Project 25 FDMA and TDMA Applications

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MOTOROLA SOLUTIONS
Project 25 Today

Hundreds of FDMA Systems In Operation

Two-Slot TDMA Available Soon!
Why Does Project 25 Have **Two** Air Interfaces?

- **12.5 kHz FDMA**
  - Meet V/U FCC requirements
  - Enable migration alternatives
  - Dominates the Public Safety market

- **12.5 kHz TDMA**
  - Meet anticipated V/U FCC requirements
  - Meet 700 MHz FCC requirements
  - Enable migration alternatives
  - Expands system capacity with same footprint as FDMA

The answer is "TDMA **and** FDMA," not "TDMA **or** FDMA".

- As coverage and connectivity expands, systems will have both
- TDMA does not replace FDMA – rather, it complements FDMA
- Phase 1 and Phase 2 subscribers support FDMA talkaround
- Phase 1 subscribers support 25/12.5 kHz analog
Evolving Public Safety Spectrum

We Are Here!

- **800 MHz @ 25 kHz**
- **VHF @ 12.5 & 25 kHz**
- **UHF @ 12.5 & 25 kHz**
- **700 MHz @ 12.5 & 6.25e kHz**
- **700 MHz P25 IOP Channels @ 12.5 kHz**
- **VHF @ 12.5 kHz**
- **UHF @ 12.5 kHz**
- **700 MHz @ 6.25e kHz**

**Note:** Timeline not to scale

- **3/7/2011**
- **1/1/2013**
- **1/1/2017**
- **??/??/????**

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The 12.5 kHz Air Interface Family

• FM Analog
  – Conventional; Published by TIA in TIA-603
  – Trunked; Done (multiple proprietary)
  – Applicable to the 800 MHz band in 25 kHz and 12.5 kHz)
• P25 Phase 1 (FDMA, non-linear subscriber, full rate vocoder)
  – Conventional; Published by TIA in TIA-102
  – Trunked; Published by TIA in TIA-102
• P25 Phase 2 (TDMA 2-slot, non-linear subscriber, half rate vocoder)
  – Trunked; Published by TIA in TIA-102
P25/TIA-102 INTERFACES

• Original interfaces (8)
  – FDMA Common Air Interface (CAI)
  – Packet Data Host and Network Interface
  – Subscriber – Mobile Packet Data Peripheral Interface (MDPI)
  – Inter-RF Subsystem Interface (ISSI)
  – Console Subsystem Interface (CSSI)
  – Fixed Station Interface (FSI)
  – Telephone Interconnect Interface
  – Network Management Interface

• Additional interfaces (3)
  – TDMA Air Interface (CAI)
  – Key Fill Device Interface (KFDI)
  – Inter-Key Management Facility Interface (IKI)
The P25/TIA-102 Standard consists of 69 published documents:
- 31 documents have been up-issued
- TIA requires a 5-year re-affirmation for each document (currently 20 need re-affirmation)

The Standard Documents can be sorted into two major categories and one minor category:
- Major
  - Core Documents for product development
  - Testing Documents for implementation verification
- Minor
  - Overview Documents that define scope
MAJOR TIA ACTIVITIES PAST TWO YEARS

• Trunked 2-Slot TDMA Standardization
  – Core and testing documents
• Adding features and services to ISSI standard
  – Supplementary services
  – Packet data
• The Compliance Assessment Program
  – Operated under DHS Charter
  – Test documents can be found at: [https://www.rkb.us/search.cfm?query=&action=5&typeid=5](https://www.rkb.us/search.cfm?query=&action=5&typeid=5)
  – Click on “P25 SDoCs (xx)” in the left hand column
  – This leads to .pdf versions of the following
    • Supplier’s Declaration of Compliance (SDoC)
    • Summary Test Reports (STR)
PRIORITIZED TIA-102 DEVELOPMENT

- Finishing Trunked TDMA Testing documents
- Update packet data documents
- Add packet data testing documents
- Complete trunked packet data encryption
- Start the development of Link Layer Encryption (LLE) service
- Adding TDMA capability to ISSI
- Finishing ISSI and CSSI testing documents
- Adding features to conventional Fixed Station Interface – Packet data
- Addendums and re-affirmations of Standards as needed
## P25/TIA WORK IN PROCESS

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<th>Overview</th>
<th>Core</th>
<th>Testing</th>
<th>WIP</th>
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<td>15</td>
<td>20</td>
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<tr>
<td>Packet Data Host (packet data services included)</td>
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<td>4</td>
<td></td>
<td>2</td>
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<tr>
<td>Packet Data Subscriber</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Inter Sub-System</td>
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<td>4</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Console Sub-System</td>
<td>1</td>
<td>4</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Fixed Station</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Telephone Interconnect</td>
<td>1</td>
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<tr>
<td>Network Management</td>
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<tr>
<td>TDMA CAI</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>4</td>
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<tr>
<td>Key Fill Device</td>
<td>1</td>
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<tr>
<td>Inter Key Management Facility</td>
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P25/TIA-102 REFERENCE SYSTEM

P25 Interfaces
• Apply to both conventional and trunking
• Apply to all bands

Network Core
- FDMA CAI
- TDMA CAI
- Key Fill
- Mobile Data
- Mobile Radio
- ISSI
- CSSI
- FSI
- Inter System Gateway
- RF Site
- Telephone Interconnect
- Packet Data GW
- Net Manager

Packet Data
- Location Server
- Packet Data Server
- Encryption Key Management
- Inter KMF

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Project 25 FDMA Applications
P 25 Systems: Available Today

Single-Site
• Single-site Conventional
  • Base Station
  • Repeater

Bigger area

Multi-Site
• Wide-area Conventional
  • Multiple single-sites
  • Multicast
  • Simulcast

Conventional

More users

Trunking

Single-site Trunking

Voting

Voting

Simulcast

Wide-area Trunking

Very Large Wide-area Trunking

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## TIA 102 FDMA Standards Status

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<th>TIA-102 Core Standards</th>
<th>Conventional/Trunking</th>
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<td>Baseline and Enhanced Full-Rate Vocoder</td>
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<td>Messages and Procedures Control Channel Messages</td>
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<td></td>
<td>Supplemental Services Trunking Procedures</td>
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<td>Conformance Tests Being Updated</td>
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For FDMA systems, TIA has published approximately 21 Conventional-system-related standards, 12 encryption standards, and 5 data-related standards, in addition to numerous informative documents. An additional 8 standards provide trunking capabilities. (Note that these numbers exclude the wireline interfaces and TDMA-specific standards. They also don’t count how many times each has been updated, added to, corrected, renewed, etc.).
The FDMA Workload Continues On...

• Examples of additional work in progress includes numerous documents for:
  – KMF to KFD interface
  – KMF to KMF interface
  – Security Services Overview
  – Packet data updates
  – Digital audio work
  – Testing, and more testing...

• Possible future work, pending market demand and P25 prioritization:
  – Packet data testing documents
  – Over-the-air programming
  – Audio logging
  – The list continuously grows!
P25 TDMA
P 25 TDMA Systems: Coming Soon!

Even Bigger Area

Wide-Area Trunking with FDMA and TDMA Subscriber units

Even More users

Very Wide-Area Trunking with FDMA and TDMA Subscriber units
Some TDMA System Tid Bits...

- While P25 Two-Slot TDMA provides trunked voice services at 12.5 kHz / 12 kbps...
- Control channel remains FDMA 12.5 kHz / 9.6 kbps
- Same control channel supports FDMA voice channels
- Packet data channel remains FDMA 12.5 kHz / 9.6 kbps
- Since the control channel and voice channels operate at different channel rates, ensure your system is designed for the coverage you require
FDMA – TDMA Trunked Interoperability

Network A equipped with P25 FDMA 9.6 kbps Control Channel, 9.6 kbps FDMA, and 12 kbps TDMA Traffic Channels

Network A user roams into Network B and auto switches to FDMA

Network A user can join talk groups with Network B users

Network B supports P25 FDMA only

Network B users roam into Network A and mobiles finds Control Channel

Network B users, and Network A users in assigned shared talk group, are assigned a P25 FDMA traffic channel

Network B supports 9.6 kbps traffic and control channels
Off-Network Interoperability

Users A and B communicate in P25 FDMA conventional direct mode.

Network B user roams out of network coverage.

Network A user roams out of network coverage.

FDMA direct mode. Essential for emergency communications.

NETWORK A
TDMA P25 CAI

NETWORK B
FDMA P25 CAI
## TIA 102 TDMA Standards Status

### Phase 2 Two-Slot TDMA Trunked Systems

| TIA-102 Core Standards | New Half-Rate Vocoder  
Also supports baseline and enhanced full rate vocoders |
<table>
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<td></td>
<td>Control Channel Messages recognize and differentiate between Phase 1 and Phase 2 radios.</td>
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### TIA-102 Testing Standards

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<th>TIA-102 Testing Standards</th>
<th>Performance Tests in Development</th>
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<td>Conformance Tests Being In Development</td>
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<td>Interoperability Tests leveraging FDMA</td>
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TDMA systems, leverage the existing trunking FDMA standards, expanding or adding eleven additional TDMA-related standards.
Future TDMA Work Possibilities Include:

• Work in progress
  – TDMA performance specs
  – TDMA measurement methods
  – Implementation conformance
  – Testing, and more testing

• Pending market demand and P25 prioritization:
  – 6.25 kHz-equivalent TDMA conventional systems
  – Slotted packet data (applications such as voice and control, or voice and data, or low density sites, or...).
  – TDMA control channel (perhaps someday when FDMA interoperability is no longer necessary)
One Final Topic: Interoperability is More Than Just the Radio

• Public Safety is moving from legacy:
  – Stove-pipe systems
  – Individual dispatch centers
  – Total system control
  – System ownership

• To more effective and efficient communications:
  – Regional networks
  – Consolidated dispatch centers
  – Managed systems
  – Shared resources

• Achieving Interoperability also requires...
  – Governance; roles, responsibilities, etc.
  – SOPs and MOUs
  – Practice, training, exercises
  – Daily usage
Technology is but a small part of system planning!

Source: US Department of Homeland Security, Office of Interoperable Communications
Next Presentation Topics

• Security Services
  – Bill Janky, Harris Corporation

• Wireline interfaces
  – Roy McClellan, EADS

• Digital audio topics
  – Chris Wilson, Motorola

• Testing and The Compliance Assessment Program
  – Nick Pennance, TAIT
Questions?