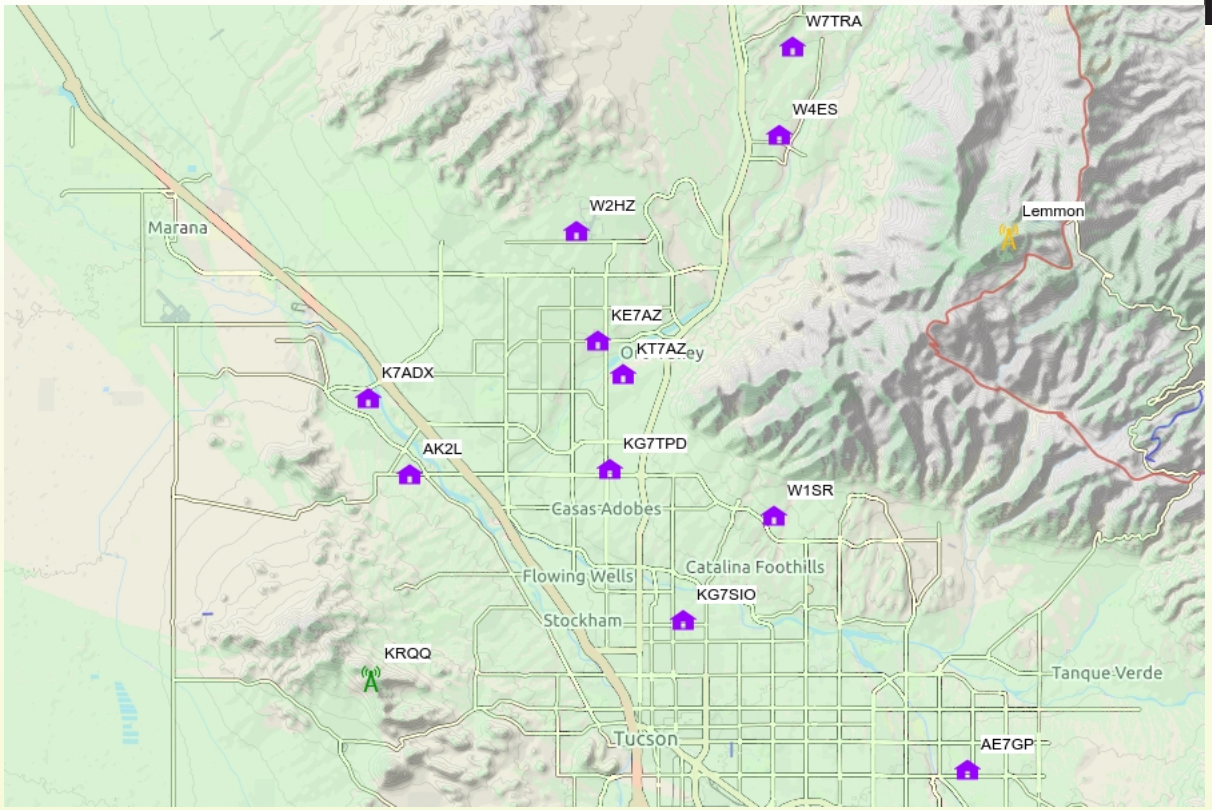
WA7PTM

Network Design Elements

7120 West Hidden Canyon Dr.

32.2491°, -111.1167°

Potential Member Coverage



18 December 2020

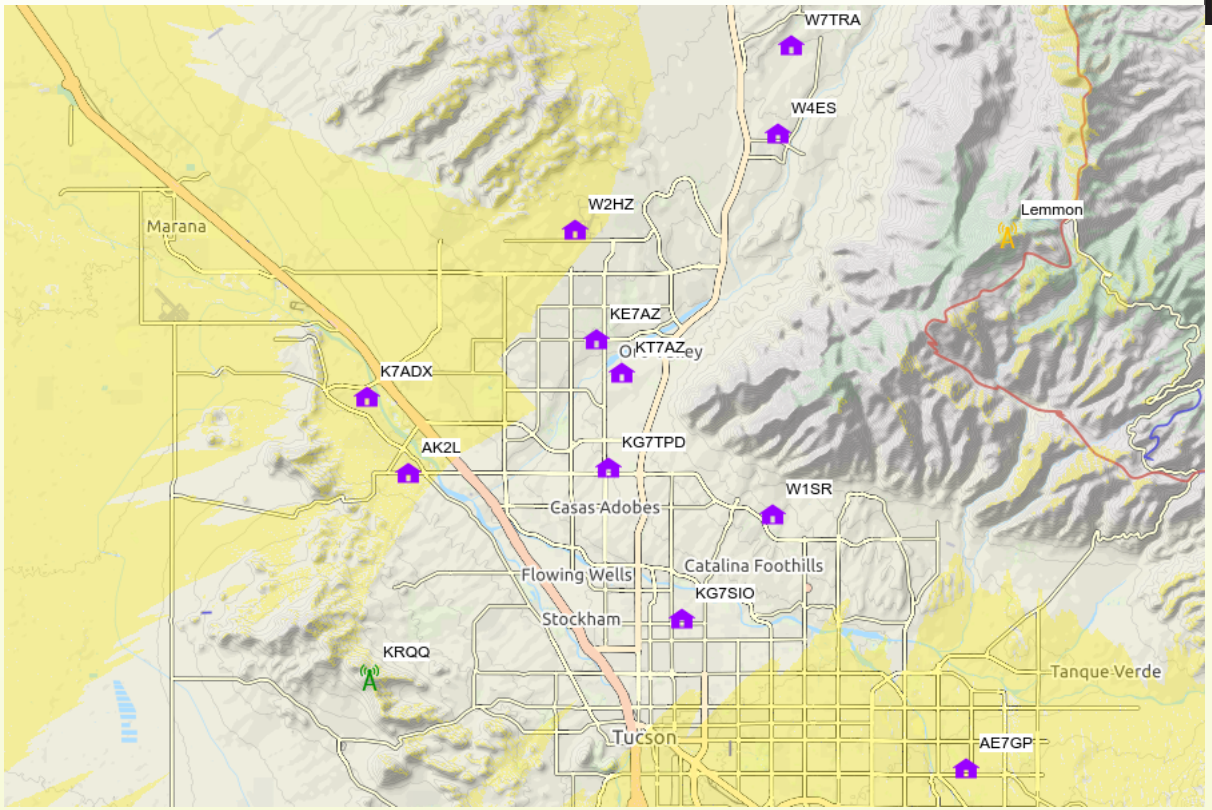
WA7PTM

Network Design Elements

Mt. Lemmon

32.4407°, -110.7881°

Potential Member Coverage



18 December 2020

WA7PTM

Network Design Elements

This is a Wide Area Network where the data is exchanged via amateur radio on microwave frequencies

Things to think about:

- What services would benefit the Emergency Management community?
- Are the coverage areas sufficient so that a client node could be moved between two different sector antennas?

Network Design Elements

Things to think about:

- Will this network be connected to the Internet?
  - If so, where?
  - For example, would a connection into Phoenix be feasible?
- Do you have access to sufficient high-level sites?
- Does your group have technical expertise in data networking?

Network Design Elements

Things to think about:

- How will you monitor and maintain the network?
- Does your group have (or can you find) a supply of “elmers” to help newcomers configure their gear?

Equipment Costs

High-level “link” site:

- $2,500 – $4,000
  - Variable elements:
    - Number of link radios/antennas
    - Number of sector radios/antennas
    - Solar power
    - PTZ camera (optional)

Equipment Costs

Client node:

- $41 – MikroTik RBSXTsq5nD
  - 802.11a/n
  - 316 mW
  - 16 dBi

Note: You must order the International version of this product in order to use amateur radio frequencies

Equipment Costs

Client node:

- $68 – MikroTik RBLHG-5HPnD
  - 802.11a/n
  - 316 mW
  - 24.5 dBi

Note: You must order the International version of this product in order to use amateur radio frequencies

Equipment Costs

Client node:

- $146 – MikroTik RBDynaDishG-5HacD
  - 802.11ac
  - 794 mW
  - 25 dBi

Note: You must order the International version of this product in order to use amateur radio frequencies

Equipment Costs

Client node:

- $162 – MikroTik RB911G-5HPacD-QRT
  - 802.11a/n/ac
  - 1 W
  - 23 dBi

Note: You must order the International version of this product in order to use amateur radio frequencies

Equipment Costs



Client node:

- $295 – Package
  - MikroTik mANT30 dish antenna + MikroTik Sleeve30 radome + RF Elements Metal Outdoor Enclosure for RB912 + MikroTik RouterBOARD RB912UAG-5HPnD MIMO modem PCB
    - 802.11a/n
    - 1 W
    - 30 dBi

Note: You must order the International version of this product in order to use amateur radio frequencies

Conclusions

- In the eyes of our emergency / disaster communications customers:
  - Decades-old amateur radio data technologies are slow and don’t serve their current needs
  - Quick information exchange is a key factor in emergency management
- Microwave spectrum is available (without §97 speed limits) and it will easily support much faster communications
- Building a radio-based data network is a way to both provide public service and to interest the next generation of hams

Further Reading

- https://en.wikipedia.org/wiki/IEEE_802.11ac#Data_rates_and_speed
- https://hamwan.org
- https://hamwan.org/Standards/Component%20Engineering/Client%20Hardware.html
- https://hamwan.org/Standards/Certification.html
- https://mikrotik.com/products/group/wireless-systems
- https://www.fema.gov/media-library-data/1484078710188-2e6b753f3f9c6037dd22922cde32e3dd/CR16_AAR_508.pdf *(see page 11)*
- https://www.oregon.gov/oem/Documents/CR16-AAR-Final.PDF *(see page 11)*
- https://mil.wa.gov/asset/5ba41f5c7498c *(see pages 7 and 18)*

Questions

You ASCII, we ANSI