FirstNet and LTE Overview
The Challenge for FirstNet
FirstNet Will Address the Greatest Need of Public Safety and First Responders — Interoperable Communications

Communications Shortcomings are Amplified During Emergencies
A Key Asset for FirstNet - Spectrum

- The Spectrum Act (a portion of the Middle Class Tax Relief and Job Creation Act) mandated the FCC hold four types of spectrum license auctions:
  - Auction of the PCS “H Bock”: frequencies at 1915-1920 MHz paired with 1995-2000 MHz
  - Auction of the AWS-3 band: frequencies at 2155-2180 MHz paired with other spectrum in the band
  - Auction of at least 15 MHz of additional spectrum between 1675 and 1710 MHz and identify an additional 15 MHz for auction. The additional fifteen MHz identified is 1755-1780 MHz
  - “Voluntary Incentive Auction” of a spectrum capacity that may be relinquished by license holders who would then share in the proceeds

- $7 billion in funding for the planning and implementation of FirstNet is expected to come from these auctions

- Some analysts expect most of the $7 billion to fund FirstNet and fund other financial obligations under the statute will come from the first two spectrum auctions - the H Block and the AWS auctions
Spectrum: FCC Spectrum Auctions

- **PCS H Block Auction:**
  - Auction ended on February 27, 2014 with Dish Network meeting the minimum reserve price of $1.564 billion and winning all 176 licenses.

- **Future Auctions:**
  - AWS-3 auction is scheduled for November 2014.
  - 50 MHz of AWS-3 spectrum, comprised of the 1755-1780 MHz airwaves currently used by the Federal government paired with 2155-2180 MHz frequencies that are currently in limited use by private entities.
  - 15 MHz of Unpaired spectrum is also being auctioned
    - The major carriers are expected to be interested in these bands.
Future Auctions (continued):
- Broadcast Television Spectrum Incentive Auction is expected in 2015, and is designed to free up spectrum in the 600 MHz band for more efficient use
  - The first step will be a reverse auction in which current license holders (mostly television broadcasters) are being encouraged to release spectrum usage rights in exchange for a share of forward auction proceeds
  - The newly freed spectrum will be repurposed and repackaged to be sold by the FCC at a forward auction to expand and improve wireless broadband service
Current Challenges with use of Commercial Networks

- Competes with Public for Priority
- Insufficient Coverage and Bandwidth needs
- Congestion
- Site Outage
The Challenge of Scope = Coverage + Users

Coverage
- Where is reliable coverage needed?
- For what level of service/device types?
- Using what potential delivery networks?

Capacity
- How many total users for 20 MHz of spectrum?
- What is their operational area?
- What type of applications do they use?

Radio Access Network (RAN) Design
- Estimated number of sites
- Initial cost estimate for public safety users
- Parameters for asset data collection

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The Proposed Solution
Proposed Solution

- Create the first nationwide public safety wireless network
- Provide high data rates ("broadband") to enable advanced applications
- Use industry standards to enable interoperability for public safety
- Leverage commercial LTE technology to speed deployment through economies of scale
- Maintain unique public safety communications requirements

Nationwide Public Safety Broadband Network (NPSBN)
Deploying LTE
The FirstNet Vision

FirstNet: Nationwide Core and Local RANs

FIRSTNET NATIONWIDE DISTRIBUTED CORE NETWORK

Communications
Applications Services
Switching Routing Scheduling
Databases/Warehouses Security
Interfaces to Other Networks

STATE and REGIONAL RANs

EMS
Mutual Aid
First Responder
Police
Fire Rescue

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Key Design Challenges to Address

- Transition from Existing Mission Critical Voice Networks
- Spectrum
- Funding
- Governance
- Policy
- National Network Architecture Approach
- Interoperability
- Unique Public Safety Requirements
LTE Technical Highlights
Evolution of Cellular Standards

- LTE is a global standard developed by 3GPP (3rd Generation Partnership Project)

- Roadmap for future growth of the technology into LTE Advanced

- Future releases will include public safety requirements, including mission critical voice

- All U.S. carriers migrating to a single standard for the first time

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LTE Technical Highlights

- The major commercial 4G standard in the U.S.
- Voice over LTE (VoLTE) has been developed but not deployed extensively over commercial networks
- Public Safety Voice of LTE standard being developed
- All-IP (Internet Protocol) architecture designed for low latency
- Prioritization/preemption capabilities
- Inter-network mobility and interoperability with commercial carriers
LTE Technical Highlights (Cont.)

- **Flexible** channel bandwidths of 1.4, 3, 5, 10, 15 and 20 MHz

- **High user data rates** to support new applications for video, data, and voice

- **Security and authentication**

- **Priority and quality of service** mechanisms

- **Modern antenna techniques** to support improved performance
At a very high level, the network has 4 basic components:
- Core Network Evolved Packet Core (EPC) or “Core”
- Transport “Backhaul”
- Radio Access Network or “Radio Sites”
- User Equipment (UE) or “User Device”
Like portable versus mobile LMR radios, different LTE device types will have different performances.

Example plots from old coverage predictions provided simply for comparison purposes.
**LMR vs. LTE Capacity**

**LMR**
- Channels pre-configured per site
- Overlapping coverage using different frequency
- Fixed bandwidth / throughput per channel
- Users on one channel don’t impact others

**LTE**
- All sites operate on same frequency thus overlapping coverage needs to be minimized
- “Channels” managed dynamically at each site
- Bandwidth determined by need and availability
  - *minimizing congestion concerns*
- Number of users at a site can impact coverage
- One large data “pipe”
  - *Up to 74 Mbps capacity near cell tower*
  - Capacity reduces as you move away from tower
  - Can handle many users with differing data demands (e.g., field reporting, dispatching)

10 MHz Public Safety LTE Band

| Police Streaming Video |
| Medical Telemetry |
| Messaging |

Variable Data Rate per User – 1 to 100 Simultaneous Users
FirstNet Technology Approach
FirstNet 3-in-1 Approach

Diverse Coverage Architecture: considering a “3-in-1” Approach: Terrestrial + Satellite + Deployable

#1: Multiple Terrestrial Mobile Systems

#2: Mobile Satellite Systems

#3: Deployable Systems

Public Safety User
FirstNet Will Have Advanced Capabilities

Communication
- Video
- Voice (non-mission critical)
- Messaging
- SMS/Text
- Data (Internet)

Applications
- CAD, RMS, NLETS
- FirstNet applications (e.g., AVL)
- Syndicated applications
- Currently used Agency applications

Services
- Records management
- Data storage
- Audio storage
- Database inquiries

Capabilities
- Network monitoring and status
- Integrated solution and services
- Priority
- Hardened and secure
- Provisioning

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Short Term Goal: Make Data Mission Critical For Public Safety

Data Applications (LTE)
- Messaging
- CAD
- RMS
- AVL
- Video

Commercial Voice (2G/3G)
- MDT / Laptop
- Smartphone
- Radio

Land Mobile Radio (UHF/VHF/800)

Current Challenges
- Competes with Public for Priority
- Insufficient Coverage
- Congestion
- Site Outage

Mission Critical
Non-Mission Critical

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What is Mission Critical Voice

- National Public Safety Telecommunications Council produced a 7 page document defining mission critical voice
  - [http://www.npstc.org/broadband.jsp](http://www.npstc.org/broadband.jsp)

- Requirements identified the following:
  - Direct or Talk Around Mode (off network communications)
  - Push-to-Talk (PTT) w/ low latency
  - Full Duplex Voice (commercial/PSTN calls)
  - Group Call (one to many)
  - Talker Identification
  - Emergency Alerting (highest level of priority)
  - Audio Quality

- Definition being used as a reference for standards developments

- No standardized solutions exist today that can meet all of these requirements
Mission Critical Voice versus Current Standards

FirstNet is currently working with standards bodies (3GPP) to ensure that LTE standards cover public safety requirements.
# Voice Service Evolution

<table>
<thead>
<tr>
<th>Voice Category</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>VoIP (Telephony)</td>
<td>Demonstrated in several applications</td>
</tr>
<tr>
<td>Voice over LTE (Telephony)</td>
<td>VoLTE preferred solution; just being implemented by some carriers</td>
</tr>
<tr>
<td>Non-mission Critical Voice (PTT)</td>
<td>Standard and proprietary options available</td>
</tr>
<tr>
<td>Mission Critical Voice (PTT)</td>
<td>Standardized approach being worked on within current standards developments</td>
</tr>
<tr>
<td>Direct mode (Peer to Peer)</td>
<td>Also being worked on within standards efforts; includes peer-to-peer data as well</td>
</tr>
</tbody>
</table>
FirstNet’s Key Network Components and the NPSBN
The RAN will be a Combination of Terrestrial, Satellite, and ‘Deployables’

Hybrid approach enables public safety users to take their wireless coverage, services, and capacity with them.

- Off-net mode, no satellite or Core – comms among incident personnel 750-1000 sq. ft.
- Mobile Communications units (mobile comms) on PS vehicles – become a mobile cell site/system mounted with an LTE Picocell: Incident Area Network (IAN) 750-1000 sq. ft.
- Public Safety Towers (boomers) 10-25 miles
- Macrocell LTE up to 1-10 miles
- Microcell LTE up to 1 mile

Designated Wilderness 27% of U.S. Land Mass
Rural 68% of U.S. Land Mass
Suburbs 5% of U.S. Land Mass
Urban Density Urban

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### The Core is for Traffic Management, Applications Deployment, Service Operations

#### Services
- Location
- Messaging
- Presence
- Multimedia
- User ID Management
- Push-to-Talk
- Applications
- Provisioning
- Voice over LTE

#### EPC
- Mobility Management
- Home Subscriber Register
- Packet Gateway
- Policy and Charging
- Serving Gateway
- Diameter Routing

#### Transmission
- Routers
- Firewall
- Border Gateway
- Transmission Facilities (Fiber)
- Dense Wave Division Multiplexers

#### Data Centers
- Hardened Facilities
- Redundant Transport
- HVAC Security
- Power Backup

#### Security
- Content
- Local Control
- NOC, SOC
- Interconnect
- QoS, priority, preemption

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Transport between RAN and Core

- **RAN Backhaul Network**
  - Service Options:
    - Microwave 150M/
    - 300M/1G/2.5G
    - Leased 100M/1G Ethernet
    - IRU Lit Fiber Lambda/Wave
    - IRU dark Fiber

- **Aggregation Transport Network**
  - Service Options:
    - Leased 10G/100G
    - IRU Lit Fiber Lambda/Wave
    - IRU dark Fiber

- **National Transmission Network**
  - Service Options:
    - Leased 10G/100G
    - IRU Lit Fiber Lambda/Wave
    - IRU dark Fiber

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# Devices – The Most Important Element to Public Safety

<table>
<thead>
<tr>
<th>Device Types</th>
<th>Portables</th>
<th>In-Vehicle Routers</th>
<th>Specialized</th>
<th>Accessories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category Driver</td>
<td><strong>Build up to an economy of scale</strong></td>
<td><strong>Special operational needs e.g. in-building, rural</strong></td>
<td><strong>Unique uses</strong></td>
<td></td>
</tr>
</tbody>
</table>
| Function | • Smartphone  
• Tablets  
• Modems | • Routers  
• Hotspots  
• Consoles | • Drones  
• Portable repeaters  
• Rovers | • Ruggedized cases  
• Battery packs  
• Chargers, mics. |
| Connectivity | • LTE, CDMA, HSPA  
• LMR/ P25  
• Wi-Fi, Bluetooth  
• Direct mode | • LTE, CDMA, HSPA  
• Wi-Fi  
• Ethernet  
• USB | • LTE, CDMA, HSPA  
• LMR/ P25  
• Satellite | **Bluetooth** |
| Location Enabled | Yes | Yes | Some | n/a |
| Band 14 Support | 2H14 | 1H14 | 2015+ | n/a |
Thank You

www.firstnet.gov