Testimony of

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"Interoperability in Public Safety Communications Equipment"

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Chairman Wu, Ranking Member Smith, Members of the Subcommittee, thank you for the opportunity to appear before you today to discuss Public Safety Communications and the P-25 project. I serve as the Program Manager for Public Safety Communications Systems in the Office of Law Enforcement Standards (OLES) at the National Institute of Standards and Technology (NIST). In addition, I am the Program Manager for the Public Safety Communications Research (PSCR) program, which is a joint effort among NIST and the National Telecommunications and Information Administration (NTIA) at the Department of Commerce (DOC) Labs located in Boulder, Colorado.

The Public Safety Communications Research (PSCR) program serves as the technical lead for several Administration initiatives focusing on public safety communications, most importantly the Department of Homeland Security's (DHS) Office for Interoperability and Compatibility (OIC) within the Science and Technology Directorate. The PSCR program is also involved in many of DHS's key communications interoperability related programs, including the SAFECOM Program within the Office of Emergency Communications (OEC). The strong partnership among OIC, SAFECOM and the PSCR program is an excellent example within the Administration of multi-agency coordination and collaboration, and is something for which we at NIST are very proud.

Working alongside our federal partners, the PSCR program has provided the lead technical role in some of the key advancements in public safety communications over the last five years. NIST, in partnership with OIC, has led the development of an open interface for Voice-over-Internet Protocol (VoIP) public safety applications, developed technical requirements for public safety video applications to ensure that they meet the needs of public safety, so that, for example, a police officer can properly identify suspects based on a video. We have also scientifically corroborated concerns from the public safety community that digital radios did not perform as well as analog radios in loud noise environments. This has been particularly important to the fire community whose communications were significantly degraded at the time they would need to communicate most. In addition, NIST has been heavily involved in the emerging public safety broadband issue by leading, over the last several years, the technical committees that have worked directly with public safety to define their requirements for a nationwide public safety broadband system. We have recently kicked off a project to develop and implement a broadband demonstration system at the Boulder Labs that will focus on understanding how the future fourth generation broadband standards will and will not meet public safety's requirements for their mission critical needs.

My DOC colleagues at the NTIA recently announced that it will make Recovery Act broadband grants available to public safety entities that this month received authorization from the FCC to build out broadband public safety communications systems utilizing the 700 MHz band. I want to note that my comments today are not related to those 700 MHz-based broadband systems.

From the beginning, one of the core focus areas of the PSCR has been to participate in the Telecommunications Industry Association (TIA) Land Mobile Radio (LMR) standards development process. These are the systems that the vast majority of our first responders use every day across the Nation to communicate as they perform their missions. These are the radios that you see police officers or fire fighters wearing on their belts. As that is the topic of today's

hearing, I will focus the remainder of my remarks this morning on the current state of the formal standards development and test programs for public safety land mobile radio systems.

Interoperability for public safety communications is defined as "the ability to share information via voice and data signals on demand, in real time, when needed, and as authorized." The public safety community expects that this level of interoperability will be available using equipment from multiple manufacturers, that they are transparent to the user requiring little or no special knowledge of the system, and that they are not dependent on common frequency assignments.

Achieving this definition of interoperability is not possible without the existence of published standards that define how the various components of a public safety communications system will interoperate, regardless of manufacturer. In the absence of standards, achieving this level of interoperability would not be possible.

Public safety users have recognized this for some time. Approximately twenty years ago, representatives from local, state, and federal public safety associations and agencies joined together to address the absence of available standards for Land Mobile Radios as they entered the transition from analog to digital based systems. They did this for two primary purposes. The first was to ensure that interoperability could be achieved, assuming the use of equipment from multiple manufacturers. Second, through standards, the public safety community wanted to be able to take advantage of cost reductions associated with a more competitive Land Mobile Radio market.

Understanding the difficulty in specifying the complex operations of the various components of a land mobile radio system, the public safety community partnered with the Telecommunications Industry Association (TIA) to serve as the standards development organization (SDO) for this effort. Thus Project 25, or P25 as we know it today, was launched. For the last six years, PSCR has been an active participant in the P25 standards process, especially in the development of test standards.

A commonly misunderstood aspect of P25 is that it is comprised of a single standard. Instead, it is a suite of standards that specify the eight open interfaces listed below between the various components of a land mobile radio system (e.g.: hand held to hand held, hand held to base station, mobile unit to repeater, etc.):

- **Common Air Interface (CAI):** this interface defines the wireless access between mobile and portable radios and between the subscriber (portable and mobile) radios and the fixed or base station radios;
- **Inter-RFSubSystem Interface (ISSI):** this interface permits users in one system to communicate with users in a different system, from one jurisdiction to another, from one agency to another, from one city to another, etc.;
- **Fixed Station Interface (FSI):** this interface describes the signaling and messages between the RFSS and the fixed station by defining the voice and data packets (that are sent from/to the subscriber(s) over the common air interface) and all of the command and control messages used to administer the fixed station as well as the subscribers that are communicating through the fixed station;

- **Console Sub-System Interface:** this interface is similar to the fixed station interface but it defines all the signaling and (CSSI) messages between the RFSubSystem and the console, the position that a dispatcher or a supervisor would occupy to provide commands and support to the personnel in the field;
- **Subscriber Data Peripheral Interface:** this interface characterizes the signaling for data transfer that must take place between the subscriber radios and the data devices that may be connected to the subscriber radio.
- **Network Management Interface:** this interface allows administrators to control and monitor network fault management and network performance management.
- **Data Network Interface:** this interface describes the RFSSs connections to computers, data networks, external data sources, etc.
- **Telephone Interconnect Interface:** this interface between the RFSS and the Public Switched Telephone Network (PSTN) allows field personnel to make connections through the public switched telephone network by using their radios rather than using cellular telephones.

For any one of these eight interfaces to be considered complete (so that multiple manufacturers can build and test to a common standard) the following five types of standards documents have to be published:

- **Overview:** serves as the general mission statement for the interface;
- **Protocol:** specifies the messages and procedures to be followed in the development of equipment implementing the interface;
- **Performance:** specifies the test procedures to be executed to ensure the device under test operates within the expected bounds identified in the standard (i.e. emissions and adjacent channel interference);
- **Conformance:** specifies the test procedures to be executed to ensure the device under test produces messages that adhere to the message format and procedures detailed in the protocol document;
- **Interoperability:** Specifies the test procedures to be executed to determine if two or more different devices under test respond appropriately when communicating over the interface.

The most important of these documents is the protocol document which provides the details needed by each manufacturer to develop products that implement the particular interface. However, of only slightly less importance are the three test documents that allow each manufacturer to comprehensively test their implementations in a common way so as to limit variant interpretations of the protocol and ensure overall uniformity in product development. In addition, uniformity in implementation of the interfaces is crucial for seamless interoperability.

Based on our experience, there are four main issues with P25 that are hampering progress toward seamless interoperability and open competition.

1) Standards for all eight interfaces are not published.
2) Only a portion of P25 systems are standards based.
3) It isn't clear to public safety agencies what a P25 system entails.

4) There is no industry-led formal compliance assessment program.

To date, only the conventional portion of the CAI and the Inter-RF-Subsystem Interface have a completed suite of documents as defined above. The more complex trunked CAI continues to lack conformance test documents (crucial for uniform implementation) although trunked CAI products have been sold for almost a decade. The remainder of the six interfaces are in various states of document completion. Therefore, since its inception in 1989, one and a half of the eight interfaces have been completed.

Second, as a result of the lack of complete standards, only a limited portion of a P25 system is truly standards based. To our knowledge, only the CAI is currently supported in most P25 system deployments, although some jurisdictions are now on the verge of procuring the recently completed ISSI, and ISSI manufacturers are piloting this new interface in several locations across the United States.

Third, many public safety agencies believe that when they purchase a system labeled P25, that it is based on a complete set of standards. They interpret a "P25 system" to mean a LMR system that incorporates the P25 interfaces. Most public safety agencies do not have the, resources to dedicate to researching the status of the complex standards process so that they have a clear picture of what a "P25 system" currently entails. The reason we, and our partners, try to provide outreach to as many public safety agencies as possible is that we believe it is important that they make their procurement decisions and valuations on a realistic set of expectations.

Fourth, there has been a lack of a compliance assessment and certification programs. As mentioned above, compliance to the standard is essential and in fact every wireless technology we know of ensures interoperability among devices by establishing rigorous and comprehensive compliance assessment and certification programs. Successful completion of the compliance assessment process often results in limited rights to the use of a certification logo (i.e. Bluetooth, Wi-Fi, or WiMAX) which is intended to impart to consumers the fact that the product has been tested in some type of formal process and should be expected to work with other devices with the same logo.

In the case of P25, the industry participants never established a formal and uniform compliance assessment and certification program. Instead, testing to determine P25 compliance was performed by each manufacturer in whatever manner they each determined was sufficient for validation of their products. There has been no industry led formal test regime and there is no certification process or stamp for P25 products.

The P25 logo has instead been used by manufacturers as a marketing logo to convey to users that their product was developed to P25 standards specifications. However, many public safety agencies that we speak with incorrectly assume that the logo is a certification stamp signifying the completion of a formal and uniform test regime.

To address the first three issues, NIST has been actively engaged on behalf of DHS in the P25 process to accelerate the adoption of standards. To address the lack of a compliance testing program DHS and NIST partnered together to establish the Project 25 Compliance Assessment

Program (P25 CAP). This is a government-led program outside of the P25 standards development process, and was created with direction from both Commerce and DHS appropriations committees in order to ensure that Federal grant dollars are being spent on communications equipment that will result in interoperability and improve public safety's ability to protect lives and property. Additionally, this program is designed to provide greater clarity to public safety agencies regarding the status of the P25 standards, and to, more importantly, provide them with a higher level of confidence that the products they are purchasing will interoperate with other P25 products. In this partnership, NIST performs the lab assessments and DHS develops the overall program policy, as well as recognizing participating laboratories. This program has been developed over the last five years and is comprised of several key elements:

- **Test Standards:** P25 CAP uses published P25 performance, conformance, and interoperability test standards. Whenever possible, the P25 CAP looks for guidance from the P25 technical committees and manufacturers for input on what tests are most applicable. In addition, the P25 CAP only uses a subset of available P25 tests. The subset of tests are published in DHS P25 CAP Compliance Assessment Bulletins.
- **Interfaces:** The P25 CAP is currently focused on the two P25 interfaces (CAI and ISSI) that are crucial to interoperability and that will help achieve the nation-wide system of system's approach supported by the DHS SAFECOM Program.
- **Lab Recognition:** The P25 CAP utilizes recognized laboratories that have been assessed and recommended by PSCR personnel based on adherence to appropriate portions of international laboratory testing standards and on their competence at executing the P25 tests specified in the DHS P25 Compliance Assessment Bulletin. If a laboratory successfully completes the assessment phase, DHS issues a Certificate of Recognition which signifies their ability to participate in the P25 CAP.
- **Manufacturer Participation:** The P25 CAP is a voluntary process and relies on vendor participation for its success. To be in compliance with the P25 CAP, participating vendors must have their equipment tested in a DHS recognized laboratory and must post the results of the testing at a publically accessible DHS website (www.rkb.us).
- **Federal Grant Guidance:** The P25 CAP is required in the SAFECOM Federal Grant Guidance which applies to DHS grant programs and is leveraged by other Federal agencies as well, such as the Department of Justice's COPS Office. The grant guidance limits P25 equipment purchases to products that have been tested in P25 CAP recognized labs and have the proper documentation posted on the RKB website. This helps ensure that all federal investments support standards-based equipment and interoperability.

The P25 CAP was developed with involvement from both the industry and the public safety community. The goal of the program is to increase public safety's confidence that P25 products being purchased will operate and interoperate, based on a formal and uniform test program, while at the same time minimizing the financial burden that implementing a voluntary compliance program might place on the P25 industry. Therefore, it should be noted that the resulting program is a minimalistic compliance assessment program. It does not rise to the level of rigor imposed by the wireless technologies mentioned above or that of the European public safety communications standard, TETRA. The P25 CAP does not involve third party certification and does not lead to a certification stamp. The program instead requires that a manufacturer publish a Supplier's Declaration of Compliance which specifies the product tested,

the tests performed, and the DHS recognized lab used to perform the test. The manufacturer must also publish a Summary Test Report (STR) that provides pass/fail data for each of the tests required by DHS. The SDoC and STR are posted by the manufacturers on a DHS website (www.rkb.us). Public safety agencies using Federal grant dollars can only purchase P25 equipment with published documents available on the DHS website. In addition to testing information being publicly available, the equipment will have been tested in laboratories that have demonstrated an adequate quality management system and P25 testing proficiency. In striking this balance our hope is increase the amount and quality of information available to the public safety community, while at the same time creating a minimalistic program that will gain wide-spread industry participation.

To date, DHS has recognized eight laboratories to perform the current CAI tests required by the P25 CAP program. As of November 2009, all DHS grantees purchasing P25 CAI related equipment are required to ensure that the equipment is in compliance with the P25 CAP guidelines, prior to taking final acceptance. Currently there are four manufacturers who have complied with the current requirements of the P25 CAP. All four have published information on their subscriber units (walky-talkies) which is out of the approximately eleven manufacturers that make P25 subscriber units (36% participation rate). In addition, two of the four manufacturers have published documents relating to their infrastructure (base stations, etc.) which is out of approximately eight manufacturers that make P25 infrastructure – a 25% participation rate.

The publication of this information is a significant milestone for public safety. For the first time, public safety officials have one place that they can go to obtain test results performed through a formal process and whose results are presented in a common manner, making comparisons between manufacturers' products much less time consuming. In fact, we are aware of multiple public safety agencies using the P25 CAP in their procurement decisions and evaluation. However, the participation rate must increase for the program to be truly effective.

It must also be noted that the current program covering the CAI includes only performance and interoperability tests. This is due to the fact that at the time of the publication of the DHS P25 CAP Compliance Assessment Bulletin in 2008, there were no relevant published CAI conformance tests to draw from.

Since 2008, conformance tests have been published for the conventional CAI, and the PSCR program and its Federal partners are currently working with the manufacturers and public safety users within the standards committees to determine the appropriate tests to incorporate into the P25 CAP. Although we are hopeful that we will be able to identify existing, and where needed develop, appropriate conformance tests for the conventional CAI, it must be noted that the issue of conformance testing has been a significant problem within the P25 standards community over the last year.

From the beginning, the P25 CAP was developed with the expectation of incorporating all three types of tests (performance, conformance, and interoperability) into the program. This expectation was articulated in program documents, charters, and presentations. Many manufacturers echoed this expectation in their own documents and presentations. However, as was noted above, the issue of conformance tests did not develop until after the drafting of the

first DHS P25 CAP Compliance Assessment Bulletin because at the time of publication there were no published conventional or trunked CAI conformance tests to draw from.

Leveraging published conformance tests into the P25 CAP became an issue for the first time in April 2009 during the development of the recommended set of tests for the ISSI. Because published conformance tests for the ISSI were available for consideration, the PSCR recommended a subset of the published conformance tests for inclusion into the P25 CAP. The general response from industry to this recommendation was that it was not their intent that the P25 CAP would include conformance testing, and should instead focus on performance and interoperability testing for compliance assessment. At that time, the PSCR as well as our federal partners and many of the public safety users participating in the meetings reiterated the expectation that the P25 CAP would incorporate conformance testing.

The rationale for this was, and remains, that at the core of any compliance assessment or conformity assessment program is the expectation that products will be tested to ensure that they adhere to the messages and procedures mandated by the standard. Interoperability, especially in the wireless field, is achieved through consistent implementation of the interface standard across products and manufacturers. If consistency in implementation is achieved, and the protocol standard is unambiguous, then the expectation of interoperability is significantly increased, though not guaranteed. By implementing conformance testing in the P25 CAP, the program is ensuring that each product tested is traceable to the published standards.

The reliance on conformance testing is common across wireless technology certification programs, all but one of which is developed and administered by their relevant wireless industry associations and interest groups such as Wi-Fi, Bluetooth, WiMAX, and LTE. The non-industry conformance testing example is the European public safety communications standard, TETRA. The TETRA compliance assessment program is a joint program between government and industry, and relies heavily on conformance testing as well. To exclude conformance testing from the P25 CAP would make it, to our knowledge, the only wireless technology compliance assessment program to do so. In fact, several of the manufacturers of P25 equipment also develop TETRA products, as well as other wireless devices for the standards listed above and submit their other products for conformance testing as required by the respective programs. As I have stated previously, the P25 CAP is already a minimalistic program. All of the programs listed above are significantly more rigorous and resource intensive. Removing conformance testing from the program would call into question its ability to achieve the goals of confidence and interoperability it was established to address. Given the critical importance of the radio equipment to both the first responders and the citizens they serve, we cannot recommend such a course.

All of the programs mentioned above also rely heavily on interoperability tests, as does the P25 CAP. However, interoperability tests only demonstrate whether two different products work together. A successful interoperability test result does not demonstrate that the products adhere to the standard. In addition, you cannot infer that because two different manufacturers' products interoperate that either will be interoperable with a third manufacturer. Interoperability must be confirmed with a direct test with another product, or in some cases a test against a reference model which does not exist in the P25 industry.

Interoperability testing in any industry is resource intensive, requiring significant coordination among all manufacturers. Understanding this, the P25 CAP requires that participating manufacturers only demonstrate interoperability with three other manufacturers' products, thus limiting the number of coordinated tests required. Conformance tests, on the other hand, can be performed without any other manufacturer's equipment present.

Finally, Land Mobile Radio equipment is designed to be fielded for years if not decades. Therefore, it is highly likely that products fielded today will be operating alongside new products fielded ten or even twenty years from now. However, there is no requirement that manufacturers test future products against past products. To do so would create an exponential growth in the number of tests required, and would place an unfair financial and administrative burden on any P25 equipment manufacturer. Instead, by including conformance testing in the program, products released today, as well as ten years from now, will show traceability to the same standards, thereby increasing the confidence in interoperability while minimizing the testing required.

NIST and DHS staff presented this rationale to the relevant committees within P25 and worked for months to develop an acceptable list of tests (at one point only proposing 18 conformance tests out of the full set of 92). However, the final recommendation out of P25 to DHS was that no conformance tests should be included in the P25 CAP for the ISSI. DHS at that point developed a list of conformance tests, with input from federal, state, and local P25 system owners and/or managers and published an ISSI Compliance Assessment Bulletin in March of this year. The P25 CAP program is now awaiting applications from laboratories interested in performing ISSI testing.

There were indications within the standards committee that there would be similar resistance to including conformance testing for compliance assessment for the other interfaces, including the common air interface.

However, the tide has turned. I am pleased to say that over the last two months we have witnessed a renewed willingness within the P25 standards body to actively participate in the identification of relevant conformance tests for the P25 CAP. We are currently working within the standards committees to identify and develop a recommended set of conformance test for the conventional CAI, and we hope to see significant and expedited progress on developing conformance tests for trunked CAI equipment.

It is frustrating to many that we are only now implementing a compliance testing program over a decade after the products have been released into the marketplace. And it is true that the program will not have a significant impact on the currently installed base. But what is important to keep in mind is that the Federal government's significant investment in communications equipment for first responders and other law enforcement agencies will drive procurement decisions. In addition, there are thousands of agencies that will be upgrading their aging Land Mobile Radio systems over the next decade, and most will likely adopt the P25 standard. The P25 CAP will have a significant impact on these future purchases and will improve the likelihood that interoperability can be achieved.

NIST hopes that within two years, the P25 CAP has a fully functional program including performance, conformance, and interoperability testing for at least the CAI and ISSI interfaces which are crucial to interoperability. Achieving this will require significant commitment and focus by all parties, and for its part, the NIST is prepared to assist in meeting this worthy goal. NIST remains dedicated to continuing to work with this Subcommittee, industry, our federal sponsors and partners, and public safety users to see the P25 standards completed and to develop programs that help public safety purchase interoperable Land Mobile Radio equipment.

Again, I am honored to be here before this Subcommittee today, and I am happy to answer any questions that you may have.

Bio for Dereck Orr.

Dereck Orr is the Program Manager for Public Safety Communication Standards at NIST's Office of Law Enforcement Standards, and has held that position since December 2002.

In that role, he leads a program that serves as an objective technical advisor and laboratory to the Department of Homeland Security and public safety to accelerate the adoption and implementation of the most critical public safety communication standards and technologies.

From October 2003 until October 2004, Mr. Orr was detailed to the Department of Homeland Security to serve as the Chief of Staff of the SAFECOM Office within the Science and Technology Directorate, to help establish the new program.

Prior to working at NIST, Mr. Orr served as a professional staff member of the Senate Appropriations Subcommittee for the Departments of Commerce, Justice, and State, and Related Agencies under Senator Fritz Hollings. In that position, Mr. Orr was responsible for the appropriations accounts relating to state and local law enforcement issues.

Previously, Mr. Orr served four years at the Office of Community Oriented Policing Services (COPS) at the Department of Justice.

Mr. Orr received a Masters in Public Policy from the College of William and Mary and a Bachelor of Arts in American History from the University of Texas at Austin.