International Wireless and Communications Expo
College of Technology
Las Vegas, Nevada
March 24, 2014

Project 25 Foundations:
System Interface Updates for 2014

Presented by:
PTIG - The Project 25 Technology Interest Group
www.project25.org – Booth 6070
Program Agenda

• **PTIG Introduction & Workshop Overview**  
  — Neil Horden, Federal Engineering Inc.

• **Project P25; The Goals, The Process, The Standards**  
  — Nick Pennance, Tait Radio Communications

• **Project 25; 25th Anniversary Progress Check**  
  — Chris Lougee, ICOM America

• **Project 25 Technology Interfaces & Services**  
  — Andy Davis, Motorola Solutions

• **Project 25 Conventional Systems**  
  — Andy Davis, Motorola Solutions

• **Project 25 Security Services Update**  
  — Bill Janky, Harris Public Safety & Professional Communications

• **Project 25 Trunking Systems**  
  — Cynthia Wenzel Cole, Cynergyze Consulting

• **PS LTE Broadband and Project 25**  
  — Cynthia Wenzel Cole, Cynergyze Consulting

• **Open Forum and Discussion, Questions and Answers**  
  — Neil Horden, Federal Engineering Inc.
Take Away Topics to Look For

- Introduction to this and other P25 sessions of interest at IWCE
- A look at P25 in the market and supporting resources
- P25 Standards, the Process, and Why P25 is Useful to Users
- The many P25 Features and Interfaces
- A look at the Interface Definitions and Standards Completed
- The Reality of Multiple Vendor Interoperability with P25
- And finally, who is PTIG?
Who and What is PTIG?
Project 25 Technology Interest Group

Who we are:

– Supporters of Project 25 technology, nurturing Project 25’s adoption, growth, and expansion

– A venue fostering an atmosphere encouraging Users to contribute to and benefit from a close interaction with the vendor community driving the on-going development of the Project 25 Standards

Set your browser to www.project25.org
What do we do:

– Provide an information 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 such as THIS SESSION.
P25 Presentations at IWCE College of Technology

• Monday AM
  – Project 25 Foundations and System Interface Updates for 2014
  – Session # M103 (This is Here and Now!!)
  – 8:30AM -12:00PM, Room N232

• Tuesday AM
  – P25 User’s Perspective and Customer Applications Update for 2014
  – Session # T301
  – 8:30AM -12:00PM, Room N232
P25 Presentations at IWCE through This Week

- A Guide to Interoperability and “Open” Standards
  W03 - Wednesday, 03/26/2014, 11:00AM -12:15PM, Room S228.

- NPSTC Presents Current Public Safety Issues
  W07 - Wednesday, 03/26/2014, 11:00AM -12:15PM, Room S229.

- Building Interoperable Communications between Departments
  W11 - Wednesday, 03/26/2014, 1:15PM - 2:30PM, Room S228.

- Get Exactly What You Want: System Specifications, RFPs and Procurement
  W12 - Wednesday, 03/26/2014, 1:15PM - 2:30PM, Room S230.

- Migrating to P25
  TH05 - 03/27/2014, 9:45AM -11:00AM, Room S231.
P25 Presentations at IWCE through This Week

- DHS Update of the National Emergency Communications Plan
  TH07 - Thursday, 03/27/2014, 9:45AM -11:00AM, Room S229.

- Firefighter Tech: Radio Interference and Accessories
  TH23 - Thursday, 03/27/2014, 2:00PM - 3:15PM, Room S229.

- LMR and LTE: A Multi-Network Architecture for Future Communications
  TH26 - Thursday, 03/27/2014, 3:30PM - 4:45PM, Room S232.

- Migrating P25 Phase 1 to Phase 2: Best Practices
  F11 - Friday, 03/28/2014, 11:10AM -12:10PM, Room S231.

- All Things Considered: Building a Public Safety System for the 21st Century
  F12 - Friday, 03/28/2014, 11:10AM -12:10PM, Room S229.
PTIG Commercial Members

- AECOM
- Aeroflex
- Airwave Solutions
- Anritsu
- ARINC
- Avtec
- Cassidian Communications
- Catalyst Communications
- Cisco Systems
- Cobham Avionics
- Codan Radio (formerly Daniels)
- Cynergyze
- Datron
- DVSI
- EF Johnson Technologies
- Etherstack
- Federal Engineering, Inc
- Genesis Group
- Harris Corporation
- Icom America
- IDA Corporation
- Kenwood USA
- Midland Radio
- Moducom
- Motorola Solutions
- Pantel International
- Powertrunk
- Radio Communications Solutions
- Raytheon Civil Communications
- Relm Wireless
- Simoco
- Spectra Engineering
- Standard Comm Pty Ltd - GME
- Tait Communications
- Technisonic
- Telex Radio Dispatch
- Thales Defense & Security
- Vertex Standard
- Wireless Pacific
- Zetron
## Project 25 Resources

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*Project 25 Technology Interest Group*
## PROJECT 25 TECHNOLOGY INTEREST GROUP

Visit PTIG in Booth # 6070

### OUR MEMBER ORGANIZATIONS AS IWCE EXHIBITORS ALSO SAY THANK YOU

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<th>COMPANY NAME</th>
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  - Neil Horden, Federal Engineering Inc.
Project 25

Nick Pennance

tait communications
Project 25: Agenda

- A Brief History of P25
- The Goals of P25
- The User Requirements
- The Standards
- Interoperability
- Did P25 Meet its Goals?
Project 25: History

- Designed for public safety by public safety

- Developed in partnership between APCO and TIA

- Project 25 formed in 1989 with the initial standards released in 1995
  - P25 is a suite of mobile radio standards and bulletins which define interoperable communications for emergency services
  - They are continuing to evolve.

- The result?
  - True multi-source procurement and interoperability
  - Smooth migration from analog while retaining backwards compatibility
Project 25: The Goals

• **To create a digital radio standard for public safety that:**
  - Uses radio spectrum efficiently
  - Is *interoperable*
  - Can be provided by **multiple vendors**
  - Is easy to use

• **This standard technology should be:**
  - Frequency independent
  - Should be compatible with existing equipment
  - Enable gradual migration from existing systems
  - Offer coverage as close as possible to existing analog coverage
  - Able to integrate both voice and data
Project 25: The Goals

- Enabling Interoperability
- Migration from Legacy Equipment
- Multi-Vendor Sourcing
- Multiple Frequency Bands
- Conventional & Trunked Operation
- Secure Communications
- Global Standard with Worldwide Adoption
- Coverage Flexibility
- Voice and Data
- Established
- Public Safety User Driven
- Spectral Efficiency
- Evolving
Project 25: The User Requirements

Public safety communication users are responsible for providing and maintaining their user needs in a system requirements document.

- Project 25 is the only user-driven, land mobile radio standard that currently exists.

The Steering Committee, with the involvement of its Project 25 User Needs Subcommittee (P25 UNS), establishes the priorities and scope for technical development by TIA of new and revised P25 standards.

P25 standards are driven by the user-defined P25 Statement of Requirements document known as the P25 SoR.

- The P25 SoR plays an essential role in Developing standards that meet users’ needs

The P25 UNS updates the SoR every other year to clarify requirements, add new and to remove outdated requirements.
Project 25: A Suite of Standards

- **The P25 Standard is not just one document.**
  - It is a suite of over 75 standard documents and over 25 TIA Telecommunication Systems Bulletins.
    - Over 125 documents have been developed and published supporting the standards and features offered in the Project 25 suite
  - The P25 suit of standards defines the system interfaces and services offered by P25
  - P25 Documentation Suite Overview (TSB-102-B) describes how the users and manufacturers envision the P25 system.
  - By dividing the P25 system up at defined standardized interfaces lets manufacturers develop products specific to their areas of expertise
    - This enables users to buy products that meet their specific needs.
    - The Goal is to provide users the flexibility to choose from various manufacturers’ offerings to build out their P25 systems
Project 25: Interfaces & Services

**AIR INTERFACES**
- P25 FDMA
  - COMMON AIR INTERFACE
  - TRUNKING Voice/Data
  - CONVENTIONAL Voice/Data
- P25 TDMA
  - COMMON AIR INTERFACE
  - TRUNKING Voice

**WIREFLINE INTERFACES**
- ISSI/CSSI
- TRUNKING Voice/Data/Control
- CONVENTIONAL Voice/Control

**SECURITY INTERFACES**
- NETWORK MANAGEMENT
- AUTHENTICATION
- TRUNKING
- SECURITY SERVICES
- ENCRYPTION
- LOCATION

**DATA SERVICES**
- DATA NETWORK INTERFACE
- SUBSCRIBER DATA PERIPHERAL INTERFACE
- KMF DATA NETWORK INTERFACE
- Gateway

**DATA INTERFACES**
- Key Fill
Project 25: The Documents

• Over 125 documents have been developed and published supporting the Project 25 suite of standards and features

• The organization of the standards divides the suite into documents relating to P25 system interfaces, services, and equipment.

• For each P25 interface, service, and equipment item there is a set of documents that:
  - Describes and specifies the appropriate standards
  - Describes the tests to demonstrate conformance, performance and interoperability of the offered interface, service, and equipment
  - Describes the suite of tests selected to demonstrate compliance of the interface, service or equipment
Project 25: Describe and Specify

- Two types of documents are used to describe and specify the interface, service, or equipment
  - The Overview document
    - Typically an *informative* Telecommunications Systems Bulletin (TSB) that describes the operation and function associated with a standard.
    - Provides background information relating to the P25 SoR, shows its relationship to the overall P25 system model, and provides guidance to users, system designers, and manufacturers
  - The Protocol documents
    - These documents provide the required messages, formats, and specifications necessary for the P25 interfaces, services, and equipment to be interoperable and meet the Project 25 Statement of Requirements.
Core Definition documents are those TIA-102 standards documents that enable manufacturers to independently develop and implement interoperable equipment.

Test documents are those TIA-102 standards documents that enable manufacturers to verify that their product implementation adheres to the respective core definition documents.

The TIA-102 suite of standards are in various stages of completion for each of the P25 Interfaces and Services.
Project 25: Tests published by TIA

- **Interoperability Testing**
  - Interoperability testing includes functional testing between manufacturer A’s equipment and manufacturer B’s equipment per the Project 25 standard.

- **Performance Testing**
  - Performance testing includes measurements that verify product specifications as specified in the P25 standard.

- **Conformance Testing**
  - Conformance testing includes verification of the messages as specified in the P25 standard.

- **Recommended Compliance Assessment Tests (RCAT)**
  - Subset of tests collected from above test documents related to a specific interface or service
Project 25: Compliance Assessment

• **P25 CAP testing ensures that there is a choice**
  - Multiple vendors subscriber equipment is tested on Multiple vendor Networking equipment.

• **Provides a mechanism for P25 equipment suppliers to formally demonstrate their products' compliance**
  - Against a key subset of the P25 Standards
  - Performed in CAP recognized labs

• **Published results**
  - After testing SDOCs and STRs are
  - published by the DHS on the
  - Responder Knowledge Base

• **The Responder knowledge Base has moved** - www.llis.dhs.gov
Project 25: Did P25 meet its Goals?

- Multi-Vendor Sourcing
- Enabling Interoperability
- Migration from Legacy Equipment
- Multiple Frequency Bands
- Conventional & Trunked Operation
- Secure Communications
- Global Standard with Worldwide Adoption
- Coverage Flexibility
- Voice and Data
- Established
- Public Safety
- User Driven
- Spectral Efficiency
- Evolving

P25 Technology Interest Group

IWCE 2014
Project 25: Today

- **P25 has met its Goals**
  - P25 Equipment and services are available from over 36 vendors
  - Adopted worldwide
  - Public safety professionals continue to be part of the standards process
  - Spectrally Efficient
  - Supports both Trunked & Conventional operation
  - Multiple configurations such as multicast, simulcast, direct/simplex operation, repeaters, voting, single-site, and multi-site
  - Supports multiple frequency bands
  - Supports Security Services
  - Improved audio quality over analog

and its continuing to evolve……
Project 25: Work in Progress

• **Enhanced Security Services**
  - Link Layer Encryption
  - Link Layer Authentication
  - Inter-KMF Interface
  - KFD Updates
  - OTAR Updates

• **Public Safety requirements for BB interfacing with P25**

• **Performance, Conformance and Interoperability Tests**

• **Packet Data**

• **Location Services**

• **Dynamic Regrouping**
Project 25: The Future

- Key Fill Interface
- Link Layer Encryption
- FSI Messages and Procedures
- Security Services Overview
- OTAR Conformance & Interoperability
- Data Application Suite
- Dynamic Regrouping
- ISSI Regrouping
- ISSI Supplementary Data Conformance, Performance and Interoperability Tests
- FSI Messages and Procedures
- FSI Conformance Tests
- Conventional Console Conformance and Interoperability

Packet Data Services
- Radio Management Protocol
- Data Host Network Interface
- Mobile Data Peripheral Interface
- Conventional Management Services
- Data Security Specification
Project 25

25th Anniversary Progress Check

Chris Lougee
Vice Chair, TIA Private Radio Section

Vice President, Icom America, Inc.
Initial principles & promises

Project 25 - Five Original Goals

1. Competition in system life-cycle procurements
2. Graceful Migration (Backward & Forward)
3. Interoperability
4. Spectrum Efficiency
5. User-Friendly Equipment
Is Project 25 a Success?

• Initial principles and promises – *have they been met?*
• World wide penetration – *has it occurred?*
• Multiple vendors of products and services – *is there choice?*
• Competition – *do they compete for your business?*
• Interoperability – *does it exist in meaningful tiers?*
• Scalable Solutions – *are they available to fit your needs?*
• Adoption rate in the U.S. – *are P25 systems being deployed?*
• Future trends – *are deployments increasing?*
• Spectrum Efficiency – *has it been achieved?*
• Range of support resources – *are they readily available?*
• P25 – *will it meet Public Safety needs for another 25 years?*
World wide penetration?

- Project 25 systems are deployed in 83 countries
38 Vendors for Project 25 Equipment and Services

16 fixed station/repeater suppliers
17 Subscriber suppliers
13 console suppliers
16 network providers
5 test equipment suppliers
7 consultant services

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

• TIA-102 suite of standards
  o 77 Standards documents completed
  o Interoperable digital Project 25 equipment
  o Common Air Interface
  o Fixed Site “Wireline” Interfaces

• Compliance Assessment Program
• Backwards compatibility
• P25 Capabilities Guide
• Tiered interoperability
Project 25 Common Air Interfaces

Phase 1

P25 FDMA Common Air Interface
- Most widely deployed
- Conventional and Trunking Operation

Phase 2

P25 TDMA Common Air Interface
- Trunking Operation
- Voice only
P25 Wireline Interfaces

• Interface standards
  o Inter-RF Sub-System Interface – ISSI
  o Console Sub-System Interface – CSSI
  o Fixed Station Interface - FSI
  o Telephone Interconnect

• Maintain P25 functionality beyond the air interface
  o Eliminate translators/gateways/application shifts

• Multiple Vendor Integration Demos
  o ISSI - APCO 2007 in Baltimore
  o FSI/CSSI - IWCE 2013

• ISSI, FSI, CSSI successfully deployed
  o Expanding Vendor Introductions for FSI and CSSI.

• Improves choices and options

• Multiple vendor sourcing beyond subscribers only
Compliance Assessment Program

- Developed to improve confidence in purchasing P25 land mobile radio (LMR) equipment
- Ensures equipment
  - complies with P25 standards
  - capable of interoperating across manufacturers
- Suppliers declaration of compliance - SDocs
  - detail standardized test reports,
  - product tested
  - version tested
  - other vendors tested against and pass/fail results for each feature.
- Test results by CAP accredited labs
- Managed by DHS OIC
- Grant guidance by DHS OEC
https://www.llis.dhs.gov/knowledgebase/certifications-and-declarations

The RKBR provides basic information about specific equipment that has a confirmed certificate or declration related to the Project 25 Program (P25), Standardized Testing and Evaluation Program (STEP), or the Integrated Public Alert & Warning System (IPAWS) program. Basic information is provided for each piece of equipment and includes the Summary Test Result and the Supplier’s Declaration of Compliance (SDoC), which have been submitted to FEMA for publication.

If you are a supplier that has updates to existing certification and declaration records published here or have new certifications and declarations information to publish here, please send an email to FEMA-NIMS@dhs.gov with the following information:

**Project 25 (P25)**
- Equipment Name
- Certification and Declaration Type (indicate P25, IPAWS, or STEP)
- SDoC Number
- P25 CAP Recognized Lab Code(s)
- SDoC Issue Date
- Equipment Type
- Installed Options
- Declarant
- Other Devices Tested
- Installed Vocoder
- Copies of the STR and SDoC in PDF format

**Integrated Public Alert & Warning System (IPAWS)**
- Equipment Name
- Certifications and Declaration Type (indicate P25, IPAWS, or STEP)
- SDoC Number
- SDoC Issue Date
- Installed Options
- Declarant
- Copies of the STR (or Program Test Report) and SDoC in PDF format
PTIG GUIDE TO P25 CAPABILITIES

A Guide to Project 25
Subscriber and Infrastructure
Equipment Capabilities as
Standardized in the TIA-102 Series

Prepared by the
Project 25 Technology Interest Group
Version 1.2
March 2013

P25 Capabilities Guide

Published TIA-102 standards
• Identify P25 services and features expected to interoperate

Radios or infrastructure may contain different services and features
• TIA-102 series of published standards - All or several of these features
• SoR features and services not published in the standards – may not interoperate without a published standard
• Manufacturer specific features – useful for some users but not expected to interoperate

Capabilities Guide
• Identifies services and features in the published standards
• Organized into functional areas (Trunking or Conventional, Subscribers or Infrastructure)
• Radios or infrastructure should be expected to interoperate using the listed features and services
Last but not least...

P25 Backward Compatibility

• Project 25 Requires Backward Compatibility
  o From FDMA/P25 to Analog/Legacy
  o From TDMA to FDMA
  o Migrate with a smooth cut over, retaining existing radios.
  o Fully compliant with current RF licensing and spectrum policy.
Mix-match between Trunked, Conventional, Site Linking, Wide Area, or Stand Alone

<table>
<thead>
<tr>
<th>Configuration Supported</th>
<th>Trunking</th>
<th>Conventional</th>
<th>Description/Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multicast</td>
<td>✓</td>
<td>✓</td>
<td>Enables coverage of wider areas with fewer transmitter sites when compared to simulcast</td>
</tr>
<tr>
<td>Simulcast</td>
<td>✓</td>
<td>✓</td>
<td>Enables reuse of frequencies to increase coverage penetration of a given area and for spectral efficiency</td>
</tr>
<tr>
<td>Direct/Simplex</td>
<td>Supported in SUs for off-network operation</td>
<td>✓</td>
<td>Enables radio to radio communication without fixed infrastructure. Quicker communication for onsite scenarios such as a fire ground</td>
</tr>
<tr>
<td>Repeated</td>
<td>✓</td>
<td>✓</td>
<td>Enables a radio call to be repeated from one frequency to another, enabling communications over a larger geographic area</td>
</tr>
<tr>
<td>Voting</td>
<td>✓</td>
<td>✓</td>
<td>Improved inbound communications for portable radios</td>
</tr>
<tr>
<td>Single Site</td>
<td>✓</td>
<td>✓</td>
<td>Enables radio communications within one site’s worth of coverage</td>
</tr>
<tr>
<td>Multi-Site</td>
<td>✓</td>
<td>✓</td>
<td>Enables radio communications over several site’s worth of coverage</td>
</tr>
</tbody>
</table>
Improved Coverage -
P25 is 8.3 dB better than narrowband FM

- 25KHz were migrated to 12.5 KHz analog to meet deadline
- Significant loss in coverage
- P25 C4FM @ 12.5 kHz more efficient than 12.5 kHz FM
- Most would see a dramatic improvement in coverage

Relative coverage P25 digital to 12.5 KHz FM

<table>
<thead>
<tr>
<th>Type</th>
<th>RX Bandwidth</th>
<th>Noise Floor</th>
<th>(C/N)_{req}</th>
<th>Min. Signal Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.5 kHz FM</td>
<td>7.4 kHz</td>
<td>-125.8 dBm</td>
<td>26.0 dB</td>
<td>-99.8 dBm</td>
</tr>
<tr>
<td>25 kHz FM</td>
<td>17.9 kHz</td>
<td>-122.0 dBm</td>
<td>20.0 dB</td>
<td>-102.0 dBm</td>
</tr>
<tr>
<td>P25 (C4FM)</td>
<td>7.4 kHz</td>
<td>-125.8 dBm</td>
<td>17.7 dB</td>
<td>-108.1 dBm</td>
</tr>
</tbody>
</table>

Engineering analysis by Jay M. Jacobsmeyer, P.E., Pericle Communications Company
P25 Adoption

P25 Global Market Share

Data courtesy of TechNavio

Cumulative market share
NA User Radios Market Share

- **P25**: 33%
- **TETRA**: 1%
- **DMR/NXDN**: 17%
- **Analog**: 49%
- **Other**: 1%

*Data for end-of-year 2012*

*Source: IMS Research*
P25 User Radio Shipments
1K Units North America

New and replacement each year – trunking and conventional

Source: IMS Research
Installed Base of Active Radios - North America

Source: IMS Research

% growth (to prior year) in shipments for new and replacement radios for trunking and conventional 2013 & 2014 = the narrow banding “bubble” and impact of recession and reduction in tax revenues affecting purchasing of new P25.
Narrowbanding mandate of 2013 increased shipments out of NA.

- Funding out of the US.
- Long term success of P25 influenced by further 2017 mandate.
- P25 Phase II projects being rolled out.
- Mainly limited to PSS application area.
- >60% of the global PMR P25 Market was in North America in 2012.

Data Courtesy of: IHS Technology - Critical Communications Division
- All States have multiple P25 V/U conventional systems
- Orange - city, county or multiple county P25 VHF or UHF trunked system.
- Green – (Plus Alaska) wide area or statewide VHF or UHF trunked system
700/800 MHz Systems

Every state except North Dakota, Maine, Vermont, New Hampshire and Alaska have 700/800 systems.
• Spectrum efficiency improved
  o 25 kHz to 12.5 kHz 2:1
  o 25 kHz to 6.25e 4:1

• Phase 2 = TDMA

• 6.25 KHz e

• V/U/700/800
P25 Another 25 Years?

• Continues to change and adapt

• A “Living Standard”
  o Regulatory
  o Technology
  o User needs

• Long term P25 influenced by current regulations (2017 mandate)

• 700 MHz Interop Channels mandate P25

• Agencies desire interoperability with V/U systems

• P25 Phase 2 projects being rolled out

• Mainly limited to PSS application area

• “Cell phone” technology won’t meet needs (NPSTC).
Is Project 25 a Success?

- Initial principles and promises – *have they been met?* Yes!
- World wide penetration – *has it occurred?* Yes!
- Multiple vendors of products and services – *real choices?* Yes!
- Competition – *do they compete for your business?* Yes!
- Interoperability – *does it exist in meaningful tiers?* Yes!
- Scalable Solutions – *are they available to fit your needs?* Yes!
- Adoption rate in the U.S. – *P25 systems being deployed?* Yes!
- Future trends – *will deployments increase?* Yes!
- Range of support resources – *are they readily available?* Yes!
- P25 – *will it meet Public Safety needs another 25 years?* Yes!
Project 25
Technology Introduction and Overview

Andy Davis
Motorola Solutions
Project 25 Interfaces & Services

- **AIR INTERFACES**
  - P25 FDMA
    - COMMON AIR INTERFACE
      - TRUNKING Voice/Data
      - CONVENTIONAL Voice/Data
  - P25 TDMA
    - COMMON AIR INTERFACE
      - TRUNKING Voice

- **WIRELINE INTERFACES**
  - ISSI/CSSI
    - TRUNKING Voice/Data/Control
    - CONVENTIONAL Voice/Control
  - FSI
    - Conventional Analog/Digital Voice/Control

- **SECURITY INTERFACES**
  - KMF
    - INTER- KMF KEY FILL

- **SECURITY SERVICES**
  - KMF
    - ENCRYPTION
      - Voice/Data
    - LOCATION
      - TIER 1 Conventional
      - TIER 2 Trunking/Conventional
    - AUTHENTICATION
      - TRUNKING
    - NETWORK MANAGEMENT

- **DATA SERVICES**
  - OTAR
    - TRUNKING/CONVENTIONAL

- **DATA INTERFACES**
  - Gateway
    - SUBSCRIBER DATA PERIPHERAL INTERFACE
P25 General Systems Model

P25 Common Air Interface (CAI) Types
1. P25 Conv CAI - Conventional P25 FDMA Common Air Interface
2. P25 Trunked CAI - Trunked P25 FDMA/TDMA Common Air Interface

P25 Wireline Interface Types
1. Eg - Inter RF Sub-System Interface (ISSI)
2. Ec - Console Sub-System Interface (CSSI)
3. Ef - Conventional Fixed Station Interface (FSI)
4. Ed - Data Host Network Interface
5. MDP - Mobile Data Peripheral Interface (MDP)
6. IKI - Inter Key Management Facility Interfaces (IKI)
7. KFD - Key Fill Device Interface
8. Et - Telephone Interconnect
9. En - Network Management

Adopted from TSB-102-B
Conventional

Standard Interfaces and Services

• Configurations Using the FDMA Common Air Interface
  • Voice/Supplementary Services
  • Adding Data

• Configurations Using Wireline Interfaces
  • Fixed Station Interface
  • Conventional Console Subsystem Interface
Conventional Configurations

Voice and Supplementary Services

- Conventional Voice services
  - Group Call, Individual Call, All Call, Talking Party ID, etc
- Conventional Supplementary Services
  - Emergency Alarm, Call Alert, Status/Message, etc
- Note: For a complete set of voice and supplementary services supported by the FDMA CAI for the 3 conventional configurations see section 2 of the PTIG Capability Guide
The RFSS is a virtual element
RFSS may take on a variety of physical forms, i.e. there may be

- multiple channels at a site or
- multiple sites, or
- channel may be a voting, multicast or simulcast “sub-system” covering multiple physical sites
Conventional Configurations

Voice and Supplementary Services

- RFSS B may still repeat
- Console may participate in calls
- Console may be the source or target of calls
- Console equipment may interface to multiple stations
- Console equipment and station(s) within the RFSS do not need a standard P25 interface

Repeated with Wireline Dispatch
Conventional Configurations

Voice and Supplementary Services

- Encryption service applies to all 3 conventional configurations
- Keys may be loaded from a Key Fill Device
- Key ID designated in the voice stream
- Transmit: Encryption keys may be selected per channel, per talkgroup or per conversation
- Receive: may use preselected encryption keys or may search the device’s internally stored keys
Conventional Configurations

Adding Data

- Data applications may reside in the radio itself
- The FDMA CAI protocol supports a data signaling protocol
- The CAI data packets may carry IPv4 datagrams
- IP Data Bearer service for data applications that use IPv4
- Note: For a complete set of CAI data bearer and IP data bearer services supported by the FDMA CAI for the Direct conventional configuration see sections 3 of the PTIG Capability Guide
Conventional Configurations

Adding Data

- Fixed Station repeats the data signal
- Note: For a complete set of CAI data bearer and IP data bearer services supported by the FDMA CAI for the Repeated conventional configuration see sections 3 of the PTIG Capability Guide
Conventional Configurations

Adding Data

Fixed Network Data

- Fixed Station does not repeat the data signal
- Data Gateway device interfaces Data Host to Fixed Station
  - within the RFSS; does not need a P25 standard interface
- Data Host outside the RFSS: standard P25 Data Host Network Interface
  - carries IP datagrams
- Note: For a complete set of CAI and IP data bearer services supported by the FDMA CAI for the Conventional Fixed Network Data configuration see section 4 of the PTIG Capability Guide
Conventional Configurations

Adding **Encrypted Data**

Fixed Network Data

- Encryption may be added to any of the 3 Conventional data configurations
- CAI data packet payload is encrypted
- Decryption required before the IP datagrams can be routed
- Encryption/decryption in radios and data gateway
Conventional

**FSI – Fixed Station Interface Configurations**

### Single Station Subsystem

- **AFSI:**
  - Use with either Air Interface
  - 2 or 4 wire analog transport,
  - clear analog voice,
  - Tone Remote Control

- **DFSI:**
  - Use with either Air Interface
  - IPv4 digital transport,
  - P25 (clear or encrypted) or PCM audio,
  - P25 control signaling
Conventional

FSI – Fixed Station Interface Configurations

- The Fixed Station Sub-System is a virtual entity that may take different physical forms
  - Single Station
  - Voting sub-system
  - Multicast sub-system
Conventional

**FSI – Fixed Station Interface Configurations**

**Multiple Station Subsystem**

- Voting or multicast sub-system requires DFSI
- Capabilities of FSI + Fixed Station Sub-System working together vary considerably
- Certain capabilities subject to equipment configurations
- Note: PTIG Capability Guide is currently being updated to include capabilities associated with these combinations of AFSI/DFSI and Analog/FDMA CAI air interfaces
Conventional
Console and Fixed Station Interface Configurations

- FSI (AFSI or DFSI) may be used to connect the sub-systems directly when:
  - **Single** Console Sub-System and
  - **Single** fixed station or a **single** voting/multicast sub-system
- Console Sub-System takes on the role of RF Sub-System
- Console equipment takes on the role of the virtual Fixed Station Host
Conventional

Console and Fixed Station Interface Configurations

- RFSS/CAR performs routing Arbitration and Protocol Conversion
- AFSI or DFSI to Fixed Station Sub-System
- Conventional CSSI to Console Sub-System
Project 25 Security Services Update

Bill Janky
Director, System Design
Harris Corporation
Agenda

- Overview of P25 Security Services
  - Confidentiality
  - Integrity
  - Key Management
- Current status of P25 security standards
  - Updates to existing services
  - New services
Hello, Bill Pagones? Can’t talk over the phone. I lost my encryption heel. We must use the Cone of Silence if we are to continue this conversation.
Why do we need security?

• Information security is a vital component of LMR systems
  – Security threats exist; getting more every day
• What’s a threat? Threats are actions that a hypothetical adversary might take to affect some aspect of an LMR system. Examples:
  – Message interception
  – Message replay
  – Spoofing
  – Misdirection
  – Jamming / Denial of Service
  – Traffic analysis
  – Subscriber duplication
  – Theft of service
What P25 has for you...

• The TIA-102 standard provides several standardized security services that have been adopted for implementation in P25 systems.
• These security services may be used to provide security of information transferred across FDMA or TDMA P25 radio systems.

Note: Most of the security services are optional and users must consider that when making procurements.
The usual suspects...

- P25 provides
  - Confidentiality
    - Payload (i.e. voice and data) encryption
    - Link layer encryption
  - Integrity
    - User authentication
    - Message authentication
  - Key Management
    - Manual key loading and over-the-air rekeying
Confidentiality

• The confidentiality services are provided to ensure that the signaling information, the voice traffic and the data traffic are understandable only to the intended recipient(s).
  – Encryption/decryption is the way to achieve confidentiality

• Confidentiality service for end-to-end encryption is typically done at the subscriber unit, console and data hosts.

• Confidentiality services are built into the P25 protocols.

If you don’t want somebody to hear you, or see your data, you need to use encryption.
Confidentiality, or not...

Missed it by that much

I asked you not to tell me that!

Thanks for sharing!

I still hate you

3^@(*@9)#2R)7(#Q#85r%$92

Sorry about that Chief
Would you believe...

No

Protection of “IDs” is a major area of focus in TIA-102

One thing to note...

3^@(* Group ID @9 )#2R)7(# User ID Q#85r%$92
Integrity, or not

I’m not 100% sure I trust you…
Integrity

• Messages
  – A more sophisticated adversary may have the capability to not only record and replay messages, but to alter them as well. Message authentication guarantees that the received message was the one originally sent.
  – The addition of air interface encryption makes message modification more difficult (e.g. sharing of secret keys), but doesn’t eliminate the possibility.
    • Message Authentication Codes (MAC) are required to guarantee message and sender integrity.

• Users
  – An adversary may “pose” as a real user or as a real system.
  – Link Layer (i.e. User) Authentication, LLA, guarantees that everybody is who they say they are.

• Integrity services are built into the P25 protocols.

If you don’t want somebody to fake your data or your identity, you need authentication services.
Here comes a new key

Thank you, ummm, Chief?

Message authentication

Here comes a new key

Chief

Siegfried

Thanks Chief!
Hi, this is Max.

Grrrr...never mind.

Really? OK, do a calculation for me.
Key Management

• The Confidentiality, Integrity and Authentication services rely on cryptographic keys.

• Cryptographic key management encompasses every stage in the life cycle of a cryptographic key, including:
  • generation, distribution, entry, use, storage, destruction and archiving

• P25 provides two ways to help manage keys – manual and OTAR.

Managing keys requires you to have some internal procedures to combine with P25 standard procedures.
P25 Key Management Techniques

Manual Keying
- Radio “touched” to program Keys and key bindings.
- Compromised Radio Compromises Keys; requires rekeying of fleet

OTAR
- Radio “touched” for UKEK
- Rekeying can be performed over the air because each radio has its own UKEK.
- Key Management Facility (KMF) needs to be secure
- Message Authentication and Encryption Employed
P25 Security Status
Raising the Bar...

June 2005
- End-to-End Voice Encryption
- Data CAI Encryption
- DES Encryption
- 3DES Encryption
- AES Encryption
- OTAR
- Multiple Keys
- Subscriber Validation

Sept 1998
- End-to-End Voice Encryption
- Data CAI Encryption
- DES Encryption
- OTAR
- Multiple Keys
- Subscriber Validation

2011+
- End-to-End Voice Encryption
- Data CAI Encryption
- AES Encryption
- OTAR
- Multiple Keys
- Subscriber Validation
- Subscriber and FNE Authentication
- Inter-KMF Interface
- KFD to SU/KMF/AF interface
- Link-Layer Encryption (Anti-Analysis)
What’s new, what’s coming

• Update to P25 Key Fill Interface (TIA-102.AACD-A)
  – Revision and update of existing standard
  – Still in comment resolution, but coming soon….
• KMF to KMF Interface Specification (TIA-102.BAKA)
  – Published April 2012. Available on TIA Global IHS site.
• OTAR Messages and Procedures (TIA-102.AACA-A)
  – Major update that provides significant clarification to resolve many interoperability issues
  – All technical issues resolved; publication soon
• Packet Data end-to-end Security
  – On hold
What’s new, what’s coming (cont)

• Security Services Overview Addendum (TIA-102.AAAB-A-1)
  – Overview of the encryption and key management architectures for voice, data, subscriber authentication, and air interface encryption.
  – Draft document completed by APIC Encryption Task Group (ETG) was sent to TR-8.3 for final review and publication.

• KMF to KFD interface – New
  – Continuing steady progress, but still in comment review.

• Link Layer Encryption standard – New (…and loving it!)
  – LLE provides confidentiality and replay protection
    • Note: LLE is NOT a substitute for end-to-end encryption
  – Requirements reviewed and agreed to. LLE Architecture document is in review with agreements on many of the key architecture concepts.
  – Work plan has been formulated with preliminary assignments for drafting standards. Some existing standards will have to be updated for LLE, including the SSO.

Keep raising the bar and plugging new holes…
Summary

- If you don’t want unauthorized people to hear you, or see your data, you need to use encryption.
- If you don’t want bad guys to fake your data or your identity, you need to use authentication services.
- Managing encryption and authentication keys requires you to have some internal procedures to combine with P25 standard procedures.
- The users and manufacturers participating in TIA-102 (P25) standardization are continuing to work to improve security services and add new features.
- System security factors affect mutual aid and interoperability. A sub-set of specific features can be defined as minimum required for mutual aid.

Finally: Remember that most of the security, encryption, and voice protection features in P25 are optional, not mandatory, and users must consider that when making procurements.
  - Encryption capabilities are not used by all, but are part of the features in the P25 Guide.
Thank you!

email: william.janky@harris.com
Project 25 College of Technology
Trunking Systems and
Public Safety LTE Introduction

Cynthia Wenzel Cole

IWCE 2014, Las Vegas, Nevada
March 24, 2014

Presented by:
PTIG - The Project 25 Technology Interest Group
Project 25 Trunking

Agenda Topics

• Introduction to P25 Trunking Interfaces
  • P25 Common Air Interface Overview
  • P25 Services & Single and Multi Site Configurations
  • Registration and Call Assignment
  • Adding P25 Packet Data Services

• P25 Wireline Interfaces
  • P25 ISSI/CSSI Introduction and Features
  • Architecture Overview

• Multi-System Configurations & Use Cases

• ISSI Case Study

• Introduction to NPSBN
Primary P25 Trunking Interfaces

Introduction

- Enabling long term interoperability
- Advanced services
- Multi-system connectivity with autonomy
- End-to-end encryption
- Enabling multivendor networks and procurements
- More competitive environment
- Intricate call controls across systems
**P25 Trunking**

*Project 25 Common Air Interface (P25 CAI)*

**P25 CAI Overview**
- All operate on 12.5 kHz Narrowband Channels
- 9600 FDMA Interoperable Control Channel (CCH)
- Supports Integrated Voice and Data (IV&D)
- Traffic Channels
  - 9600 FDMA – 1 Talkpath/channel
  - 12000 TDMA – 2 Talkpaths/channel (2x efficiency)
- DATA: 9600 FDMA
- Supports Simulcast
- Supports 256 bit AES Encryption

**Extended Control Channel**
- Controls traffic on the network
- 9600 bps OTA bit rate
- Advertises unique WACN-SysID
- Assigns to FDMA, TDMA or DATA
- Backward compatible to all P25
- Extended version enables TDMA
- Supports Supplementary Services to FDMA & TDMA

**P25 TDMA VOICE Services**
- Two talkpaths per channel
- Half Rate AMBE
- 12000 bps OTA bit rate
  - Allows extra signaling
- Requires TDMA-capable subs
- Supports Encrypted Mode
- Supported across ISSI

**P25 PACKET DATA Services**
- 9600 bps OTA bit rate
- Supports Integrated Voice & Data (IVD)
- Backward compatible

**P25 FDMA VOICE Services**
- One talkpath per channel
- 9600 bps OTA bit rate
- Full Rate IMBE or AMBE
- Backward compatible to all P25
- Supports Encrypted Mode
P25 Trunking

Basic Service & Configurations

- Integrated Voice & Data Services
- Mobility & Registration
- End-to-End Voice & Data Encryption
- Supplementary Services
  - Radio Inhibit/Uninhibit
  - Call Alert
  - Emergency Alarm
  - Priority Call
  - Pre-emptive Priority
  - Radio Check
  - Discreet Listening
  - Radio Unit Monitoring
  - Short Message
- Telephone Interconnect
P25 Trunking

Registration and Call Assignment

• Registration - When radios roam into or power up in coverage of a particular system they perform P25 full registration using their Home Individual ID (WACN + System + Unit ID) and provides following functions:
  o Registration identifies TDMA capability
  o An access authorization check usually occurs based on the P25 Unit ID
  o P25 Radio authentication or mutual (radio + system) authentication may be performed
• After successful registration, the radio performs P25 affiliation to the selected talkgroup using the full Home talkgroup ID (WACN + System + Group ID).
  o An access authorization check may occur and is based on talkgroup ID.
  o P25 ISSI/CSSI supports TG affiliation Home or Visiting radios and/or home or foreign talkgroups
  o When radios roam between sites, P25 mobility management services use P25 registration to track “Serving Sites” by Unit and TalkGroup IDs.
• When calls are assigned, call processing software ensures audio is routed between console equipment and sites serving the call participants.
The standard P25 Data Network Interface connects a data gateway device or functional element to the application Host(s) in the Public Safety Application Network (PSAN).

- Trunking uses only the Fixed Network configuration.
- In trunking, data service requests on the control channel result in assignment of a data channel.
  - P25 Trunked FDMA Data channels may be assigned for single data transaction requests or a data channel may be assigned and then shared between multiple, independent data transactions.
P25 Trunked ISSI/CSSI Overview

**ISSI**
- Inter RF Sub-System Interface Features
  - Inter-System Group Call
  - Emergency Group Call
  - Emergency Alarm
  - Transparent to AES
  - Inter-System Unit-to-Unit Call
  - Broadcast Call
  - Status Query/Update
  - Unit ID
  - Call Alert
  - Radio Inhibit

**CSSI**
- Console Sub-System Interface
  - P25 CSSI Adds to P25 ISSI Features:
    - Monitor Simultaneous TalkGroups
    - Dispatcher Audio Takeover (also called Console Priority)
    - Console Take Over by Another Console
    - Parallel Console Audio
  - Console-Initiated Group Call
  - Radio-Initiated Group Call
  - Console Priority
  - Emergency Group Call
  - Multiple TG Support

**Enabling**
- Communications and control between P25 systems & supporting consoles
- Interoperability across vendor solutions
- Interoperability option with neighboring networks, regardless of how they evolve and change
- Connectivity while maintaining system autonomy
- Support of mixed vendor backbones
- End-to-end encryption
P25 ISSI/CSSI

Architecture Overview

• Each P25 RFSS and P25 console subsystem is identified by a unique WACN ID + System ID + RFSS ID.

• The P25 ISSI/CSSI may be used to connect any combination of WACN IDs, System IDs and RFSS IDs.

• The ISSI architecture is based on the concept of a “Home” and a “Serving” RFSS:
  o The “home” RFSS represents the home based location and radio coverage area under which a particular talk group and/or individual operates.
  o A “serving” RFSS represents a foreign location and radio coverage area to which a talk group (or certain members of a talk group) and/or individual has roamed, and is away from the home-based radio coverage area.

• ISSI TIA 102.BACA-A Messages & Procedures
  o ISSI Messages and Procedures defines the basic ISSI protocol for trunked voice and mobility management operations
  o Based on SIP for session/call setup, control, and teardown
  o Uses RTP for transmission of P25 IMBE voice packets and PTT floor control
P25 ISSI & CSSI

Multi-System Use Cases

Connecting RF Sub-Systems Using ISSI (no CSSI)

- Creates interoperable P25 Services across disparate systems
- Console operate across ISSI but without CSSI features;
  - Consoles behave like subscribers.

Connecting Systems Using CSSI Only

- CSSI can be used to connect a separate Console Sub-system B, allowing console operator (Console OP) positions to control traffic on System B
  - Enables 3rd party P25 console options
- Consoles can operate on both sides of interface

Connecting Systems Using ISSI/CSSI

- This configuration supports all P25 ISSI/CSSI features between different subsystems and a separate Console Subsystem, allowing intricate controls over vast network resources.

March 24, 2014

Project 25 Technology Interest Group

Slide 108
P25 ISSI Case Study

CONNCT Overlay System Case Study

- The system uses two trunked RFSSs with different System and WACN IDs connected over a P25 ISSI
- ISSI has been rock solid through over 3 years of operation
- Federal LE (DEA) use dedicated, encrypted talkgroups across the region which have enormous operational value.
  - Wide area Radio Inhibit, has been particularly powerful for them, saving them time, energy and money.
- Challenges include: governance, portable coverage, funding, regional planning, end user training, O&M and Unit ID coordination across multiple systems
  - CONNCT implemented ID coordination which creates a unique “P25 Radio Unit ID” which is unique to the device across the State of Texas
The NPSBN is defined as a single, nationwide Public Safety LTE (PS LTE) network.

- LTE is based upon the global 3GPP standard.
- FirstNet is the authority created by Congress to govern, construct and manage the FirstNet Network (FNN).
- FirstNet pledges to build the FNN to meet the needs of Public Safety users.
- Congress\(^1\) allocated $7B in funding and $121M for State grant program (SLIGP)
  - Will be a self-sustaining, fee-based network which will leverage tribal, state and local government assets.
- FirstNet was allocated 20MHz of spectrum nationwide in the 700MHz band.
  - FirstNet is the nationwide FCC License holder.

\(^1\) Middle Class Tax Relief and Job Creation Act of 2012
Thank You!

*These powerful interfaces are deployed into real products today.*

Thank you for your continued interest and support of the Project 25 Standard!

Cynthia Wenzel Cole, CEO

cynthia@cynergyze.com

@Cynergyze
P25 General Systems Model

P25 Common Air Interface (CAI) Types
1. P25 Conv CAI - Conventional P25 FDMA Common Air Interface
2. P25 Trunked CAI - Trunked P25 FDMA/TDMA Common Air Interface

P25 Wireline Interface Types
1. Eg - Inter RF Sub-System Interface (ISSI)
2. Ec - Console Sub-System Interface (CSSI)
3. Ef - Conventional Fixed Station Interface (FSI)
4. Ed - Data Host Network Interface
5. MDP - Mobile Data Peripheral Interface (MDP)
6. IKI - Inter Key Management Facility Interfaces (IKI)
7. KFD - Key Fill Device Interface
8. Et - Telephone Interconnect
9. En - Network Management

Adopted from TSB-102-B
Take Away Topics From Today

• Introduction to other P25 sessions of interest at IWCE
• A look at P25 in the market and supporting resources
• P25 Standards, the Process, and Why P25 is Useful to Users
• The many P25 Features and Interfaces
• A look at the Interface Definitions and Standards Completed
• The Reality of Multiple Vendor Interoperability with P25
• Use the PTIG Resources at - www.Project25.Org
Questions and Answers
P25 Presentations at IWCE College of Technology

• Monday AM
  – **Project 25 Foundations and System Interface Updates for 2014**
  – Session # M103 (This is Here and Now!!)
  – 8:30AM -12:00PM, Room N232

• Tuesday AM
  – **P25 User’s Perspective and Customer Applications Update for 2014**
  – Session # T301
  – 8:30AM -12:00PM, Room N232
P25 Presentations at IWCE through This Week

- A Guide to Interoperability and “Open” Standards
  - W03 - Wednesday, 03/26/2014, 11:00AM -12:15PM, Room S228.

- NPSTC Presents Current Public Safety Issues
  - W07 - Wednesday, 03/26/2014, 11:00AM -12:15PM, Room S229.

- Building Interoperable Communications between Departments
  - W11 - Wednesday, 03/26/2014, 1:15PM - 2:30PM, Room S228.

- Get Exactly What You Want: System Specifications, RFPs and Procurement
  - W12 - Wednesday, 03/26/2014, 1:15PM - 2:30PM, Room S230.

- Migrating to P25
  - TH05 - 03/27/2014, 9:45AM -11:00AM, Room S231.
P25 Presentations at IWCE through This Week

- DHS Update of the National Emergency Communications Plan
  TH07 - Thursday, 03/27/2014, 9:45AM -11:00AM, Room S229.

- Firefighter Tech: Radio Interference and Accessories
  TH23 - Thursday, 03/27/2014, 2:00PM - 3:15PM, Room S229.

- LMR and LTE: A Multi-Network Architecture for Future Communications
  TH26 - Thursday, 03/27/2014, 3:30PM - 4:45PM, Room S232.

- Migrating P25 Phase 1 to Phase 2: Best Practices
  F11 - Friday, 03/28/2014, 11:10AM -12:10PM, Room S231.

- All Things Considered: Building a Public Safety System for the 21st Century
  F12 - Friday, 03/28/2014, 11:10AM -12:10PM, Room S229.
PTIG Commercial Members

• AECOM
• Aeroflex
• Airwave Solutions
• Anritsu
• Avtec
• Cassidian Communications
• Catalyst Communications
• CISCO Systems
• Cobham Avionics
• Codan Radio (Daniels)
• Cynergyze
• Datron World Communications
• Digital Voice Systems Inc
• EFJohnson Technologies
• Etherstack
• Federal Engineering Inc
• Genesis Group
• Harris Corporation
• ICOM America

• Kenwood USA
• Midland Radio
• ModUCom
• Motorola Solutions
• Pantel International
• PowerTrunk
• Raytheon
• Radio Communication Systems Australia
• RELM Wireless
• Simoco ComGroup
• Spectra Engineering
• Tait Radio
• Technisonic Industries
• Telex Radio Dispatch
• Thales Communications
• Vertex Standard, Inc.
• Wireless Pacific
• Zetron, Inc.
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