FirstNet LTE Overview
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
LTE Technical Highlights

- **Voice**
  - Voice over LTE (VoLTE) – being deployed currently
  - Mission Critical Push to Talk - standards are being developed

- **All-IP** (Internet Protocol) architecture designed for low latency and high resiliency

- **Quality of Service Priority and Preemption capabilities**

- **Inter-network mobility and interoperability** with commercial carriers

- **Security and authentication**

- **Modern antenna techniques** to support improved performance
**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*
- 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)

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**10 MHz Public Safety LTE Band**

- Variable Data Rate per User – 1 to 100(s)
- Simultaneous Users

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*February 23, 2015*
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”
## 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>• Build up to an economy of scale</td>
<td>• Special operational needs e.g. in-building, rural</td>
<td>• Unique uses</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 |
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
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
- **Macrolcell LTE up to 1-10 miles**
- **Microcell LTE up to 1 mile**
Like portable versus mobile LMR radios, different LTE device types will have different performances.

- **Vehicular modem**
- **USB dongle**

Example plots from old coverage predictions provided simply for comparison purposes.
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

February 23, 2015
FirstNet Will Have Advanced Capabilities

- Key FirstNet Characteristics
  - Quality of Service Priority and Preemption
  - Local Control
  - Hardening
    - Security - Physical and Cyber
    - Structural Hardening
    - Resiliency

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

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

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

Current Challenges

- Competes with Public for Priority
- Insufficient Coverage
- Congestion
- Site Outage
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)

- The following requirements were identified:
  - 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
<table>
<thead>
<tr>
<th>Voice Category</th>
<th>Status</th>
<th>Readiness</th>
</tr>
</thead>
<tbody>
<tr>
<td>VoIP (Telephony)</td>
<td>Demonstrated in several applications</td>
<td></td>
</tr>
<tr>
<td>Voice over LTE (Telephony)</td>
<td>VoLTE preferred solution; just being implemented by some carriers</td>
<td></td>
</tr>
<tr>
<td>Non-mission Critical Voice (Push to Talk)</td>
<td>Standard and proprietary options available</td>
<td></td>
</tr>
<tr>
<td>Mission Critical Push to Talk (Push to Talk)</td>
<td>Standardized approach being worked on within current standards developments</td>
<td></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>
<td></td>
</tr>
</tbody>
</table>
Thank You