



Public Safety Communications Research Program

Dereck Orr
NIST/OLES
Program Manager

Jeff Bratcher
NTIA/ITS
Technical Manager

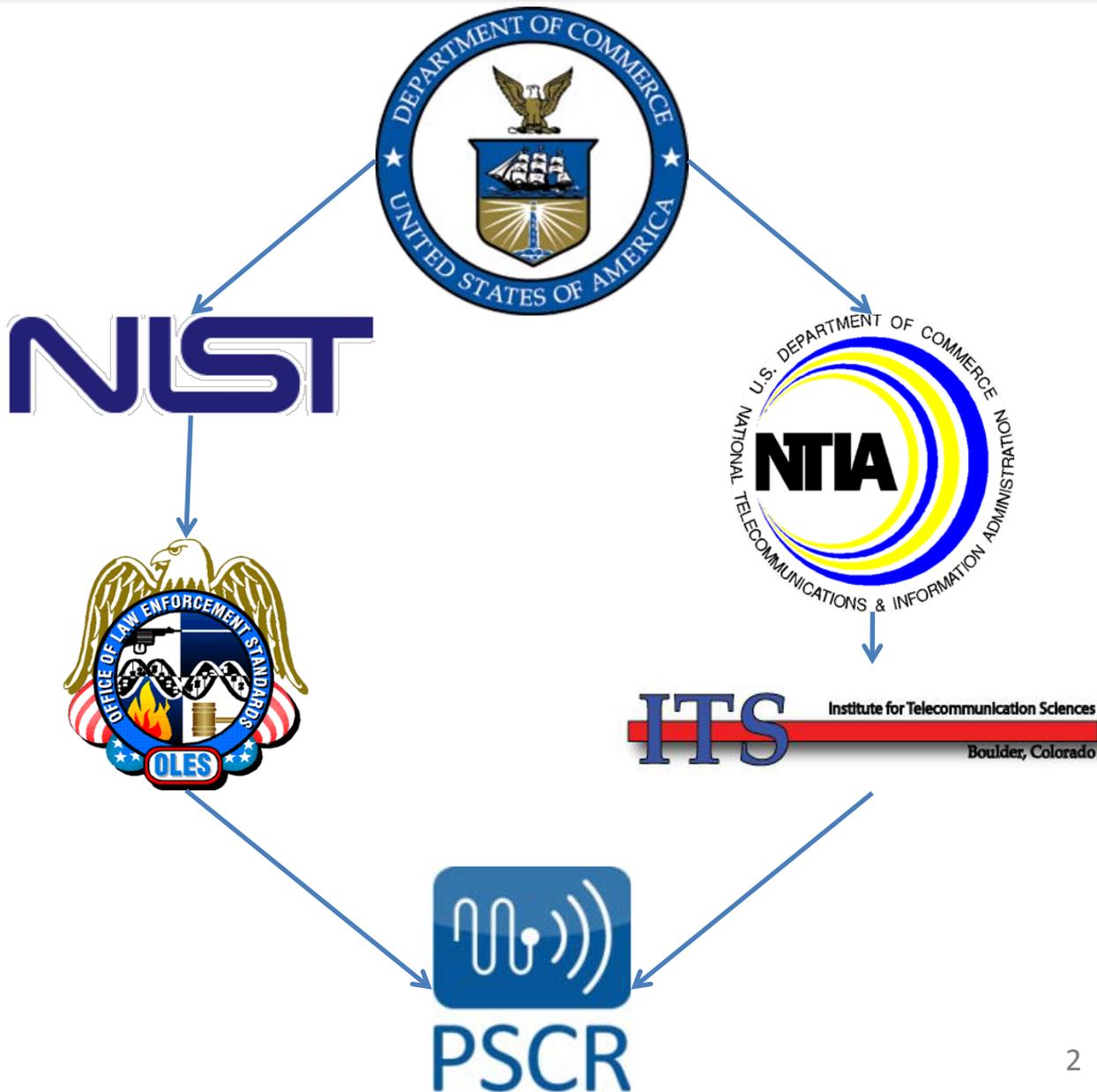
Department of Commerce – Boulder Labs

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 Vision & Mission

VISION

The response community nationwide can exchange voice and data seamlessly to effectively respond to any incident or emergency.

MISSION

To fulfill this vision, PSCR will act as an objective technical advisor and laboratory to public safety to accelerate the adoption and implementation of only the most critical public safety communication standards and technologies.

Public Safety Interoperability



PSCR Sponsors



Homeland Security

Department of Homeland Security

Office for Interoperability and Compatibility



COPS

Department of Justice

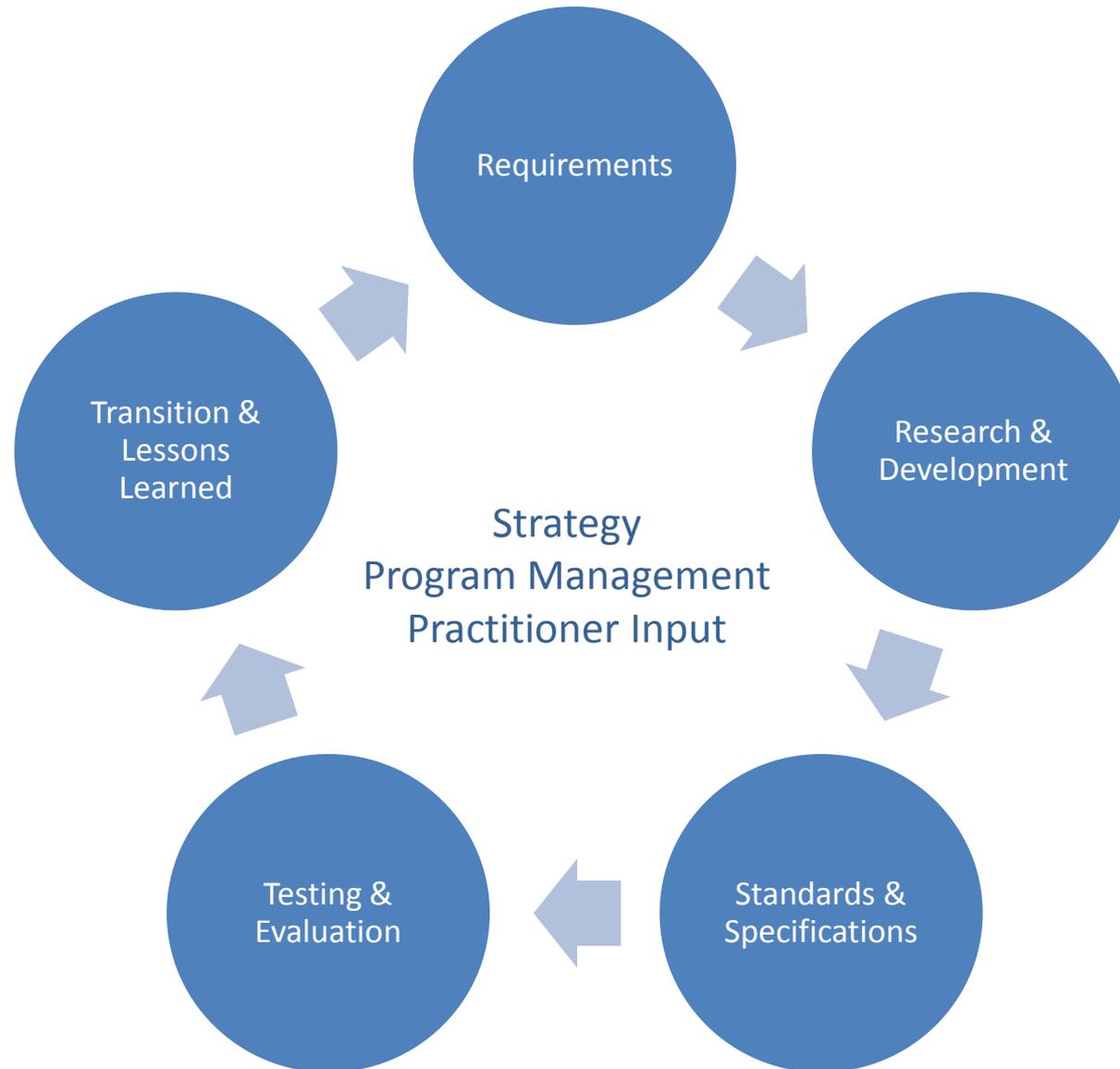
Office of Community Oriented Policing Services

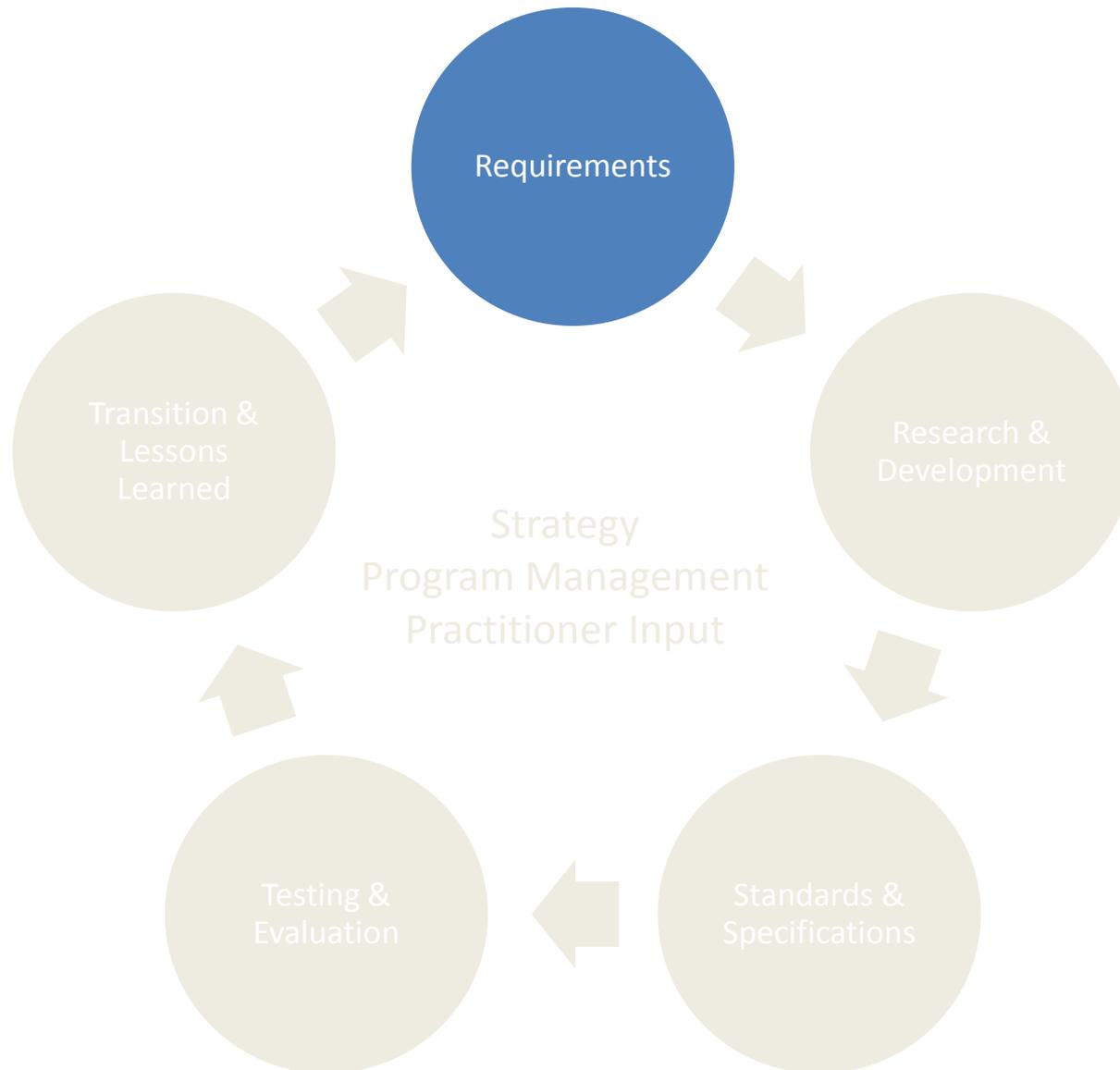
PSCR Portfolio

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	RF Propagation Studies	

* Project funded by DHS Office of Interoperability and Compatibility

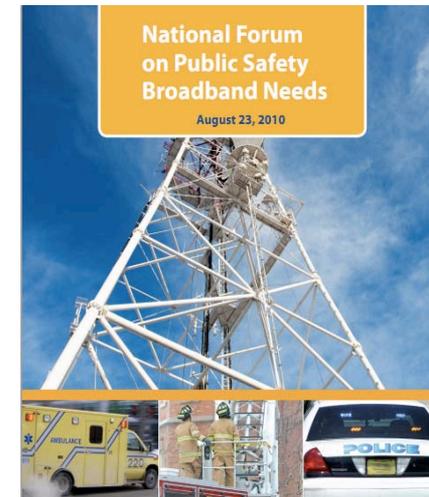
PSCR Approach & Capabilities

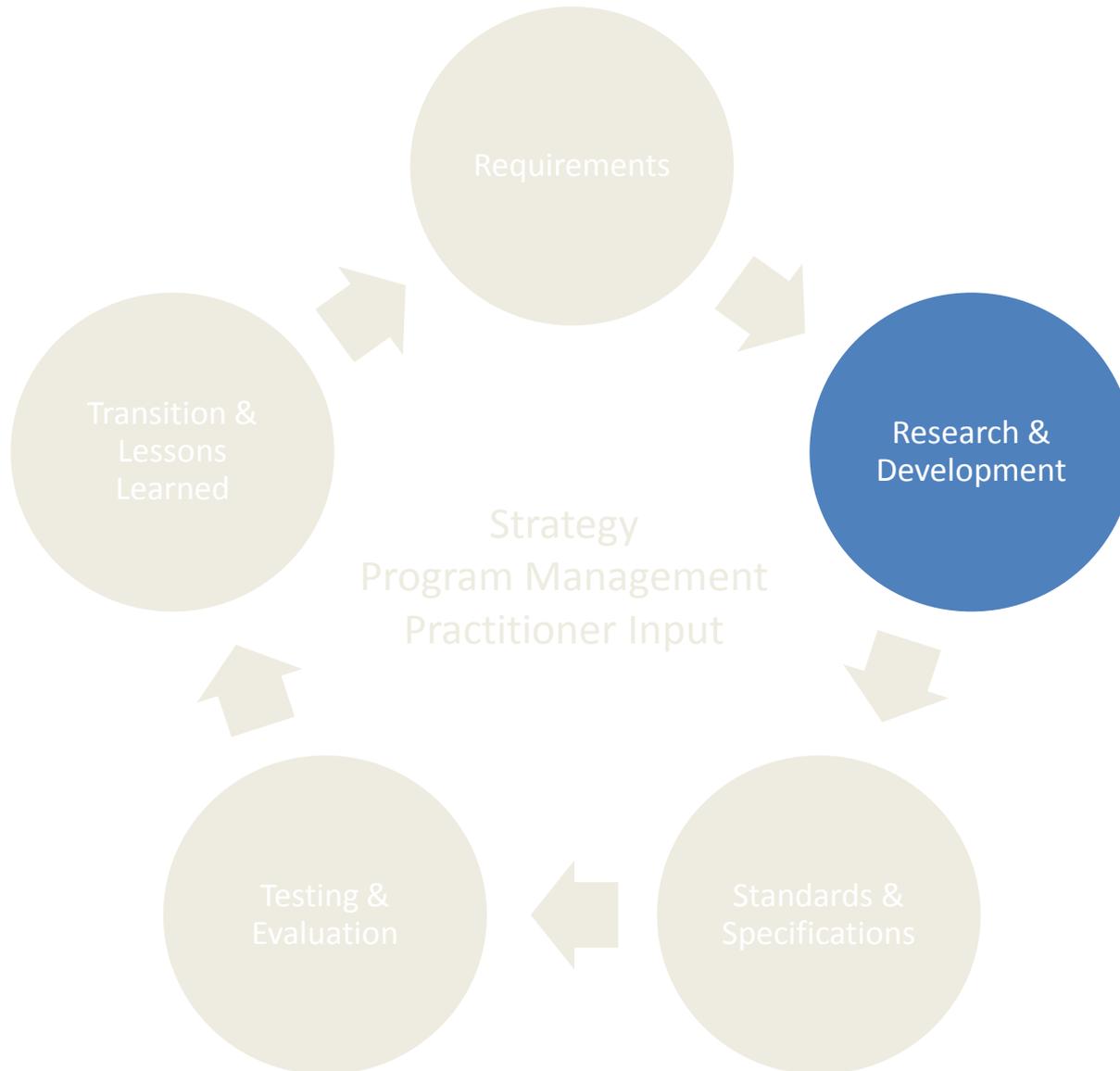




Requirements

- PSCR chairs the NPSTC Broadband Working Group
 - 200+ public safety members
 - Developed the [700MHz Broadband Statement of Requirements](#)
 - Defined [Mission Critical Voice](#)
- PSCR leads 5 BBWG Task Groups
 - Local Control
 - Multimedia Emergency Services
 - Priority/Quality of Service
 - Security
 - Voice
- PSCR is active in other broadband requirements gathering efforts
 - APCO Broadband Working Group
 - DOJ's National Forum on Public Safety Broadband Needs
 - PSST Operators Advisory Council





R&D: Demonstration Network Study Items

- **Network Identifiers:** Developing requirements for a single nationwide public safety 700-MHz public land mobile network (PLMN), as well as test cases to evaluate such requirements.
- **Network Performance:** Defining basic and public-safety-specific 700-MHz LTE demonstration network requirements for coverage, use planning and implementation, metrics and test strategy.
- **UE Testing:** Determining UE test cases for UE deployments in the public safety 700-MHz demonstration network. The goal is to ensure that UE deployments meet performance and interference requirements identified by Federal, state, and local agencies.
- **Infrastructure Testing – RAN & EPC:** Defining test processes, requirements, and specifications to cover minimum performance and conformance to LTE/3GPP specifications. The infrastructure testing group is also addressing the same issues related to interoperability of network infrastructure.
- **Roaming & Clearing:** Defining standards, recommending architecture, and creating test cases for possible LTE roaming scenarios applicable to the public safety 700-MHz demonstration network.
- **Universal Integrated Circuit Card (UICC):** Defining an initial set of parameters and requirements for the UICC, including software features.

R&D: Audio Quality Testing

Audio Quality Testing:

- Firefighter reports showed that some background noises created by firefighting equipment can interfere with digital narrowband communication
- Similar audio quality issues may arise as voice is introduced to the public safety broadband network
- PSCR worked with practitioners to develop and implement tests that measure the operation of digital radios, and also tested mitigation techniques for the problems.
- PSCR is initiating broadband audio quality testing with:
 - A transcoding study between the Adaptive Multi-Rate Narrow Band vocoder (the fallback vocoder for Voice over LTE) and the Project 25 vocoder
 - A subjective experiment to understand the effect of background noise on the new vocoder



Example of the Audio Issue

Analog
(no background noise)



P25
(no background noise)



Analog
(low air alarm)



P25
(low air alarm)



Changes in P25 Intelligibility Since 2008

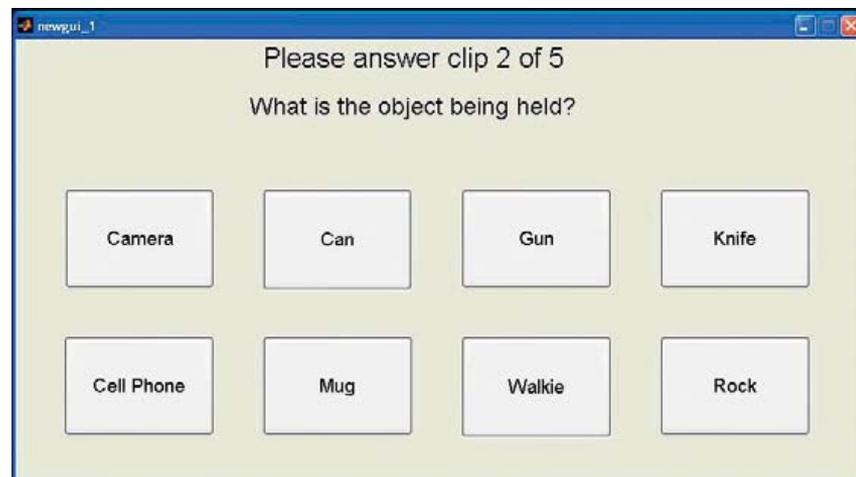
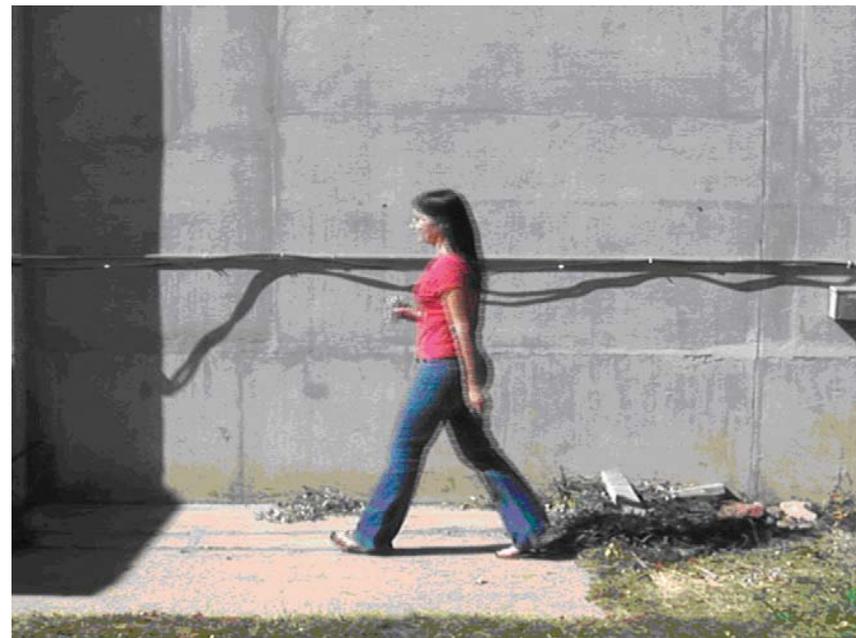
<p>Mask 2008 (no background noise)</p> <p> 59%</p> <p></p>	<p>PASS Alarm 2008</p> <p> 21%</p> <p></p>
<p>Mask 2011 (updated best practices)</p> <p> 69%</p> <p></p>	<p>PASS Alarm 2011 (Updated Vocoder)</p> <p> 50%</p> <p></p>

R&D: Video Quality Testing

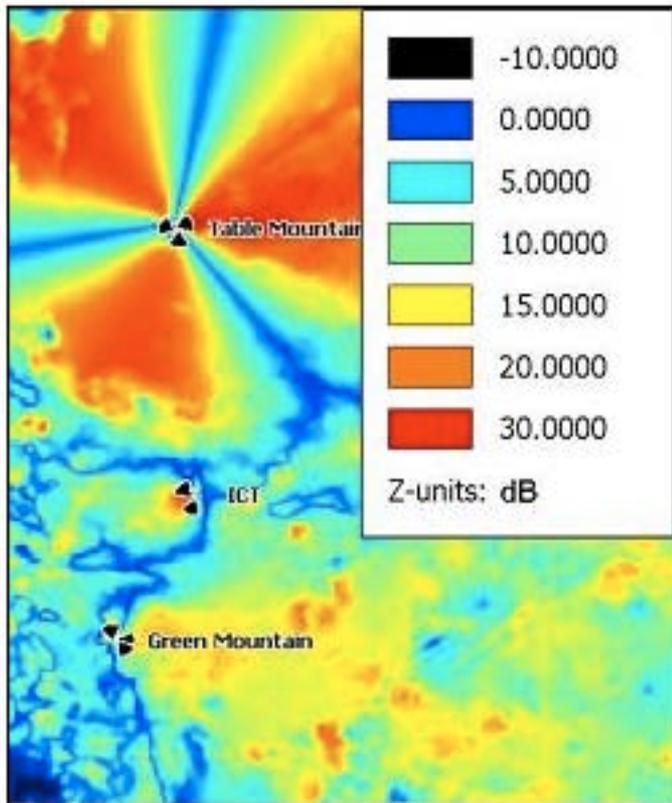
Video Quality Testing:

Video is one of the most commonly identified use cases for the network and also the most likely to congest it.

- Traditional methods of evaluating perceived broadcast video quality are not appropriate for public safety video.
- PSCR has been conducting research to develop task-specific video quality requirements for public safety applications.
- This work has been incorporated into International Telecommunication Union (ITU) standards for subjective task-based video quality.
- Outputs of this research will allow for informed decisions on quality of service parameters for the public safety network.



R&D: 700MHz Modeling & Simulation



700MHz Modeling and Simulation:

Work performed by:

NIST Information Technology Laboratory

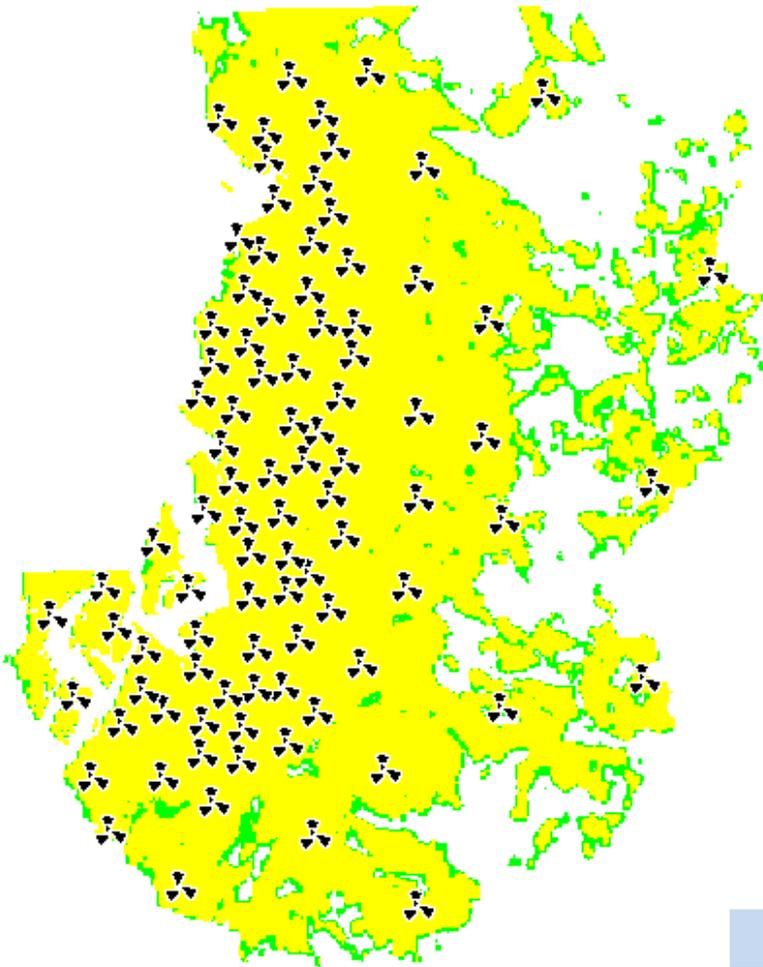
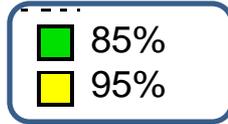
and

NIST Physical Measurement Laboratory

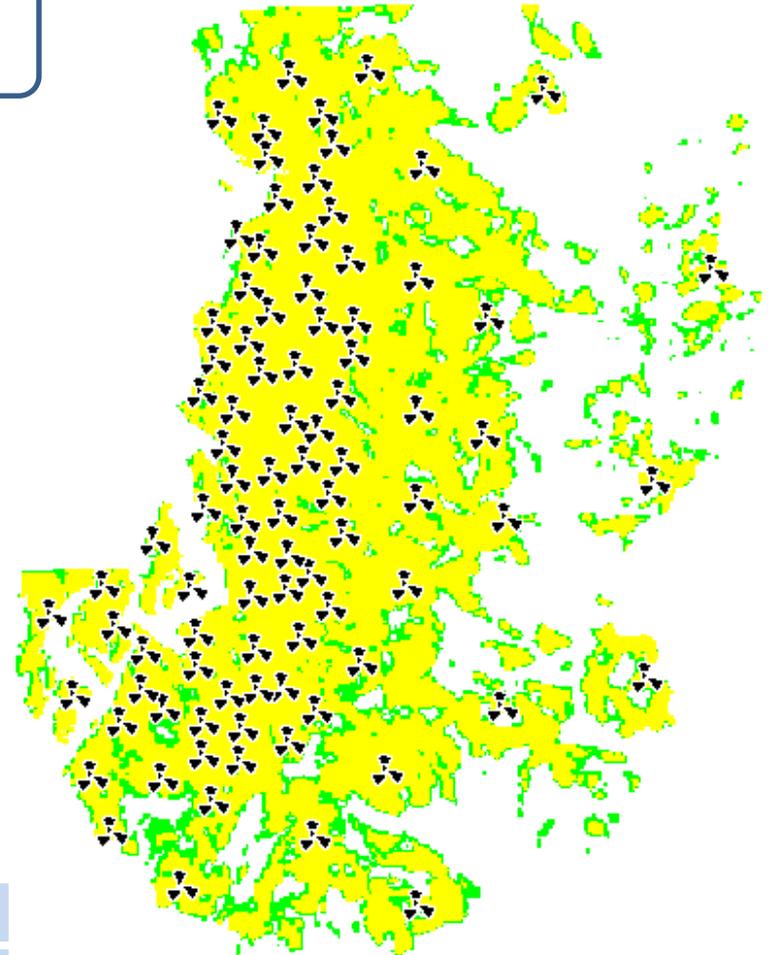
- Providing the public safety community with the performance analysis tools needed to better understand emerging network technologies, including:
 - The evaluation of worst/best case network deployment scenarios
 - The investigation of how well new technologies support public safety requirements
 - The development of quantitative requirements for public safety communications
- Informing build out of the Demonstration Network and using the network's data to inform models
- Driving the development of next generation network standards in support of public safety communication needs

R&D: 700MHz Modeling & Simulation

Seattle Region - RSRP



MCS0



MCS6

Settings

91 sites
4 W/MHz/ant.

R&D: LMR to LTE Interface

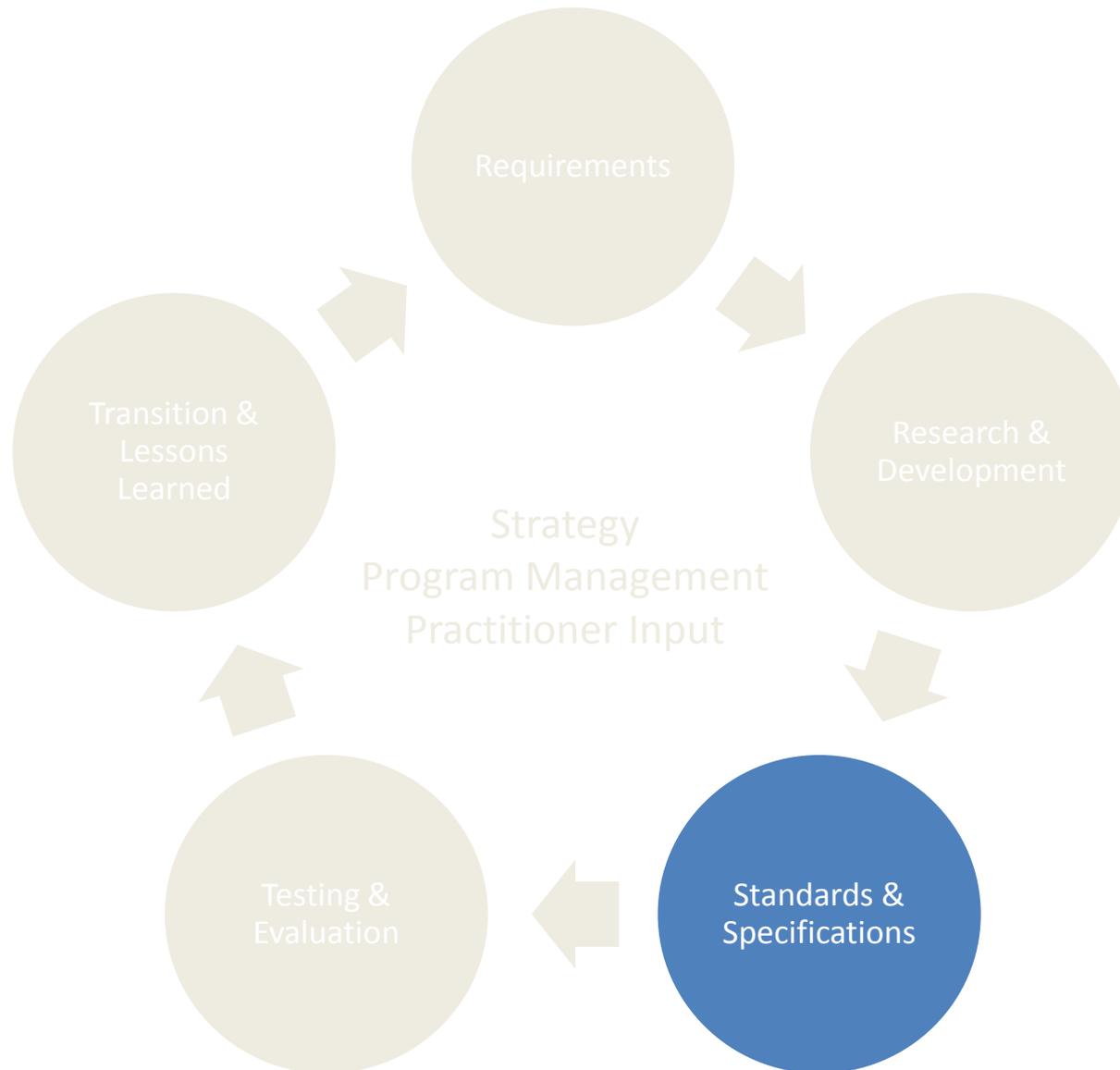
LMR to LTE Interface:

For the foreseeable future, public safety will be leveraging narrowband for voice and broadband for data communications, but there must be the capability to connect the narrowband and broadband systems together to create more dynamic communications capability amongst all existing systems.

- Through the NPSTC BBWG Broadband Voice Task Group, PSCR is looking at LMR/Broadband integration, including mission-critical voice over broadband and requirements for direct mode communication



- In developing a specification for an LMR to LTE interface, PSCR is leveraging its past work in:
 - **Radio over Wireless Broadband (ROW-B)**, which successfully integrated radios operating on an existing Land Mobile Radio (LMR) system with a 700MHz broadband network
 - **Voice over Internet Protocol (VoIP)**, in which PSCR led a coalition of public safety officials and bridging systems vendors to develop a VoIP implementation profile so one emergency response agency could seamlessly connect its radio system to another agency's system over a network—regardless of manufacturer



Standards and Specifications

PSCR has historically provided insight and direction to IT and wireless standards committees that are developing standards for voice, data, image, and video communication specific to public safety. PSCR's work is currently focused in these SDOs:



The **3rd Generation Partnership Project (3GPP)** produces the technical standards and specifications for LTE, uniting numerous telecommunications standards bodies under one group.

- PSCR is a member of 3GPP and represents public safety's requirements
- PSCR has introduced a work item into 3GPP to address Direct Mode (Proximity Services) communications



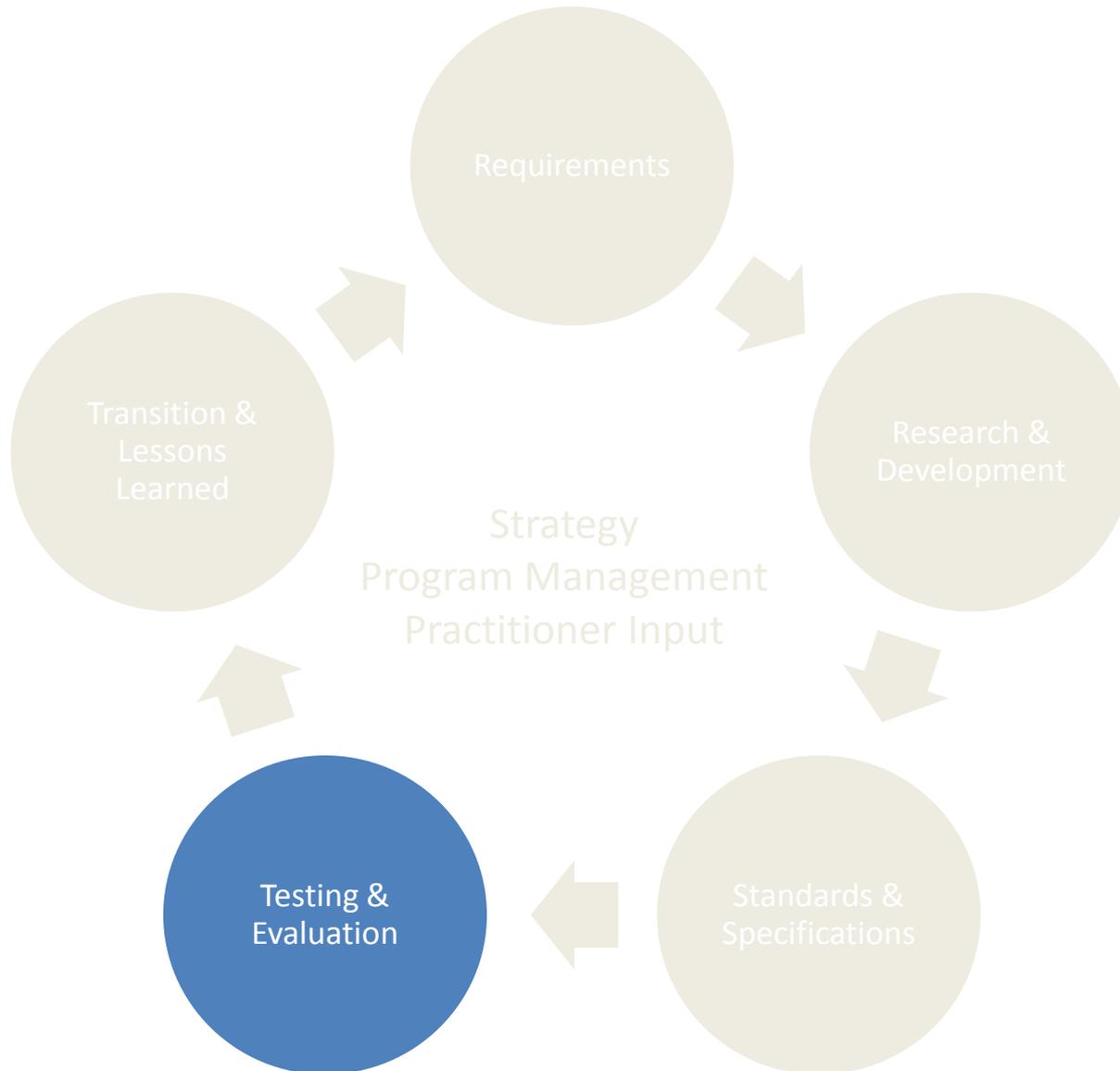
The **Alliance for Telecommunications Solutions (ATIS)** is the North American standards body representative in 3GPP.

- PSCR is a member of ATIS and represents public safety's requirements
- PSCR has created an issue statement that would give the ATIS WTSC the ability to work on public safety specific issues



The **GSM Association (GSMA)** is an association of mobile operators and related companies that support the standardization of the GSM system.

- PSCR is actively seeking membership to GSMA in order to represent public safety's requirements to their Voice over LTE (VoLTE) initiative



T&E: Demonstration Network

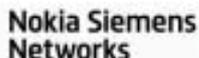
The only government or independent lab facility located in the United States to test and demonstrate public safety 700 MHz broadband networks and applications

The Demonstration Network provides:

- A place for manufacturers and carriers to deploy their systems to test them in a multi-vendor environment. This provides integration opportunities.
- A place for public safety to see how these systems will function, specific to their unique needs. Interested agencies can visit the network and get hands-on experience with these systems, as well as run public safety specific test cases that relate directly to their operational environments.
- A place where early builders can ensure that the systems they might procure will in fact work in the eventual nationwide network, assisting agencies in their procurement process.

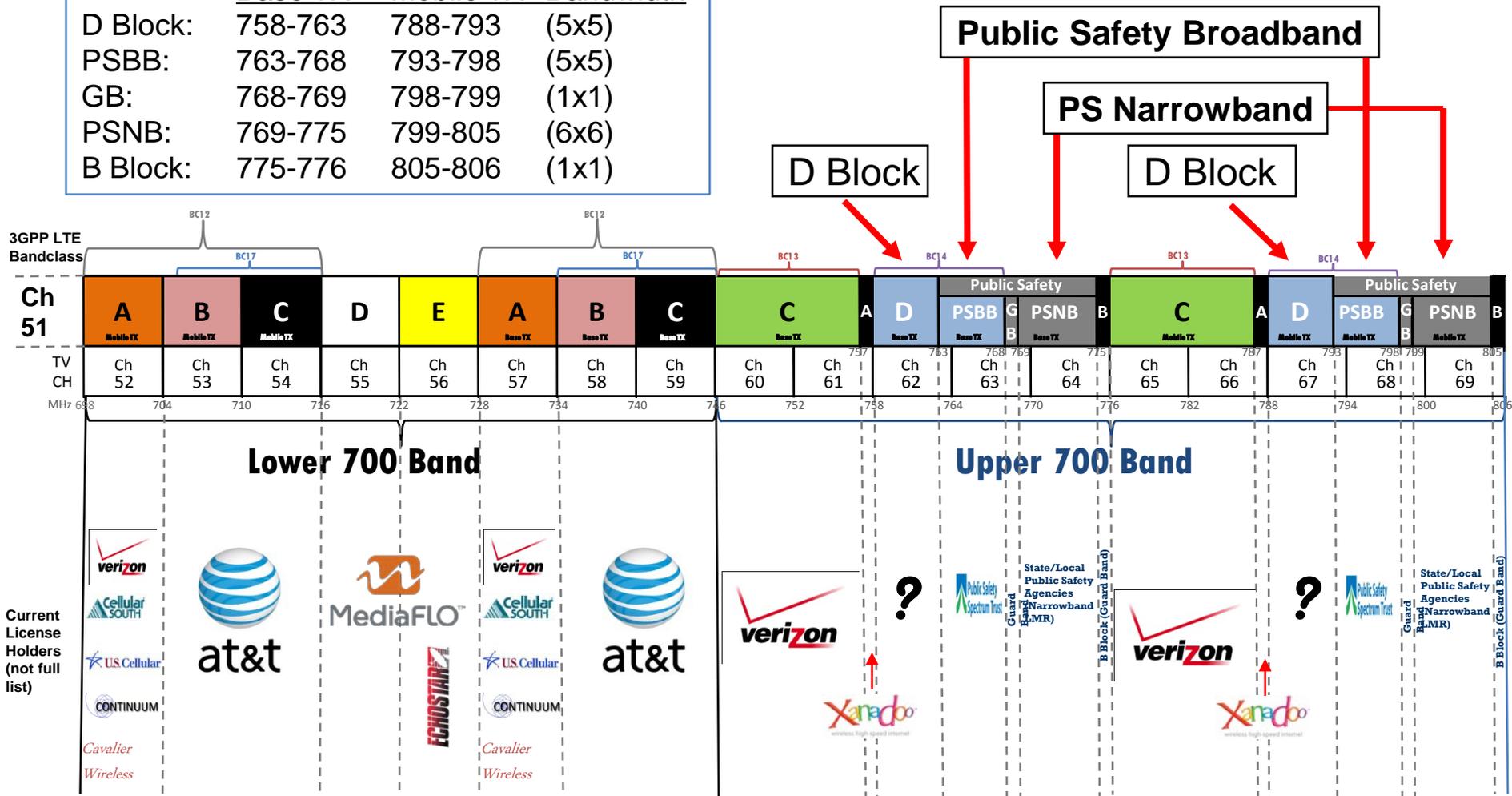


T&E: Demo Network CRADA Partners

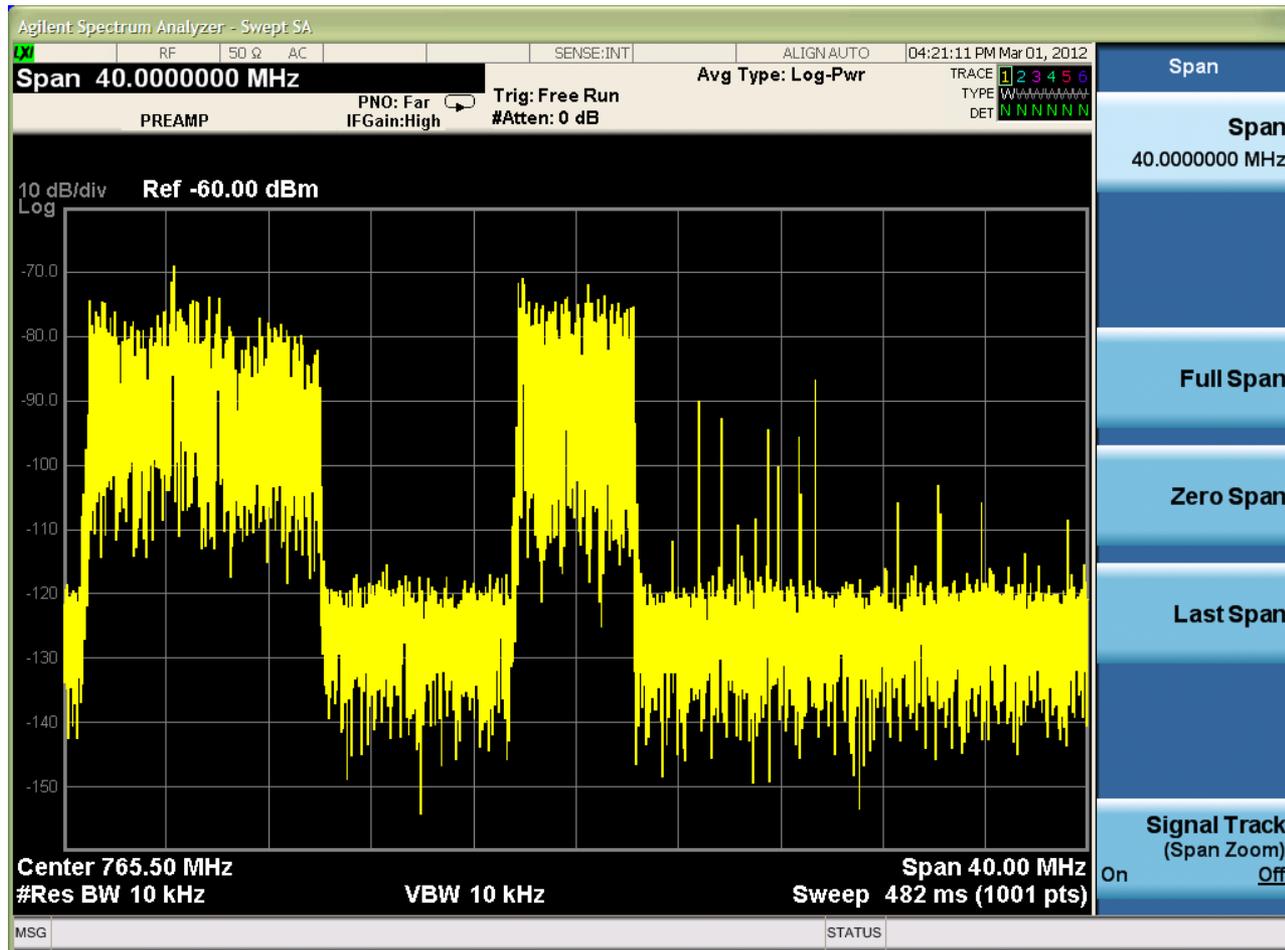


700 MHz Spectrum

	Base TX	Mobile TX	Bandwidth
D Block:	758-763	788-793	(5x5)
PSBB:	763-768	793-798	(5x5)
GB:	768-769	798-799	(1x1)
PSNB:	769-775	799-805	(6x6)
B Block:	775-776	805-806	(1x1)

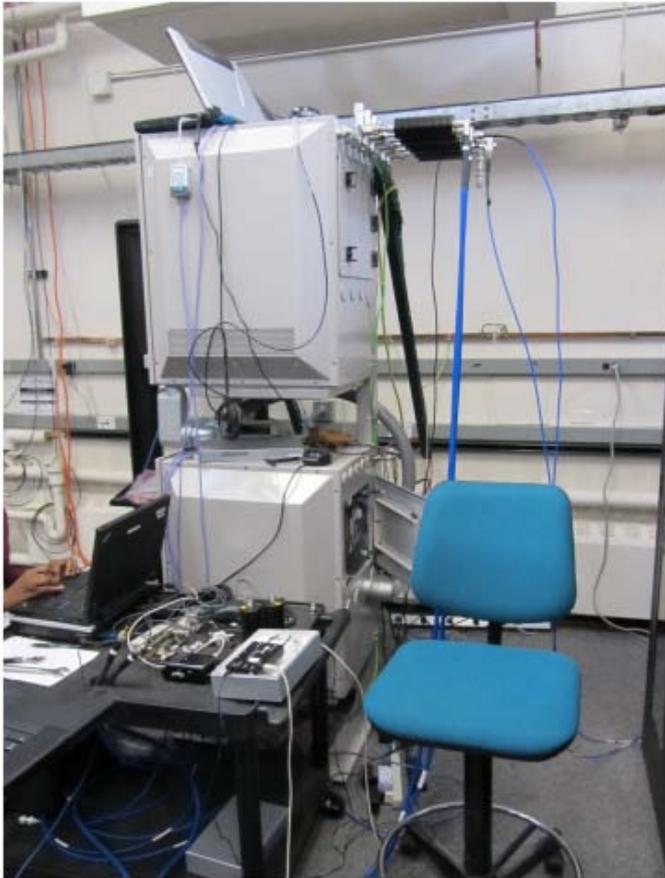


Measured 700MHz Spectrum



T&E: Demonstration Network

eNodeB



eNodeB Antenna

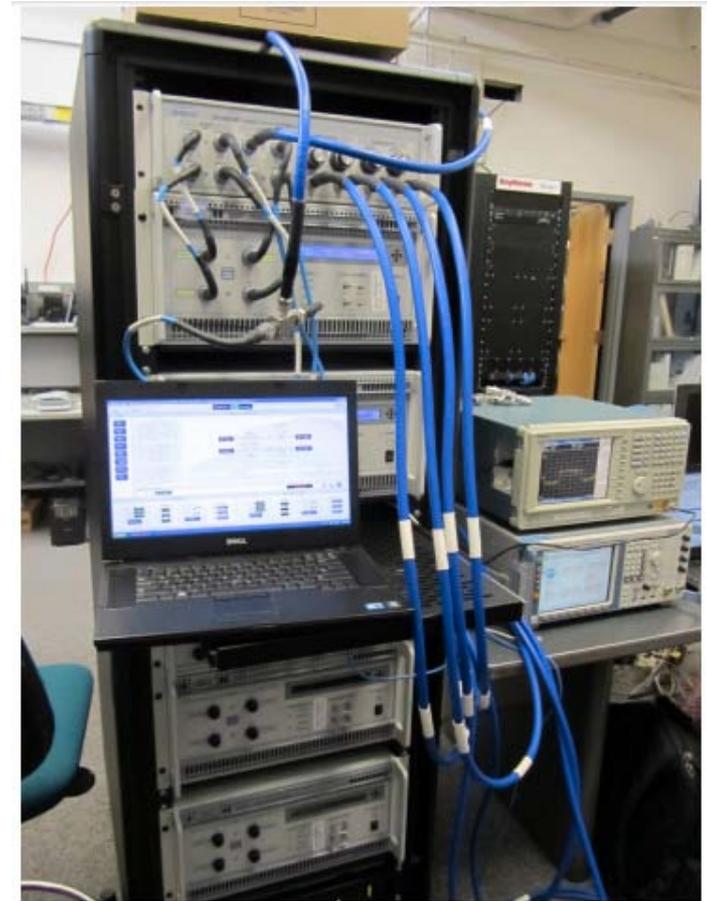


T&E: Demonstration Network

Evolved Packet Core

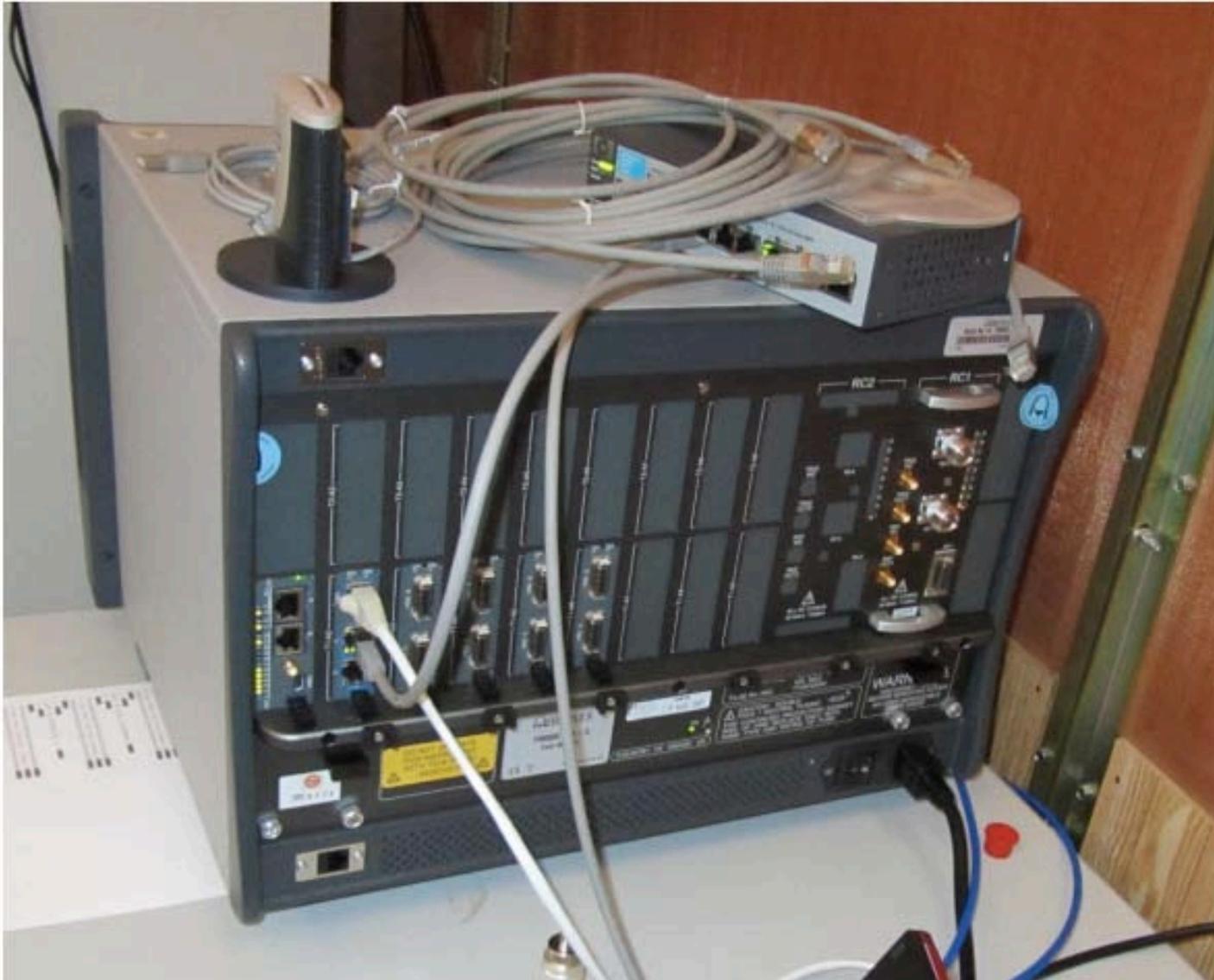


Channel Emulator



T&E: Demonstration Network

User Equipment Emulator



T&E: PTCRB and MSF

The **PCS Type Certification Review Board (PTCRB)** was created by network operators to provide an independent evaluation process for cellular devices.

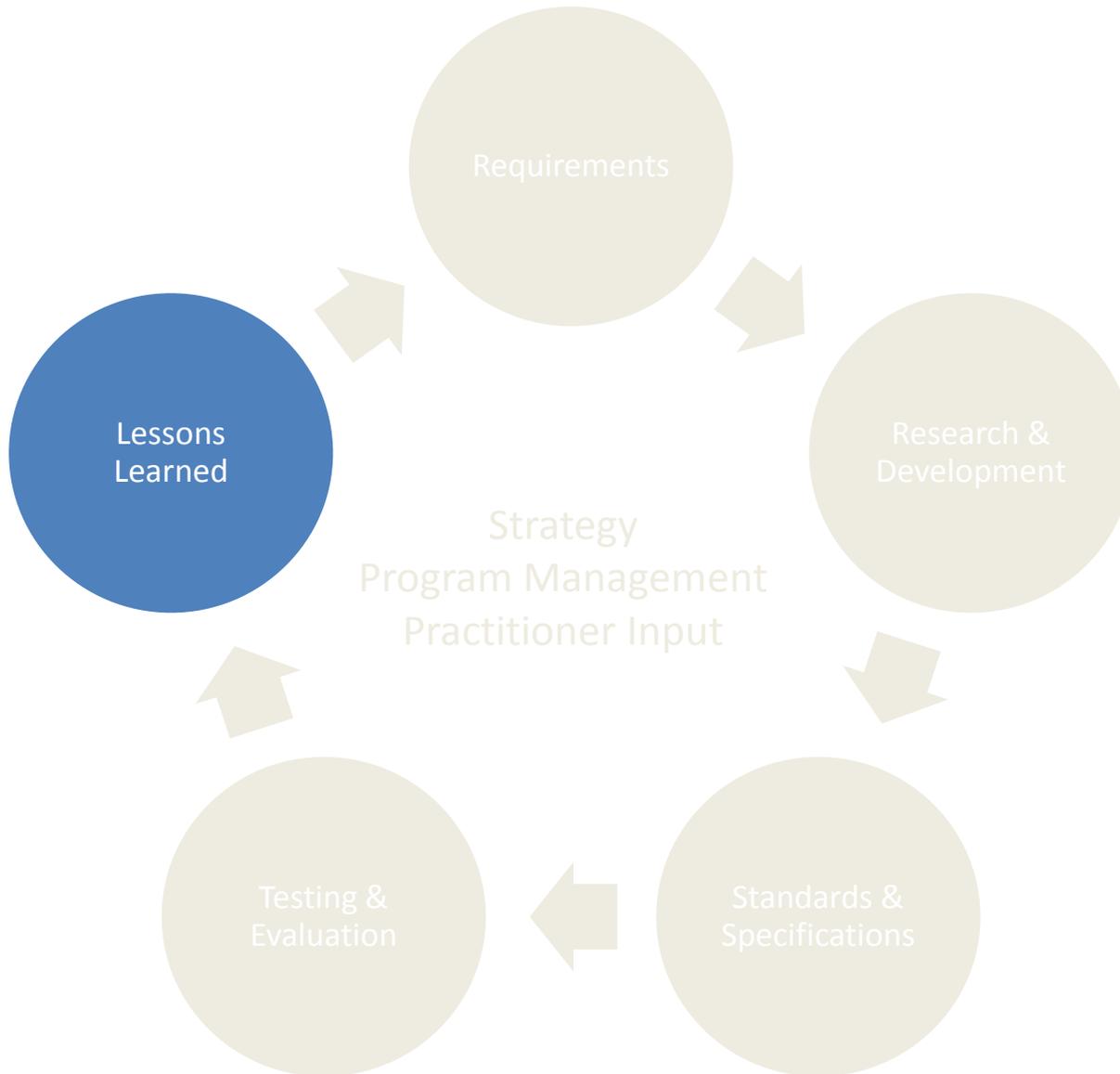
- PSCR worked with PTCRB to change rules in order to allow public safety involvement in the group
- PSCR has also submitted an initial list of tests for Band Class 14 devices.
- Based on this list, PTCRB has identified official test equipment and laboratories are preparing to certify Band Class 14 devices



The **MultiService Forum (MSF)** is an organization of service providers and equipment vendors charged with interoperability testing of cellular infrastructure.

- PSCR is working with MSF to understand how other segments of the cellular industry are performing interoperability testing
- Public safety can then leverage this process or model a process similar on best practices from industry





Lessons Learned: Stakeholder Meetings

- **Inaugural Stakeholder Meeting** (Apr. 20-21, 2010): Brought together interested parties for the first time to shape how the demonstration network will be implemented. The two-day meeting of 138 participants covered project planning and scheduling, stakeholder participation and expectations, and initial test planning.
- **Winter 2010 2nd Stakeholder Meeting** (Dec. 1-2, 2010): Gathered 285 stakeholders to discuss planning, scheduling, testing, and stakeholder participation and expectations.
- **March 2012 3rd Stakeholder Meeting** (March 6-7): Brought together 300+ stakeholders to focus on test results, study item updates, lessons learned from vendors and waiver recipients, and standards developments.



Lessons Learned: Technical Advice and Reports

PSCR provides technical advice to crucial public safety and Federal partners:

- Office of the Vice President (OVP)
- Federal Communications Commission (FCC)
- Department of Homeland Security (DHS)
- Department of Justice (DOJ)
- National Telecommunications and Information Administration (NTIA)
- State and Local Public Safety Practitioners and Associations
 - Waiver Jurisdictions
 - NPSTC

Reports on Lessons Learned from the Demonstration Network will be published as testing phases are completed

Moving Forward

Providing objective technical information about the network

- The PSCR Demonstration Network provides a central and independent test bed/laboratory to help public safety understand 3GPP Release 9, 10, etc.
 - Provides an objective forum for public safety to test and verify new capabilities

Ensuring the network has the crucial long-term capabilities to meet public safety's needs

- Coordinating development of crucial capabilities to make the network successful across multiple requirements efforts and standards bodies:
 - Audio Quality over LTE testing
 - LMR to LTE

Uniting public safety to ensure the network meets long-term needs

- PSCR is currently interacting with the vast majority of the key stakeholders across these multiple efforts
- The next step is for NIST to pull them into a coordination point that ensures public safety's requirements are being met by the various organizations



For Additional Information:

<http://www.pscr.gov>

Dereck Orr

dereck.orr@nist.gov

Jeff Bratcher

jeff@its.bldrdoc.gov