



FirstNet™

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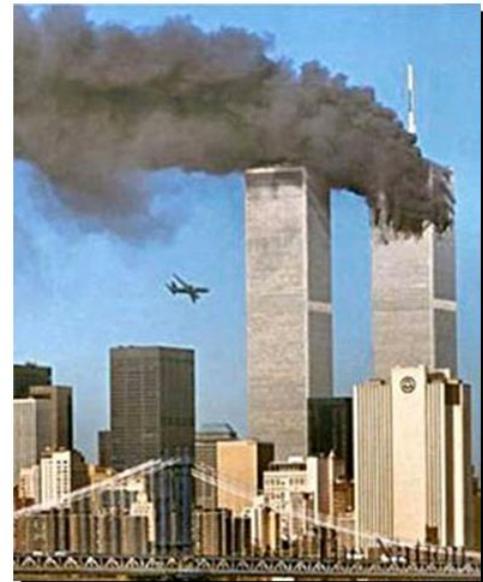
FirstNet and LTE Overview



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 Block”: 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

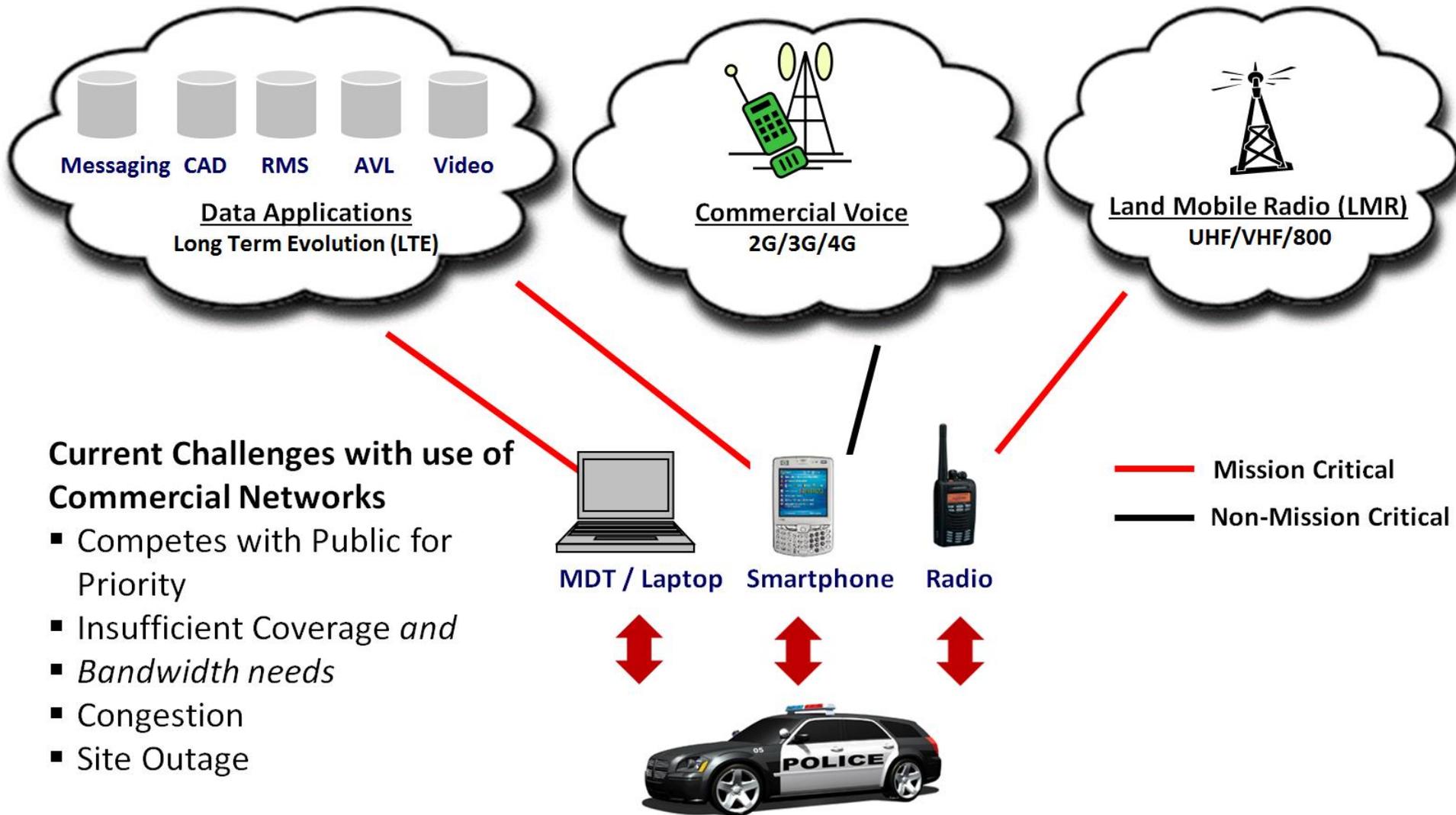
- Future Auctions:
 - AWS-3 auction is scheduled for November 2014
 - 50 MHz of AWS-3 spectrum, comprised of the 1755-1780 MHz airwaves currently used by the Federal government paired with 2155-2180 MHz frequencies that are currently in limited use by private entities
 - 15 MHz of Unpaired spectrum is also being auctioned
 - The major carriers are expected to be interested in these bands

Spectrum: FCC Spectrum Auctions (Cont.)



- 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

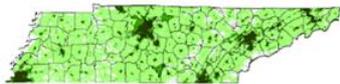
Public Safety Needs Mission Critical Data



Current Challenges with use of Commercial Networks

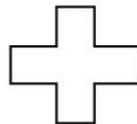
- Competes with Public for Priority
- Insufficient Coverage *and*
- Bandwidth needs
- Congestion
- Site Outage

The Challenge of Scope = Coverage + Users



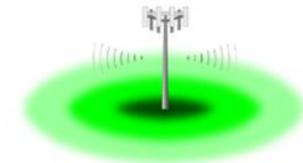
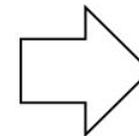
Coverage

- 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*

The Proposed Solution



Proposed Solution



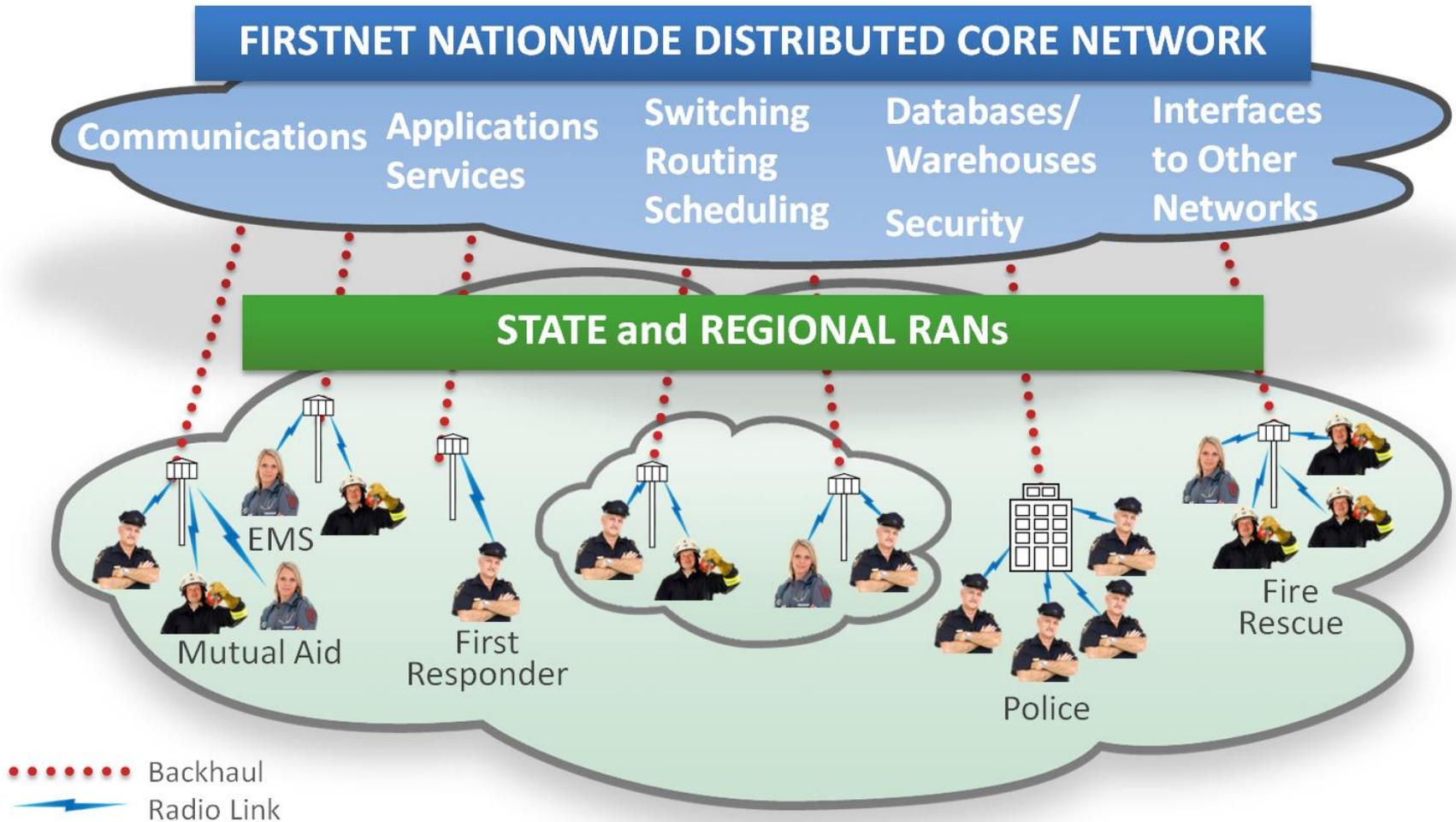
- Create the first nationwide public safety wireless network
- Provide high data rates (“broadband”) to enable advanced applications
- Use industry standards to enable interoperability for public safety
- Leverage commercial LTE technology to speed deployment through economies of scale
- Maintain unique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

*Nationwide Public Safety Broadband Network (NPSBN)
Deploying LTE*

The FirstNet Vision



FirstNet: Nationwide Core and Local RANs



Key Design Challenges to Address

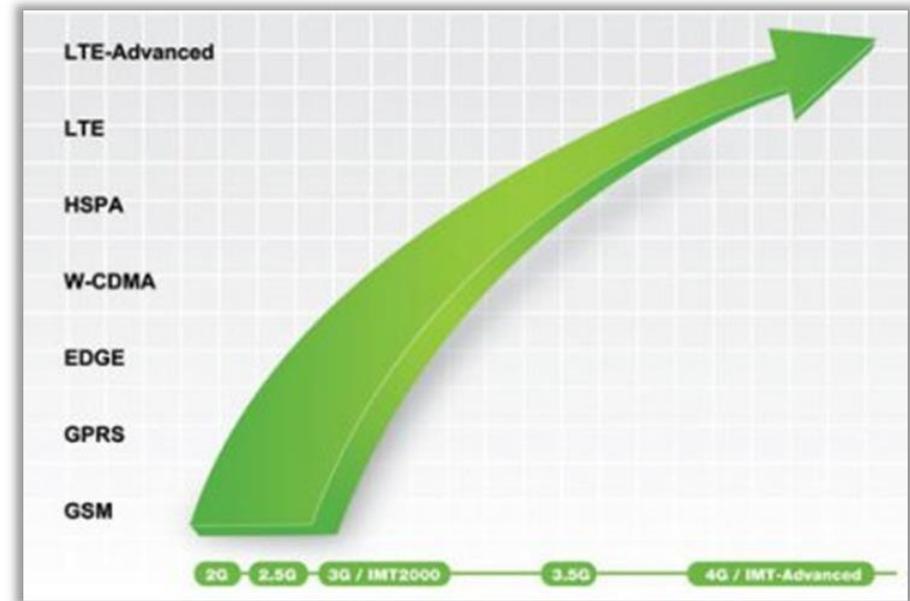


LTE Technical Highlights



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



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.)

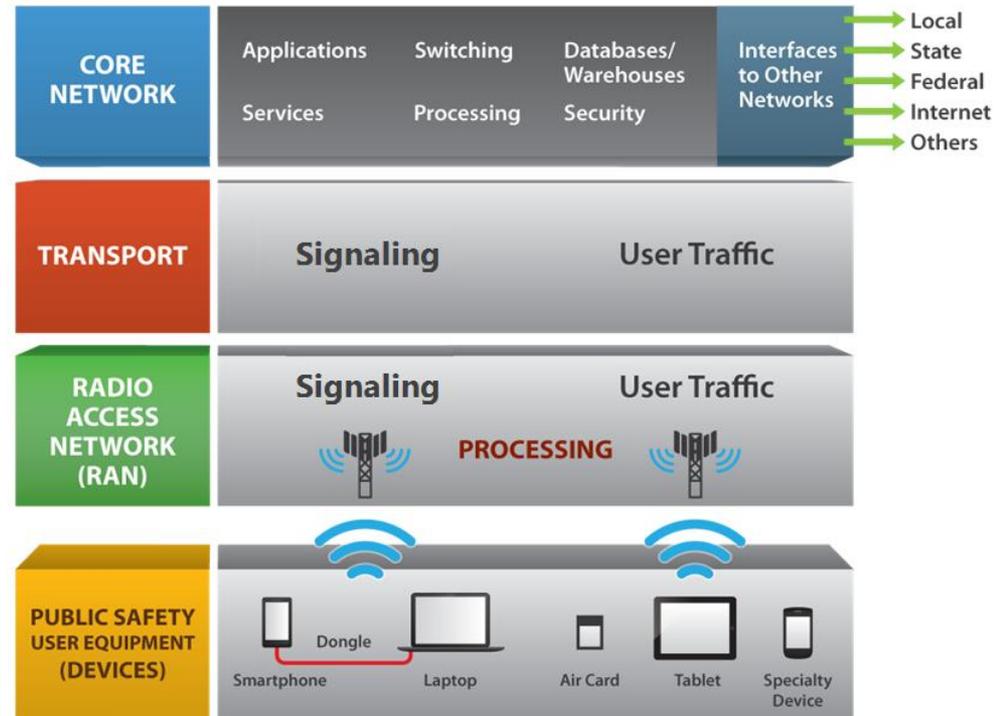


- **Flexible** channel bandwidths of 1.4, 3, 5, 10, 15 and 20 MHz
- **High user data rates** to support new applications for video, data, and voice
- **Security and authentication**
- **Priority and quality of service** mechanisms
- **Modern antenna techniques** to support improved performance

Basic LTE Network Components



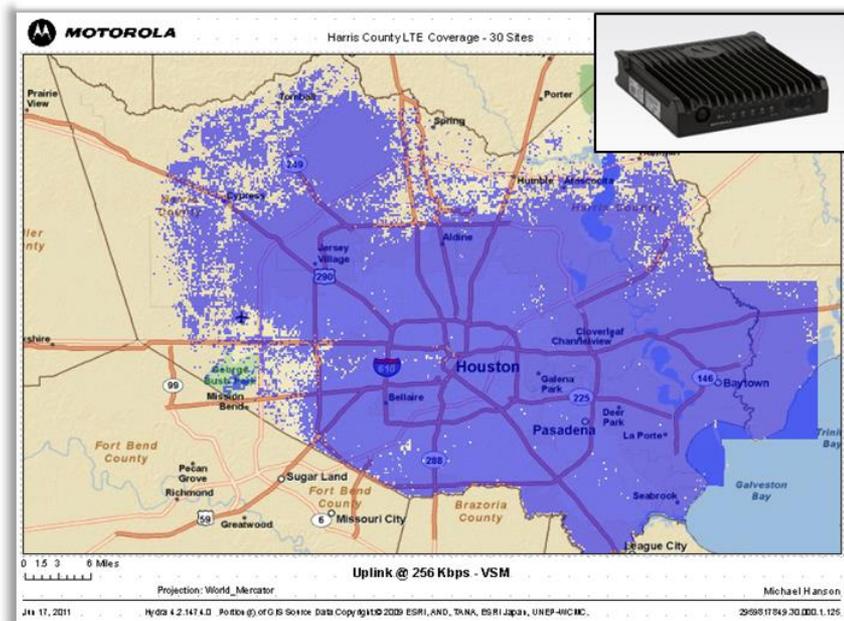
- At a very high level, the network has 4 basic components:
 - Core Network Evolved Packet Core (EPC) or “Core”
 - Transport “Backhaul”
 - Radio Access Network or “Radio Sites”
 - User Equipment (UE) or “User Device”



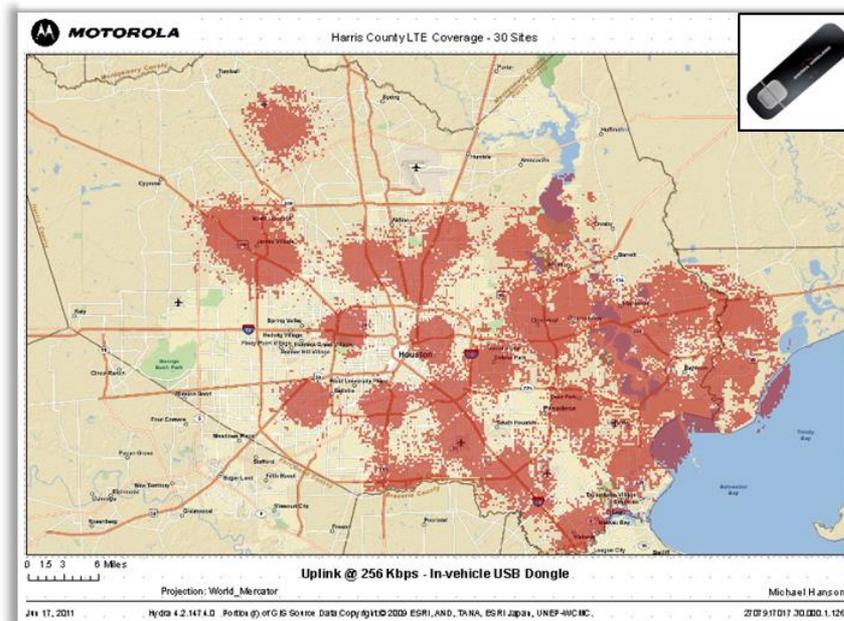
LTE Coverage: Device Type Comparison

- 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.

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



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*
- 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)



Variable Data Rate per User – 1 to 100
Simultaneous Users

FirstNet Technology Approach



FirstNet 3-in-1 Approach



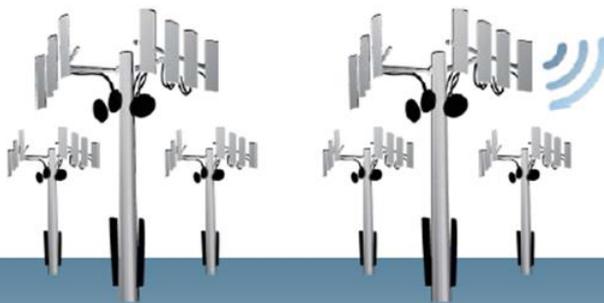
**Diverse Coverage Architecture: considering a “3-in-1” Approach:
Terrestrial + Satellite + Deployable**



**#2:
Mobile Satellite Systems**



**#1:
Multiple Terrestrial Mobile 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

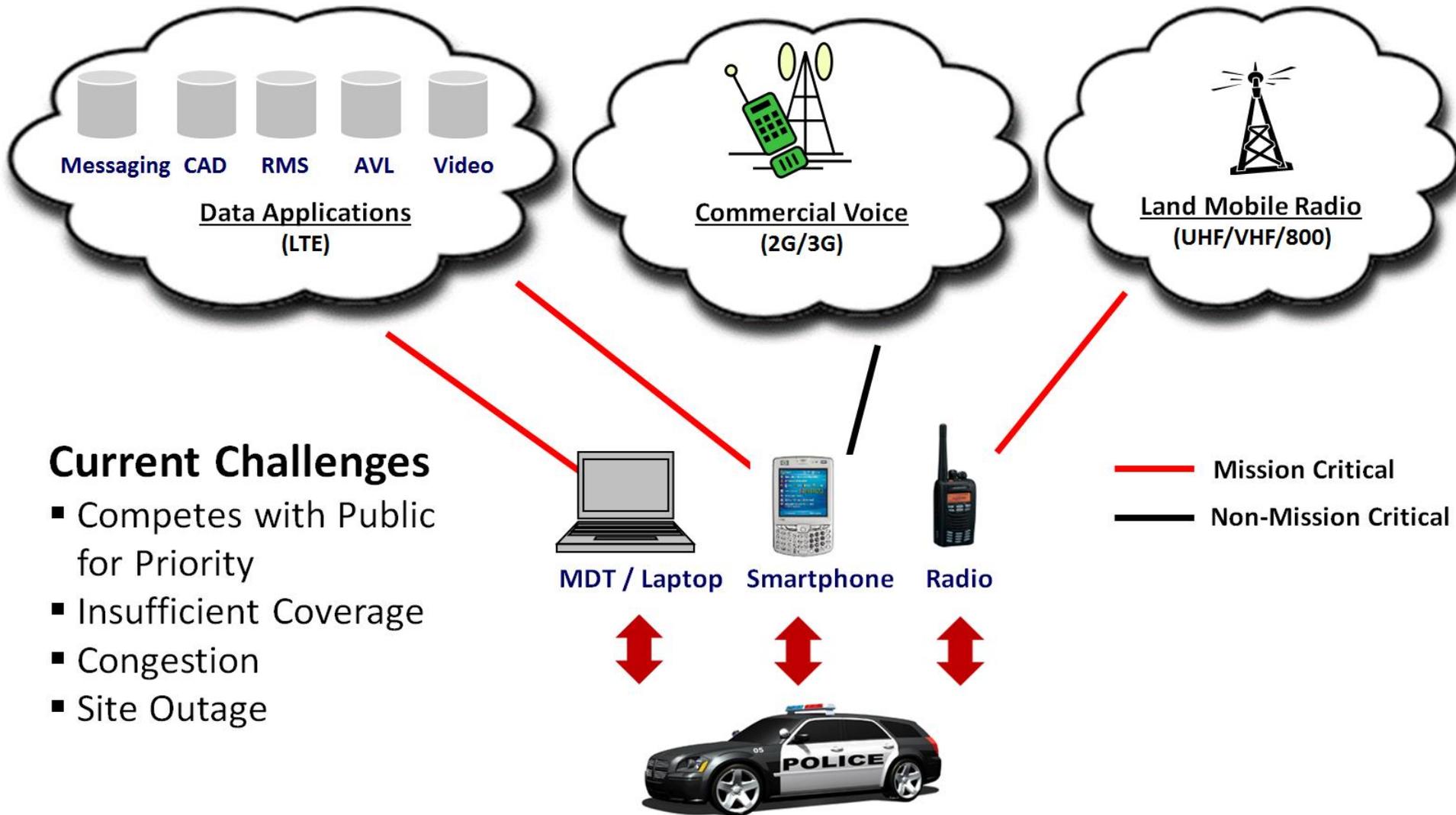


Capabilities

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



Short Term Goal: Make Data Mission Critical For Public Safety



Current Challenges

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

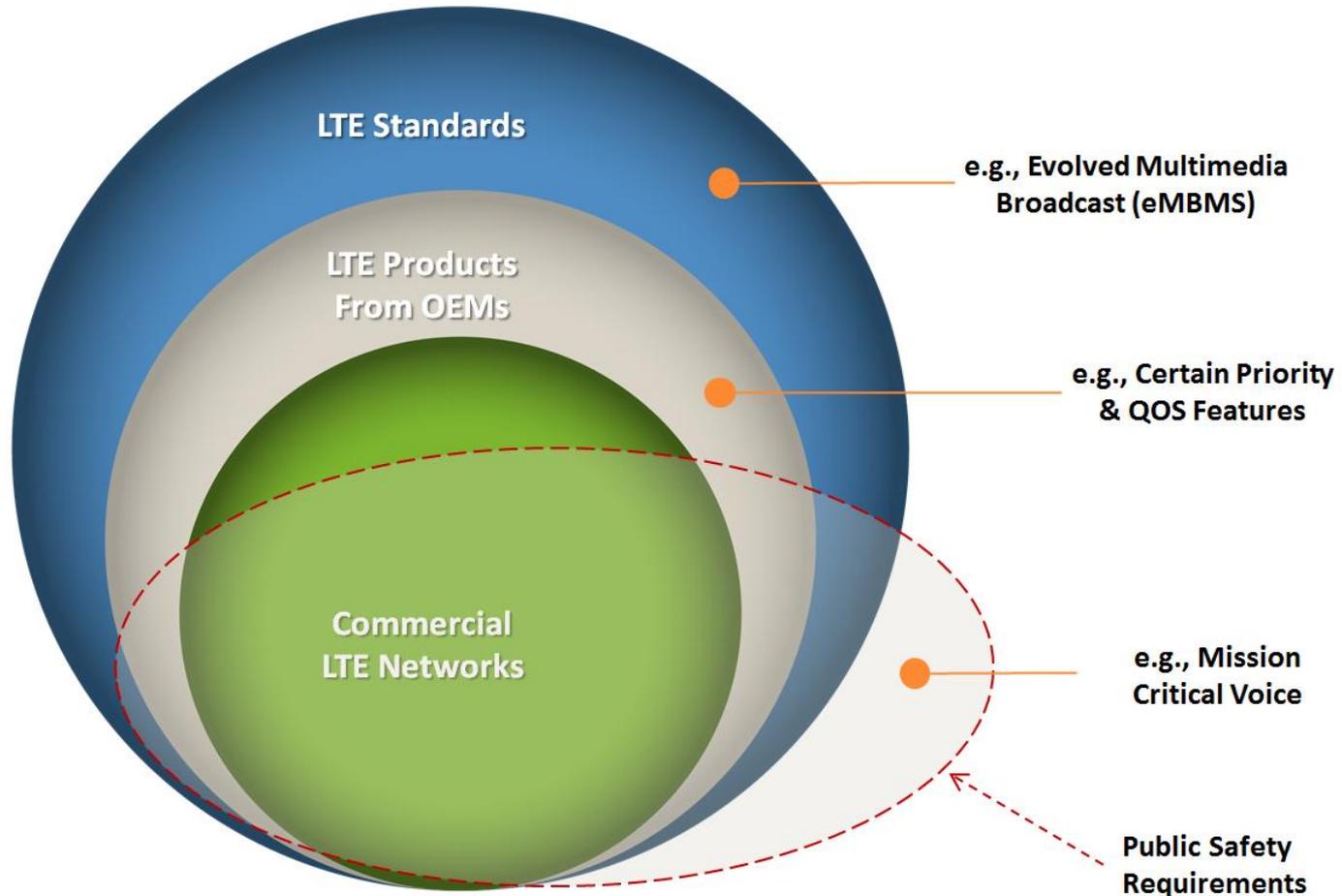
What is Mission Critical Voice



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

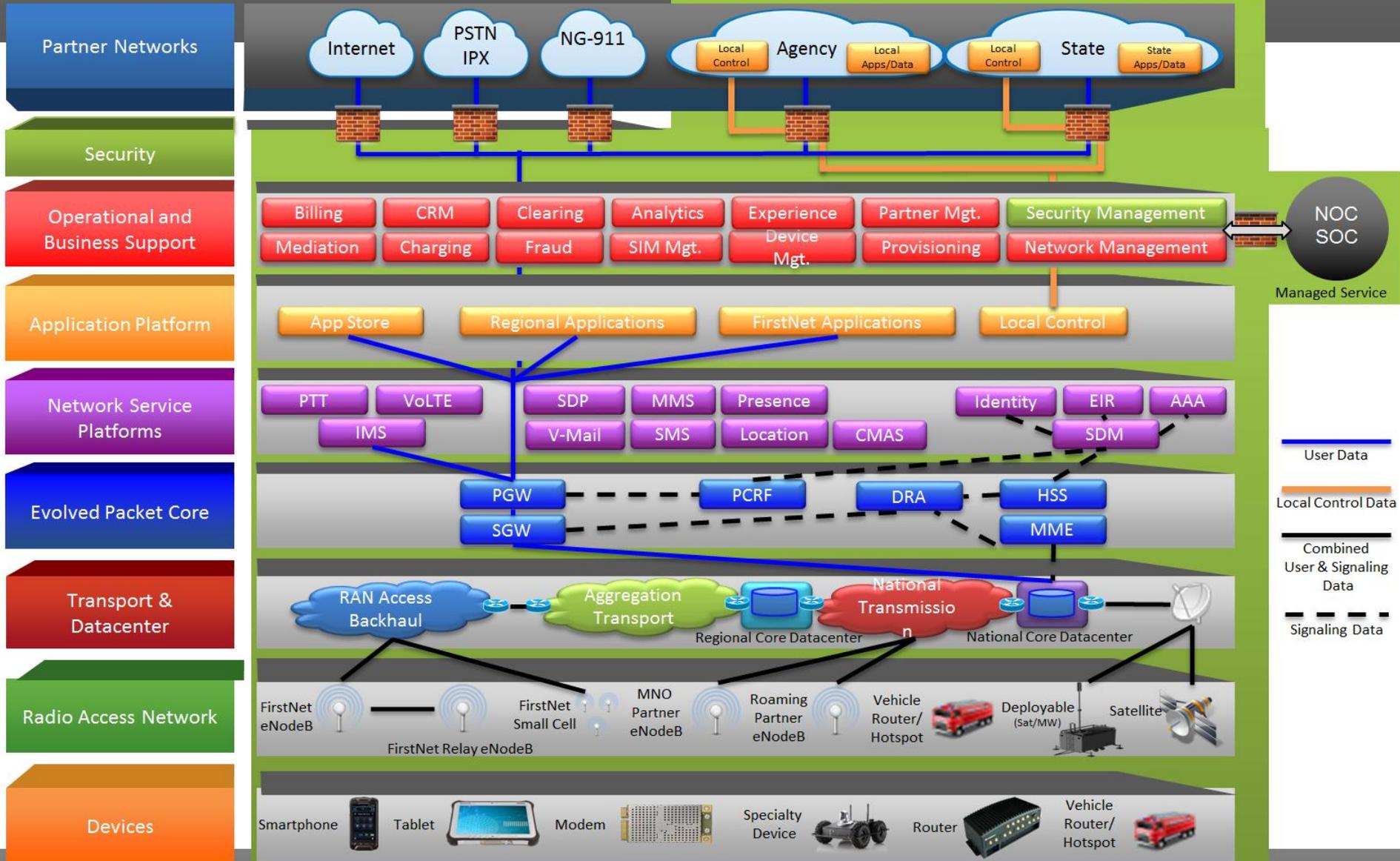


Voice Category	Status	
VoIP (Telephony)	Demonstrated in several applications	Green
Voice over LTE (Telephony)	VoLTE preferred solution; just being implemented by some carriers	Yellow-Green
Non-mission Critical Voice (PTT)	Standard and proprietary options available	Yellow
Mission Critical Voice (PTT)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

FirstNet's Key Network Components and the NPSBN



FirstNet Network Architecture



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

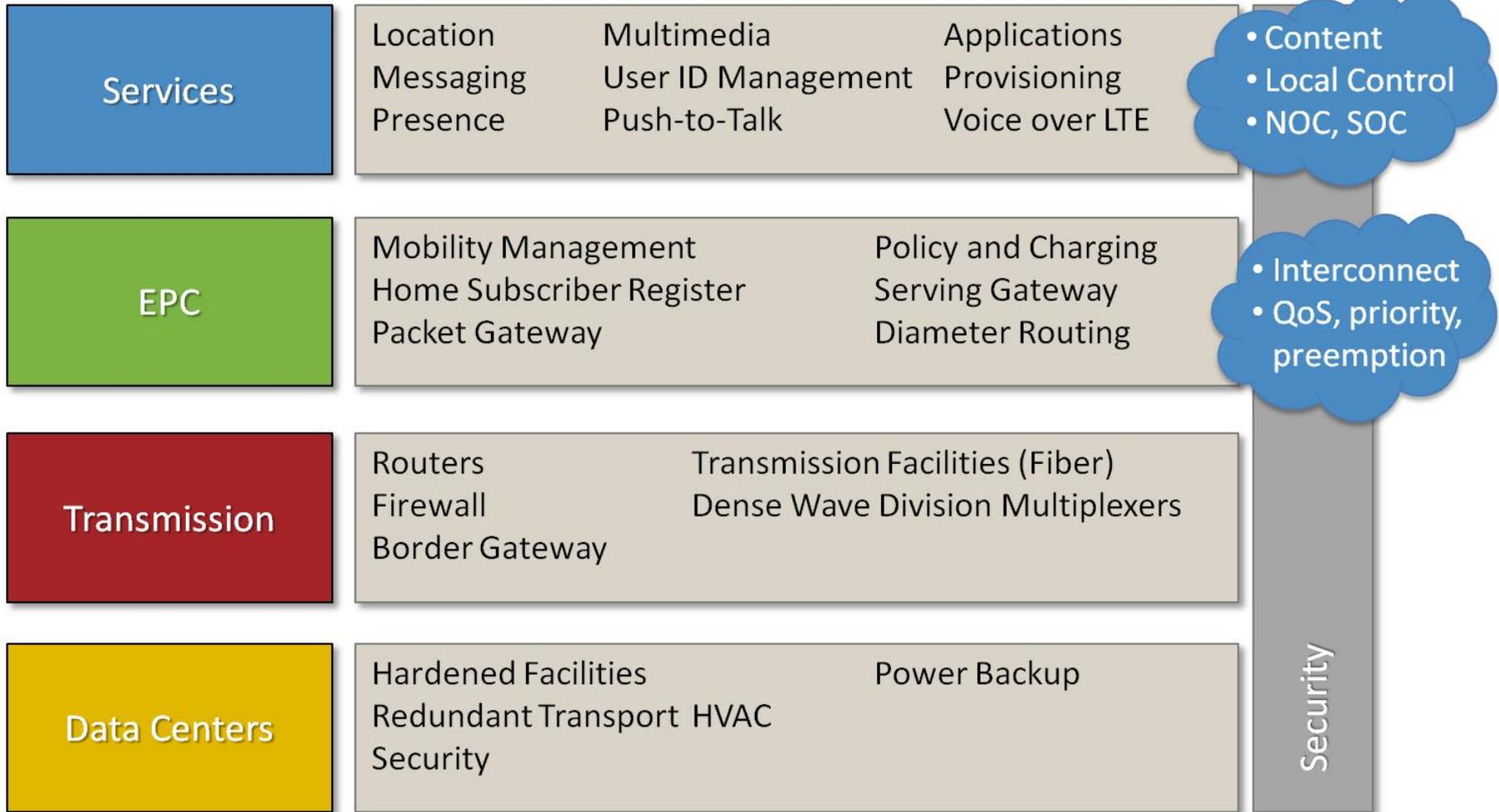
Rural
68% of U.S. Land Mass

Suburbs
5% of U.S. Land Mass

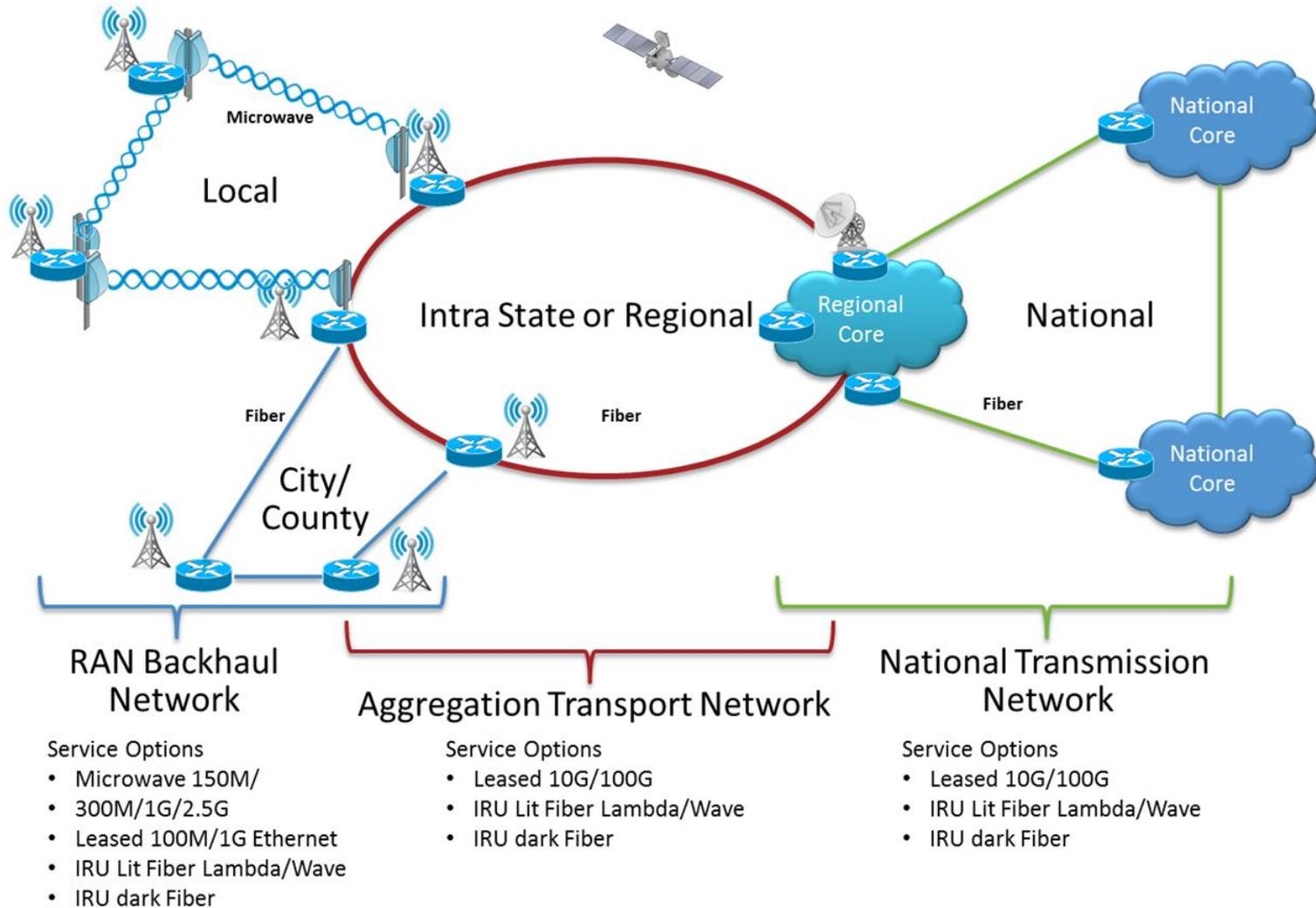
Urban

Dense Urban

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



Transport between RAN and Core



Devices – The Most Important Element to Public Safety



	Portables	In-Vehicle Routers	Specialized	Accessories
Device Types				
Category Driver	<ul style="list-style-type: none"> • Build up to an economy of scale 		<ul style="list-style-type: none"> • Special operational needs e.g. in-building, rural 	<ul style="list-style-type: none"> • Unique uses
Function	<ul style="list-style-type: none"> • Smartphone • Tablets • Modems 	<ul style="list-style-type: none"> • Routers • Hotspots • Consoles 	<ul style="list-style-type: none"> • Drones • Portable repeaters • Rovers 	<ul style="list-style-type: none"> • Ruggedized cases • Battery packs • Chargers, mics.
Connectivity	<ul style="list-style-type: none"> • LTE, CDMA, HSPA • LMR/ P25 • Wi-Fi, Bluetooth • Direct mode 	<ul style="list-style-type: none"> • LTE, CDMA, HSPA • Wi-Fi • Ethernet • USB 	<ul style="list-style-type: none"> • LTE, CDMA, HSPA • LMR/ P25 • Satellite 	<ul style="list-style-type: none"> • Bluetooth
Location Enabled	Yes	Yes	Some	n/a
Band 14 Support	2H14	1H14	2015+	n/a

Thank You



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