Public Safety Communications Research (PSCR)

Department of Commerce – Boulder Labs

We'll be starting shortly

Logistics

PSCR 700MHz Demonstration Network Webinar

1. WebEx info on support and conf bridge?
2. For support, please contact Corey Reynolds:
   - creynolds@corneralliance.com
   - 303-324-8905

- How to submit questions during the webinar:
  - Use the text messaging option – make sure to use moderator and host option and submit via text.

- Can be submitted throughout the presentation – will try to address them if not will be addressed in face-to-face or email out to group.

- Phone lines will remain muted for duration

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 Program Plan Snapshot

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 OIC and public safety to accelerate the adoption and implementation of only the most critical public safety communication standards and technologies.

PSCR Projects

LMR Standards and Technologies	Broadband Standards and Technologies	Interoperability Device Standards and Technologies	Emerging Standards and Technologies	Cross-cutting or Supporting Activities
P25 CAP	ROW-B	Multi-Band Radio	Public Safety Security	Program Management & Reporting
Project 25 (P25) Standards Development	Public Safety VoIP	Interim Interoperability Device Testing	Technical Services Projects (MANET, Security)	Statement of Requirements (SOR)
ISSI Test Tools	4.9 GHz Broadband Task Group		Video Quality	Public Safety Architecture Framework
Audio Quality	700 MHz Broadband Working Group			RF Propagation Studies
	Modeling and Simulation			

PSCR Approach

Requirements — Standards and Specifications — Testing and Evaluation — Transition — Lessons Learned — Strategy/ Program Management/ Practitioner Input

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700 MHz Broadband… History

- The 700 MHz broadband spectrum allocations were created over several years and rulings by the Federal Communications Commission (FCC).

- The public safety 700MHz broadband spectrum and the D-Block are based on clearing of UHF TV stations 60 – 69 (746 – 806 MHz), in addition to the FCC 2nd, 8th & 9th Notice of Proposed Rule Making (NPRM).
  - 2nd NPRM moved narrowband and wideband operations to allow for more high speed data spectrum
  - 8th NPRM allowed for broadband operations in the 700 MHz Band
  - 9th NPRM calls for a national broadband network

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2ⁿᵈ Report & Order

- On July 31, 2007 the 2nd Report and Order was created by the FCC to "to promote the creation of a nationwide interoperable broadband network for public safety and to facilitate the availability of new and innovative wireless broadband services for consumers".

- The Order established a framework for a nationwide 700 MHz single licensee, nationwide license for the public safety broadband spectrum, assigned to a Public Safety Broadband Licensee.
  - Current license assigned to the Public Safety Spectrum Trust (PSST)

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Auction & Waiting

- Auction time - 01/24/08 - 03/18/08 – 700 MHz Auction #73.
  - Auction raised almost $20 billion.
  - Only one bid for the D Block spectrum which did not meet the minimum bidding requirement of $1.33 billion.
- 03/20/08 – FCC Order Delaying Further D Block Action until further notice
- The current status of 700 MHz **had** not changed much until June 2009 – this is now changing rapidly.
  - HDTV transfer is done
  - FCC commissioner sworn in
  - Within the past few months multiple cities and states have filed waiver requests to deploy their own 700 MHz broadband networks.
  - FCC National Broadband Plan, proposal for the ERIC and several meetings discussing Public Safety Broadband

Technology Choice

- Public safety organizations have openly supported LTE
  - NPSTC, NENA, MCC, PSST and APCO have chosen LTE as their broadband technology of choice
  - LTE – Long Term Evolution a.k.a 3rd Generation Partnership Project (3GPP) Release 8

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Spectrum Allocation

Public Safety Spectrum Allocation in the 700 MHz Band
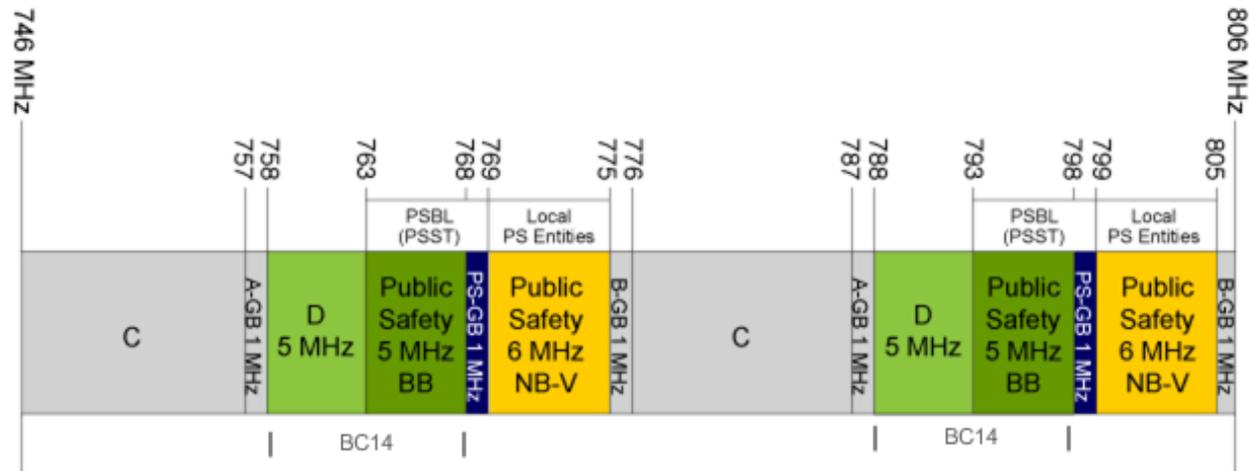
Public Safety 700 MHz Allocations

Total Allocation	(12 x 12)	24 MHz
Broadband Portion	(5 x 5)	10 MHz
Narrowband Portion	(6 x 6)	12 MHz
Guardband Portion	(1 x 1)	2 MHZ

Legend

PSBL = Public Safety Broadband Licensee
PSST = Public Safety Spectrum Trust
PS Entities = Public Safety Narrowband Licensees

BB = Broadband
NB-V = Narrowband Voice (e.g., P25 systems)
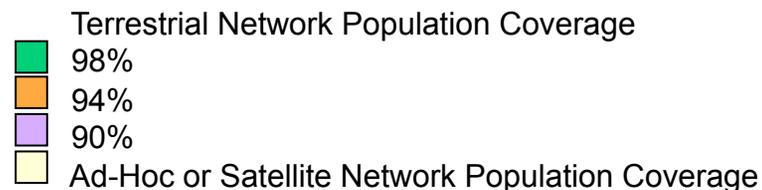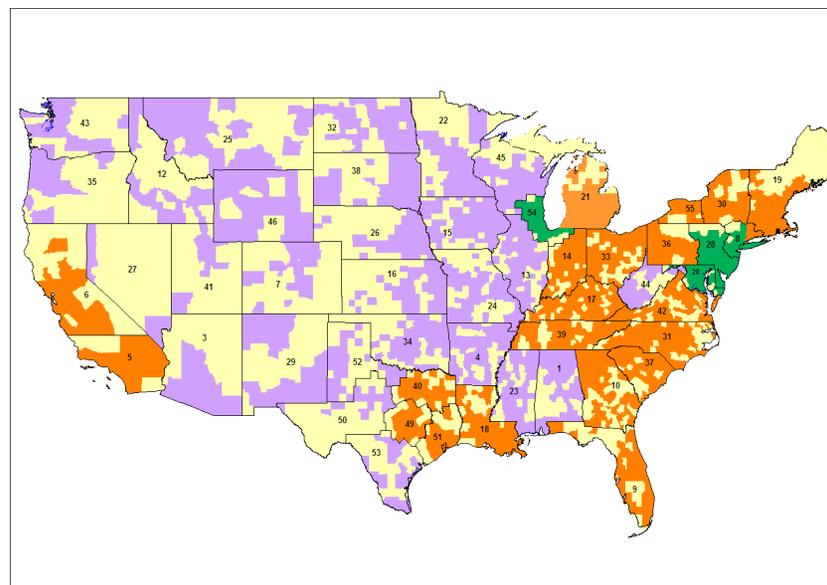PS-GB = Public Safety Guardband

FCC allocated spectrum to public safety for broadband data services

Commercial D block

Market Share

- Creates a new nationwide spectrum block for public safety users and potentially commercial users (e.g. Utility Companies)

- Estimated 10~15 million users in the USA

  - Includes all Emergency Support Functions (ESF) for local, state and potentially federal users

  - 2002 Census data shows
    - State – 5.1 million
    - Local – 13.2 million
    - Federal – 1+ million

  - **Does not include M2M or sensors**

- Typical nationwide cellular service providers require approximately 40,000+ macro base-stations

Terrestrial Network Population Coverage

- 98%
- 94%
- 90%
- Ad-Hoc or Satellite Network Population Coverage

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Why is this necessary?

- Public Safety has been licensed to use this spectrum but there are currently no government or independent laboratory facilities in the United States to test and demonstrate the public safety specific LTE implementation requirements
  – PSCR is creating this network to provide manufacturers with a site for early deployment of their systems, an opportunity to evaluate them in a multi-vendor environment, and create integration opportunities for commercial service providers.

Public Safety Requirements

- **PSCR has been involved for several years working with public safety on their requirements for Broadband**
  - 700 MHz Broadband Questionnaire
  - Public Safety 700MHz Broadband Statement of Requirements (SoR)

- Led the Technology Working Group of the 700MHz NPSTC Broadband Task Force (BBTF)
  - Overwhelming support from public safety, press, PSST, emergency responder organizations and vendors

- All documents available on http://www.pscr.gov/projects/broadband/700mhz/700mhz.php

PSCR Standards Efforts

- PSCR uniquely positioned to represent public safety requirements to Standards Development Organizations (SDO) such as:
  - Alliance for Telecommunication Industry Solutions (ATIS)
  - 3rd Generation Partnership Project (3GPP)
- ATIS is the North American Organizational Partner
- Department of Commerce is member of ATIS
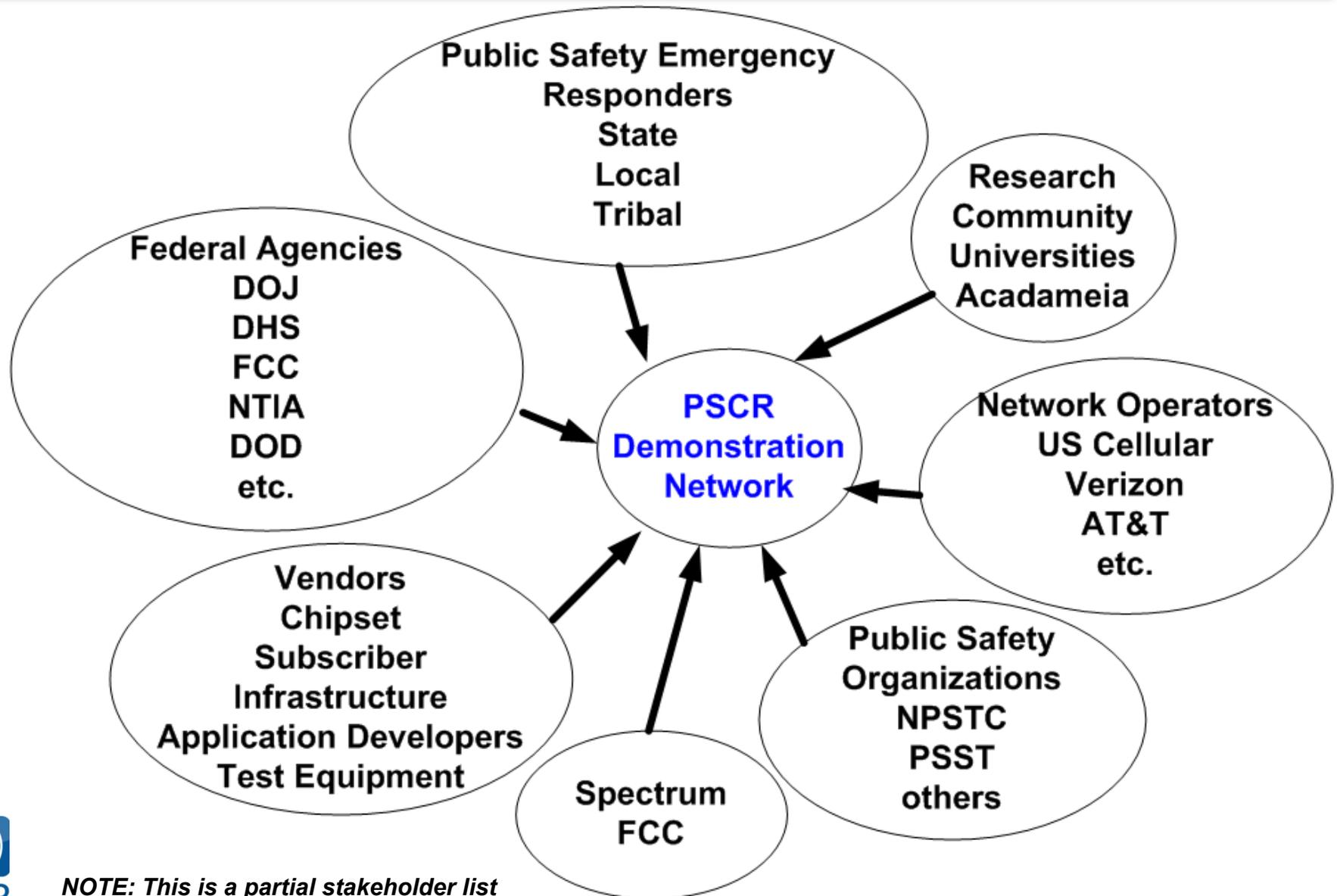 - **PSCR is a now a member of 3GPP**

PSCR will be directly involved in commercial standards representing public safety requirements.

PSCR Demonstration System

- Concept: The PSCR Broadband Demonstration Project (PBDP) is a *collaborative effort of public safety and industry* being led by the Public Safety Communications Research (PSCR) group in Boulder, CO.

  - A primary goal of this project is to accelerate the ecosystem for public safety 700 MHz broadband technologies and provide vendor neutral evaluation environments.

Stakeholders

Public Safety Emergency Responders
State
Local
Tribal

Research Community
Universities
Acadameia

Federal Agencies
DOJ
DHS
FCC
NTIA
DOD
etc.

PSCR Demonstration Network

Network Operators
US Cellular
Verizon
AT&T
etc.

Vendors
Chipset
Subscriber
Infrastructure
Application Developers
Test Equipment

Spectrum
FCC

Public Safety Organizations
NPSTC
PSST
others

NOTE: This is a partial stakeholder list
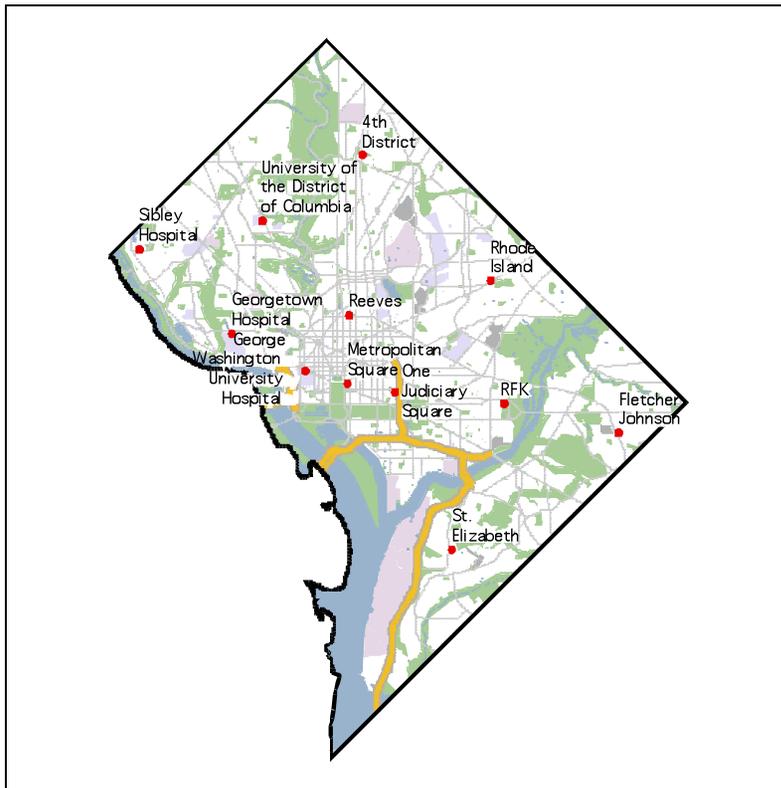
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PSCR Demo Network Project Plan

- **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)**
  - Stimulate early development for public safety systems
  - Support the commercial 3GPP standards process with public safety requirements
- **Demonstrate broadband air-interface and core network capabilities**
  - Proof of concept, Improve quality for future systems, Create new technology and requirement benchmarks
  - Evaluate broadcast capabilities for wide area, simultaneous data delivery
- **Interoperability with existing cellular, broadband and LMR technology**
  - Roaming functionality with LTE and non-LTE systems
  - How QoS, billing, priority, pre-emption and applications work when roaming
- **Validation of key public safety functionalities and requirements**

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Boulder Site

- **The initial laboratory and demonstration network will utilize the PSCR facilities located in Boulder, CO.**
  - **PSCR Boulder labs will be used for evaluation of signalling, RF and EPC hosting**
  - **Over The Air (OTA) test site at two potential locations.**
    - **Department of Commerce Boulder Laboratories Table Mountain Radio Test**
      - **1 of 2 RF quite zones in the US allows us to do specific RF related testing**
      - **Good for rural coverage testing**
    - **Green Mesa at the Boulder DoC campus**
  - **All facilities are Federal property and are secure locations**
  - **VPN connections for external vendor access can be provided**

Photo by D.J. Atkinson

- **Washington DC Office of the Chief Technology Office (OCTO) collaborating with PSCR**
    - **OCTO and PSCR have a MOU in place now**
    - **Common test planning and coordinated testing**
    - **Excellent urban test environment to evaluate MIMO*, OFDMA+ behaviours, 5 MHz and 10 MHz channel allocations**
    - **12 sites currently available**

    *MIMO=Multiple Input Multiple Output
    +OFDMA=Orthogonal Frequency Division Multiple Access

Site Location Information

- Both the PSCR Boulder and OCTO DC locations are **open** to all stakeholders within the parameters defined in the project.
  - Not a "network" exclusive to just PSCR and Washington DC staff
  - PSCR and OCTO are not obtaining/procuring a network for operational use but for R&D
  - Meant to be representative of the network morphologies across the US
    - Limited potential to add additional location(s) as deemed necessary and within resource constraints

Holistic Approach

- **Stakeholders will be able to come and deploy their equipment in a neutral host network**
  - Allows vendors to inter-operate with each other and create virtual "leveraged network models"
  - Allows smaller vendors and service providers to evaluate the technology
  - Public safety emergency responders will be able to participate actively in the project, so they do not have to potentially waste capital expenditures for evaluating a network technology

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Test Issues

- **Difficult design issues can be tested and evaluated**
  - **MIMO issues (Multiple Input Multiple Output)**
  - **Inter-cell interference (ICI)**
  - **Inter & Intra network roaming**
  - **Voice & SMS (Short Message Service)**
  - **QoS, ARP (Quality of Service, Allocation Retention Priority)**
  - **Wireless Priority Services (WPS)**
- **Common testing and evaluation procedures used for repeatability**
- **Evaluation results will be available publically so results can be used to enhance the system**

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Test Methodology

- Two general test tracks being developed
    1. Evaluation Track
        - "Engineering/Development" type test cases that are evaluating specific standards or implementations e.g. Advanced antenna techniques such as Tx Diversity and spatial multiplexing
    2. Demonstration Track
        - Series of "Demo Days" will be made available to the stakeholder community to attend at both OTA test sites and "kick the tires" on the network e.g. Mobile Streaming Video Demonstration – integrated with QoS

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Test Process

- High level test plan in development process now
  - Initial plan put together by PSCR and OCTO staff
  - Will be submitted for formal stakeholder comments at least one week before Boulder face-to-face meeting
  - Stakeholder participation required to ensure test coverage is complete, accurate and achievable
- Additional topic specific meetings will be held to further refine the test plan and overall project

Stakeholder Involvement

- Mechanism of agreement between NIST and vendors is a CRADA
  - Cooperative Research And Development Agreement
    - The CRADA is a partnering tool that allows federal laboratories to work with US industries, academia and other organizations on cooperative R&D projects. The CRADA provides flexibility in structuring project contributions, intellectual property rights, and in protecting proprietary information and CRADA research results.
    - http://jazz.nist.gov/ts/220/external/crada.htm (generic form)
  - NIST Legal Office working on a CRADA for this specific project that will be uniform for all stakeholders

Equipment Expectations

- EPC, HSS and IMS to be deployed in Boulder but open to other options such as MPLS connections to vendor labs

- Equipment will be loaned for duration of demonstration project or specific testing period
  - Actual amounts per location TBD

- PSCR and vendors will coordinate appropriate installation, commissioning and support levels required for duration of project to help keep costs down

Band Class Support Expectations

- LTE Bandclass 14 eNodeB and Ue support
  - Reference design, prototype or non-commercial "quality" equipment is expected
  - Initially focusing on Public Safety part of Band Class 14 (5 MHz channel) 763-768 MHz and 793-798 MHz
  - Intending to evaluate full Band Class 14 (10 MHz channels) 758-768 MHz and 788-798 MHz

- Evaluating emissions, filtering, interference, inter-modulation issues, PHY signal and channel powers (in addition to performance)

Overall Project Outcome

- The NPSTC BBTF Report was the initial starting point to ensure basic interoperability

- The PSCR Demonstration Network will allow us to not only evaluate the technology for public safety needs but will allow us to determine what else needs to be done to enable network build-outs and may include the following:

  - New features or change requests to 3GPP
  - North American specific features or changes via ATIS
  - Recommended implementations or profiles for public safety networks

Overall Project Outcome (cont'd)

- Project recommendations may be used by organizations or used to create a "public safety" LTE profile
  - May require stakeholder agreement on how multiple implementations will interwork (interoperate)
  - Create Traffic Flow Templates to enable priority access while roaming between regions or networks

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Schedule

- Q4 '09 – PSCR Press Release
  - Tentative Stakeholder Meeting before end of year
- Q1 '10 – Stakeholder meetings, project & budget planning, Site survey, procure lab equipment, test planning
- Q2 '10 – Formalize agreements with stakeholders, train personnel, continue procurements and test planning
- Q3 '10 - Start Deployment of systems and Start evaluation and testing of systems

All dates are TBD and vary on funding and stakeholder involvement

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Another explanation

- **LTE is like a high performance race car capable of very fast speeds.**
- **Think of LTE performance (MIMO & OFDMA) in terms of:**
  - **The tires are like MIMO, the suspension is the control system.**
  - **The road conditions are like the radio propagation conditions**
  - **The road traffic is the interference.**
- **You don't get to choose the road conditions and have limited control of the traffic** *but you do have more control over the tires & suspension.*
  - **PSCR Demo System will be able to provide real world data to public safety**

- *LTE simulations for performance typically assume perfect conditions using a simplified interference model.*
- *Simulations are great but testing these parameters in a real world environment is the only way to determine the best solutions.*

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Boulder Face-To-Face

- Face-to-face meeting with all participating stakeholders in Boulder, CO at the PSCR facilities
- April 20-21
- Primarily a technical meeting to discuss the following:
  - Project Planning & Schedule
  - Evaluate stakeholder participation and expectations
  - Phase 1 Common Test Plan
    - High Level Test Plan scheduled to be released 1 week prior to meeting
    - 2-Track Test plan with Evaluation and Demonstration tests
  - Plan future meetings to gatherer input on new work items
  - More detailed agenda will be posted on PSCR website
- Register for the event at:
  https://partnerweb.its.bldrdoc.gov/regpscr/register.aspx

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Final Thoughts

- We have only scratched the surface on what we understand about LTE & 700 MHz broadband

- The technology is advancing quickly and dynamically – PSCR is well placed to evaluate the best solutions to public safely.

Thank you for your support and participation in the project.