P25 for the Future
New Products, Applications, Interoperability and Security

Presented by:
PTIG - The Project 25 Technology Interest Group
www.project25.org – Booth 2761
Program Participants

Moderator

- **Steve Nichols**, Director, PROJECT 25 TECHNOLOGY INTEREST GROUP (PTIG)

Panelists

- **Dominick Arcuri**, Subject Matter Expert, TELEVATE LLC
- **Andy Davis**, Senior Resource Manager, Project 25, MOTOROLA SOLUTIONS, Chairman TIA TR-8
- **Jeremy Elder**, Director Integrated Platforms, HARRIS CORPORATION
- **Alan Massie**, Federal Bureau of Investigation
- **Keith LaPlant**, US Coast Guard
- **Justin Evans**, Radio System Mgr., Montgomery County TX Hospital District
- **Greg Jurens**, Senior Manager Technical Operations, Harris County TX
- **Del Smith**, Alaska Landmobile Radio System (ALMR)
- **Cindy Cast**, Radio Systems Manager, Miami Dade County FL
- **Jim Holthaus**, Vice President - Chief Technology Officer, BK TECHNOLOGIES; Chairman Private Radio Section, TIA
- **Robin Grier**, President, Catalyst Communications Technologies
- **Cheryl Giggetts**, Principal, CTA Consultants
- **Jim Downes**, Jim Downes, Cybersecurity and Infrastructure Security Agency (CISA), Project 25 (P25) Steering Committee Chair
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Project 25 Technology Interest Group (PTIG)

What do we do?

• Provide a forum for users and manufacturers
• Manage education and training on Project 25
• Create and distribute Project 25 information
• Support the TIA standards process
• Offer Users access to the standards process without the rigor of TIA membership
• Maintain a “neutral ground” among the competing manufacturers and providers

And…

• Present Classroom Training and Panels such as THIS SESSION.
Founding Members

BK TECHNOLOGIES
MOTOROLA SOLUTIONS
VI AVI

Sustaining Members

CODAN
RICOM
TAIT communications
HARRIS
TiL
JVCKENWOOD

EF Johnson Technologies, Inc.

a JVCKENWOOD Company
Project 25 Technology Interest Group

Corporate and Professional Members
38 Vendors for Project 25 Equipment and Services

Available in VHF, UHF, 700, 800, and 900 MHz

16 Fixed station/repeater suppliers
13 Subscriber suppliers:
   Mobiles, Portables, Vehicle Repeaters, Pagers
13 Console suppliers
16 Network providers
10 Test equipment suppliers
10 Consultant services
# Project 25 Products and Services Available

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Welcome to the Project 25 Technology Interest Group

The Project 25 Technology Interest Group (PTIG) brings you this web site to provide information on all topics concerning Project 25.

Please register on the site for access to additional information. If you previously registered prior to June 2010, a new registration is required. This is to assure we have current and accurate information.

Registration is required to maintain a spam free site for you. No fees are required for website registration.

PTIG MEMBERS NOTE: When your individual registration is validated for affiliation to a paid membership or a commercial member company, your registration will provide member access privileges.

Use the dialog box titled “Contact Us” on the home page for any inquiries about registration and membership.

This site is the official home of PTIG and our P25 community. Your suggestions and comments are always welcome. Use the dialog box titled “Contact Us” on the home page to make your suggestions, offer comments, or seek more information.

What is Project 25?
Project 25 (P25) is the standard for the design and manufacture of interoperable digital two-way wireless communications hardware. Developed in North America

Why P25?
Project 25 enables successful fulfillment of these factors so critical to public safety operations and use of two-way radio communications in the field.
Project 25 Technology Interest Group (PTIG)

Documents available at www.Project25.org

• P25 Standards Update Summary
  *Summary of the latest TIA TR-8 P25 Standards Meetings with user benefits defined*

• List of P25 Systems (2200+)

• P25 Case Studies, PTIG Conference Presentations

• P25 Testing (Links to DHS CAP Program)

• P25 Non CAP ISSI/CSSI Interop Testing Template & Reports

• P25 Frequently Asked Questions

• P25 Capability Guide
  *Remains the best tool for managing P25 features and capabilities for system planning and RFP development*
Project 25 Technology Interest Group (PTIG)

New Documents available at www.Project25.org

New P25 White papers:
- What is P25 Compliance?
- P25 Authentication

P25 System of the Month

Each month a new Project 25 system is featured describing the system, coverage, agencies served, interoperability achieved and other unique details of this application of Project 25 technology.

White Paper: Technology Benefits of Project 25

This article has been recently updated to include the new wireline interfaces (ISSI, CSSI, FSI) and new operational capabilities recently added to the P25 suite of standards.

The Whitepaper covers the background and history of the P25 Standard, original goals and objectives, a summary overview of the standards and how they translate into benefits for the Public Safety community.
The Project 25 Eco-System Today

Established Base of over 2250 Project 25 Systems on the air today
Including 37 Statewide P25 Systems, numerous region wide, county wide, municipality, campus, and individual facility 25 systems.

Examples: Michigan 90,000 users, 1,665 Agencies, 12 Million PTT /mo.

Miami/Dade 30,000 users, 110 Agencies, 7 million PTT /mo.

A Vibrant Competitive Market-place with 38 Project 25 Product and Service providers offering a diverse range of P25 solutions at multiple price points and P25 is the preferred technology for Federal Grants

Independent Testing through the DHS CAP Program and a number of certified independent testing Labs.

A Live, Active, Evolving Technology that continues to develop with new capabilities, upgrades, and test standards.
Why have so many PTT Users chosen P25?

**Public Safety Grade Reliability and Performance**

*Developed through 25 years of Standards evolution and product technology improvements.*

**Multiple P25 PTT Voice and Data Services:** Group Call, Emergency Group Call, Broadcast All Call, Unit to Unit Individual ID Call, Telephone interconnect call, Tier 2 Location (GPS), OTAP/OTAR. *All with talking party ID*

**Feature Rich Supplementary Services:** Call Alert, Status Message/Status Update, Radio Check, Radio Unit Monitoring, Radio inhibit/Uninhibit, Priority/Preemptive Priority

**Superior Voice Encryption and Security** using 256 bit AES Encryption, Over the Air Re-Keying, and Authentication.

**High Performance Audio Volume and Clarity (P25 Vocoder)** combined with rugged housings that are designed for demanding Public Safety environments
Why have so many PTT Users chosen P25?

**Project 25 is Cost Effective**

**Multiple System Configurations:** P25 offers: direct mode, repeated, single site, multi-site, voting, multicast, and simulcast configurations allowing scalable, cost effective, system design.

**Sharing P25 Infrastructure** P25 permits multiple agencies to share common infrastructure and each make their own purchasing decisions.

**Statewide and Regionwide P25 Systems are growing rapidly** as smaller agencies realize the benefits of eliminating their LMR operating costs and getting improved coverage and performance of P25.

**P25 is the preferred LMR technology for Federal Grants**

38 Project 25 Product and Service providers compete for Standards based RFPs
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PROJECT 25 TECHNOLOGY INTEREST GROUP

Visit PTIG Booth # 2761 IWCE 2019

OUR MEMBER ORGANIZATIONS AS EXHIBITORS ALSO SAY THANK YOU
International Wireless and Communications Expo
Las Vegas, Nevada
March 5, 2019

P25 Standards Overview, Interfaces and Terminology

Dominick Arcuri
Subject Matter Expert, Televate, LLC

Presented by:
PTIG - The Project 25 Technology Interest Group
www.project25.org – Booth 2761
### P25 Objectives/Technology Goals

- **Maximize Spectrum Efficiency**
  - Frequency Independent
  - Coverage Equivalent to Existing Analog Coverage
- **Promote Interoperability**
  - Compatible with Existing Equipment
  - Integrate both Voice and Data
- **Facilitate Multi-source Procurement**
- **Develop User-Friendly Equipment**
- **Gradual Migration from Existing Systems**

Coverage Equivalent to Existing Analog Coverage
P25 Standards Process and Documents

P25 is a suite of over 85 Standard documents and Telecommunication Systems Bulletins that define the services and interfaces.
Key Project 25 Interfaces

P25 has standardized the Common Air Interface (CAI) and multiple Wireline Interfaces.
P25 RF System Configurations

• Single Site
  - Single Site Trunked RF Sub-System

• Multi Site
  - Simulcast
  - Multicast
  - Multi-Site Trunked RFSS
  - Multi-Site Overlay
    - Trunking RFSS (voice & data)
    - Conventional RFSS (e.g. paging)

• Multi Site Overlay
  - Project 25 Trunked RF Sub-System
  - Multi-Site Trunked & Conventional Overlay
    - Project 25 Conventional RF Subsystem
      - Console Sub-System (CSS)
    - Conventional Digital Fixed Station Interface (DFSI)
P25 Phase I Common Air Interface (CAI)

- Designed to operate with 12.5 kHz channel spacing
- Frequency Division Multiple Access (FDMA)
- Data Rate: 9.6 kbps
- Modulation: 4-level form of FSK (C4FM)
- Vocoder: DVSI’s IMBE (7.2 kbps)
- Supports conventional, trunking and secure communications
- Conventional channel protocol same as trunking traffic channel
P25 Phase 2 CAI

- 12 kb/s air link rate for 2 slot TDMA
- Modulation
  - H-DQPSK for downlink (outbound)
  - H-CPM for uplink (inbound)
- TDMA Voice Channels
- Dual Rate Vocoder
- FDMA Control Channel (Phase 1 CCH base)
  - With TDMA extensions (for migration & compatibility with PH I)
P25 Inter-System Configurations

Connecting RF Sub-Systems Using ISSI

ISSI/CSSI Supports various P25 call types, P25 services and console features

Connecting Systems Using CSSI

ISSI/CSSI Supports various P25 call types, P25 services and console features
How P25 Promotes Interoperability

- Over the air interoperability
  - Radio to Radio of different manufacturers
  - Radios from different manufacturers on a common system within a coverage area (conventional or trunked)
    - Neighboring jurisdictions during a common event or vehicle pursuit
    - Outside agencies responding during a mutual aid event

- Intra and Inter System Interoperability
  - Multiple dispatch facilities utilizing a common infrastructure
  - Neighboring jurisdictions that permit roaming while maintaining home system contact
  - Multiple systems interconnected to create a larger system
Over the Air Interoperability via P25

- Direct Mode
- Trunking
- Conventional

Inter Sub-System Interface (ISSI)

Conventional Direct Mode Trunking
Multi-Agency Interoperability via P25

P25 permits multiple agencies to share common infrastructure and each make their own purchasing decisions.
Intersystem Interoperability via P25

The P25 ISSI permits roaming to a neighboring system while maintaining home system contact.
P25 Transition and Migration

P25 manufacturers supports backward compatibility to legacy systems

P25 supports a smooth migration from Phase 1 to Phase 2
Project 25: Summary

Designed for public safety by public safety
P25 is a suite of mobile radio standards and bulletins which define interoperable communications for emergency services

Developed in partnership between Public Safety and TIA

- Project 25 formed in 1989
- Initial standards released in 1995
- Original goals have been met, yet
- Ongoing development and evolution of the standards continue with broad industry support
Project 25: Top 10 Benefits

- Superior Security using 256 bit AES with OTAR
- A User-Driven Technology with support at numerous frequency bands
- The reliable, de-facto, choice for mission critical communications during Natural Disasters and critical events
- Superior Audio volume and clarity combined with high performance radio designs for Public Safety environments
- Independent testing for performance and interoperability
- Mature, well defined, Air and Wireline Standardized Interfaces
- A Large Installed Base of over 2250 Systems
- A vibrant market-place with more than 3 dozen suppliers and the preferred technology for Federal Grants
- A live, active, technology that continues to evolve with new capabilities, upgrades, and test standards
- The reliable, de-facto, choice for mission critical communications during Natural Disasters and critical events
- Superior Audio volume and clarity combined with high performance radio designs for Public Safety environments
- Independent testing for performance and interoperability
- Mature, well defined, Air and Wireline Standardized Interfaces
- A Large Installed Base of over 2250 Systems
- A vibrant market-place with more than 3 dozen suppliers and the preferred technology for Federal Grants
- A live, active, technology that continues to evolve with new capabilities, upgrades, and test standards
Thank You

Dominick Arcuri
Subject Matter Expert, Televate, LLC

darcuri@televate.com
P25 Standards Update

Andy Davis
Chairman, TIA TR-8 Mobile and Personal Private Radio Engineering Committee
Sr. Resource Manager, P25 Standards - Motorola Solutions

Presented by:
PTIG - The Project 25 Technology Interest Group
www.project25.org – Booth 2761
P25 Standards Activity Update

Background
2018 & 2019 Publications
Work in Progress
Background

Project 25 Steering Committee Approved P25 Standards list includes ~85 documents

• To date, all are produced, published and maintained by TIA TR-8 Mobile and Personal Private Radio Engineering Committee

• Overviews, Standards, Standard Tests, Telecommunications Systems Bulletins

• In addition to new documents, TIA publishes document revisions and document addendums
  - Revisions and addendum may provide clarifications, correct errors or add additional material
Air Interfaces (2018)

• An addendum to the Trunking Control Channel Messages standard was approved for publication.

    This addendum introduces an “Accessory Sensed Emergency” flag to the Emergency Alarm message.

• A revision to the Conventional (Air Interface) Interoperability Test standard was approved for publication.

    This revision corrects editorial errors and makes clarifications on various test procedures but does not add, remove or technically alter tests.

• A revision of TSB-88.1-E (Part 1 Performance Modeling) was approved for publication.

    This revision incorporates Addendum 1 and incorporates proposals to clarify performance modeling methods approved by Working Group 1

• A revision of TSB-88.3-E (Part 3 Performance Verification) was approved for publication.

    This revision incorporates Addendum 1 and incorporates proposals to clarify performance verification approved by Working Group 1
Wireline Interfaces (2018)

• An addendum to the ISSI Messages and Procedures for Supplementary Data

This addendum introduces the messages and procedures for Individual Regrouping control across an ISSI/CSSI.

• A revision of the ISSI/CSSI Interoperability Test Procedures for Trunked Voice Operation

This revision adds a normative annex that intends to simplify ISSI/CSSI Interoperability testing by recommending existing test configurations that use only 2 RF Sub Systems at a time and test a single ISSI/CSSI link at a time.

• A revision of the ISSI Recommended Compliance Assessment Tests bulletin

This revision will add recommended interoperability tests for Trunking CSSI applications and add recommended interoperability tests of TDMA operation of the Trunking ISSI and CSSI.
2018/2019 Publications (3 of 4)

Data (2018)

• A revision of the Tier 2 Location Service Specification
  *This revision corrects editorial errors and makes corrections to EXI Encoding examples.*

• TCP/UDP Port Number Assignments
  *This revision addresses errata that have been collected since the last publication.*

• Mobile Data Peripheral Interface
  *This revision addresses errata that have been collected since the last publication.*

• CMS Specification for Packet Data
  *This revision addresses errata that have been collected since the last publication.*

• Packet Data Host Network Interface
  *This revision addresses errata that have been collected since the last publication.*
Security (2019)
• A revision of the Security Services Overview document

  This revision merges a previously published addendum with the parent document.

Air Interfaces (2019)
• A revision to the Trunking Control Channel Messages standard was approved for publication.

  This revision addresses errata that have been collected since the last publication.
Air Interfaces

• **Creation of a High Signal Strength Intermodulation Rejection Test** is in progress.
  
  *This test will measure the ability of a P25 or analog conventional FM receiver to reject an unwanted broadband base station signal, thereby preventing degradation to the reception of a desired signal. Performance specifications are expected to follow completion of the measurement method.*

• **A revision of ANSI/TIA-4950-B “Requirements for Battery-Powered, Portable Land Mobile Radio Applications in Class I, II, and III, Division 1, Hazardous (Classified) Locations“** is in progress.

  *UL is proposing improvements/clarifications to the document regarding electrical protection parameters.*
Wireline Interfaces

• **Group Regrouping for the Trunking ISSI/CSSI Standard** is in progress.
  
  *This work will enable dispatch equipment connected to Trunking Infrastructures via the ISSI/CSSI to control group regrouping services. Note the control channel messaging for these services has already been standardized.*

• **A new Interoperability test standard for Trunked ISSI Supplementary Data Services** is in progress.
  
  *This document will provide a standard set of tests for validating interoperability of Supplementary Data Services (Emergency Alarm, Call Alert, etc) operating across a Trunked ISSI.*
Security

• **Definition of a Link Layer Encryption Security Service** is in progress.  
  *This is the first big new technology upgrade for improved Security for all air interfaces of P25. It protects control channel control messages, and hides group and individual IDs.*

• **An addendum to the Key Fill Interface standard** is in progress.  
  *This will enable Key Fill Device (KVL) interface to a KMF, an Authentication Facility and another Key Fill Device*

• **An addendum to the Over The Air Rekeying Messages and Procedures standard** is in progress.  
  *This will allow single key radios to use any Encryption Key ID and will allow multi-key radios to use any Encryption Key ID in order to ensure interoperability between single key and multi-key equipment.*
Security (cont.)

• An addendum to the Over The Air Rekeying Messages and Procedures standard is in progress.

  This will allow single key radios to use any Encryption Key ID and will allow multi-key radios to use any Encryption Key ID in order to ensure interoperability between single key and multi-key equipment.

Broadband

• Definition of 3GPP Mission Critical standard services interworking with TIA Land Mobile Radio standard services is in progress.

  This document will describe interworking of features (example; group and individual calls) that are common between 3GPP LTE standards and P25 Trunking, P25 Conventional and Analog Conventional FM LMR standards.
ATIS/TIA Joint LMR LTE Joint Project Committee Status Update

Andy Davis
Chairman; TIA TR-8 Mobile and Personal Private Radio Engineering Committee
Sr. Resource Manager; P25 Standards - Motorola Solutions
ATIS and TIA Background (1 of 2)

• TIA and ATIS Memorandum of Understanding dates back to 2006 in which the two SDOs “agree to jointly sponsor and work cooperatively in the development of joint standards documents that are of mutual interest”.

• ATIS – Alliance for Telecommunications Industry Solutions is a Standards Development Organization (SDO) develops technical and operational standards and solutions for the ICT (Information and Communication Technologies) industry (members include manufacturers and user agencies such as APCO)

• TIA – Telecommunications Industry Association is a Standards Development Organization (SDO) that develops voluntary, consensus-based industry standards for a wide variety of ICT products (members include manufacturers and P.S. Agency reps)
• TIA and ATIS began work on interworking of LTE Mission Critical (MC) and LMR services in 2012
  • Joint Project Committee known as “JLMRLTE”
  • This included Tetra, P25 Conventional, P25 Trunking and TIA-603 based Conventional Analog FM service
• In 2014, the JLMRLTE agreed to “postpone further work in JLMRLTE until the LTE part of MCPTT work in 3GPP is more developed”
• In 2015 work resumed that created documents defining kLMR terminology and high level service descriptions
  • Provided to 3GPP in 2016
• In December 2017, JLMRLTE work resumed
  • Primary participants are 3GPP member representatives, TIA member representatives, Firstnet, AT&T
Current ATIS Issue statement (WTSC-JLMRLTE-2017-00001R001) excerpt:

This issue statement proposes that ATIS WTSC (SN and RAN) initiate work with TIA TR-8 (TR-8.8 subcommittee) to develop joint ATIS/TIA specification(s), with ATIS as the lead Standards Development Organization (SDO).

Joint ATIS/TIA specification(s) on Use Cases, requirements, architecture, call/message flows, and implementation guidelines would be developed that define interworking of standard interfaces for published or future TIA LMR standards to the 3GPP interworking specifications. The JPC shall coordinate with 3GPP and TIA committees to identify and address gaps and evolve those standards as necessary in support of this issue. As application and service protocols evolve, the work should accommodate, in so far as is possible, interoperation of new broadband public safety features with new features of TIA-102 and TIA-603 conventional FM systems.
Current work item WTSC-JLMRLTE-2019-00001R001 title:

“Study of Interworking between P25 LMR and 3GPP (MCPTT) Mission Critical Services”

Scope excerpt:

This document contains scenarios and considerations for the use of a 3GPP Release 15 Interworking Function to enable interoperability of services between a 3GPP MC system and a TIA-based LMR system. For the purposes of this document there are three distinct TIA-based LMR systems that will be examined, namely: P25 trunking, P25 conventional, and TIA-603 analog conventional FM.

NOTE: This document is intended to describe how that 3GPP Interworking Function may be used to enable interoperability of those services that are common between 3GPP MC systems and each of the three TIA-based LMR systems mentioned above. Interoperability of services between 3GPP MC systems and TETRA-based LMR systems are outside the scope of this document.
ATIS/TIA JLMRLTE Status (3 of 7)

- 3GPP Release 15 and 16 documents define:
  - Interconnection of 3GPP LTE Mission Critical Systems
  - Interworking between LTE and non-LTE Systems

- The 3GPP Interworking architecture defines an Interworking functional entity (IWF)
  - Adapts LMR Systems to mission critical systems via the IWF interface and supports interworking between LMR systems and mission critical systems.
  - From the 3GPP side, the IWF acts as another MC System
  - From the LMR side, the IWF acts as another LMR System
  - The IWF is the functional entity responsible for conversion of media and control signaling between LTE and LMR technologies to enable interoperable services
ATIS/TIA JLMRLTE Status (4 of 7)

- High level functional model found in the JLMRLTE document:

L603 – TBD interface to Conventional analog FM system
L102C – TBD interface to P25 Conventional System
L102T – TBD interface to P25 Trunking System
IWF-1, -2, -3 – Interfaces to 3GPP Mission Critical (MC) System Services
• Current philosophy of the JLMRLTE document:
  • Describe how common services (features) may interwork (interoperate)
    o Do not prescribe a particular LMR interfaces to the IWF although ISSI/DFSI are likely candidates
    o Do not prescribe specific 3GPP or TIA messages to or from the IWF
    o Do not prescribe specific TIA devices that may interface with the IWF
  • High level identification of message translations that are needed for interworking
  • High level identification of media translations that are needed for interworking
  • Identify issues “For Future Study (FFS)” that must be resolved
Current JLMRLTE document Table of Contents includes:
- Architectural considerations and assumptions
- Functional models
- Addressing
- Deployment models
- Features and scenarios

Architectural considerations and assumptions section provides high level descriptions of how services operate.

Features and scenarios section provides descriptions and generic message flows for establishing, maintaining and terminating interworking services.
Thank You

Andy Davis
Andy.davis@motorolasolutions.com

Chairman, TIA TR-8 Mobile and Personal Private Radio Engineering Committee

Sr. Resource Manager, P25 Standards - Motorola Solutions
International Wireless and Communications Expo
Las Vegas, Nevada
March 5, 2019

P25 Security
New Standards, Applications, and Interoperability

Jeremy Elder,
Director of Integrated Platforms, Harris

Presented by:
PTIG - The Project 25 Technology Interest Group
www.project25.org – Booth 2761
P25 Encryption Standards Update

• Link Layer Encryption (LLE)
  o Problem Statement
  o Solution Overview
  o Standards Update
  o Important User Considerations

• Key Fill Device Addendum
LLE Problem Statement

P25 Link Layer Encryption helps ensure:

• **Integrity** – How can you know the message has not been altered?
  o Specifically, Replay Protection ensures that a message cannot be resent later by an untrusted source

• **Confidentiality** – How can you be sure that the message is only received by the intended parties?

• **Key Distribution** – Do the initiating and receiving parties have the means to securely communicate?
LLE Problem Statement

• P25 End-to-End Encryption for voice calls and packet data protects the contents of the transmission
• End-to-End Encryption by itself does NOT protect against intercepting the identities of the parties involved in a call
  o Initiator of a Call (Typically a User ID)
  o Target of a Call (Typically a Group ID but may be a Supergroup or another User ID)

From: Jeremy
To: Bill
Message: Q@#$%DFG%^&
LLE Problem Statement

Current state of P25 systems:
• Control signaling messages on traffic channels and conventional channels are not protected.
• P25 trunking control channel messages (inbound & outbound) are not protected.
• This includes:
  o User Registration/Group Affiliation, Service Requests & Channel Assignments
  o Supplementary Data Services such as Status Update, Short Message, Radio Unit Monitor, Unit Inhibit
LLE Solution Overview

- LLE only protects the air interfaces—nothing wired
- “Protected” means that identities and user data are encrypted
LLE Solution Overview

- Protected (P), Unprotected (U), and Legacy (L) SU can all co-exist on the same channel/site/system
  - Protected: Supports LLE and is operating with LLE
  - Unprotected: Supports LLE, but is running without LLE
  - Legacy: Doesn’t support LLE
- All existing P25 channel types are supported—including TDMA CC
Key Management for LLE

Important Concepts:

• The Link Encryption Facility (LEF) securely stores & distributes LLE Crypto material

• LLE Key Management provides for a hierarchy of keys and multiple key distribution methods. There are 3 types of LLE key distribution in the standard:
  o Broadcast key distribution: provides an efficient method for SUs to be efficiently key managed
  o Group Key Distribution: provides a method for groups of SU to be efficiently key managed
  o Individual key distribution: provides a method to provision keys to an individual SU
Important Concepts:

- **Root Link Encryption Key (RLEK)** – All LLE operational Keys within an LLE Domain are derived from the RLEK.
- Broadcast Keys are derived using cryptographically sound methods from the RLEK (CLEKs & STEK/STAK).
- Operational Keys can be securely distributed over the air via “Broadcast Key Distribution” (BKD) from conventional or trunked sites.

Notes:

- Key derivation methods ensure that the encryption keys used on each conventional channel and trunked channel are unique.
- Crypto synchronization uses a time value to provide “replay protection.”
- If the RLEK is compromised, all sites & radios must be rekeyed.
Individual Key Distribution

- OTAR & KFD interfaces can be utilized to distribute Individual Keys (ILEKs) to individuals – especially for initial onboarding
- Individual Keys can be securely distributed over the air via “Individual Key Distribution” from conventional or trunked sites
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LLE standardization is a major effort with many impacts on existing P25 standards

March 2019

Project 25 Technology Interest Group
LLE Important User Considerations

- Updates to P25 standards for LLE will have no impact on users that don’t require LLE
- LLE will support interoperability with legacy subscriber units that don’t support LLE and subscriber units that support LLE on the same network
  - For example in P25T, the standards will support a mix of protected & unprotected groups operating on the same site
- Key management is designed to be as seamless as possible – supporting distribution of future keys before they take affect
- Protection of the RLEK (& derived CLEK) is very important
- There is still some time until the standard is published—equipment conforming new standards are typically available 12-18 months after publication
P25 Encryption Standards Update

• Link Layer Encryption (LLE)

• Key Fill Device (KFD) Addendum
  o Scope of the Addendum
  o Status of the Addendum
  o User Considerations
KFD Addendum Scope

- Enhances interoperability for P25 encryption by providing standards-based interfaces between a Key Fill Device (KFD) and the following:
  - A Key Management Facility (KMF)
  - An Authentication Facility (AF)
  - A Link Encryption Facility (LEF)
  - Another KFD
KFD Addendum Status

- Much simpler standards update than LLE!

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<tr>
<td>Key Fill Device (KFD) Interface Specification – Addendum 1</td>
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March 2019

Project 25 Technology Interest Group
KFD Addendum User Considerations

• TODAY: Interfaces between KMF, AF, and KFD and the KFD are proprietary—presenting challenges for interoperability between different P25 manufacturers
• There is no impact on the interface between the KMF and SU with this change—allowing support for legacy devices with new/updated KFDs
• There is still some time until the standard is published—equipment conforming new standards are typically available 12-18 months after publication
Thank You

Jeremy Elder,
Director of Integrated Platforms, Harris
jelder@harris.com
P25 Standards Update P25
Encryption Update and Best Practices for Interoperability

Alan Massie – FBI
P25 and FBI

FBI Shared Land Mobile Radio System (SLMRS)
- A nationwide P25 VHF Conventional system
- CONUS, Puerto Rico, USVI
- Cores located in Denver and Quantico
- Shared resources – ATF, DEA, FBI, USMS
- Each Agency has own Dispatch, KMF’s
- FBI alone has approximately 47,000 SLMRS subscribers
- FBI Operates two former DOJ IWN VHF Trunking systems – NCR & PNW
P25 Feds and Encryption

FBI Shared Land Mobile Radio System (SLMRS)
- Federal Information Security Management Act
- SLMRS received ATO Oct 2016.
- Federal Information Processing Standards
- FIPS 140-2, AES Standard FIPS – 197, Nov 2001
  - FIPS 140-2 precludes the use of unvalidated cryptography for the cryptographic protection of sensitive or valuable data within Federal systems. Unvalidated cryptography is viewed by NIST as providing no protection to the information or data—in effect the data would be considered unprotected plaintext. If the agency specifies that the information or data be cryptographically protected, then FIPS 140-2 is applicable. In essence, if cryptography is required, then it must be validated.
  - With the passage of the Federal Information Security Management Act (FISMA) of 2002, there is no longer a statutory provision to allow for agencies to waive mandatory FIPS.
  - FIPS 46-3, DES was withdrawn May 2005.
FBI and other federal agencies/departments
- Are obligated to seek FISMA compliance
- In the case of Encryption that means FIPS
- That means it cannot be DES, or RC4 variants
- So – to promote encrypted interoperability...
- Please consider using AES
- Note recent CAP AP/DHS rules on non-standard encryption
- Ponder how long DES may remain in P25 Standard?
- Encrypted Interop with Feds the justification you need?
- DHS/CBP/NLECC distributes interop key material
P25 Feds and Encrypted Interop

FBI and other federal agencies/departments

- Use of CBP NLECC’s SLN’s 1-20 are essential
- SLN’s 1-20 help enable encrypted interop
- NLECC will help you with getting Key material
- NLECC OTAR Team Supervisor David Moore
- Call NLECC at 407-975-1966 or 877-326-532
- Email NLECC at NLECC-WSOC@cbp.dhs.gov
# National SLN Assignments

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<td>NTAC D</td>
<td>Single Event Use – Not to exceed 30 Days</td>
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*Annual key changes are completed on the first working Monday of October*
P25 Feds and Encrypted Interop

The best for last - SLN/CKR’s

- SLN’s are only required for comms between KMF and subscriber radio during OTAR
- SLN’s have nothing to do with radios ability to decrypt a message (Key, Key ID, ALGID do matter)
- SLN de-confliction is only relevant within the context of your KMF/OTAR environment.
- If you want to interoperate with a subscriber that gets key from another KMF as long as you have the same Key, Key ID and ALGID, you will communicate.
International Wireless and Communications Expo
Las Vegas, Nevada
March 5, 2019

Thank You

Alan Massie – FBI
Legacy Capability

Analog wideband coverage of marine band channels deployed nationwide in early 1970s
Motorola 6 channel consoles
Mixed deployment of non-standard VHF transceivers at 300 radio sites
Spectra mobile and Sabre or MX-300R handheld radios
1994 Requirements documenting need for increased capacity and better coverage

1995 Acquisition project chartered to modernize the National Distress and Response System

2000 Phase I contract awarded

2001 Contractors demonstrate ability to meet critical design criteria
2002 Phase II awarded to General Dynamics
2005 Rescue 21 IOC in Atlantic City NJ and the Eastern Shores VA
2012 32 of 37 Sectors are operational, 253 Remote Fixed Facilities on air
2017 Alaska and Inland Rivers Sectors complete with modified R21 architecture
P25 chosen as core of new radio system

- Established standard
- Vendor agnostic
  - Subscriber base is mix of Motorola, EF Johnson, Harris and Relm radios
- Easier to draft specifications when standards are already defined
- P25 standards support some core R21 requirements such as OTAR and AES encryption
  - VHF and UHF channels are OTAR capable nationwide
  - Single KMF supports OTAR for 13,000 plus subscribers
P25 facilitates increased interoperability

- P25 conventional channels (correctly programmed) work across any network regardless of vendor
- Use of a NAC eliminates confusion about CTCSS v CDCSS
- CG is expanding the purchase and use of dual or multi-band radios many of which include P25 trunked capability
What is RESCUE 21

Rescue 21 is a command, control, and communication system that supports all US Coast Guard coastal missions, with emphasis on Search and Rescue (SAR) and Homeland Security

- Maintains compatibility with legacy maritime customers (analog wideband)
- Implements digital, encrypted tactical channels
- Fully IP based with VoIP from remote sites
What is RESCUE 21

Key Features

- Improved Voice and Direction Finding Coverage out to 20 NM offshore
  - U.S. Coast Guard operational frequencies
  - Working frequencies in the marine band
  - Monitoring of VHF-FM distress channels 16 and 70 in the coastal zone

- Improved System Availability – 99.5%

- Enhanced Situational Awareness
  - Geo Display
  - Direction Finding

- Digital Recording
  - Instant Playback
  - Archiving

- Key Features
  - Interoperability
    - Federal
    - State
    - Local
    - National Law Enforcement and Incident Response interoperability frequencies
    - Region-specific mutual aid frequencies
    - DHS first responder frequencies
  - APCO Project 25 (P25) compliant
    - P25 OTAR capable
    - Clear or encrypted
  - Phone patch capability
  - 24 x 7 network and system monitoring and fault detection
RFF Configuration

VHF-FM CH16 GUARD

VHF-1
• VHF-FM MARINE BAND
• CG VHF-FM P25 CHANNELS
• VHF-FM INTEROP CHANNELS
• ENCRYPTED OR CLEAR

VHF-2
• VHF-FM MARINE BAND
• CG VHF-FM P25 CHANNELS
• VHF-FM INTEROP CHANNELS
• ENCRYPTED OR CLEAR

• UHF-1
  – CG P25 CHANNELS
  – UHF-FM INTEROP CHANNELS
  – ENCRYPTED OR CLEAR

• DIGITAL SELECTIVE CALLING (DSC)
  – CHANNEL 70
  – DIGITAL DISTRESS TRANSCEIVER

• VHF-3
  – UNUSED
Typical RFF

DF Array (9 element)

UHF Tx/Rx

VHF Rx

VHF Tx
R21 Coverage

NOTE: Coverage rings are depicted for illustration purposes only
NOTE: Insert maps are not to scale with the US mainland.
R21 Continues to Evolve

Replaced hardware DIUs with software DIU’s
Dynamic encryption key selection implemented
  • Allows operator selection of any encryption key loaded into system
Sector to Sector handoff implemented
Thank You

Keith LaPlant
Telecommunications & Interoperability Program Mgr
U.S. Coast Guard
Miami, FL
(305) 415-7007
Keith.H.LaPlant@uscg.mil
International Wireless and Communications Expo
Las Vegas, Nevada
March 5, 2019

P25 System and Console Interoperability using the ISSI/CSSI/FSI

Justin Evans
Radio System Mgr., Montgomery County TX Hospital District

Greg Jurrens
Senior Manager Technical Operations
Harris County TX
'Extremely dangerous' inmate captured after manhunt in Conroe

By R.A. Schuetz, Alison Medley, and Catherine Dominguez  Updated 10:25 am CST, Monday, February 4, 2019
ISSI – Harris SR10.3 – Motorola
7.17.1
How many engineers does it take to implement an ISSI connection?
ISSI Console Testing
MCHD/HC ISSI Network Layout

**Primary ISSI**
- Internet Access Router 1
- Internet Firewall 1

**Standby ISSI**
- Internet Access Router 2
- Internet Firewall 2

*Foreign ISSI's will target ISSI NAT'd Address while using the HSRP Shared Address as the next hop address*

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**Harris County Primary Zone Core**
- INTER RF SYSTEM GATEWAY (ISGW)

**MCHD NETWORK**
- uWave

**Harris County DSR Zone Core**
- MCHD 911 CISCO SWITCH
- MACR0ISDL SWITCH 2
- uWave 7705

**ASTRO P25 NETWORK**
- MCHD NETWORK

---

**MCHD NSC1 and NSC2**
- Primary ISSI
- Standby ISSI
- Internet Access Router 1
- Internet Firewall 1
- Internet Access Router 2
- Internet Firewall 2

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**REVISIONS**

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Implementation Successes

What works well

- P25 Phase I to P25 Phase I - Group Calls W/Unit ID
- P25 Phase II to P25 Phase II - Group Calls W/Unit ID
- P25 Phase II to P25 Phase I - Group Calls W/Unit ID
- P25 Phase I to P25 Phase II - Group Calls W/Unit ID
- P25 Phase I AES to P25 Phase I AES - Group Calls W/Unit ID
- P25 Phase II AES to P25 Phase II AES - Group Calls W/Unit ID
- P25 Phase I AES to P25 Phase II AES - Group Calls W/Unit ID

All the technical staff and both vendors worked great as a team to have a successful deployment.

The audio quality is amazing, the users can’t tell they are on 2 different systems

Mapping Talk Groups over ISSI worked great no more “patching” needed
Implementation Challenges

- Very few “Experiences” Subject matter experts
- Vendor documentation – Language barriers
- No Verified “How-to’s”
- Single IP vs. Multi-IP – Affects ability to implement resiliency

Operational Challenges

- **Emergency Clear/Knockdown** (Project 25 Inter-RF Subsystem Interface Messages and Procedures for Voice, Mobility Management, and RFSS Capability Polling Services - Addendum 1 - Group Emergency Behaviors TIA-102.BACA-B-1)
- **Automatic Roaming** – Adjacency is not passed via ISSI
- **SuperGroup/Patching** (ISSI Messages and Procedures for Group Regrouping TIA-102.BACG)
- **SimulSelect/Multi-select** (ISSI Messages and Procedures for Group Regrouping TIA-102.BACG)
- Aliasing (subscriber and Talkgroups)
- “Foreign” vs. “Homed” Talkgroups – Requires hard patching
ISSI/CSSI Focus Group

- Established in 2016 under the FPIC to explore the ISSI/CSSI technology environment including but not limited to:
  - Successfully connecting single and multiple manufacturer ISSI or CSSI systems
  - Collecting user and manufacturer implementation procedures
  - Troubleshooting methods
  - Identifying best practices

- Serves as the voice for the ISSI/CSSI community and is actively working with manufacturers to improve standards for interoperability

Example ISSI/CSSI Focus Group Participating Agencies

- Alberta First Responder Radio Communications System
- Connecticut Emergency Services and Public Protection Department
- Department of Information Technology County of Fairfax, Virginia
- Department of Interior, Bureau of Land Management
- Federal Bureau of Investigation
- Harris County Public Safety Technology Services
- Iowa Statewide Interoperable Communications System Board
- Missouri Department of Public Safety
- Montgomery County Hospital District TX
- New York Metropolitan Transportation Authority Police Department
- Oregon Department of Transportation
- State of New Jersey Office of Information Technology
- U.S. Coast Guard
ISSI/CSSI Focus Group

- Hosted three user-focused working sessions to facilitate information sharing and on-going dialogue among participants
- Meeting participants included public safety communications professionals and ISSI/CSSI manufacturers’ representatives
- Past meetings
  - May 2016 – Denver, CO
  - September 2017 – Arlington, TX
  - July 2018 – Denver, CO
- Next meeting tentatively planned for summer 2019
On-going Efforts

- The action items from the in-person meetings resulted in the establishment of three Product Development Groups
  - Best Practices PDG
  - Information Sharing PDG
  - Features & Function PDG
ISSI/CSSI Best Practices PDG

- The Best Practices guides are a collaboration among the ISSI/CSSI user community to establish references for planning an ISSI or CSSI implementation.

- Volume I addresses pre-planning, partnerships, and governance and was recently published on the DHS CISA website.

- Volume II is currently under development and will cover topics including:
  - Stakeholder Engagement
  - Technology
  - Policies and Additional Governance
  - Maintenance & Upgrade Planning

- User input and feedback continues to be essential. To participate, send an email to FPIC@hq.dhs.gov.
Information Sharing PDG

- Homeland Security Information Network (HSIN) portal available for on-going participant collaboration
HSIN Example Library
ISSI/CSSI Features and Functions PDG

- **Conveners:** Steve Dyson (Texas DPS) and Rick Iverson (Oregon Department of Transportation)

- **Purpose:** To develop a manufacturer neutral list of priority features and functions needed to achieve interoperability across ISSI/CSSI (manufacturer neutral), as well as understand current use of said features and functions

- ISSI/CSSI User Survey released in two iterations by Texas Statewide Interoperability Coordinator (SWIC)
  - Version 1.0: Fall 2018, received 76 total responses
  - Version 2.0: Winter 2019, in progress
Survey Version 1.0 Results

- Distributed to several user groups: NCSWIC, SAFECOM, FPIC, P25 UNS, SWBCWG, and NPSTC

- Respondent details
  - Majority of the 76 respondents were state and local users
  - About 43% of respondents have an operational ISSI, 18% have an operational CSSI, and 53% have neither
Survey Version 1.0 Results: Demographics

Respondent Agency Breakdown by Jurisdiction Level

- County / city / township: 49
- State / regional: 17
- Tribal / territorial: 2
- Federal agency: 4
- Other: 2
Survey Version 1.0 Results

ISSI Implementation Status

- ISSI Only: 22, 29%
- CSSI Only: 3, 4%
- ISSI & CSSI: 11, 14%
- No ISSI/CSSI: 40, 53%

N = 76

If no ISSI, do you plan on implementing ISSI?
- Yes: 18
- No: 23

If no CSSI, do you plan on implementing CSSI?
- Yes: 13
- No: 41
Survey Version 2.0 Purpose

- Version 2.0 includes questions to capture more specific demographic information and clarifies features that may have been confusing to survey respondents in Version 1.0
- Current Status: Texas SWIC distributed survey to NCSWIC and SAFECOM – please request survey link if have not received it
- Close date **March 25, 2019**
- Feel free to forward to any public safety emergency communications users, particularly those with ISSI/CSSI implementations
- Remember the survey may take up to 20-30 minutes to complete
Recent Publications

- ISSI Fact Sheet
  - Provides a high-level overview of a broad range of introductory topic areas relevant to ISSI and CSSI
  - Published in February 2019

- Best Practices: Volume I
  - Provides best practices observed during the initial planning stages by local, county, regional, and state agencies implementing ISSI/CSSI
  - Published in February 2019
Best Practices: Volume I

- Includes a one-page Best Practices Checklist that address pre-planning and partnerships and governance

Examples:

- Clearly articulate the purpose and underlying motivation for pursuing ISSI connections to and from other stakeholders

- Attend vendors’ in-depth technical courses to develop a thorough understanding of what ISSI/CSSI enabled systems can and cannot do

- Coordinate ISSI governance with existing system governance, management, and use, as relevant

Appendix B: Best Practices Checklist

This appendix is meant to serve a single page checklist of things to consider as agencies work through pre-planning and partnerships and governance. It is meant to prompt practitioners to ask questions and consider strategic elements that may otherwise be overlooked.

Pre-Planning:
- Clearly articulate the purpose and underlying motivation for pursuing ISSI connections to and from other stakeholders
- Identify potential partner agencies or jurisdictions and discuss what you want to interoperate, under what circumstance, for what purposes, and for which individuals or departments
- Develop a list of actual expectations and derived requirements that address a potential partner agency’s technical and administrative factors that would impact planning and implementation
- Conduct a cost-benefit analysis, at minimum identifies capital costs, cost sharing opportunities, recurring costs, and expected O&M costs, as well as potential funding sources
- Attend vendors’ in-depth technical courses to develop a thorough understanding of what ISSI/CSSI enabled systems can and cannot do
- Engage with a body, such as the FPIC ISSI/CSSI Focus Group, and/or directly with other agencies that have similar ISSI configurations to capture lessons learned and other best practices

Partnerships and Governance:
- Reference the SAFECOM/National Council of Statewide Interoperability Coordinators Emergency Communications Divides for State, Local, Tribal, and Territorial Officials
- Engage in open and honest dialogue with potential partners to establish, build, and maintain trusted relationships
- Establish a desire to interoperate and recognize and respect the bounds of what can and cannot be achieved through an ISSI implementation
- Leverage existing governance bodies, as appropriate, to identify potential partners
- Select partner agencies on jurisdictions and remain open and inclusive to partners joining later
- Establish an agreed upon and workable governance arrangement with the selected agencies
- Coordinate ISSI governance with existing system governance, management, and use, as relevant
- Examine existing agreements to determine if the option exists to modify existing agreements to reflect the technical components and coordination required for an ISSI/CSSI implementation
- Manage expectations regarding the technology to be implemented and the scope of the implementation project(s)

- Draft formal agreements (e.g., memoranda of understanding) and governing documents (e.g., charter, by-laws)
  - Define roles and responsibilities for each participating agency and potentially individuals or technical teams from each participating agency
  - Address the need to assess governance board members’ skill sets at regular intervals to ensure the current team is adequately prepared to address the current lifecycle needs
  - Include language to address board members or representatives continued and active participation in the group’s activities
  - Include language to revisit the agreement itself every three to five years to ensure the document, underlying agreements, technologies, and assigned parties are still relevant
  - Address each participating agency’s initial and future financial commitments and whether agencies will cost-share, transfer funds, or split costs proportionally
- Include a commitment to craft shared operational policies for the use of the systems(s) and the expected interactions among participating agencies
Thank You

Justin Evans
jevans@mchd-tx.org

Radio System Mgr., Montgomery County TX Hospital District

Greg Jurrens
Greg.jurrens@cts.hctx.net

Senior Manager Technical Operations
Harris County TX
P25 Cost Savings and Resource Sharing Overview

Presented by:
PTIG - The Project 25 Technology Interest Group
www.project25.org – Booth 2761
P25 Sharing = Cost Savings

Sharing Scenarios

- Multiple Agencies Join a Single P25 System to share Infrastructure and operational Costs. *Examples: Village of Pinecrest FL, University PD and EM Miami FL Area*
- Multiple P25 County/Municipal Systems join to create a Region-wide P25 System sharing Infrastructure and Operational Costs and expanding Coverage area. *Examples: Hamilton County IN, Washington Capital Region, GATTRS Austin TX*
- Local/Regional P25 Systems join a P25 Statewide System sharing Infrastructure and Operational Costs and expanding Coverage area. *Examples: Michigan, Ohio, Wyoming, South Carolina*
- Adjacent P25 Systems Share Talk Groups to offer Interoperability across Jurisdictional/State/or National Boundaries. *Examples: Ohio/Indiana, Ohio/Michigan*