APCO Technology Forum

PUBLIC SAFETY BROADBAND
(LTE201)

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Disclaimer

- Andrew M. Seybold serves as a Senior Public Safety Communications Advisor to FirstNet (A Contractor)
- Andrew Seybold is representing himself and NOT FirstNet in this presentation
- The views expressed in this presentation are his own and not based on any inside information obtained from FirstNet
- None of his comments are to be construed as FirstNet policy
- Andrew Seybold is a consultant, writer, and educator in the field of wireless communications
- Clients include Public Safety Agencies as well as Commercial Wireless Operators in addition to FirstNet
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 ($10K per vehicle average cost)
- Multi-band portables are available but very expensive
- Additional radio channels hard 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 that 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
  » 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
PUBLIC SAFETY MOVES INTO THE FUTURE

Adds Video/Data/GPS
Public Safety Broadband, What It 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 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

<table>
<thead>
<tr>
<th>746 MHz</th>
<th>756 MHz</th>
<th>766 MHz</th>
<th>776 MHz</th>
<th>786 MHz</th>
<th>806 MHz</th>
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<tr>
<td>Downlink</td>
<td>FirstNet</td>
<td>Local PS Entities</td>
<td>Uplink</td>
<td>FirstNet</td>
<td>Local PS Entities</td>
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<tr>
<td>Verizon</td>
<td>Public Safety 5 MHz BB1</td>
<td>Public Safety 5 MHz BB2</td>
<td>PS-GB 1 MHz</td>
<td>A-GB 1 MHz</td>
<td>Public Safety 5 MHz BB1</td>
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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 Licensees
- 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
The 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

Current LMR system

Coverage area

Public safety broadband cellular towers serving same footprint as current LMR system

Coverage area

Source: GAO.
Harris County Texas Demo System
LTE: Long Term Evolution

4G Wireless Technology

WHAT LTE IS

<table>
<thead>
<tr>
<th>3GPP Release</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
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<tr>
<td></td>
<td>Launched LTE</td>
<td>Bucket List Items</td>
<td>Carrier Aggregation, CoMP, LiPA M2M etc.</td>
<td>Carrier Agg. improvements IMS, roaming, P2P, etc.</td>
<td>WiFi, Small Cell improvements, signaling opti., SON, MDT, adv. receiver, MIMO improvements,</td>
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<td></td>
<td>(Regulatory, etc)</td>
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<td>Improved Performance</td>
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<tr>
<th></th>
<th>Rel. 8 LTE</th>
<th>LTE-Advanced</th>
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<tr>
<td>Peak data rate</td>
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<tr>
<td>DL</td>
<td>300 Mbps</td>
<td>1 Gbps</td>
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<tr>
<td>UL</td>
<td>75 Mbps</td>
<td>500 Mbps</td>
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<tr>
<td>Peak spectrum efficiency [bps/Hz]</td>
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<tr>
<td>DL</td>
<td>15</td>
<td>30</td>
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<tr>
<td>UL</td>
<td>3.75</td>
<td>15</td>
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</table>
What LTE Is

- LTE stands for Long Term Evolution
  - Standard developed by 3GPP organization
  - Networks and vendors tired of 1G, 2G, 2.5G, 3G names; LTE is really 4G technology
  - Unlike 1G, 2G, 3G that were designed for voice first with data added, LTE was designed for broadband data services first and foremost
    - Voice, using Voice over LTE (VoLTE) will be an add-on (at some point)
  - All-IP network
  - used by commercial networks
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
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 start:
  - 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
The Differences

BROADBAND VERSUS LMR SYSTEM DESIGN
LTE Broadband System Design

- LMR Systems Base
  - High-level sites
  - High-power transmit
  - Transmit as needed
  - Coverage 20-40 miles
  - Omni antenna

- LMR Mobile/HT
  - High power (5-100W)
  - External antennas
  - Talk-around simplex

- LTE Broadband Cell
  - Low-level sites
  - Low-power transmit
  - Transmits 24/7
  - Coverage 1-3 miles
  - Sectored antennas

- LTE Devices
  - Low power (250 MW)
  - Built-in antennas
  - MUST use cell site
Other Differences

• LMR
  – Wireline/control station/microwave
  – Low capacity requirements
  – Dumb networks
    • Trunked are semi-smart
  – Set and forget
  – External spkr/mic
  – Channel change by user

• LTE Broadband
  – Fiber/microwave
  – High capacity
    • 50+ Mbps per site
  – Smart cell sites
  – Requires network core
  – Modify parameters to handle data demand on real-time basis
  – Channel change by network
Typical LMR System Diagram
Typical LTE Broadband Systems
LMR AND LTE TERMINOLOGY

- LMR
- PTT
- LTE
- Base Radio
- Simplex
- Talk Around
- eNodeB
- RAN
- IMS

LMR AND LTE TERMINOLOGY
LMR and LTE: Different Languages

LMR Speak
- Base station/repeater
- Tower/radio location
- Mobile/HT
- Omni-directional antenna
- Output power in Watts
  - 5 Watts = 37 dBm
- Connection to dispatch
- Simulcast
- Narrowband Voice

LTE Speak
- eNodeB
- RAN (Radio Access Network)
- User device
- Sectorized antennas
- Output power in dBm
  - 250 MW = 23.98 dBm
- Network backhaul
- Multi-cast (future)
- Broadband data
LTE Architecture: A Complex Network
LTE Systems Basics

• LTE:
  – is a complex broadband cellular architecture
  – has many built-in system and user controls
    • Some can be static, others designed to be changed dynamically

system design differs from LMR system
design in many ways

• More, lower-level cell sites: Lower-powered user
equipment: Optimized for data and video today
More Points of Failure for Broadband

• LTE networks built as cellular networks—without connectivity to back-end system, cell site won’t be usable

• 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
    • Used 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

- Lots of planning remains
- States all have their planning grants
- FirstNet has sent out large number of RFIs
  - Many are all ready being reviewed and compiled
- NPSTC and APCO working on what is ‘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
- Will take multiple years to complete nationwide
While Waiting for FirstNet

WHAT CAN YOU DO?
Prepare, Test, and Learn

• Making use of the Broadband network will require
  – Agencies working together closer than ever before
    • 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 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
Commercial Networks for Broadband

- Commercial 3G and 4G caveat
  - Commercial MAY offer some form of priority access, but not pre-emptive priority access
    - One reason Congress agreed Public Safety needs its own network
  - During times of major incidents, commercial networks may be overcrowded; Public Safety may not have access
  - If device cannot communicate with signaling channel, network will have no idea you are attempting to access it
Commercial Networks for Broadband (2)

• For this reason and others
  – Do NOT consider commercial networks as mission-critical networks
  – Understand their shortcomings as well as their advantages

• However
  – Making use of commercial networks before, during, and after NPSBN is deployed makes sense.
MAKING USE OF
COMMERCIAL NETWORKS

Hands-on with LTE
Start Now with Commercial Networks

- Four commercial networks are deploying LTE
  - AT&T Wireless
    - Fall-back to HSPA and HSPA+ (3G)
  - Verizon Wireless
    - Fall-back to CDMA EV-DO Rev A
  - Sprint/Nextel
    - Fall-back to CDMA EV-DO Rev A
  - T-Mobile
    - Fall back to HSPA+
- Networks continue to roll out more LTE coverage
  - Only AT&T, Verizon have deployed 700-MHz LTE
Getting Started

- If you have not already deployed commercial broadband
  - Take it slow: You don’t have to equip all first responders at first
  - Make sure police, fire, EMS all have subscribers to experiment with interoperability between departments
  - Choose devices that meet your needs
    - Vehicular modems for laptop-equipped vehicles
    - Tablets for Chiefs, Command Staff, Investigators, Incident Command
    - Smartphones
  - Work with network operators/vendors for security of the network
    - Virtual Private Network (VPN) connections, secure applications
    - Locked devices in the field
FirstNet May Start at Street Level

- Vehicular modems are best place to start
  - If you already use laptops, new LTE modems can be easy deployed
  - If you already use low/speed text-based applications, today’s LTE modems will let you move into more robust data and video world
  - You can purchase modems “FirstNet”-ready
Choosing a Commercial Network

• Caveat
  – During Incidents, commercial networks may become overloaded and not available

• Determine which network provides best coverage in your area
  – Which has best overall coverage to handheld devices
  – Ask for drive test information from each
Choose One or More Networks

• It is possible to contract with more than one network operator
  – There is no LTE roaming between major networks today, but some devices will enable a session to remain up when switching
  – One contract for each network OR primary contract with one and a bucket of data from a second network
    • Play them against each other
LTE Commercial Contracts

• The more users you sign up, the less the cost per user (normally)
  – Work cross-agency in your area to achieve maximum number of units and best pricing

• Commercial networks want your business
  – Now and after FirstNet is live for routine traffic
  – Will work with you and your organization to have you up and running over broadband
What You Can Do over LTE

• Send and receive videos
• Send and receive pictures
• Faster, more complete license plate checks
• Building plans to first-in responding units
• More advanced EMS diagnostics
• Much more
What Applications Are Available

• APCO Application Community (APPCOMM)
  – Various applications including FBI Child ID, EMS, utilities, local police, fire and EMS applications, learning tools, resource books, many more

• Smith Micro, Motorola Solutions, many more

• Many in development
Applications

• GPS and voice-enabled navigation apps
  – Real-time route traffic updates
• Location of needed incident resources
  – Location of all responders regardless of agency
  – Other resources such as fire hydrants
• NCIC access (must be secure)
• Online report preparation and submittal
• Missing persons pictures
• Fingerprints from the field
CAD to the Field

• Many CAD companies have, or are developing CAD extensions for sending call data to responding units
• Many existing text-based apps being upgraded to take advantage of broadband
• Harris County Texas has number of applications up and running
• More to come soon!
CAD to the Field

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• Many existing text-based apps being upgraded to take advantage of broadband
• Harris County Texas has number of applications up and running
• More to come soon!
Once You Are Connected

• Try the network, both data and video
• Send and receive information not only with your own department but to other first responders in your jurisdiction as well
  – Get used to sharing incident information among law, fire, and EMS
• Unified Incident Command will be more important than ever after FirstNet is in operation
  – Practice network sharing during incidents
Learning about Broadband Now

• Makes sense
• Will reduce training time on FirstNet
• Will teach how to share data
• Will jumpstart advantages of data and video capabilities
• First responders will learn to work closer together
• Remember: Commercial networks are NOT mission-critical and can become congested
• During major incidents, commercial networks may not be available for use
BROADBAND DEVICES
Broadband Devices

- Start out with mobile-only modems
- Next, tablets for command, control, reporting
- Others will evolve over time
  - Separate LTE and LMR handheld devices
  - Combined LTE and LMR devices
- **Someday** perhaps a single LTE device for voice, data, and video
LTE Band 14

HANDHELD DEVICES
First Responders and Smartphones

• Today’s smartphones are not one-handed devices
  – Require two hands to operate
  – Most use touchscreen
  – Not a problem when first responder is patrolling or sitting in a vehicle BUT it is a problem when on an incident
  – Today’s smartphones not designed for harsh environments
  – Touchscreens not conducive to use when wearing gloves

• Hardened devices are coming but most vendors do not understand one-handed requirements of Public Safety
  – If used in the field, will augment but not replace existing LMR radios for the next few years at least
Law Enforcement and Other Responders

- Will Public Safety REALLY use both hands on a device?

Will they use two hands during even a routine traffic stop?
Getting Ready to

MOVE FORWARD WITH LTE
Commercial Networks

• Commercial 3G, 4G networks have good coverage today
  – AT&T, Verizon use 700-MHz band for LTE so coverage and building penetration will be similar
  – Sprint, T-Mobile deploying LTE on higher spectrum
    • Coverage will be good but different from 700-MHz coverage

• Commercial operators want your business
  – Make them earn it with pricing and compatibility guarantees
  – How much will it cost per user per month?
  – Remember, you will have to pay for both commercial and FirstNet service, don’t get into long-term commercial contracts that cannot be changed
Once You Choose Your Network

– Stage the equipment
– Check it out before installation
– Pre-load applications from your network
  • DO NOT install more than a few applications to start
  • Choose the ones that will be most used and of benefit in the field
  • Train those who will be using the applications
  • Start slow, get feedback from the field—insist on it!
  • Seed your field users
    – Give some units to those who adapt to technology quickly
    – Give some to those who resist using new technology
  • Make sure you can manage the devices over the air
Questions that Need Answers

• Adding broadband capabilities to augment existing LMR voice services will require a learning curve
  – What can it be used for?
  – How much video can be used over the network?
    • How do we manage video streams?
  – What types of applications can it support?
    • How do we secure our applications?
  – How is capacity and bandwidth managed across all of the agencies?
Questions that Need Answers (2)

– Ideal to use now to shorten learning curve for FirstNet
– What types of devices should be given to which types of first responders?
– How secure are the devices? How do we make them more secure?
– How secure is the network? How do we make it more secure?
Recapping

CONCLUSION
Recommendations

• Get together with all first responder organizations in your jurisdiction
  – Make a group purchase/lease agreement
    • Pool data between all agencies
    • Make sure devices are interoperable between agencies
  – When dealing with vendors
    • Make sure to purchase FirstNet upgradable devices
    • Get a guarantee that the vendor will replace/upgrade devices
  – Go slow...remember that LTE is about data and video
  – FirstNet is a network to AUGMENT voice not replace it!
Recommendations (2)

- Experiment with coverage for mobile and handheld devices
  - Coverage will be different
  - Check in-building coverage
  - If Wi-Fi roaming is available make sure it has same security levels
    - Experiment with applications and video
  - Check your applications; make sure what you have on commercial network will be nearly the same on the Public Safety network
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 upon how many commercial users are sharing same cell sector
• MOST OF ALL
• DURING MAJOR INCIDENTS YOU MAY HAVE NO ACCESS!
VOICE OVER LTE: WHEN, WHAT, AND HOW MUCH?
Voice over LTE

- AT&T, Verizon, Sprint
  - All offer push-to-talk over their networks
  - Each network has its own PTT service
  - They are *NOT* compatible or interoperable with each other
    - All work well for *NON*-mission-critical communications
- Can be interconnected to LMR systems using IP bridges
- Voice over LTE for dial-up calls will happen soon
Voice over LTE (2)

- PTT over LTE is *NOT* mission-critical in nature today
- There is *NO* LTE PTT standard for either commercial or FirstNet broadband
- Public Safety needs LMR for voice, use broadband *ONLY* for data and video services
- PTT over LTE *may* become available at some point
- Harris County using PTT over LTE but it too is a proprietary technology from its vendor, could provide some interesting test results
- PTT over LTE will reduce network capacity for data and video services
Moving into the 21st Century

PUBLIC SAFETY BROADBAND
CHANGES EVERYTHING!
Public Safety Broadband

– Nationwide
– Interoperable
– Adds data, streaming audio, video to Public Safety in the field
– Enables operations center, incident commander to see in real time
– Dispatch will include video from nearest camera
LTE Benefits

– LTE Public Safety broadband
  • Mission-critical data and video services to Public Safety communications
  • Nationwide, fully interoperable data/video network
  • Lower-cost devices because they are based on commercial technology
  • Public Safety will have full control of Public Safety LTE network
    – Won’t have to share network with commercial customers
  • Network will be secure, hardened, mission-critical in nature
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