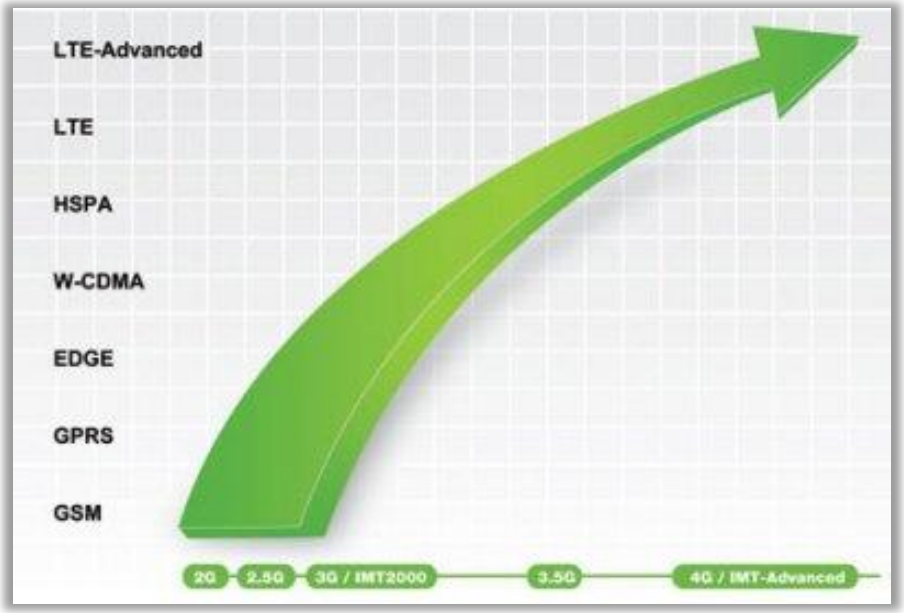
FirstNet LTE Overview

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

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 vs. LTE

LMR

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

Each channel supports a conversation

LTE

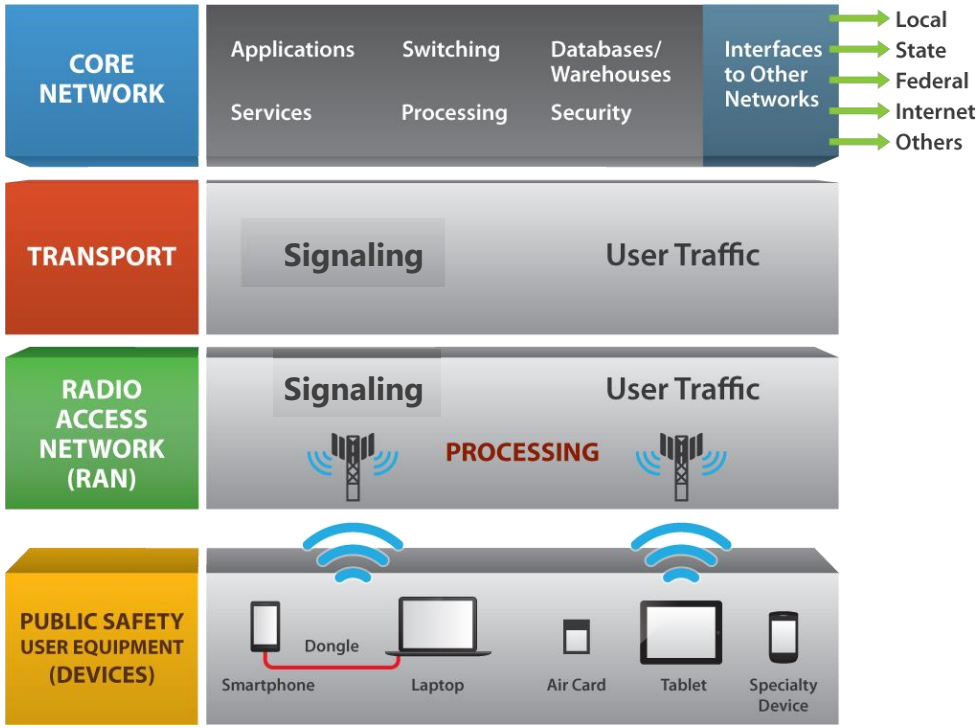
- All sites operate on same frequency thus overlapping coverage needs to be minimized
- "Channels" managed dynamically at each site
- Bandwidth determined by need and availability *minimizing congestion concerns*
- One large data "pipe"
  - *Up to* 74 Mbps capacity near cell tower
  - Capacity reduces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

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

Basic LTE Network Components

At a very high level, the network has 4 basic components:

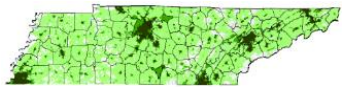
- Core Network Evolved Packet Core (EPC) or "Core"
- Transport "Backhaul"
- Radio Access Network or "Radio Sites"
- User Equipment (UE) or "User Device"



Devices – The Most Important Element to Public Safety

	Portables	In-Vehicle Routers	Specialized	Accessories
Device Types				
Category Driver	• Build up to an economy of scale		• Special operational needs e.g. in-building, rural	• Unique uses
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

The RAN will be a Combination of Terrestrial, Satellite, and 'Deployables'

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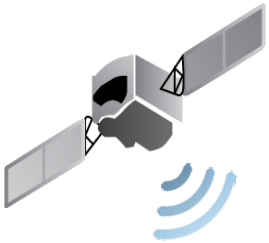
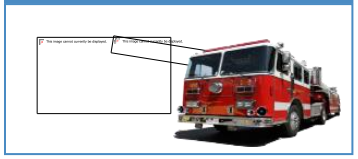
Hybrid approach enables public safety users to take their wireless coverage, services, and capacity with them



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

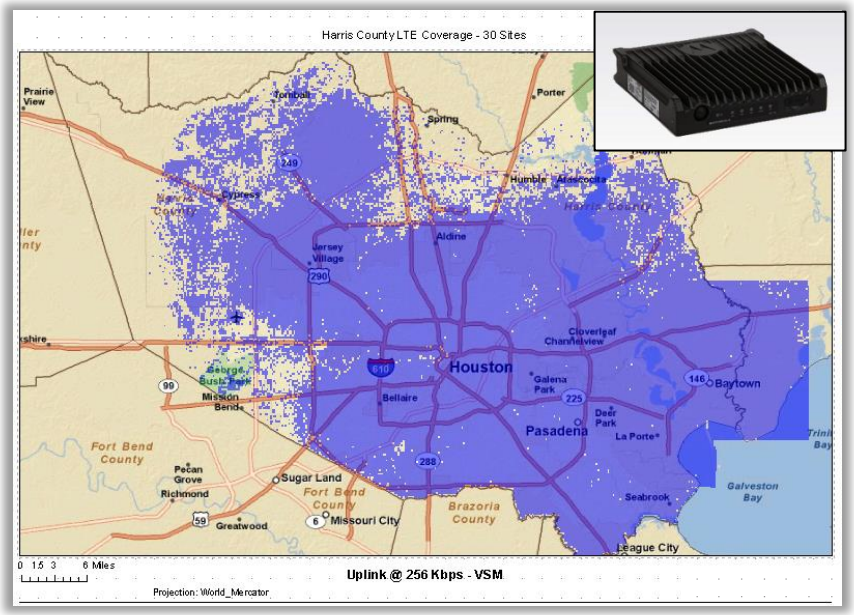
Macrocell LTE up to 1-10 miles

Microcell LTE up to 1 mile

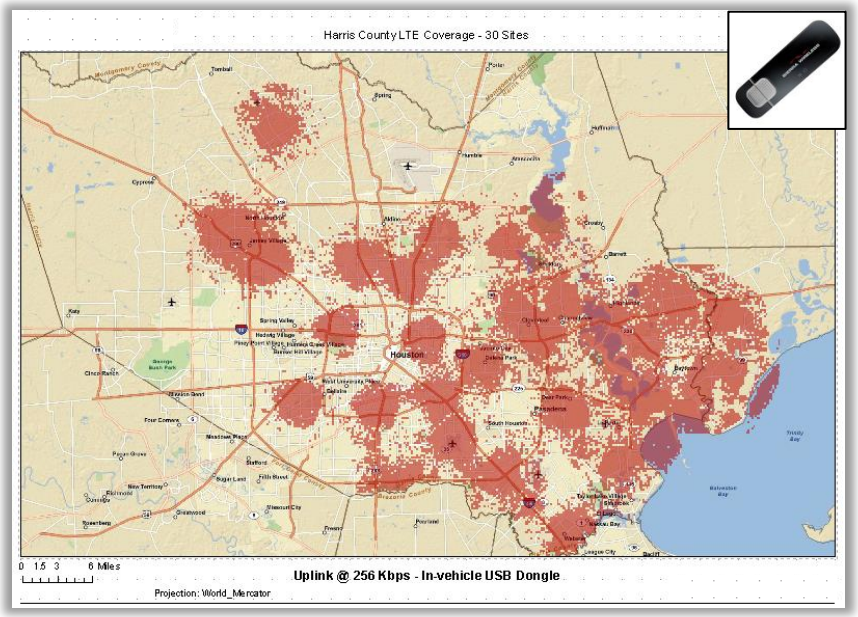
LTE Coverage: Device Type Comparison

- Like portable versus mobile LMR radios, different LTE device types will have different performances

Vehicular modem

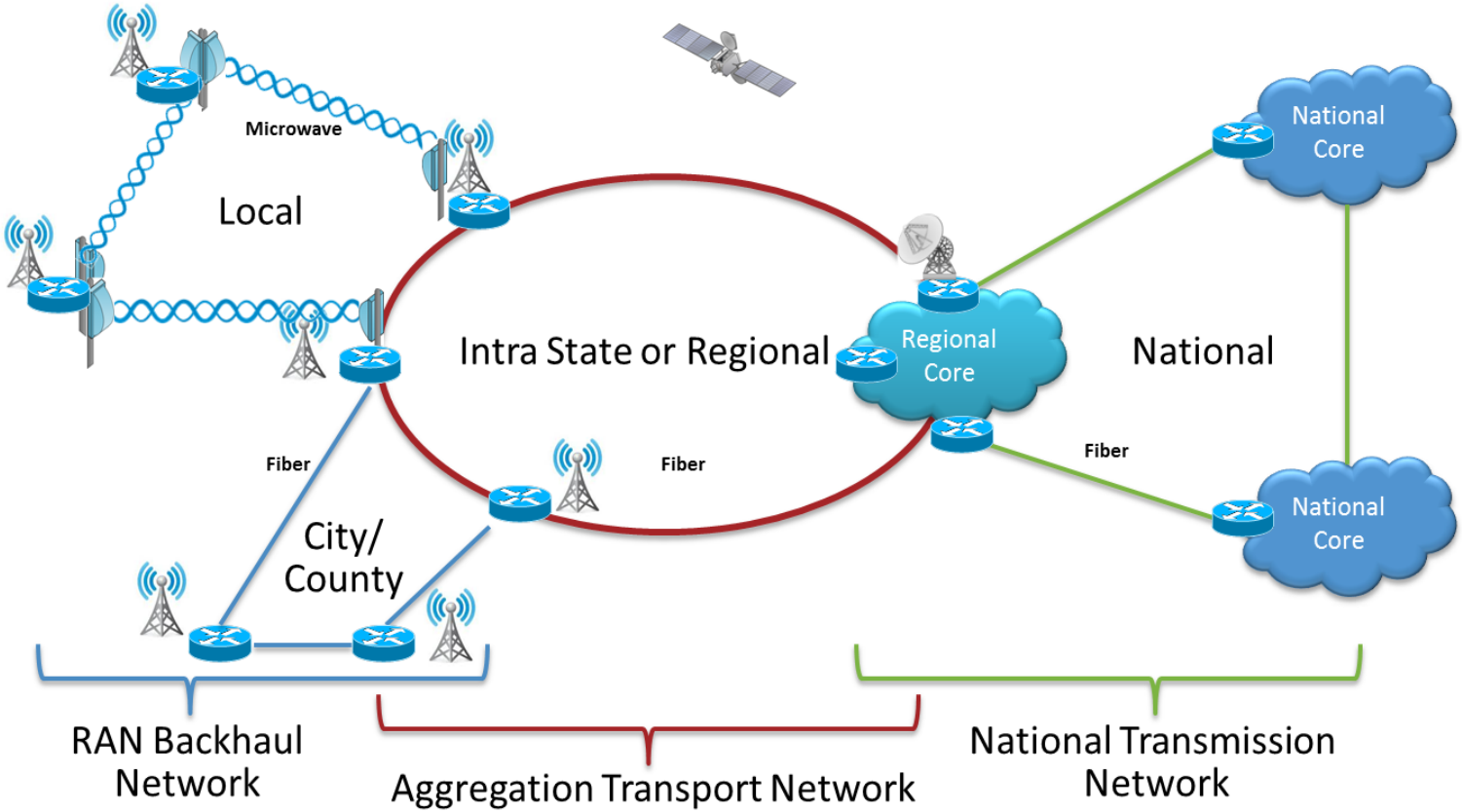


USB dongle



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

Transport Between RAN and Core



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

Service Options
- Leased 10G/100G
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The Core is for Traffic Management, Applications Deployment, Service Operations

FirstNet™

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

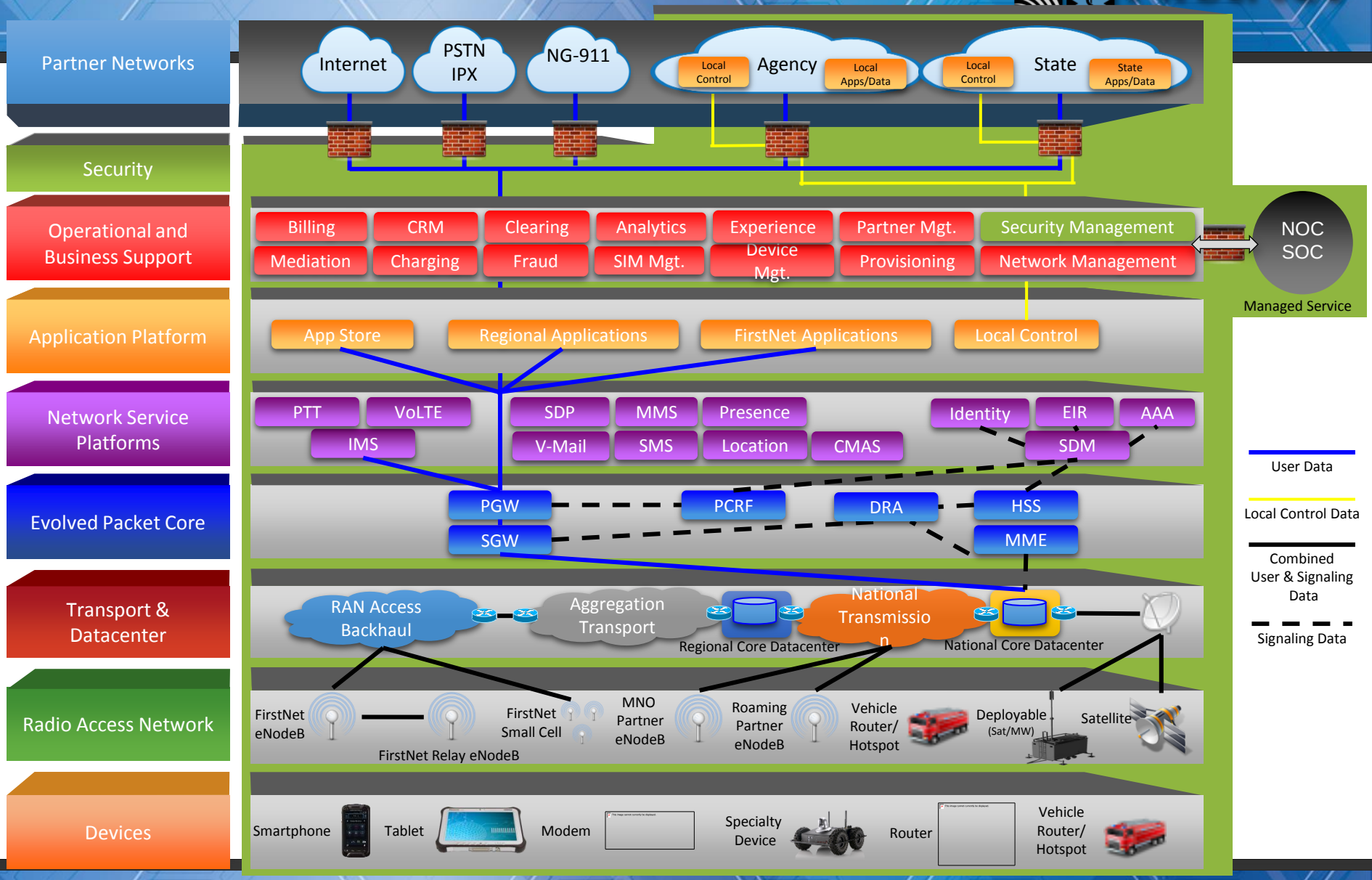
Hardened Facilities
Redundant Transport
Security
HVAC
Power Backup

- Content
- Local Control
- NOC, SOC

- Interconnect
- QoS, priority, preemption

Security

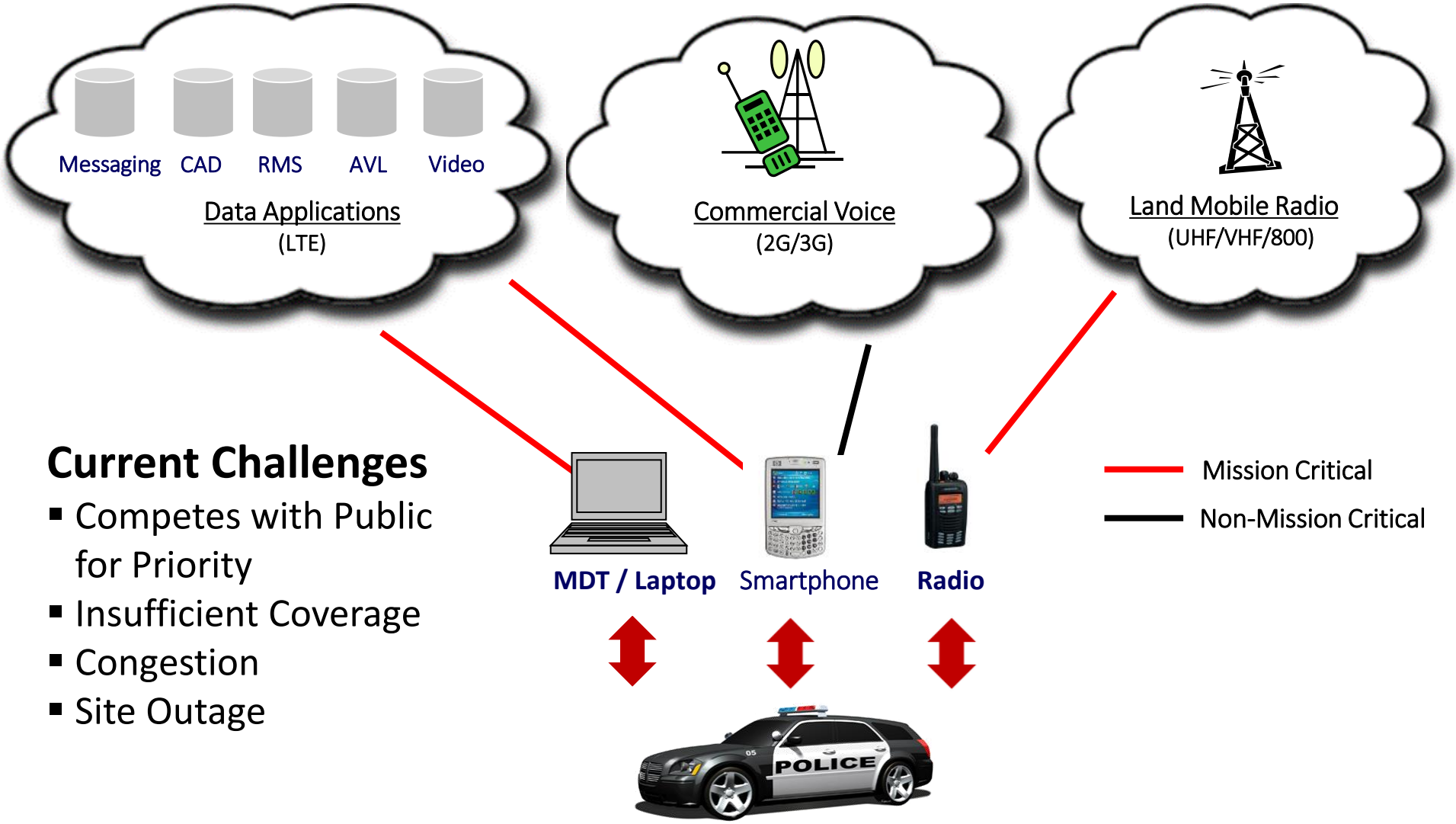
FirstNet Network Architecture



FirstNet Will Have Advanced Capabilities

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

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

- 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

npstc Broadband Requirements NPSTC

Mission Critical Voice Communications Requirements for Public Safety

National Public Safety Telecommunications Council

Broadband Working Group

Executive Summary

The term mission critical voice has been used within the public safety community for decades. However, until now there has been no one single complete definition of what, exactly, mission critical voice is. There are a number of definitions in use today but until the National Public Safety Telecommunications Council (NPTSC) Broadband Working Group took up the issue of providing a finite definition, mission critical voice has meant different things to different groups within the first responder community.

The effort to establish an accepted definition for mission critical voice was undertaken by NPSTC because, as public safety transitions to the Nationwide Public Safety Broadband Wireless Network, voice communications may transition from today's Land Mobile Radio (LMR) channelized narrowband voice systems to voice over the broadband network. If this transition is to be accomplished, it is imperative that those companies who will be developing the technology to provide voice over broadband fully understand all of the requirements that make up public safety mission critical voice.

This transition will take a number of years to accomplish and it is not clear that all of the features and functions required by public safety for mission critical voice can be accommodated using the commercial standards for wireless broadband. *This document is not designed to provide a road map for those who desire to build mission critical voice into wireless broadband technologies, but rather it has been written to provide a basis for a common understanding of the meaning of and the multiple requirements of mission critical voice.* Some of the features listed below contain descriptions of technology solutions and

American Association of State Highway and Transportation Officials | American Radio Relay League | Association of Fish and Wildlife Agencies | Association of Public-Safety Communications Officials – International | Forestry Conservation Communications Association | International Association of Chiefs of Police | International Association of Emergency Managers | International Association of Fire Chiefs | International Municipal Signal Association | National Association of State Chief Information Officers | National Association of State Emergency Medical Services Officials | National Association of State Foresters | National Association of State Technology Directors | National Sheriffs' Association

Mission Critical Voice Definition for Public Safety Page 1

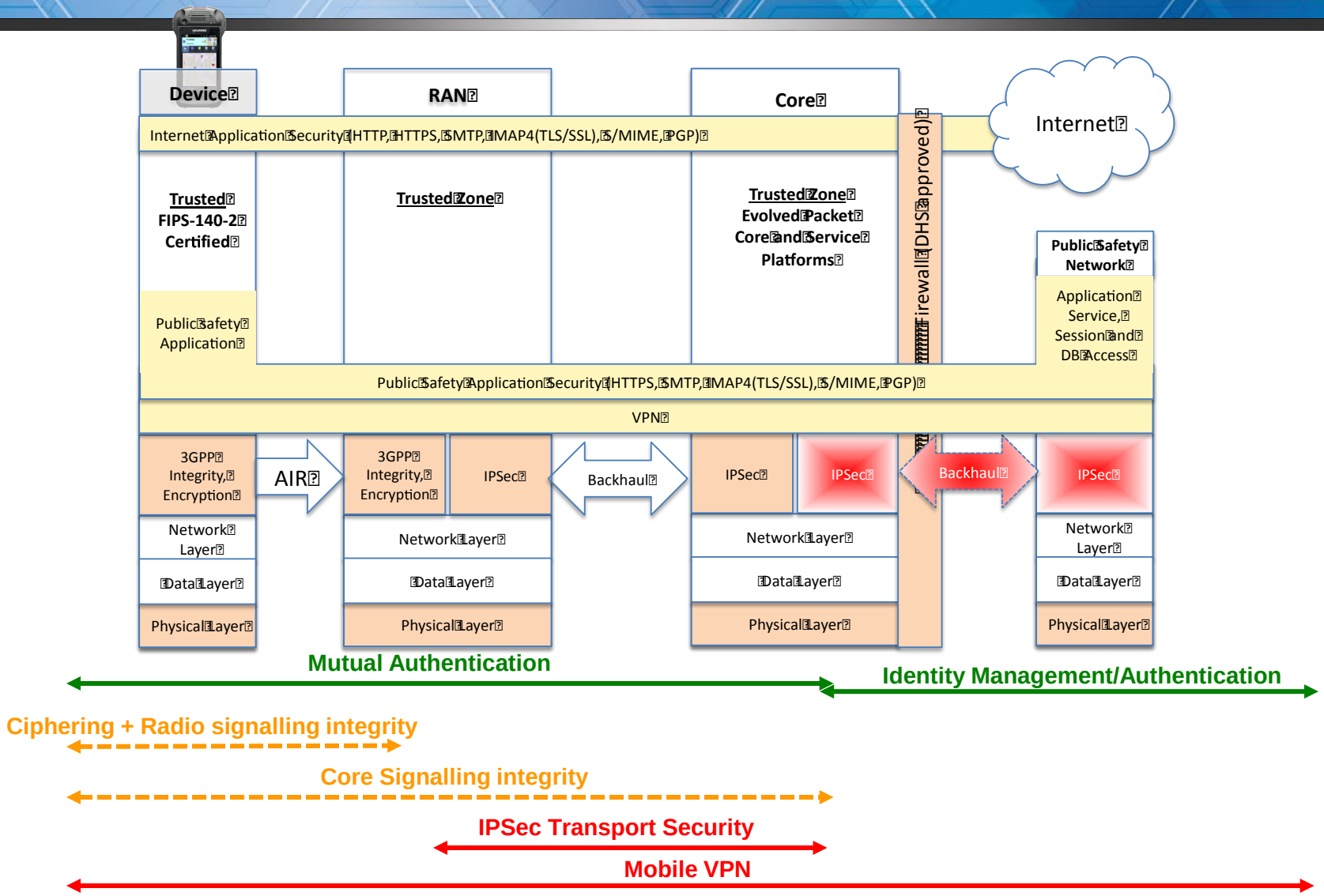
- Definition being used as a reference for standards developments

- No standardized solutions exist today that can meet all of these requirements

Voice Service Evolution

Voice Category	Status	Readiness
VoIP (Telephony)	Demonstrated in several applications	
Voice over LTE (Telephony)	VoLTE preferred solution; just being implemented by some carriers	
Non-mission Critical Voice (Push to Talk)	Standard and proprietary options available	
Mission Critical Push to Talk (Push to Talk)	Standardized approach being worked on within current standards developments	
Direct mode (Peer to Peer)	Also being worked on within standards efforts; includes peer-to-peer data as well	

LTE Security



Thank You