APCO International Emerging Technology Forum

Public Safety Communications Research (PSCR)

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Public Safety Communications Research Program

Located at the
Department of Commerce
Boulder Labs in Colorado

The PSCR Program is a joint
effort between:

NIST's
Office of Law
Enforcement Standards
(OLES)
and
NTIA's
Institute for
Telecommunication
Sciences
(ITS)

PSCR Funding Sources

Department of Homeland Security

Office for Interoperability and Compatibility

Office of Emergency Communications

FirstNet

PSCR Portfolio

LMR Standards and Technologies	Broadband Standards and Technologies	Emerging Standards and Technologies
P25 Standards and CAP	Demonstration Network	Bridging LMR & LTE
P25 Test Tools and Simulation	Requirements and Standards	Video Quality
Public Safety VoIP	Mission Critical Voice	
Audio Quality	Modeling and Simulation	
RF Propagation Studies		

PSCR Approach & Capabilities

Requirements

Research & Development

Standards & Specifications

Testing & Evaluation

Transition & Lessons Learned

Strategy
Program Management
Practitioner Input

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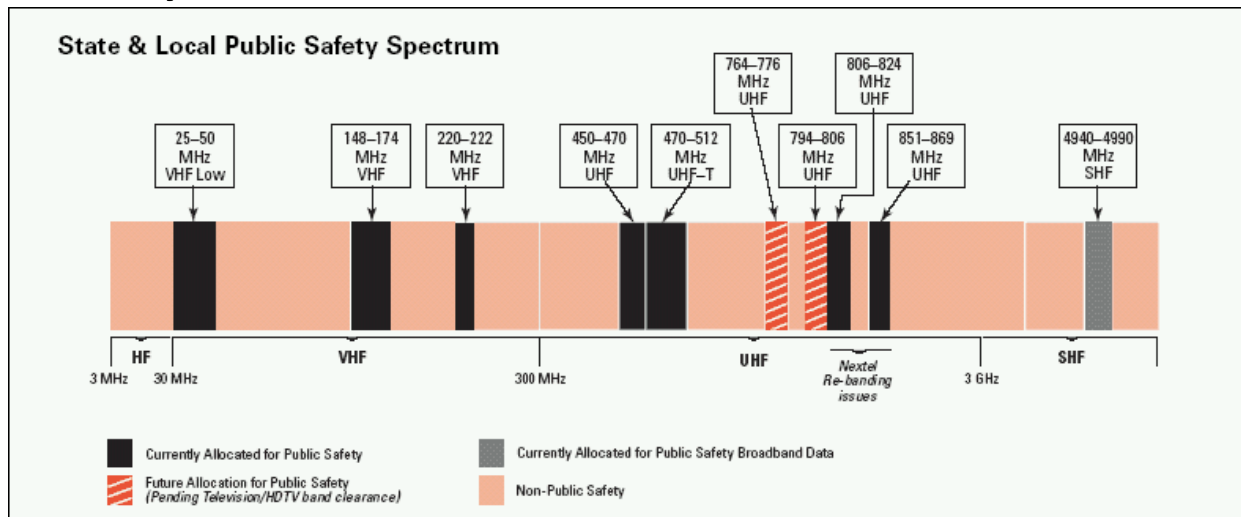Leaders in Public Safety Communications™

DISCLAIMER

The full description of the procedures used in the following PSCR presentations require the identification of certain agencies, localities, commercial products and their suppliers. The inclusion of such information should in no way be construed as indicating that such agencies, products or suppliers are endorsed by PSCR, or are recommended by PSCR, or that they are necessarily the best materials, instruments, software or suppliers for the purposes described.

Public Safety Communications Interoperability

Fragmented PS Radio Frequency Spectrum

- ## Limited and fragmented radio spectrum
  - – Inadequate and scattered spectrum allocations
  - – Over 10 separate bands are used for public safety narrowband communications

State & Local Public Safety Spectrum

US Public Safety Broadband Background

- As early as 2004, public safety began developing requirements for a dedicated broadband network

- In July 2007, the Federal Communications Commission (FCC) designated the lower half of the 700 MHz Public Safety Band (763-768/793-798 MHz) for broadband communications. This spectrum had been cleared by the Digital Television and Public Safety Act of 2005

- In early 2009, Congress directed the FCC to develop a National Broadband Plan, including recommendations for a dedicated public safety broadband network

- Later in 2009, public safety chose Long Term Evolution (LTE) as the primary technology for the broadband network

Nationwide Public Safety Broadband

Middle Class Tax Relief and Job Creation Act of 2012

Title VI – Public Safety Communications and Electromagnetic Spectrum Auctions

Created the First Responder Network Authority – aka "FirstNet"

Signed into Public Law 112-96 on February 22, 2012
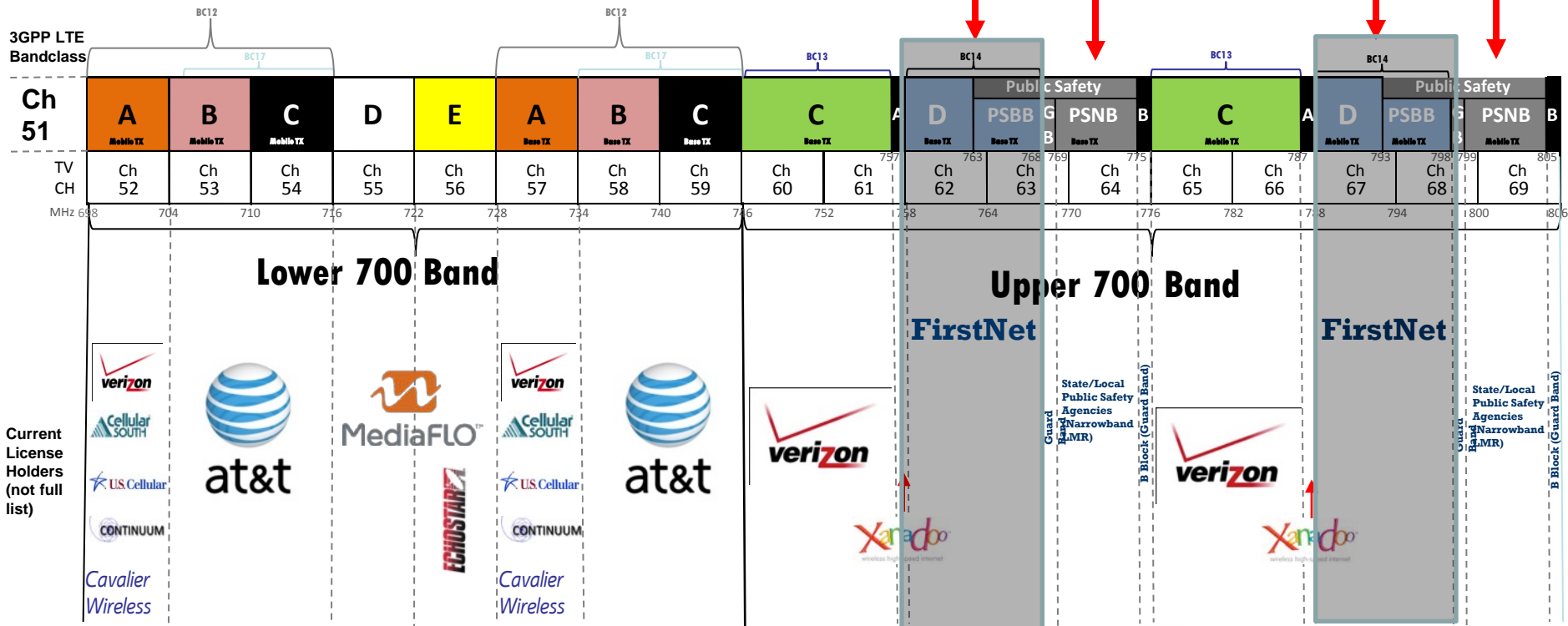
US Public Safety Broadband in 2012

- In February, Congress passed the Middle Class Tax Relief and Jobs Creation Act of 2012, which re-allocates the D Block (700 MHz spectrum adjacent to the existing public safety block) to public safety and allocates $7 Billion of incentive auction proceeds to the build out of a nationwide, interoperable public safety broadband network

- The Act created the First Responders Network Authority (FirstNet), the body charged with developing and managing the network
  - The FirstNet Board of Directors was announced in August 2012, and the FirstNet Board held their first meeting in September
  - In October, the NTIA (on behalf of FirstNet) issued a Notice Of Inquiry to "seek public comment on the conceptual network architecture presentation made at the FirstNet Board of Directors' meeting held on September 25, 2012, as well as to invite input on other network design and business plan considerations."

700 MHz Spectrum after Public Law 112-96

	Base TX	Mobile TX	Bandwidth
FirstNet License:	758-768	788-798	10x10 MHz

FirstNet PS Broadband

PS Narrowband

PSCR Current Efforts
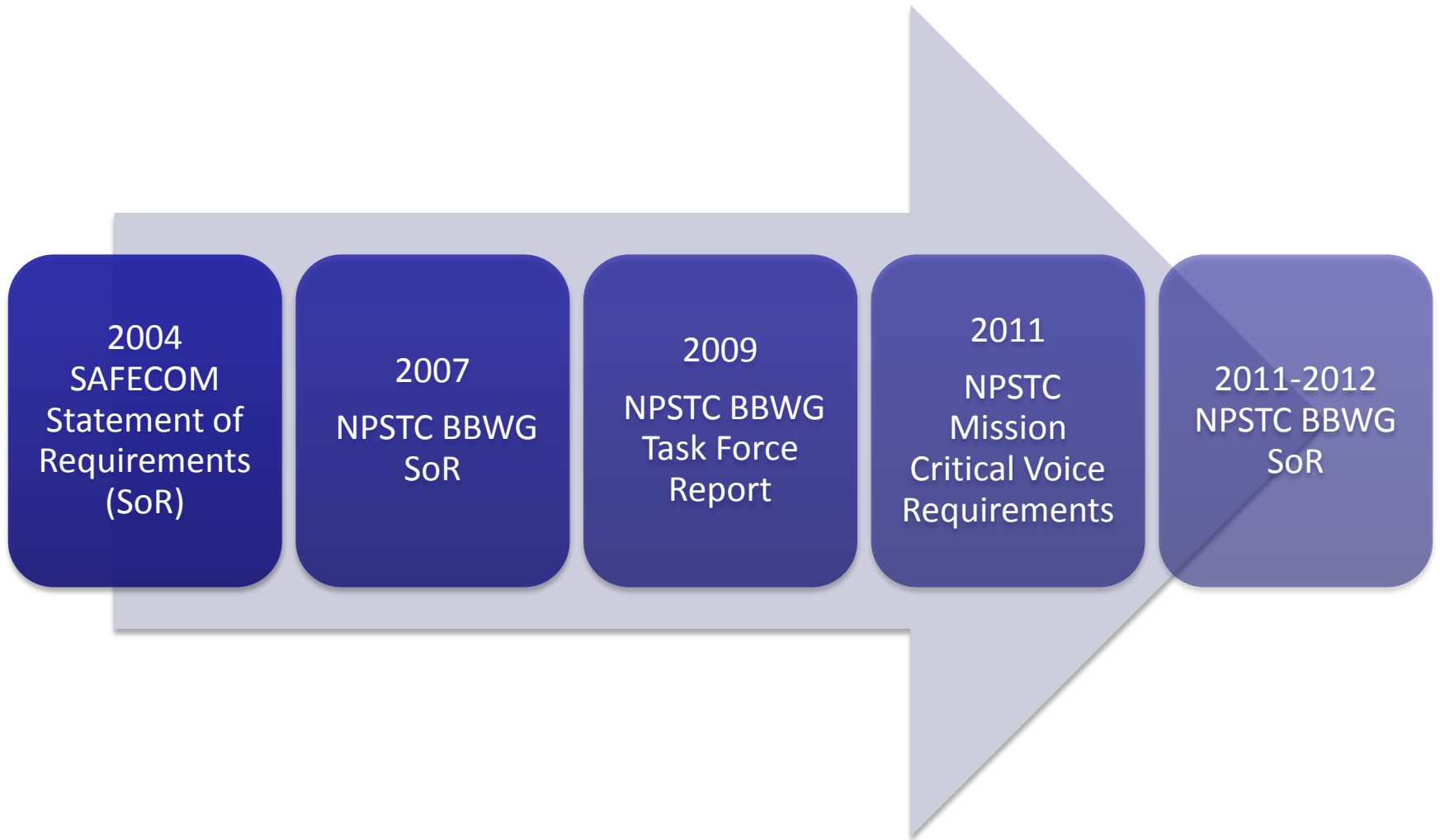
Requirements

Standards

700 MHz Public Safety Broadband Demonstration Network

Modeling & Simulation

Requirements

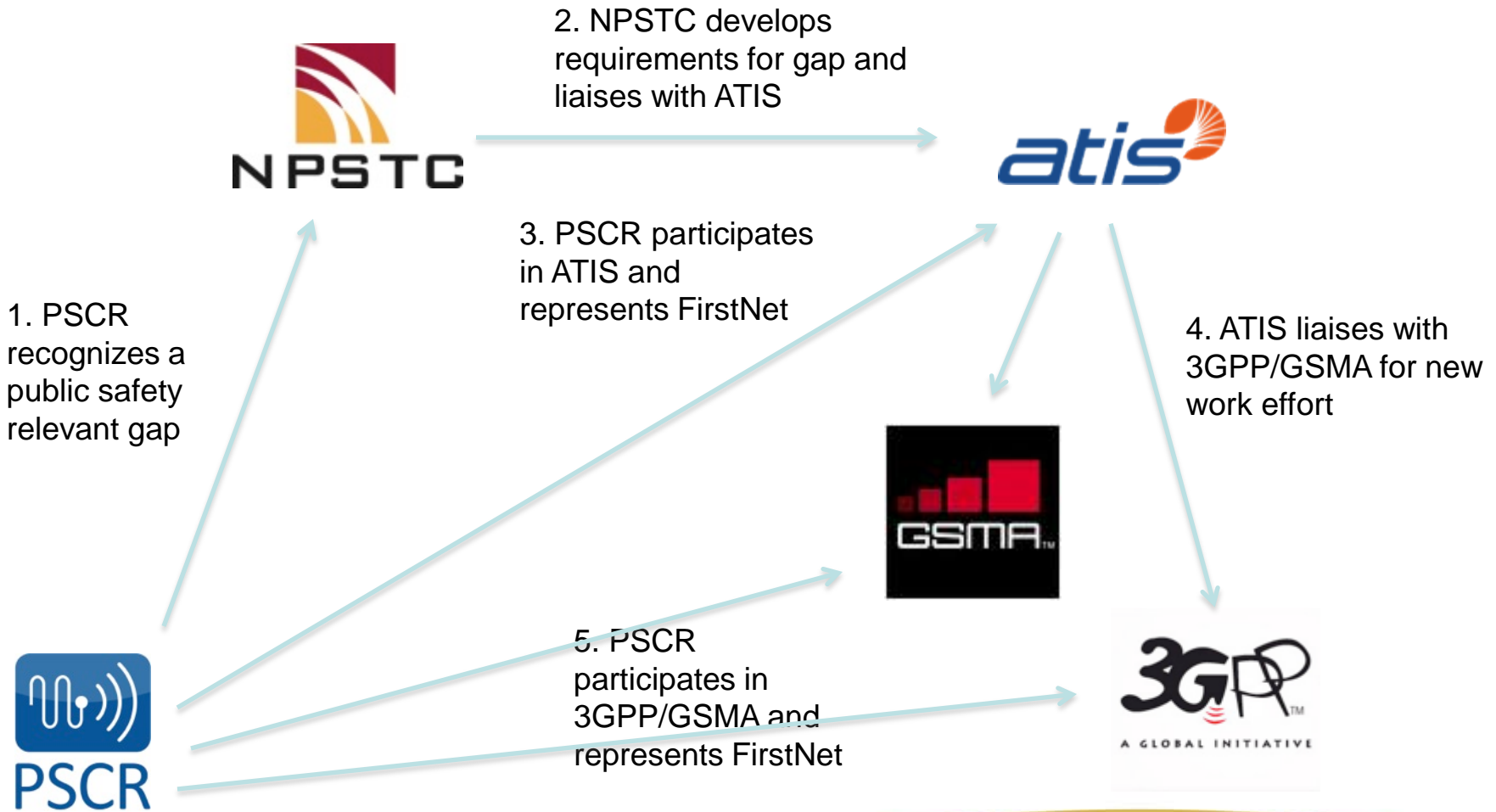| 2004 SAFECOM Statement of Requirements (SoR) | 2007 NPSTC BBWG SoR | 2009 NPSTC BBWG Task Force Report | 2011 NPSTC Mission Critical Voice Requirements | 2011-2012 NPSTC BBWG SoR |

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Requirements: Current Efforts

- 2004 SAFECOM Statement of Requirements
  - Who, what, why, when operational understanding
- 2007 National Public Safety Telecommunications Council (NPSTC) Broadband Working Group (BBWG) Statement of Requirements
- 2009 NPSTC BBWG Task Force Report
  - Public safety selects LTE
  - LMR model for procurement and operation
- 2011 Mission Critical Voice Requirements
  - BBWG seeks to define features/functions that make up mission critical voice
- 2011-2012 NPSTC BBWG Task Group Efforts
  - Priority/quality of service
  - Local control
- 2012 NPSTC BBWG Statement of Requirements
  - Developed "Launch Requirements" for FirstNet

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Broadband Standards: Current Efforts

2. NPSTC develops requirements for gap and liaises with ATIS

3. PSCR participates in ATIS and represents FirstNet

1. PSCR recognizes a public safety relevant gap

4. ATIS liaises with 3GPP/GSMA for new work effort

5. PSCR participates in 3GPP/GSMA and represents FirstNet

Standards Continued: 3GPP Structure

Technical Specifications Group (TSG) Structure

TSG GERAN	**TSG RAN**	**TSG SA**	**TSG CT**
GSM EDGE Radio Access Network	**Radio Access Network**	**Service & Systems Aspects**	**Core Network & Terminals**

TSG GERAN	TSG RAN	TSG SA	TSG CT
GERAN WG1 — Radio Aspects	RAN WG1 — RL 1 Spec	SA WG1 — Services	CT WG1 — MM/CC/SM (Iu)
GERAN WG2 — Protocol Aspects	RAN WG2 — RL 2 Spec / RL 3 RR Spec	SA WG2 — Architecture	CT WG3 — Interworking w/ Ext networks
GERAN WG3 — Terminal Testing	RAN WG3 — Lub, Iur, Iu specs / UTRAN O&M Reqs	SA WG3 — Security	CT WG4 — MAP/GTP/BCH/SS
	RAN WG4 — Radio Perf / Protocol Aspects	SA WG4 — Codec	CT WG6 — Smart Card App Aspects
	RAN WG5 — Mobile Terminal Conformance Testing	SA WG5 — Telecom Mgt	

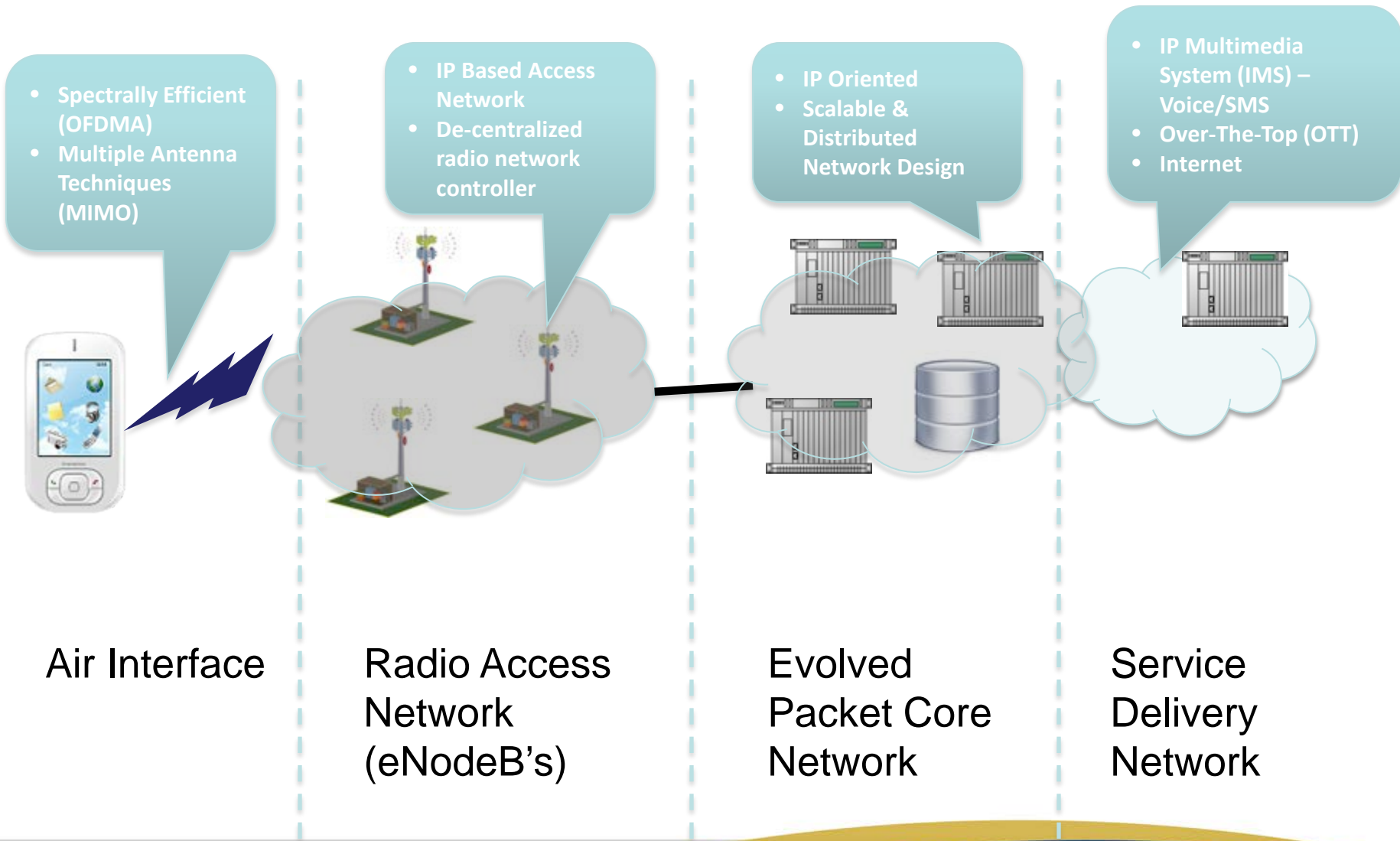# Broadband Standards: Current Efforts

- Current Focus
  - 3GPP
    - Proximity Services/ProSe (Talk-around)
    - Group Efficiency (Group communications)
  - ATIS
    - PLMN ID (Public Land Mobile Network Identifier)
    - PTT over LTE (Push-to-talk over LTE)
  - GSMA
    - VoLTE (Voice over LTE)

- Lessons Learned
  - Public safety LTE is a global market; PSCR's global partnerships have been successful

PSCR BB Demonstration Network

- Obtain, procure, and generate interest from broadband vendors to develop a 700 MHz broadband equipment ecosystem - including Band Class 14 (D Block & Public Safety Block), Long Term Evolution (LTE)

- Demonstrate broadband air-interface and core network capabilities

- Interoperability with existing cellular, broadband and LMR technology

- Validation of key public safety functionalities and requirements

- Modeling & Simulation of various potential public safety LTE deployments

- R&D **nationwide interoperability** through a unified approach to network design and implementation
  - Testing (conformance, performance and evaluation)
  - Multi-site/vendor Over-The-Air network – allows consistent testing between vendors
  - Develop guidelines/industry requirements for network architecture
  - Advanced feature testing

LTE Network Architecture

- **Spectrally Efficient (OFDMA)**
- **Multiple Antenna Techniques (MIMO)**

- **IP Based Access Network**
- **De-centralized radio network controller**

- **IP Oriented**
- **Scalable & Distributed Network Design**

- **IP Multimedia System (IMS) – Voice/SMS**
- **Over-The-Top (OTT)**
- **Internet**

Air Interface

Radio Access Network (eNodeB's)

Evolved Packet Core Network

Service Delivery Network

Executed CRADAs

Testing Status

- Current LTE Infrastructure in Labs:
  - Alcatel Lucent**
  - Harris/Nokia-Siemens Networks**
  - Motorola/Ericsson**
  - General Dynamics Broadband (formerly IPWireless)**
  - Cisco
  - AMDocs
  - Thales
  - Tekelec   **also eNodeBs

- Phase 3 Interoperability Testing (IOT) nearing completion

- RF Network configuration complete for Boulder Demo Network

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Testing Status (cont.)

- Phase 3 Drive Testing in progress – anticipate completion by March 2013

- Received 2 new vendors Bandclass 14 LTE datacards

- Received two Android based LTE Bandclass 14 devices – smartphone and tablet

- Implemented interface (ISSI) and client software to provide Voice over IP connection between existing PSCR P25 over the air systems from Cassidian and Raytheon

- Acceptance testing of Tekelec Diameter Routing Agent

PSCR Boulder Sites

- **PSCR Demonstration network cellsites:**

Cellsite On Wheels (COW)

Green Mountain

Table Mountain Mesa

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PSCR Boulder Sites

Site locations for the Boulder Demo Network:

A. **Green Mountain**
   - Dept. of Commerce Labs

B. **Table Mountain Mesa**
   (9 miles NE of DOC Labs)
   - Radio Quiet Zone
   - Managed by NTIA/ITS

C. **Cell on Wheels (COW)**
   - Currently at GunBarrel

Green Mountain Base Station
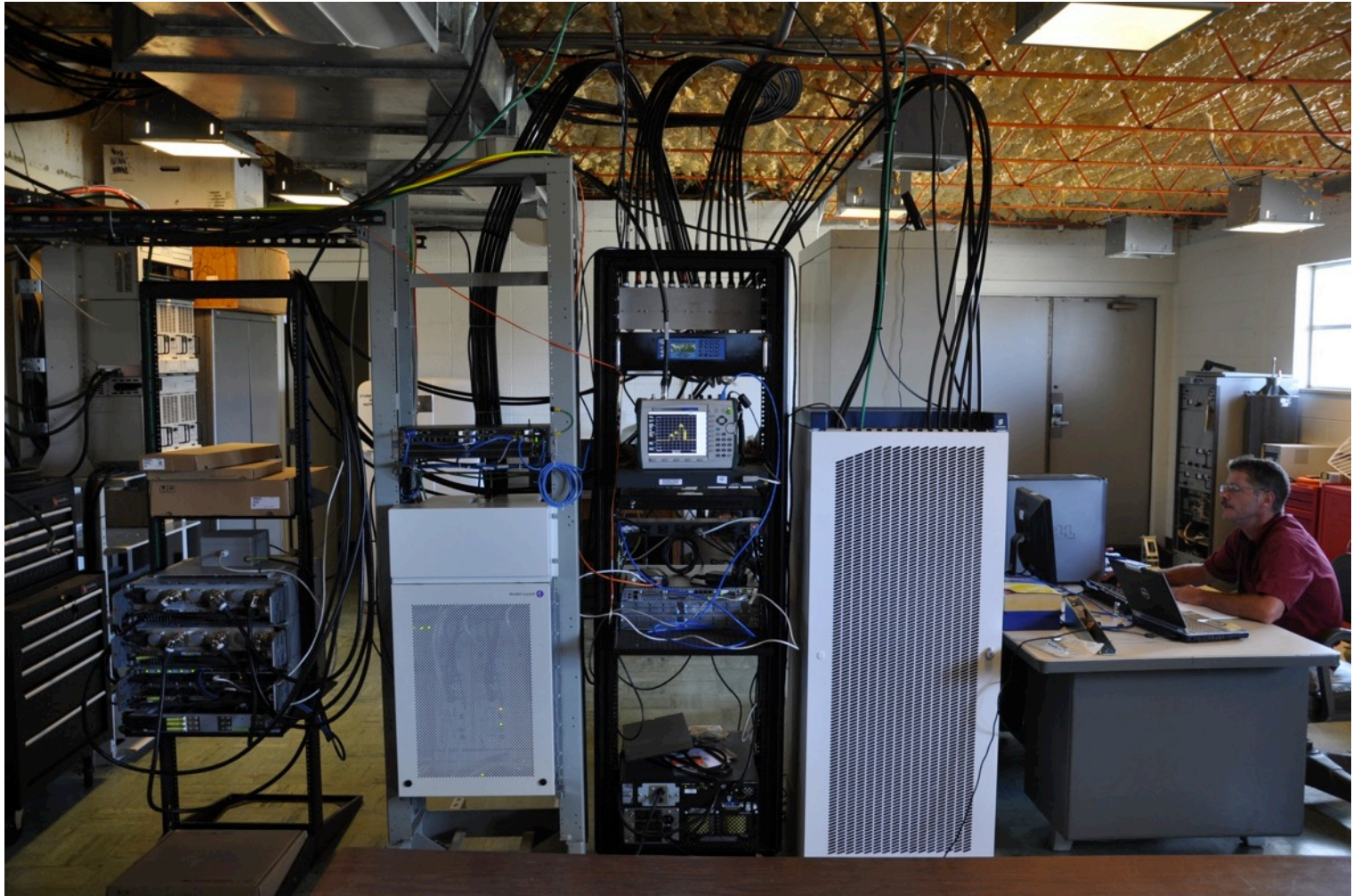

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Table Mountain Mesa

Table Mountain Mesa (inside)

Cellsite Base Stations

Cellsite Base Stations

Cellsite on Wheels (COW)

GunBarrel Co-Located Cellsite

Demo Network R&D (future)

- Efforts under discussion with FirstNet

- Developing test plan for Small Cell trial, evaluating site locations, backhaul, and RF Coverage

- Developing test plan for in-building LTE performance – evaluating indoor measurement system from JDSU

- Implementing RCS and IMS into Lab network

- Investigating LTE roaming with IPX providers and integration into commercial carriers

Network Modeling: Current Efforts

- Evaluate the performance of Long Term Evolution (LTE) networks and their capacity to support Public Safety requirements
  - Optimize different scenarios for the demonstration network
  - Estimate the resources required to build a nationwide public safety broadband network
  - Define performance metrics to facilitate the comparisons of network scenarios and deployments
  - Obtain area, population, and user coverage
  - Determine maximum supported capacity

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Network Modeling: Inputs and Assumptions

Sample area 100 km x 100 km

User densities (users/km²) for Police, Fire, and EMS employees

Color	Range
	< 0.1
	0.1 - 0.5
	0.5 - 1
	1 - 2
	2 - 5
	5 - 10
	10 - 20
	20 - 50
	> 50

- Area
  - Boundaries
  - Geodata (elevation, clutter)
- User distribution
  - How many and where
- Traffic model
  - Application types
  - Usage scenarios
- Propagation model
  - HATA, CRC Predict, Universal Model
  - Model tuning
- Site placement

Thank You!

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http://www.pscr.gov

Q & A

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