

APCO Technology Forum

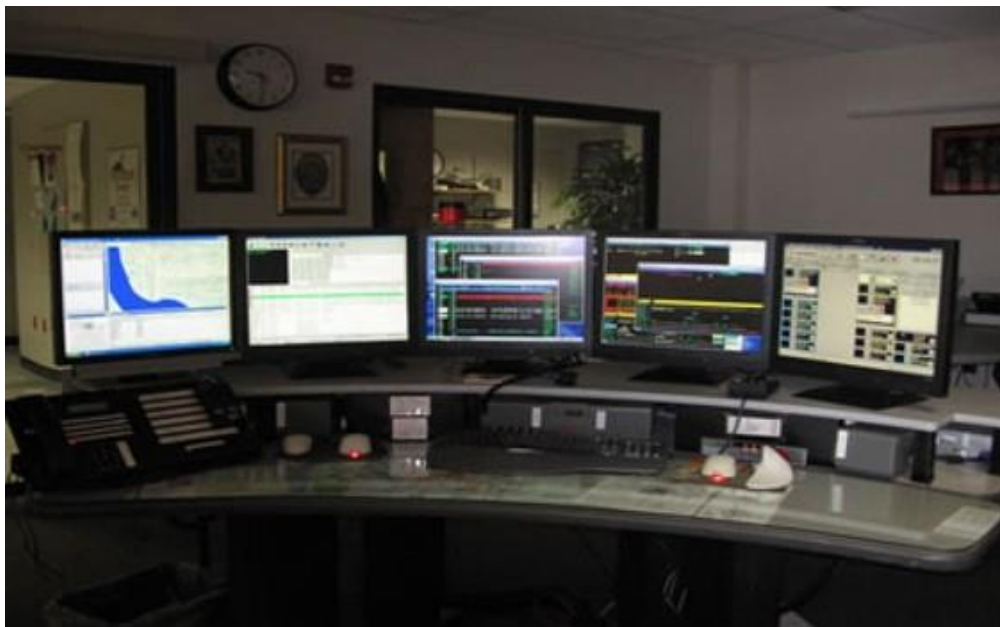
THE CONVERGENCE OF WIRELESS COMMUNICATIONS IN PUBLIC SAFETY

Andrew M. Seybold

February 26, 2014

Some Terminology

- NPSBN—Nationwide Public Safety Broadband Network
- LMR—Land Mobile Radio
- PSCR—Public Safety Communications Research (Federal Government organization assisting FirstNet)
- Off-Network—Device-to-device communications with no network connection, simplex/talk-around
- On-Network—Device using a network



Public Safety Communications

CURRENT STATUS



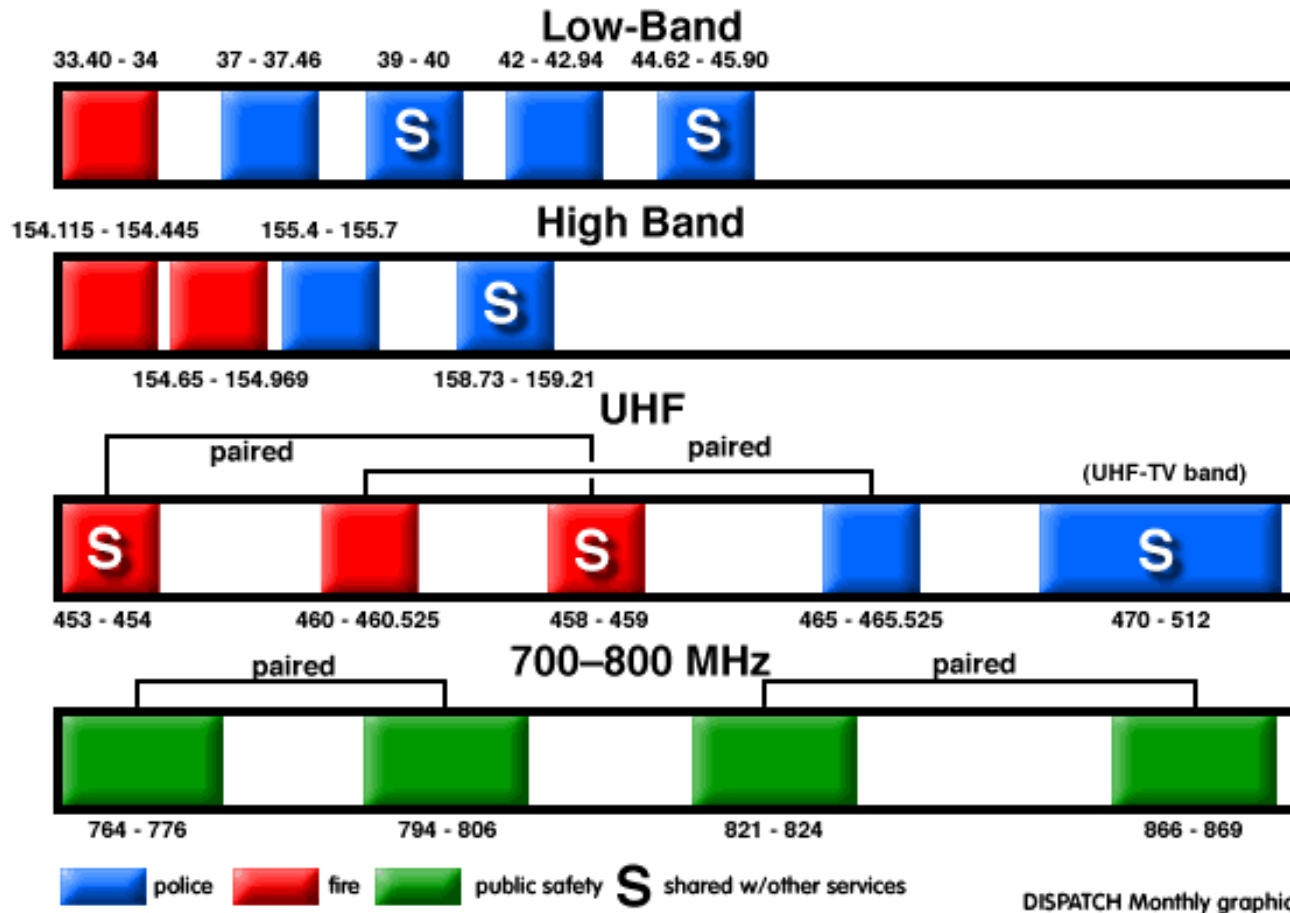
Public Safety Today

- Lack of true interoperability between agencies for voice
- Many departments employ two radios per vehicle in order to talk to other agencies (ave. \$10K per vehicle)
- Multi-band portables available but expensive
- Additional radio channels difficult to come by
 - New FCC rules limit output power based on height above average terrain
- FCC's narrowband requirement took effect Jan. 1, 2013
- Congress mandated T-Band (470-512 MHz) be returned to FCC by 2021

Public Safety Interoperability Issues

- FCC provided new spectrum to Public Safety over time
 - Started with 30-50 MHz, added 150-174 MHz
 - Then 450-470 MHz, next 800 MHz
 - Then came 470-512 (T-Band) in 11 metro areas
 - In some areas, 220 MHz, last was 700 MHz
- Result: No one band has enough channels for all services
 - Interoperability nightmare
 - 9/11 and Katrina: Responding units could not talk to each other— but we already knew this!
 - Per-vehicle cost for radios \$5K to \$10K!
 - Some Public Safety moving from analog FM to P-25 digital voice systems—still a lot of analog FM in use

Current Public Safety Spectrum



Can Voice over LTE Solve Interoperability Issue?

- Those in Congress, the FCC, the NTIA, and other U.S. government organizations believe so
 - AND believe it will be RSN (Real Soon Now)
 - Public Safety lost T-Band because of this belief
- Vendors saying they can do it now!
- More on this...

Voice over LTE: Reality Check

- There is no push-to-talk standard today
 - Each vendor offers proprietary PTT solution
 - 22 companies offer PTT over LTE but NONE of them will work with any of the others
- PSCR, 3GPP, and others are working on a standard
 - Best-guess timing: 2015 for NON-Public Safety Grade PTT over the NPSBN

LMR Voice: The Best Solution

- Even with interoperability issues, LMR voice is still best solution for long time to come
 - Interoperability is improving
- There is no data that proves whether the NPSBN can handle all of the Public Safety voice requirements plus data and video
- LMR systems need to be kept in place!



Adds Video/Data/GPS

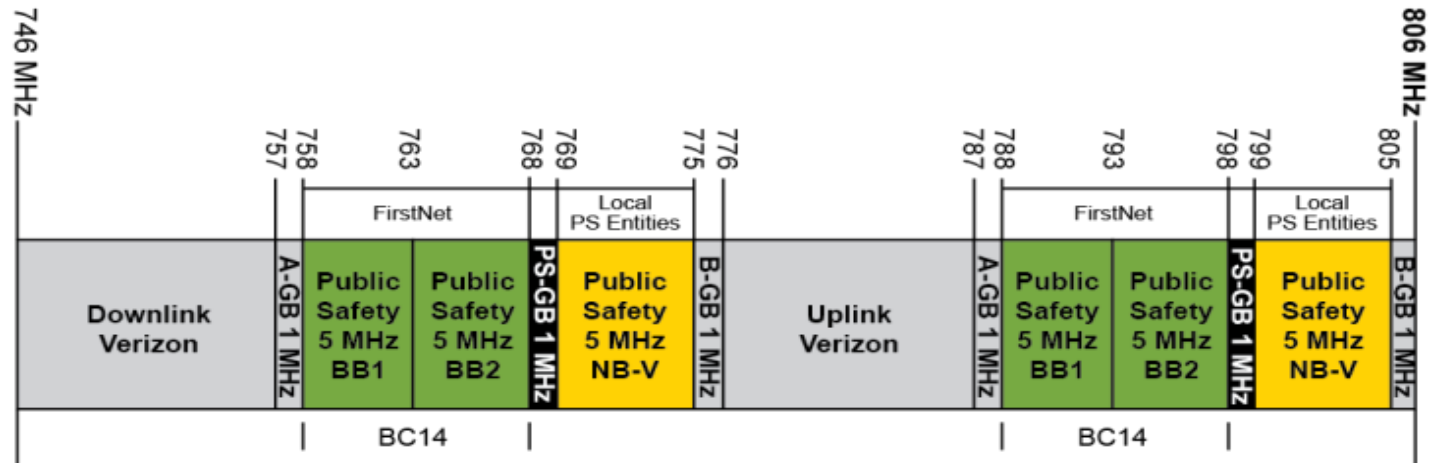
PUBLIC SAFETY MOVES INTO THE FUTURE

What Public Safety Broadband Is

- Starts with new, **Nationwide** Public Safety radio license for 20 MHz of 700-MHz spectrum
- Will be fully interoperable on nationwide basis
- Network will provide Public Safety with mission-critical
 - High-speed data/video services/GPS and more
 - Will provide same types of services citizens have with smartphones but on hardened, mission-critical network CONTROLLED by Public Safety, NOT commercial network operators
- Will be based on commercial 4G technology (LTE)
- Will bring Public Safety into 21st century
- **Will be MOST secure wireless network ever built!**

Public Safety 700-MHz Spectrum

Public Safety Spectrum Allocation in the 700 MHz Band



Public Safety 700 MHz Allocations

Total Allocation	34 MHz
Broadband Portion (10 x 10)	20 MHz
Narrowband Portion (6 x 6)	12 MHz
Guardband Portion (1 x 1)	2 MHz

Legend

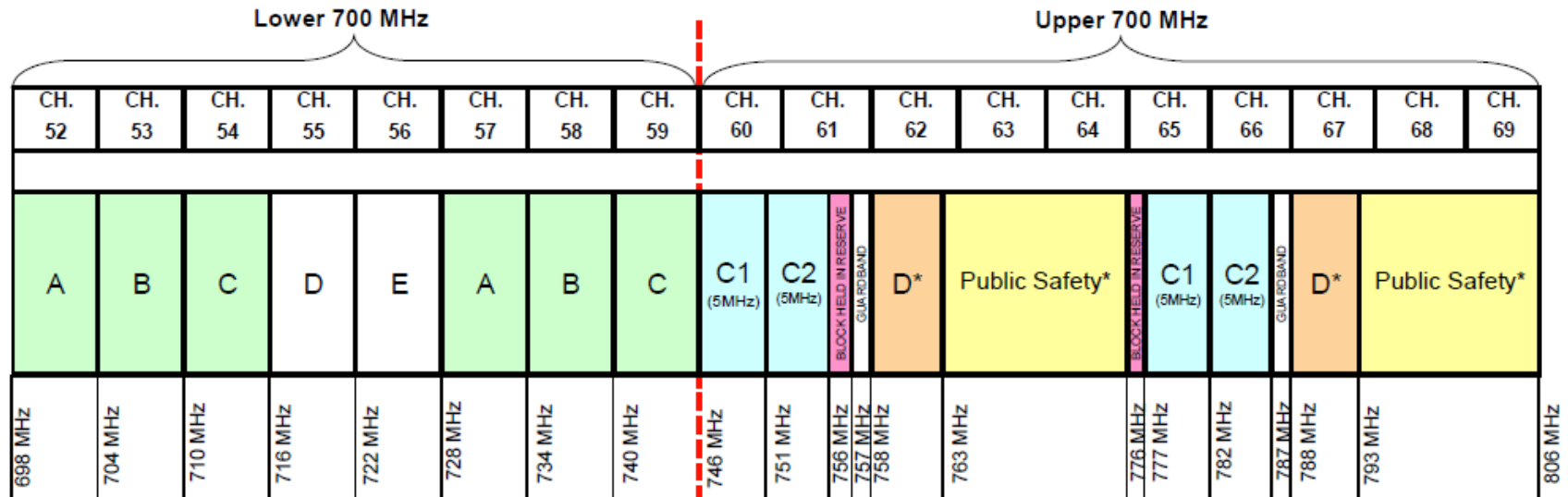
FirstNet = First Responder Network Authority
 PS Entities = Public Safety Narrowband Licencees

BB = Broadband
 NB-V = Narrowband Voice (e.g., P25 systems)
 PS-GB = Public Safety Guardband

 FCC allocated spectrum to public safety for broadband data services

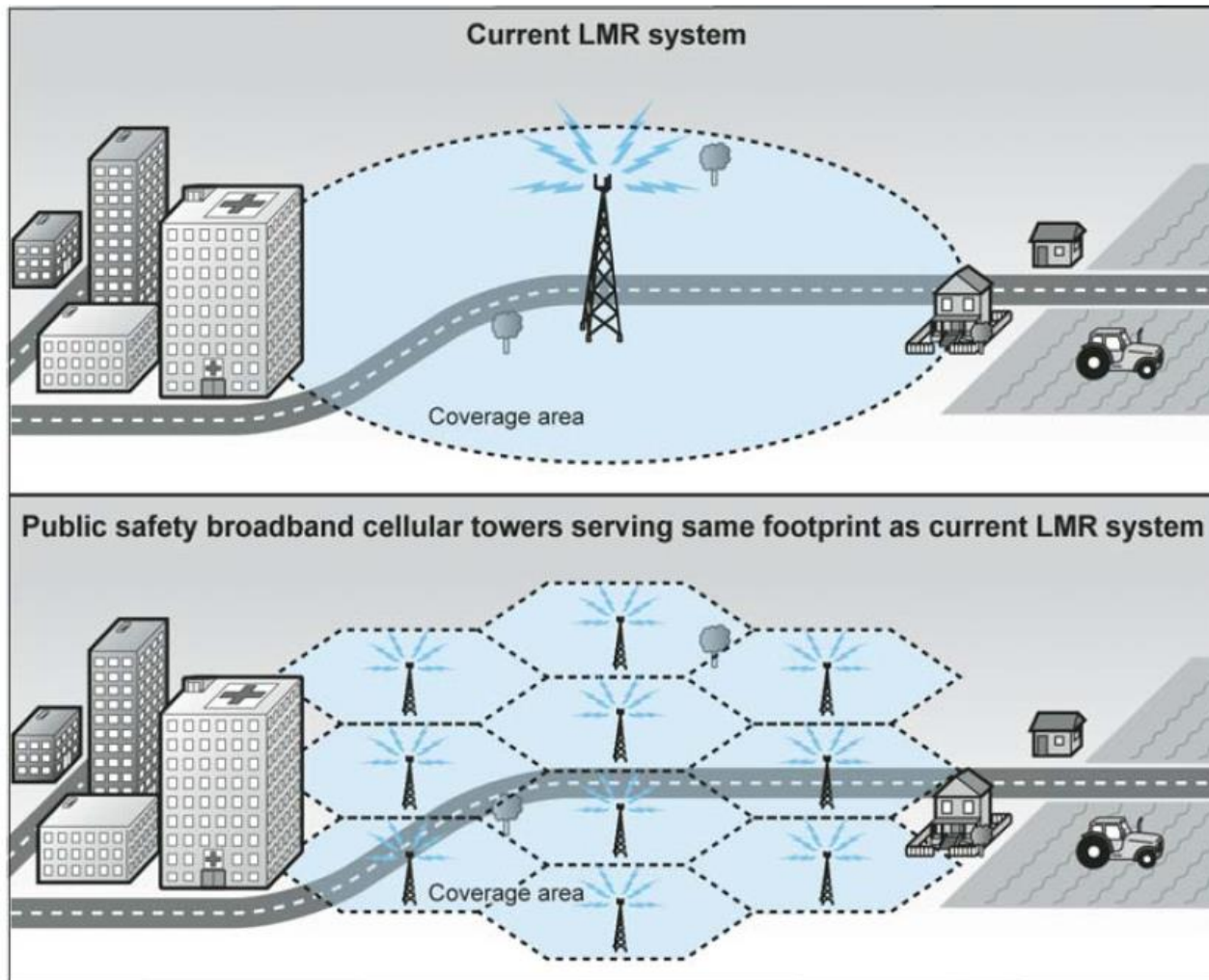
 Commercial Mobile Carriers

Entire 700-MHz Broadband Spectrum



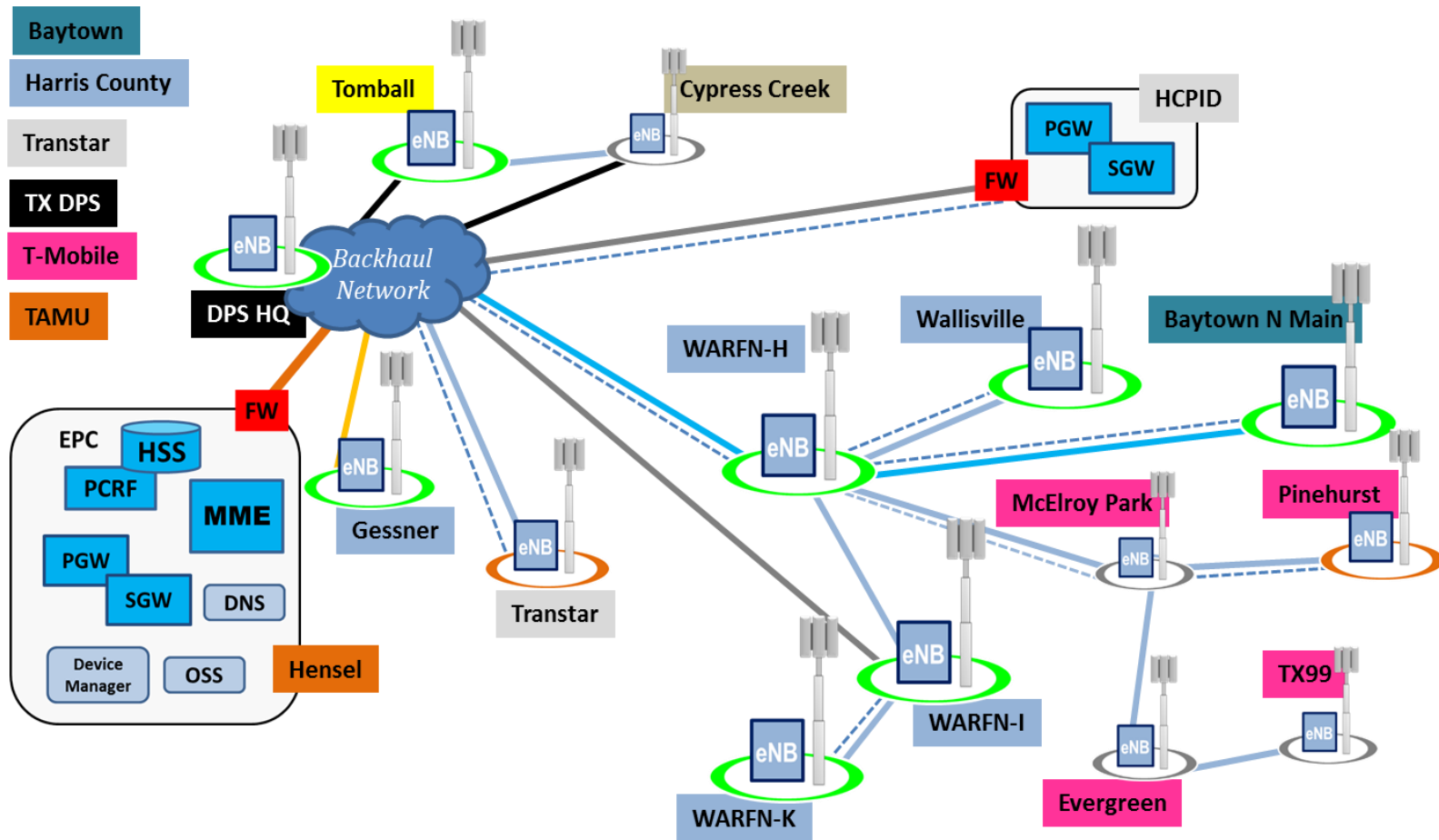
Lower 700 MHz: AT&T and small operators
Upper 700 MHz: Verizon and Public Safety

LMR and LTE System Differences



Source: GAO.

Harris County Texas Demo System



Voice and Data Convergence

WILL IT HAPPEN AND WHEN?

LMR and LTE Very DIFFERENT

- LMR
 - High-power, wide-area coverage
 - High power out to devices
 - High power from devices
 - Transmit as needed
 - Repeaters, simulcast, trunked systems
 - Multiple fallback modes
 - Systems have “graceful” degradation
 - Final fallback is simplex (talk-around)

LMR/LTE Differences

- LTE is cellular technology
 - Multiple cells to cover an area
 - Transmits 24/7 (cell sites)
 - Devices in constant contact with network
- Fallback mode
 - Today: NONE!
 - Future: Potential for talk-around or peer-to-peer (timing unknown)

LMR/LTE Differences (2)

- LMR systems in multiple bands
 - Major issue with lack of interoperability
 - Not enough channels in any single band
- LTE system is 20 MHz of 700-MHz spectrum
 - Verizon on one side, 700-MHz narrowband voice on other side
- LTE system will be shared by all first responders: fire, EMS, law, more

Before Total Convergence

- Can 20 MHz of LTE spectrum accommodate all voice/data/video first responder traffic?
 - Today there is no answer to this question
 - Data/video traffic will expand as more apps come onto the market
 - Video demand will soar as more devices come onto the network
- Spectrum may be shared with secondary users

Before Talking about Convergence

- Collect data/video usage information from actual incidents
 - Is there enough bandwidth/capacity for data/video during an incident
 - That occurs in a single cell sector?
 - That occurs in 2 or 3 cell sectors?
 - If there is excess bandwidth, how much?
 - Track routine data/video usage

Real-Time Load Testing

- During drills and exercises
 - Use the NPSBN for data and video
 - Check actual priority and Quality of Service
 - Find network breaking point
- After live incidents
 - Track actual data/video usage
 - Check loading of LTE signaling channel
 - Verify network speed/capacity and usage

Based on this Information

- Determine if there is sufficient capacity to add voice services
- One PTT standard is selected
 - Determine additional loading for PTT
 - Some existing proprietary PTT systems require that all active PTT users be “kept alive” by assigning network resources
 - During incidents within a single cell sector this could reduce data/video handling capacity

Points to Remember

- The NPSBN is shared bandwidth
 - All agencies involved in an incident will be sharing the network capacity
 - Units not directly involved in the incident may require capacity in same area for routine work
 - User priority will change based upon the incident

Small Steps toward Convergence

- My recommendations
 - No voice, NONE on NPSBN until it is up and running for data/video
 - Public Safety users are trained in its use
 - Devices are readily available
 - No push-to-talk over LTE until there is a 3GPP or Public Safety standard for PTT that is available to all vendors (no proprietary systems)

Next Steps

- Use LMR voice for all mission-critical voice communications
 - Connect LMR systems to NPSBN ONLY for interoperable PTT voice during an incident
 - Dial-up voice should not be permitted until network can provide go-anywhere coverage
 - Dial-up voice should remain on commercial networks
 - Remember, today if the NPSBN fails the devices become paper weights!

LTE Voice Moving Forward

- On-network voice
 - How many talk groups will it support?
 - How much network capacity will be consumed by voice services?
 - When (if ever) will it be able to replace LMR PTT voice services?
 - This decision should be made by the network users exclusively! (Public Safety)

LTE Off-Network Voice

- Off-network, simplex, talk-around PTT
- A MUST-have for Public Safety
 - Will the NPSBN be able to provide off-network PTT?
 - Public Safety Communications Research (PSCR) is working with 3GPP on this requirement
 - Many unanswered questions about off-network PTT over LTE—no idea on timing

Off-Network PTT over LTE

- Will it work both in and out of network coverage? (Required)
- Will it provide communications ranges equal to today's handheld LMR radios? (Required)
- Will it support multiple channels or talk-groups? (Required)
 - How many? (What is the right number? 50?)

Voice/Data/Video Convergence

- Some in a rush to move forward
 - Believe the NPSBN will provide full voice/data/video services for all first responders
 - Many articles, demos, and certainly many propriety PTT over LTE solutions
 - But reality is very different from the hype
- Let's not be in such a hurry!

Broadband Learning Curve

- Let FirstNet build the network
- Learn how to use it for data and video
- Bandwidth and capacity will be shared across all agencies in an area
- Treat the NPSBN as an augmentation of communications capabilities NOT a replacement (yet or ever?)

Before FirstNet Arrives

- Contract with one or more commercial LTE providers
 - Realize commercial LTE is NOT Public Safety grade
 - Networks can become congested during high-usage periods
 - Public Safety has no priority access
 - BUT it will help you learn what you can do!

All Public Safety Services

WILL SHARE LTE BANDWIDTH

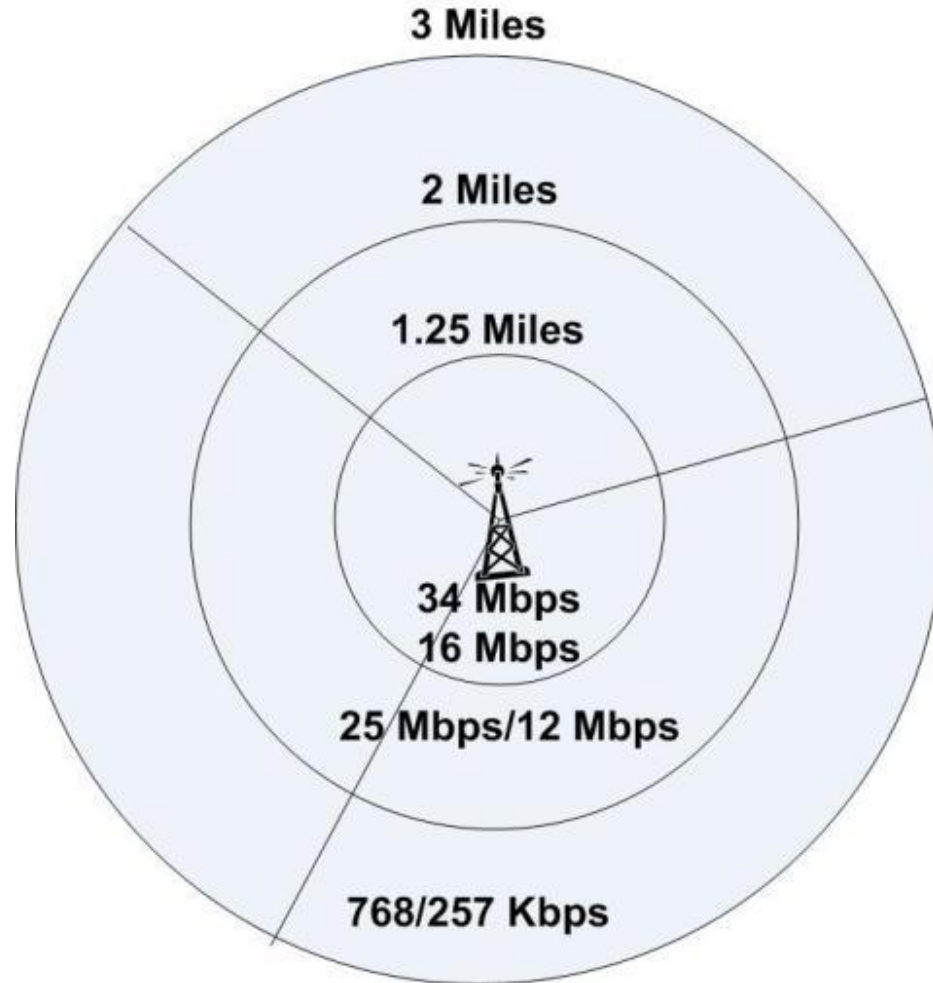
Typical LTE Cell Site at 700 MHz

Data speeds down to device/up from device

Capacity in each sector shared by all users in the sector

These are typical numbers, may vary from system to system

Many incidents will be limited to one or two cell sectors—shared by all



Shared Bandwidth/Capacity

- Bandwidth will not be an issue for
 - normal dispatch, patrol, location, and other services spread out over a city or county
- Where it becomes an issue
 - When a large incident occurs in a confined area
 - LTE coverage from only one or two cell sectors
- In this case, real-time network management will be required
 - Priority traffic settings, which videos are important
 - Change video resolution/frame rate
- Public Safety WILL have pre-emptive priority

It Is Important Therefore...

- For all Public Safety Agencies in an area to begin
 - Working together with Unified Incident Command
 - Identify who will be managing bandwidth at an incident
 - This spectrum will be shared by all agencies responding and MUST be allocated on a priority basis
 - Priorities can shift from law, to fire, to EMS during an incident
 - More use of Unified Command structure is essential

Moving Forward

VOICE AND BROADBAND CONVERGENCE?

The Wireless Landscape: Near Term

- Existing LMR systems for voice
- Broadband for data/video
- What can be shared between networks
 - Tower sites
 - Emergency Power
 - Backhaul
 - Separate voice and broadband devices

Wireless Landscape: 3-5 Years

- Shared IP backhaul
 - Microwave and fiber
- Shared tower sites
 - All should be Public Safety grade
- Using existing LMR sites will require
 - Upgrading back-up power
 - LTE transmits 24X7
 - Room for panel antennas

More Points of

REFERENCE

More Points of Failure for Broadband

- LTE networks built as cellular networks, without connectivity to back-end system, cell site won't be usable—NO fallback!
- Points of failure due to storm, fire, other events including
 - Antenna damage at site, damage to site
 - AC power loss, no generator and running out of battery back-up, generator runs out of fuel
 - Fiber or microwave backhaul is disabled

When Will the Network Arrive?

- Harris County Texas up and running
- BTOP Grant recipients will be next to build
 - These builds should be considered beta areas for the network
 - Use to prove out capabilities, capacity, operation of the network
 - These portions of the network will be proving grounds for FirstNet network, devices, applications, and security

Timeframe Moving Forward

- Much planning remains
- States all have their planning grants
- FirstNet sent out large number of RFIs
 - Many already being reviewed and compiled
- NPSTC and APCO working on what qualifies as 'Public Safety Grade'
 - Will serve as guideline for network build-out and hardening requirements
 - Includes site hardening for both LTE and LMR sites
- Best Guess: Network build-out will start in 2014/15
- Will take multiple years to complete nationwide

While Waiting for FirstNet

WHAT YOU CAN DO

Prepare, Test, and Learn

- Making use of the broadband network will require
 - Agencies working together closer than ever
 - At incidents involving law, fire, EMS
 - Bandwidth demands for all three
 - Priority traffic for all three
 - Some will also require capacity for ongoing field use
 - Network will have to be carefully managed

Working Together

- Better use of Unified Command structure
 - Who needs bandwidth when
 - May not be enough for all, must be on “need to have” basis
- Pre-planning cross-agencies a must
- Start now to work closer together
 - Practice incidents, tabletops
 - Real incidents, how much data/video is needed

Pre-Planning Is Essential

- Bringing video from the scene into a PSAP
 - Implications for dispatchers
 - How video priorities will be set, by whom
 - What is acceptable video resolution
 - From incident to IC/PSAP
 - From PSAP to IC and others at incident
 - There are companies working on video resolutions/compression/switching systems
 - Different types of incidents will require different types of video resolution

During an Incident

- Who determines what video is needed
 - Initial response
 - After incident command has been established
 - After incident is under control
- How much capacity do EMS teams need
 - From scene for vital signs/ultrasound
 - For video triage
- Who else needs access

There Will Be a Learning Curve

- Not only in what the network will do
- How each city/county will allocate network resources during incidents
- This will be a nationwide network BUT controlled locally
- Local control means managing the network
- Across ALL first responder services

Recapping

CONCLUSION

LMR and LTE Convergence

- IF it happens it will take many years
 - Public Safety Grade VOICE is NOT dial-up!
- There will be convergence
 - Backhaul
 - Radio sites
 - NG 9-1-1 broadband requirements
 - Dispatch and PSAP integration

Convergence Over Time

- Devices
 - LMR and NPSBN devices are different
 - Different uses, different requirements
 - We will see convergence over time
 - From two devices to one combined device
 - Perhaps some day LTE will handle all Public Safety traffic—but not for a very long time
 - Move slowly, don't bet on what you are told by vendors—bet on what you know!

Backhaul and System Back-Ends

- As we move more and more into an IP world
 - There will be more opportunities for back-end convergence
 - Digital LMR, LTE, NG 9-1-1
- BUT: Don't confuse IP with the Internet
 - Make sure you can isolate ALL of your networks from the Internet if needed

Radio Site Convergence

- Your LMR sites should be considered prime locations for NPSBN sites
- Many LMR sites already Public Safety Grade ready
 - Work with your state—have your locations well documented
 - If locations are LTE-ready, that is a plus
- Commercial sites used to fill in gaps!

Final Thoughts

- Convergence does not have to be about radio channels: voice/data/video
- Convergence is about sharing resources
- As you build and upgrade consider the future
 - More broadband back-end, more sites
 - What resources can be shared to save money and aid in making your systems more robust?

One Final Reminder

- Using commercial LTE will help prepare for FirstNet!
- *BUT* understand the differences between commercial networks and what is coming on FirstNet
- On commercial networks you will have
 - No priority access
 - Slower data speeds (good for learning)
 - Differing capacity issues depending on how many commercial users are sharing same cell sector
- MOST OF ALL
- ***DURING MAJOR INCIDENTS YOU MAY HAVE NO ACCESS!***

Q & A



Follow APCO at...



facebook.com/apcointernational



[@apcointl](https://twitter.com/apcointl)