HAMCATION 2015
The Florida Statewide Amateur Radio Network "SARnet" Forum

February 14, 2015

Presented by
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and
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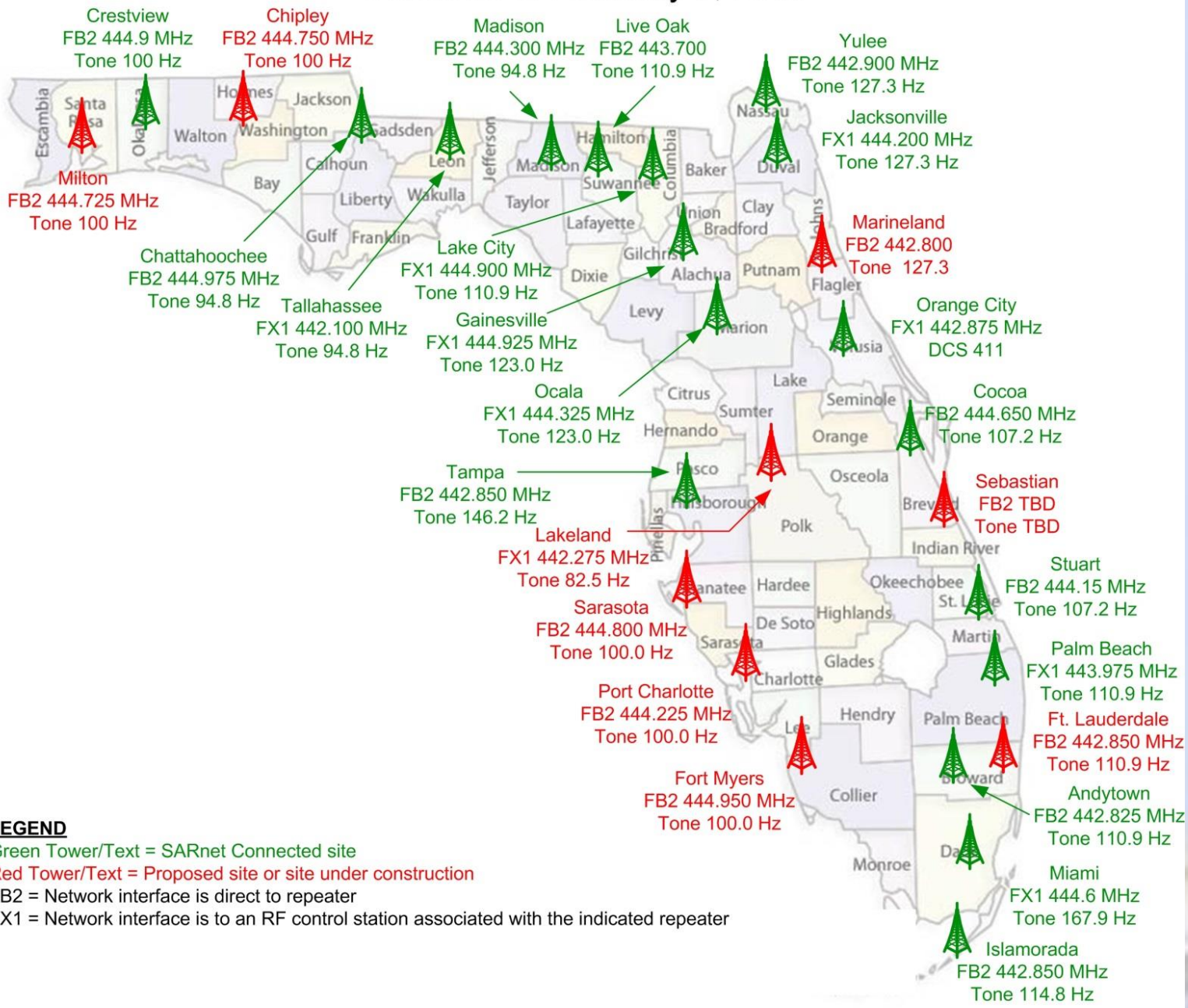
- Presentation Outline
  - What is SARnet?
  - SARnet Maps
  - How ham radio repeaters interface with SARnet
  - The network side and radio over IP
  - Why do I need to pause before keying?
  - Special case: Palm Beach
  - How we control and monitor SARnet today
  - SARnet and EMCOM
  - Current Status and The Future

- What is SARnet?
  - A network of connected local UHF repeaters
  - The network uses dedicated bandwidth
  - The network does not touch the internet
  - The network is made up of hardened microwave and fiber sites with automatic backup generators
  - The network is provided by the FDOT
  - Why is the FDOT helping hams?...It is the other way around.
  - The FDOT is using SARnet as a live-traffic test bed to investigate Radio over IP technologies

Statewide Amateur Radio Network "SARNet"

Status as of February 7, 2015



LEGEND

Green Tower/Text = SARnet Connected site

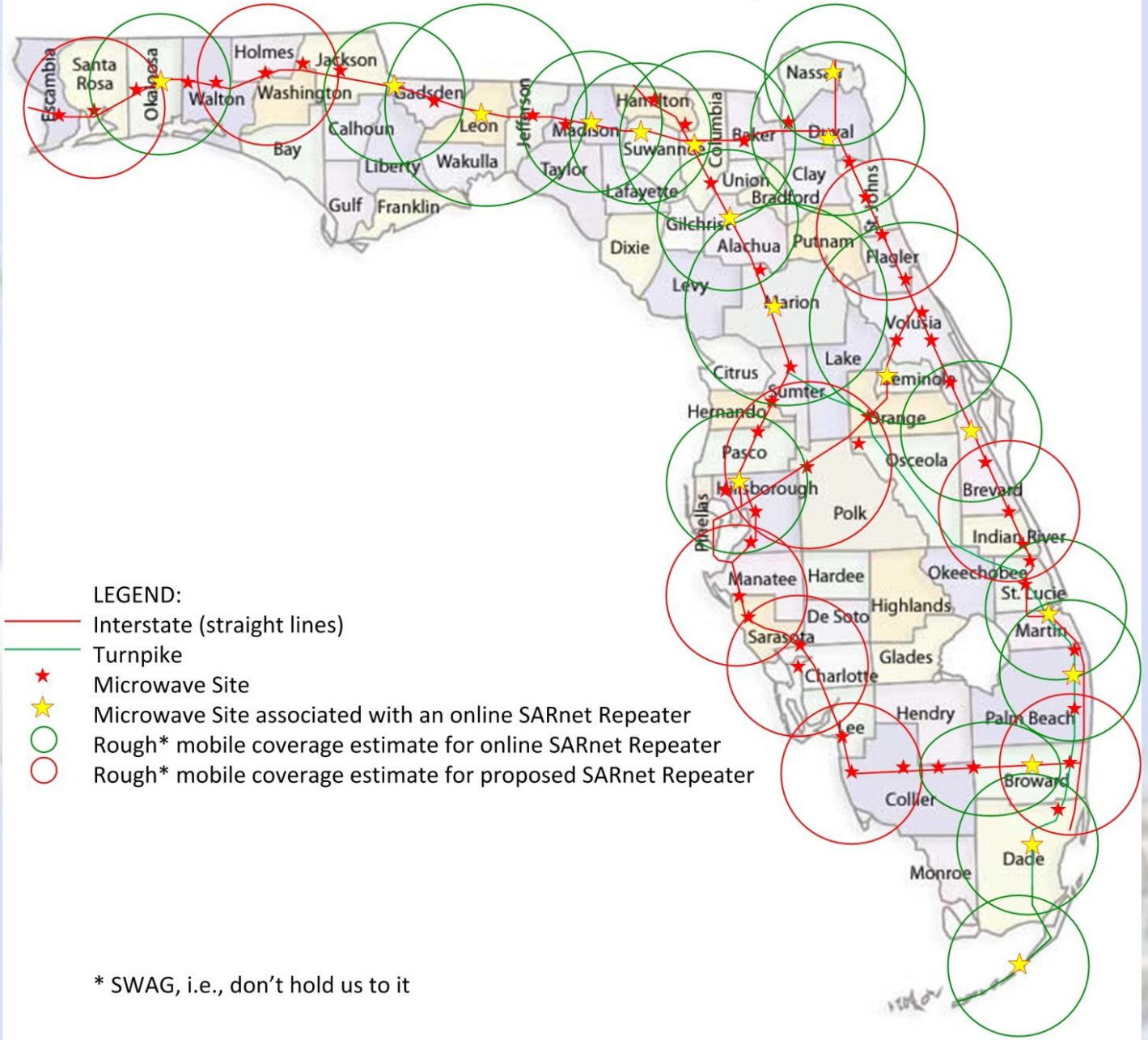
Red Tower/Text = Proposed site or site under construction

FB2 = Network interface is direct to repeater

FX1 = Network interface is to an RF control station associated with the indicated repeater

Statewide Microwave Network

"SARnet" sites shown as of January 22, 2015



LEGEND:

- Interstate (straight lines)
- Turnpike
- Microwave Site
- Microwave Site associated with an online SARnet Repeater
- Rough* mobile coverage estimate for online SARnet Repeater
- Rough* mobile coverage estimate for proposed SARnet Repeater

* SWAG, i.e., don't hold us to it

- How do ham repeaters connect to SARnet?
- Two methods: Direct Connection or Radio Connection
- DIRECT CONNECTION SARNET SITES
  - With Direct Connection the local repeater and SARnet node are physically connected and co-located.
  - The local repeater transmitter must accept receive audio from the either the repeater receiver or from SARnet.
  - To transmit SARnet traffic the attached SARnet node provides a PTT signal to the repeater transmitter along with the audio from the network.
  - When the repeater receiver is receiving local traffic it is sent back out over the air via the repeater transmitter and also sent over SARnet via the attached SARnet node.
  - The repeater receiver must also provide a Carrier Operated Relay (COR) signal to the SARnet node to initiate a transmission into SARnet.
  - Direct Connection sites are known as FB2 sites.

- DIRECT CONNECTION SITES (continued)
  - Current SARNET Direct Connection Sites:
    - Yulee (Hamtronics FB2)
    - Cocoa (Mastr II/TP3200 FB2)
    - Stuart (Mastr II/TP3200 FB2)
    - Andytown (FR4000)
    - Islamorada (Mastr II/TP3200 FB2)
    - Tampa (Quantar FB2)
    - Live Oak (Base Tech II FB2)
    - Madison (Quantar FB2)
    - Chattahoochee (Mastr II/TP3200 FB2)
    - Crestview (Base Tech II FB2)

- Example Direct Connection Site: Yulee

- Example Direct Connection Site: Tampa

- Example Direct Connection Site: Islamorada

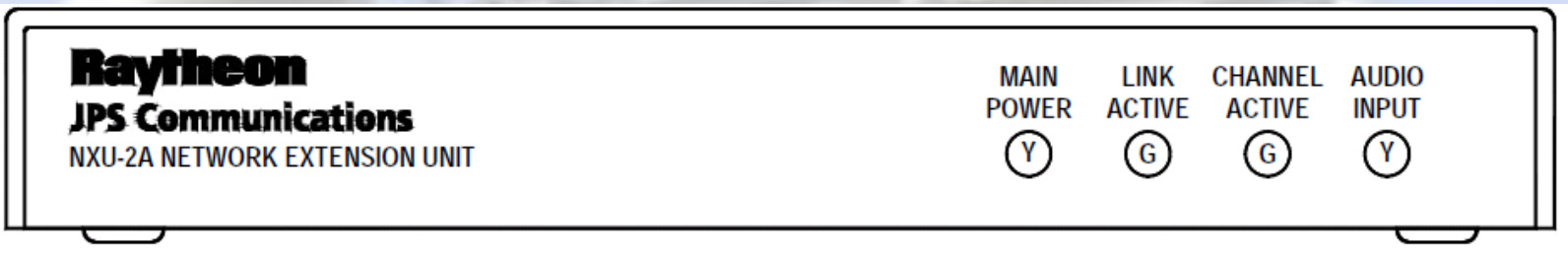
- Second Method for Connecting Repeaters to SARnet: RADIO CONNECTION SARNET SITES:
- Repeaters are NOT physically connected to SARnet.
- A SARnet node has a control station radio connected to it that accesses the repeater just like any other local repeater user.
- The type of control station radio used for SARnet is a GE MDX in a console mount.
- The MDX accepts transmit audio and a PTT from the SARnet node (network traffic) and provides received audio and a COR signal (local repeater traffic) to the SARnet node.
- Radio Connection sites are known as FX1 sites because they use a control station radio to access a repeater.

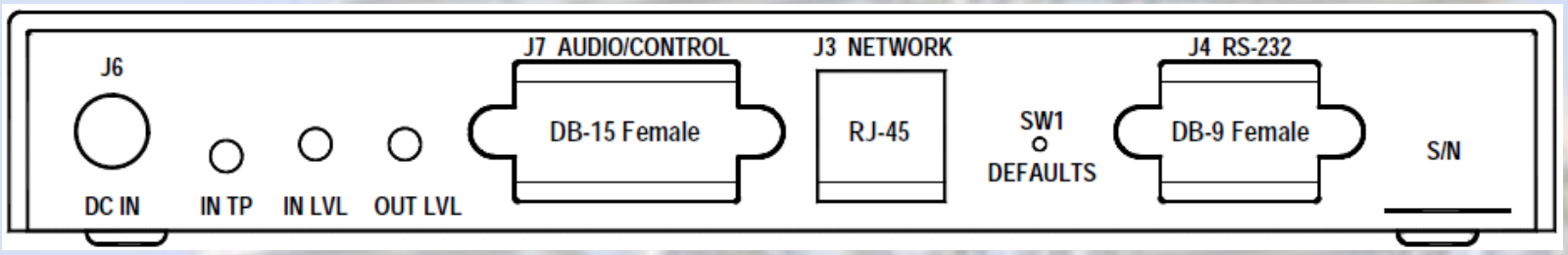
- RADIO CONNECTION SITES (continued)
  - Current SARNET Radio Connection Sites:
    - Jacksonville
    - Orange City
    - Palm Beach
    - Miami
    - Ocala
    - Gainesville
    - Lake City
    - Tallahassee

- Example Radio Connection Site: Tallahassee

- Example Radio Connection Site: Lake City

- The network side and Radio over IP
  - Each SARnet node is a JPS Raytheon NXU
  - The NXU converts the radio audio, PTT, and COR signals to Internet Protocol IP traffic



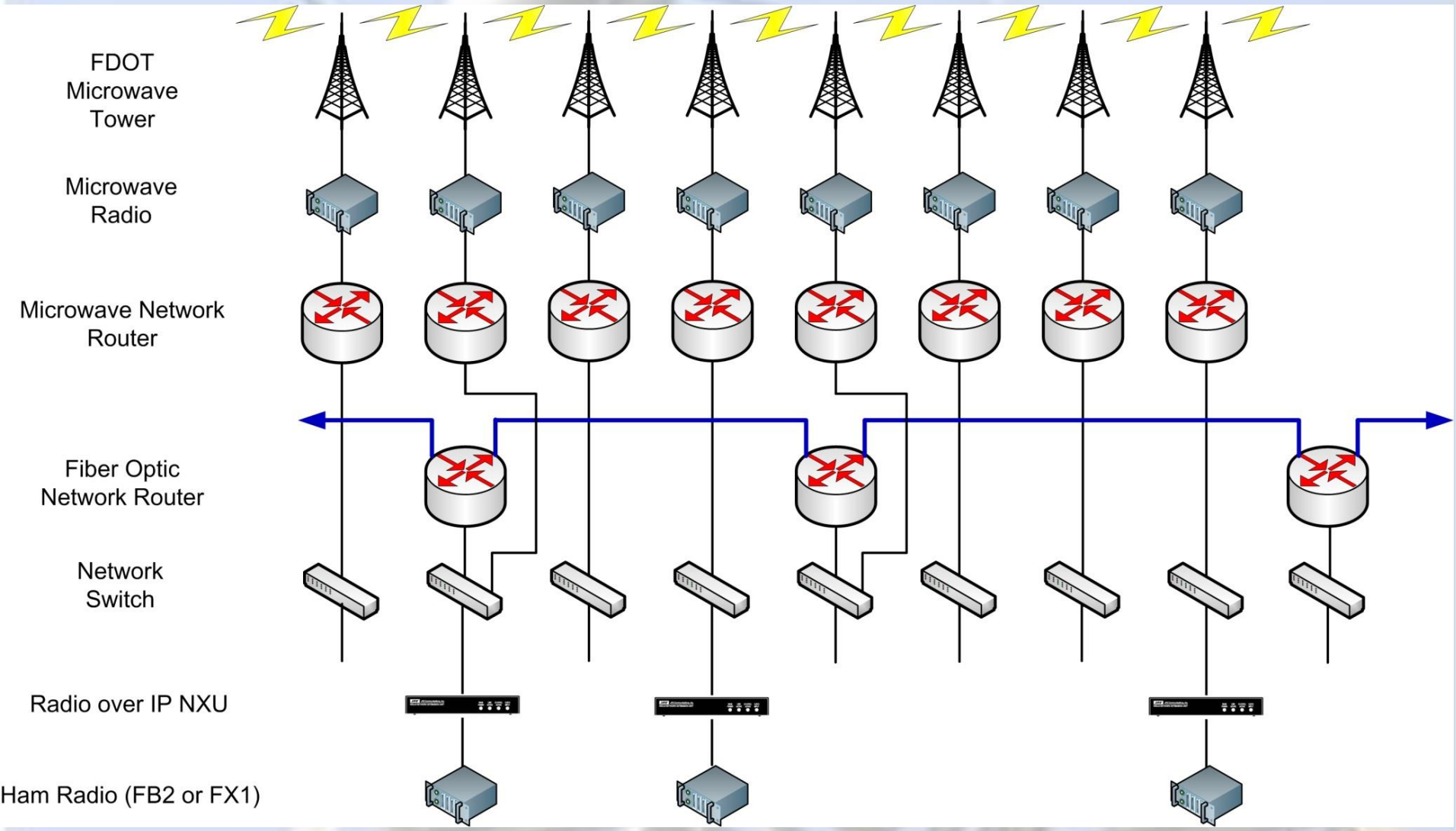


- The network side and Radio over IP (continued)
  - The J7 audio connection on the NXU-2A

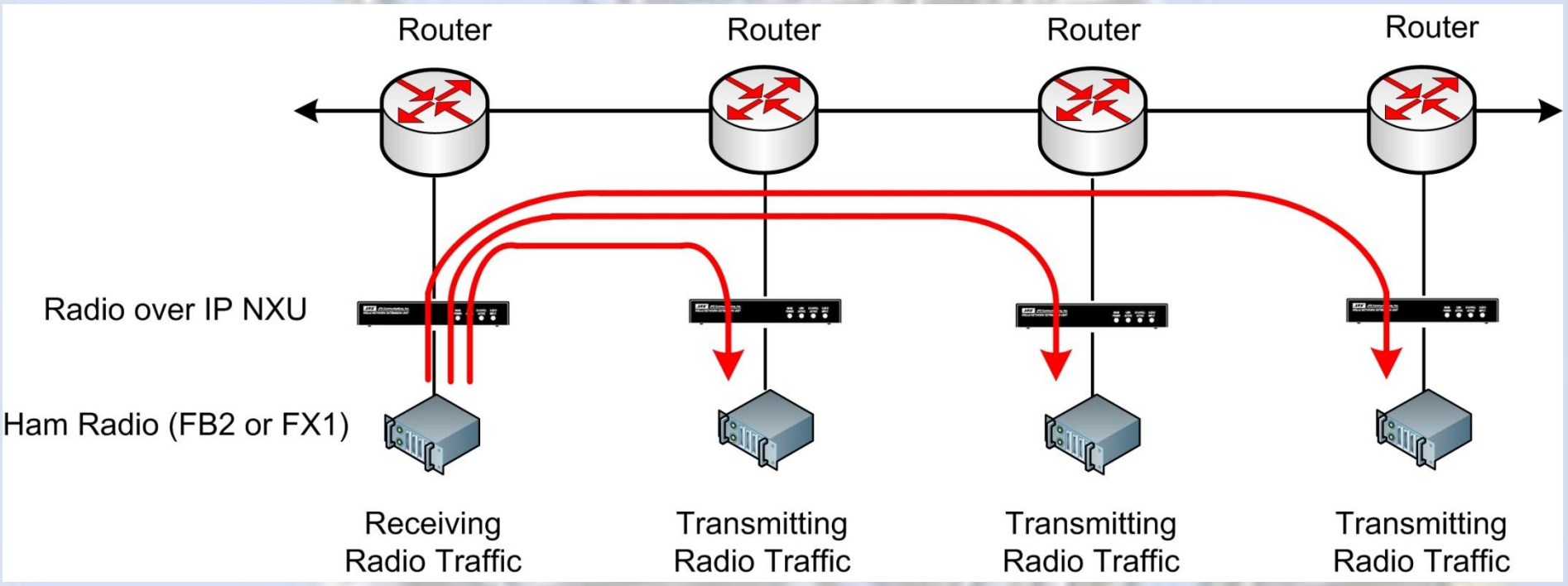
PIN	Signal	Description
1	Ground	Ground connection.
2		Not used.
3	/AUX In 0	Auxiliary Input 0 - Active low.
4	/AUX Out 0	Auxiliary Output 0 - Active low.
5	Ground	Ground connection.
6	Audio Input	Balanced audio input.
7	Analog Ground	Analog ground.
8	Audio Output	Unbalanced Audio output.
9		Not used.
10	/AUX In 1	Auxiliary Input 1 - Active low; general purpose.
11	/AUX Out 1	Auxiliary Output 1 - Active low; general purpose.
12	/COR Input	Input from radio COR, programmable active high or low.
13	/PTT Out	Output to radio PTT, active low, open drain.
14	Audio Input	Balanced audio input.
15	Analog Ground	Analog ground.

- The network side and Radio over IP (continued)
  - The backhaul network is an IP routed mesh network that traverses the statewide microwave and fiber networks.
  - The network connection at each SARnet node site is a T1/Ethernet router and Ethernet switch
  - The microwave and fiber connections tie the routers together in a statewide mesh topology

- The network side and Radio over IP (continued)
  - A little linear piece of the network topology



- The network side and Radio over IP (continued)
  - Traditional conference style VoIP and RoIP
  - The contributing node puts a copy of the audio on the network for each destination.
  - If there are 30 nodes then there are 29 copies.



- The network side and Radio over IP (continued)
  - The alternative to conference bridging is IP Multicast
  - From a Raytheon App note……

Raytheon

Application Note: AN-3013-2

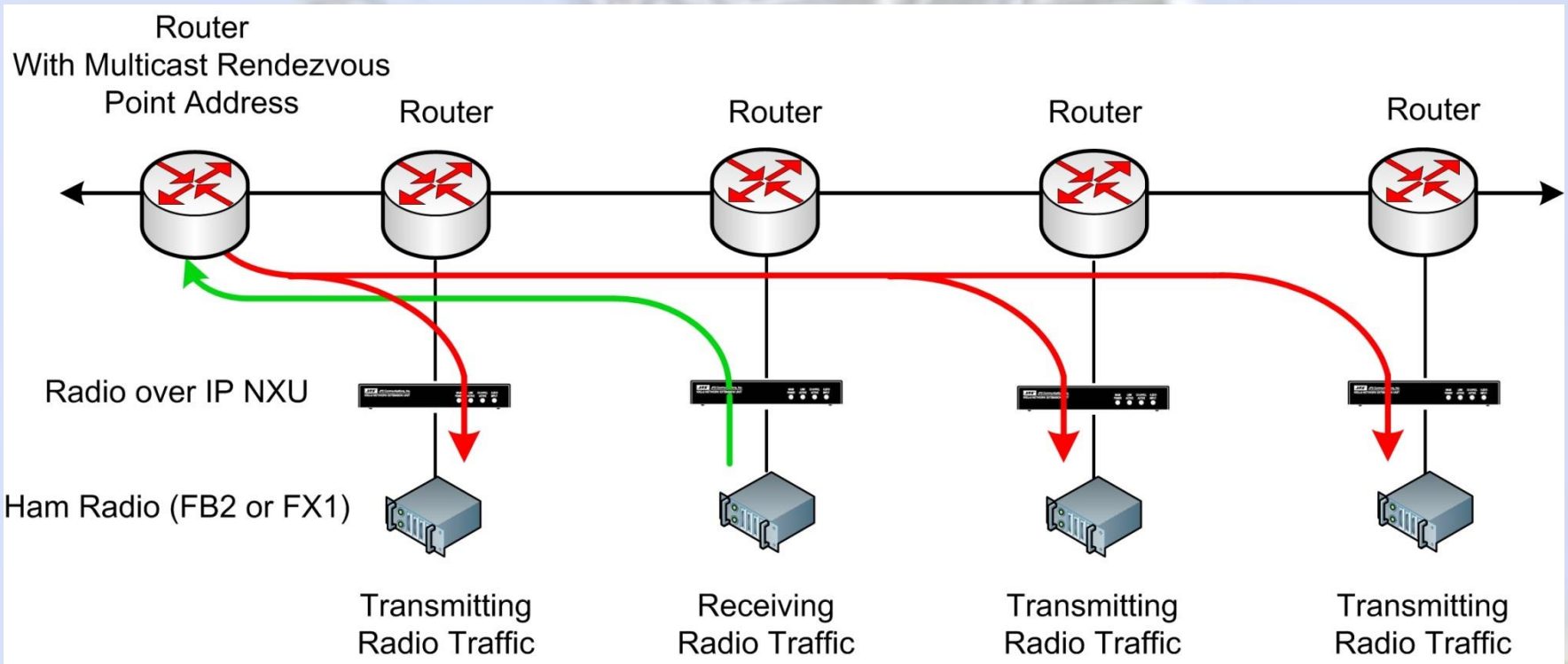
In terms of the NXU, not only does Unicast create network congestion (see previous diagram), but Unicast requires (5) source host NXU's to support the (5) destination hosts.

Raytheon's VoIP/RoIP capable products, by default, function in Unicast mode. Point-to-point network associations between the following modules are common:

- NXU to NXU
- NXU to DSP-2
- NXU to PCNXU
- DSP-2 to PCNXU
- DSP-2 to DSP-2

IP Multicast is a multifaceted networking algorithm that is defined by many mystifying protocols that encompass legacy and emerging techniques, of which will not be addressed in this application note. However, we will discuss some of the basic principles with regards to the NXU and multicasting of its VoIP/RoIP data, and how we can create successful multicasting applications that can be useful in land mobile radio communications.

- The network side and Radio over IP (continued)
  - Multi-cast style VoIP and RoIP
  - The contributing node sends one copy of the received audio to the Multi-cast rendezvous point.
  - All Multi-cast clients listen to the same copy of the traffic rebroadcast by the Multicast rendezvous point.



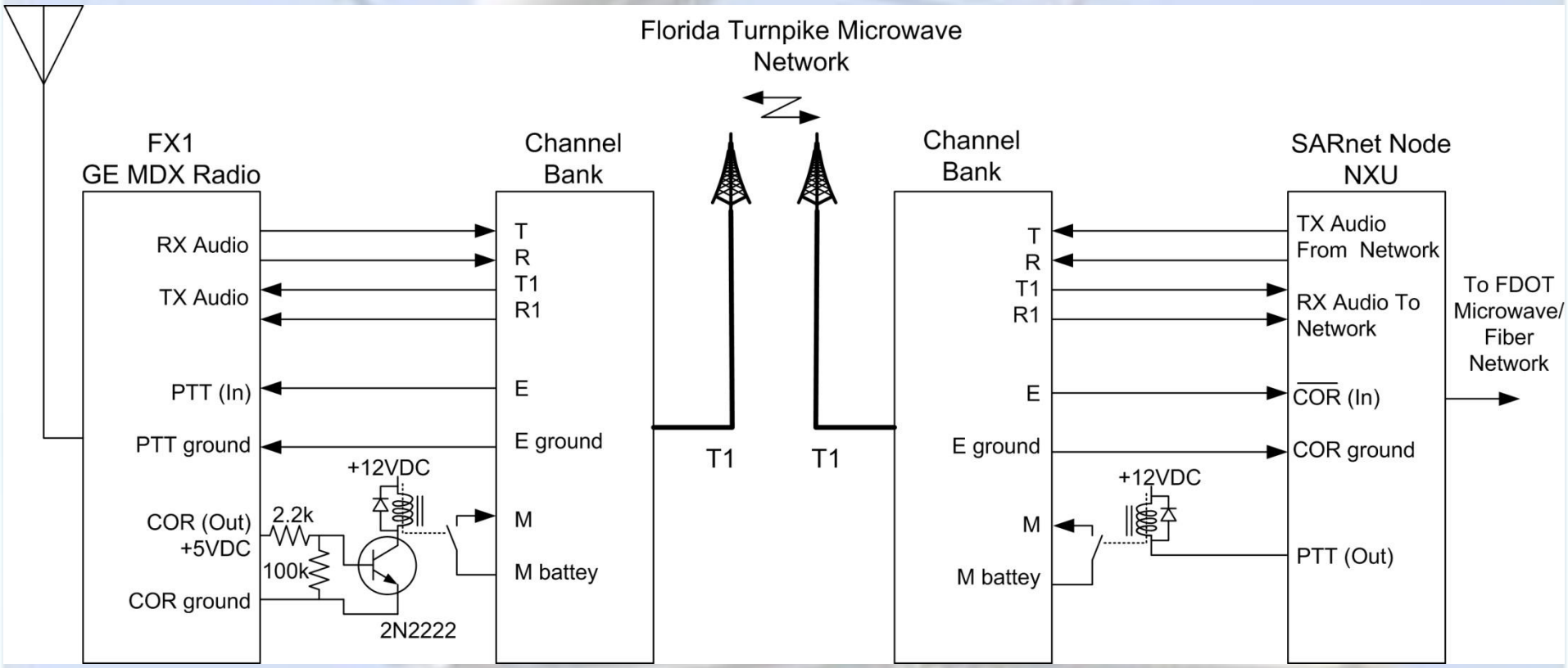
- Multicast Timing and Why I Need to Pause….Before Keying
  - When a SARnet node radio provides a COR signal and received radio audio to the NXU, the NXU tells the Multi-cast network that it is the “Master”.
  - All other NXU’s declare themselves slaves and ground their associated PTT signal (activating it).
  - The Master then begins broadcasting audio over IP packets to the Multi-cast rendezvous point and from there out to the slaves who send the audio out to their connected radios.
  - When the Master’s COR signal ends, the Master stops sending audio into the network and the slaves raise their PTT signals terminating radio transmission. The last Master remains the Multi-cast master until a new site takes over.

- Multicast Timing and Why I Need to Pause….Before Keying (continued)
  - If a slave happens to be an FX1 then it has been transmitting via radio to a radio connected repeater whose squelch tail continues after the slave terminates the PTT signal.
  - The FX1 radio will hear the squelch tail and immediately set its COR line (if the repeater sends tone during the squelch tail).
  - This could be a problem if it were not for the ability of the NXU to inhibit the detection of the COR immediately after a transmission for a designated number of milliseconds (2000)

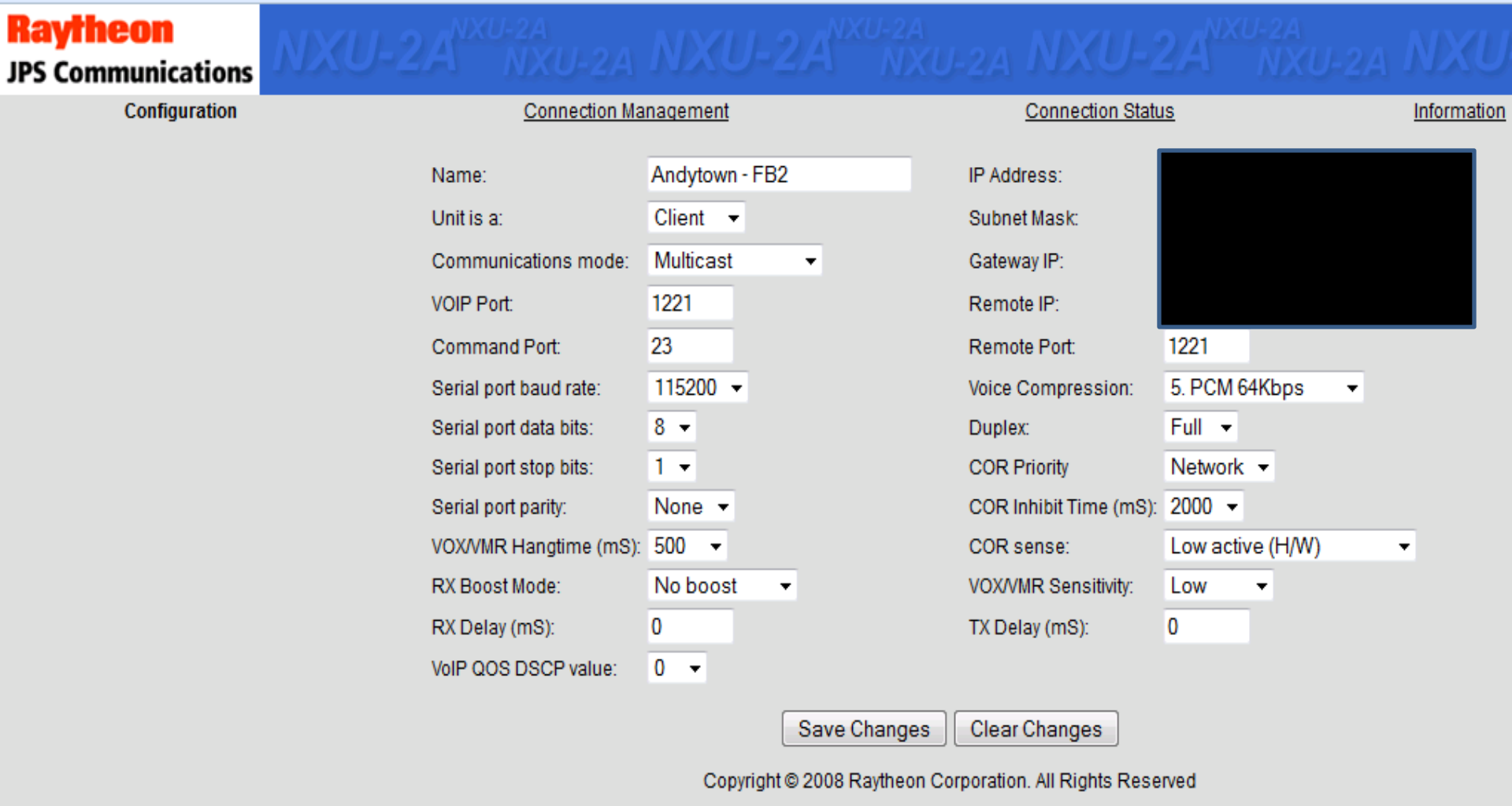
- Multicast Timing and Why I Need to Pause….Before Keying (continued)
  - The delay helps to keep the repeaters on SARnet from “ping-ponging”.
  - Early on it was discovered that without the 2 second COR inhibit repeaters on SARnet would hear a site ker-chunk after clearing a transaction. This was the ping-pong effect.
  - It has also been discovered that fast and short responses are sometimes missed by FX1 sites that have a radio connection to a repeater with a long squelch tail, e.g. Orange City. This is likely related to this COR inhibit requirement and the turn around time for SARnet nodes to change from Master to Slave.
  - To mitigate these issues and ensure reliable comms, it is recommended that you pause before keying. (a second or two should do)

- Special Case: Palm Beach FX1
  - No FDOT microwave tower close by the 443.975 repeater.
  - Only a nearby Florida Turnpike tower.
  - Solution: run the FX1 audio, PTT, and COR over a turnpike analog microwave circuit to a joint FDOT/Turnpike microwave tower location where the SARnet node is located
  - The solution includes the use of a channel bank interface with Type 2 E&M signalling

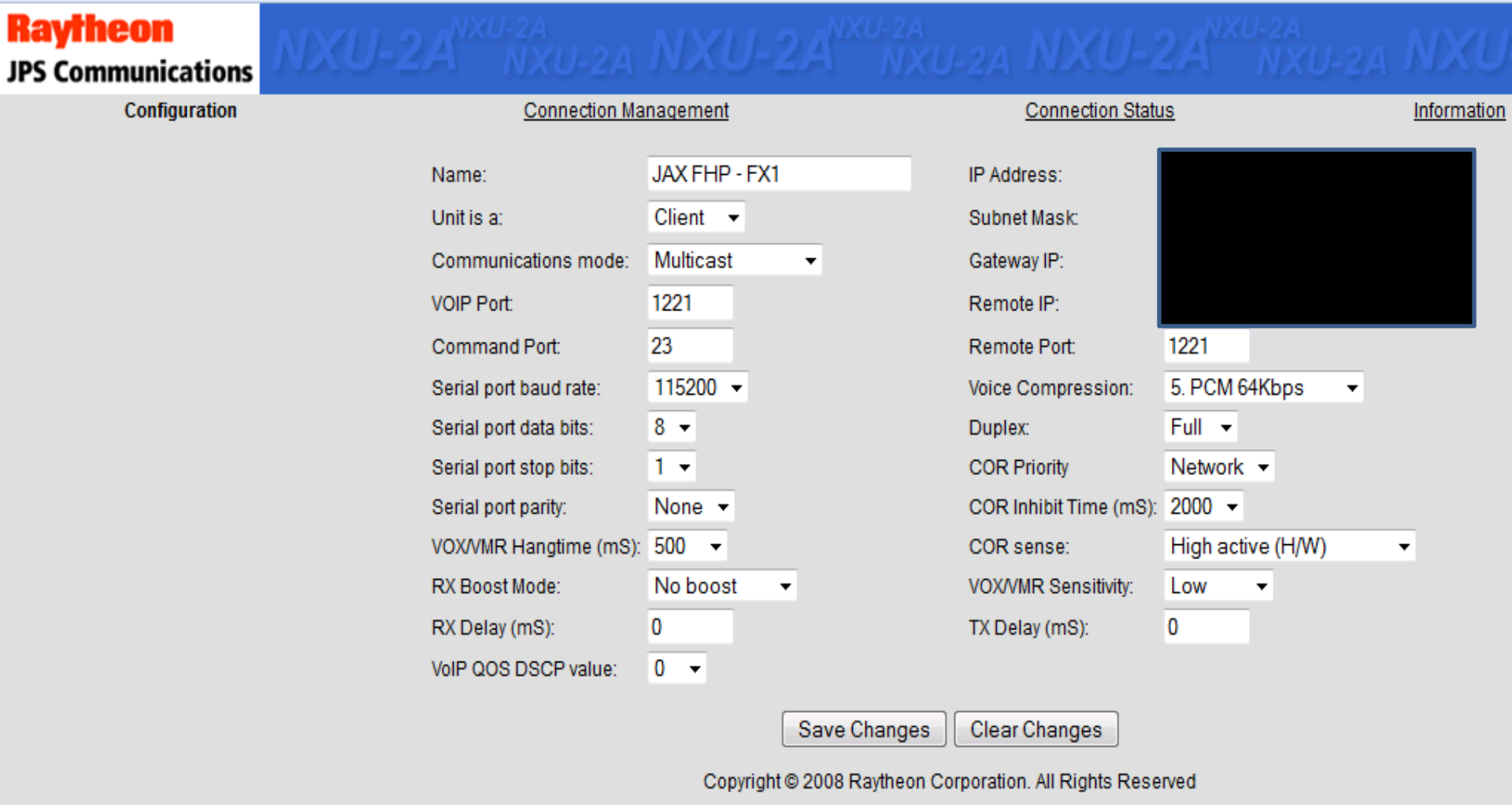
- Special Case: Palm Beach FX1 (continued)



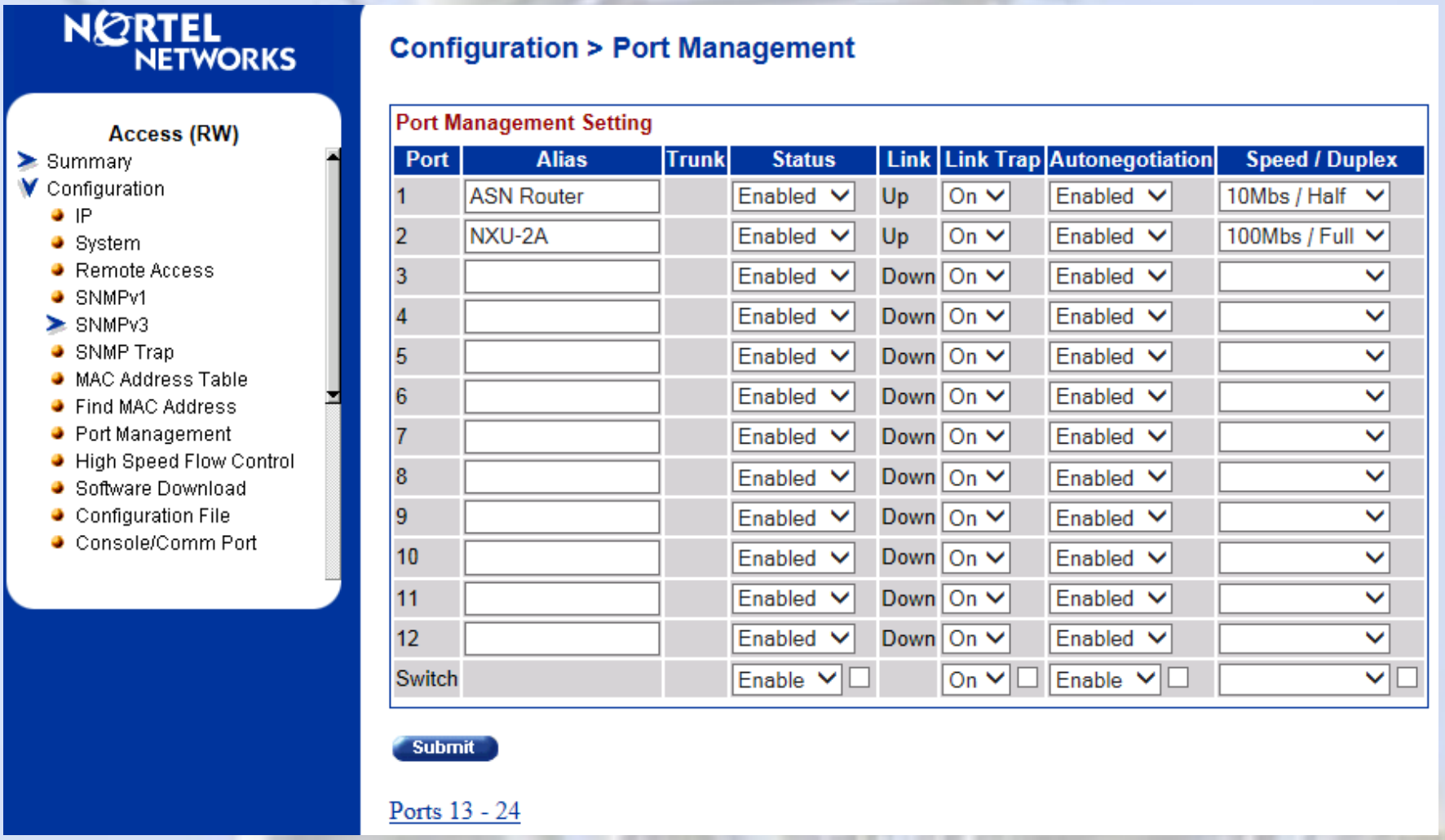
- How we Control and Monitor SARnet
  - Screen grab from SARnet node (FB2)



- How we Control and Monitor SARnet
  - Screen grab from SARnet node (FX1)



- How we Control and Monitor SARnet
  - Screen grab from remote login to FDOT switch



- SARnet and EMCOMM
  - County EOCs run a Friday morning net
  - NHC 444.6 MHz repeater at FIU is Miami repeater
  - State EOC can monitor SARnet in Tallahassee
  - FDOT microwave sites are hardened, have automatic propane generators and large storage tanks.
  - No internet use (see time lapse video of internet outage during Tropical Storm Sandy to understand why this is important for EMCOMM)
  - During an emergency it is hoped SARnet will be a contributing tool that is reliable and available

- Current Status and the Future
  - 18 SARnet nodes online.
  - At least nine more expected.
  - The FDOT is continuing to utilize the knowledge and experience it obtains from running the network side of SARnet.
  - The FDOT is planning to upgrade its statewide networks over the next ten years and it is anticipated that SARnet will continue to be a valuable test-bed for the advanced IP technologies associated with both the current and the new network

- Discussion
  - The www.sarnetfl.com homepage

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What is SARnet?

The Statewide Amateur Radio Network (SARnet) is a network of linked UHF voice repeaters that serves the State of Florida. The repeaters are operated by their local trustees and the network that connects them together does not interfere with the local use of the repeaters.

The key to this network is that it uses dedicated bandwidth that is separate from the internet. Statewide connectivity is achieved without the use of any commercial telecommunications services. SARnet does not use the internet, cellular telephones, or land lines.

Why was SARnet Started?

The state of Florida Department of

Is SARnet only for EmComm?

SARnet is a network of amateur repeaters. So no, it is not just for emergency communciations. That being said, the creators of SARnet are active in public safety communications, both commercial and amateur, so they have an understanding of what SARnet can do for emergency communciations in the state of Florida. Currently, the Duval County EOC conducts a brief check-in net on Friday mornings starting at approximately 0900 on SARnet and any amateur that can access SARnet is encouraged to check in (late check-ins are ok too).

During a significant emergency event, the SARnet may be called upon for support and radio traffic in and out of an affected area may become heavy. Under such a scenario, it is hoped that all of the local repeater trustees in the affected area will agree to let their repeaters continue to be used as part of SARnet.

(4:04)

9:54 AM
2/7/2015