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Track 1
Communications

Transit Agency Implementation of, or Migration to Digital Trunked Radio

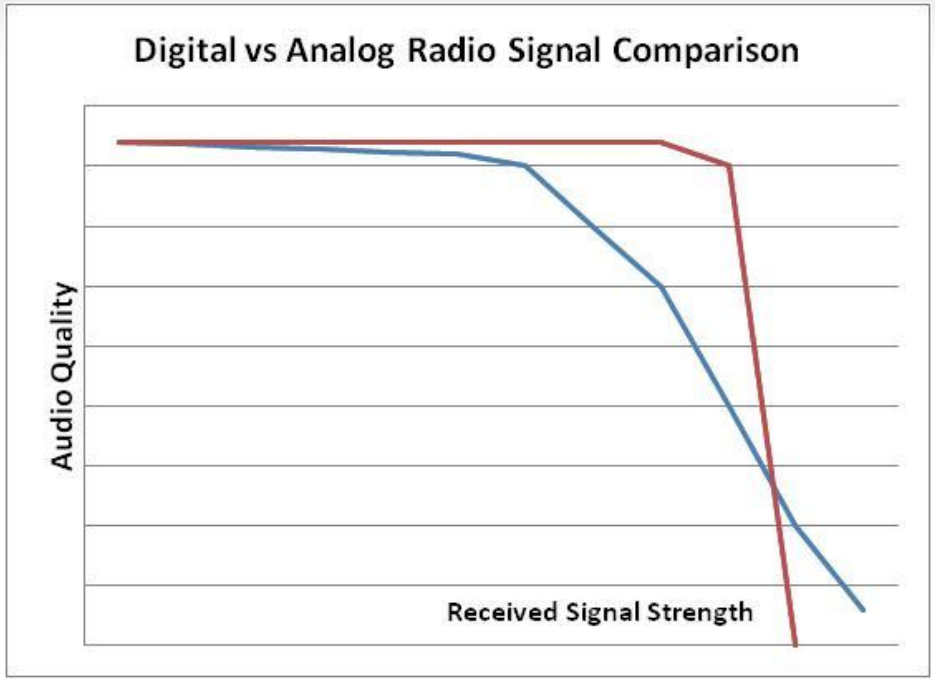
The need to change

- Obsolescence of existing radio systems and technology
- Increased requirements for data
- Need for one to one calls
- Additional features required
- Need to migrate to narrow-band technology (FCC requirements to free up bandwidth)

Trunked Radio Systems

- Trunked radio systems allow a limited number of channels to be shared between multiple users and dynamically assign frequencies to both users and call groups

Digital vs Analog



Digital advantages when compared with analog trunked radios:

- Improved Voice Quality
- Expanded RF Coverage with acceptable voice quality
- Enhanced Data Services
- Improved Security
- Lower Cost

Digital - signal quality remains consistent over a wide range of received signal strengths and then drops off sharply when the signal strength reaches a threshold

Analog - as the received signal strength decreases the audio quality also degenerates

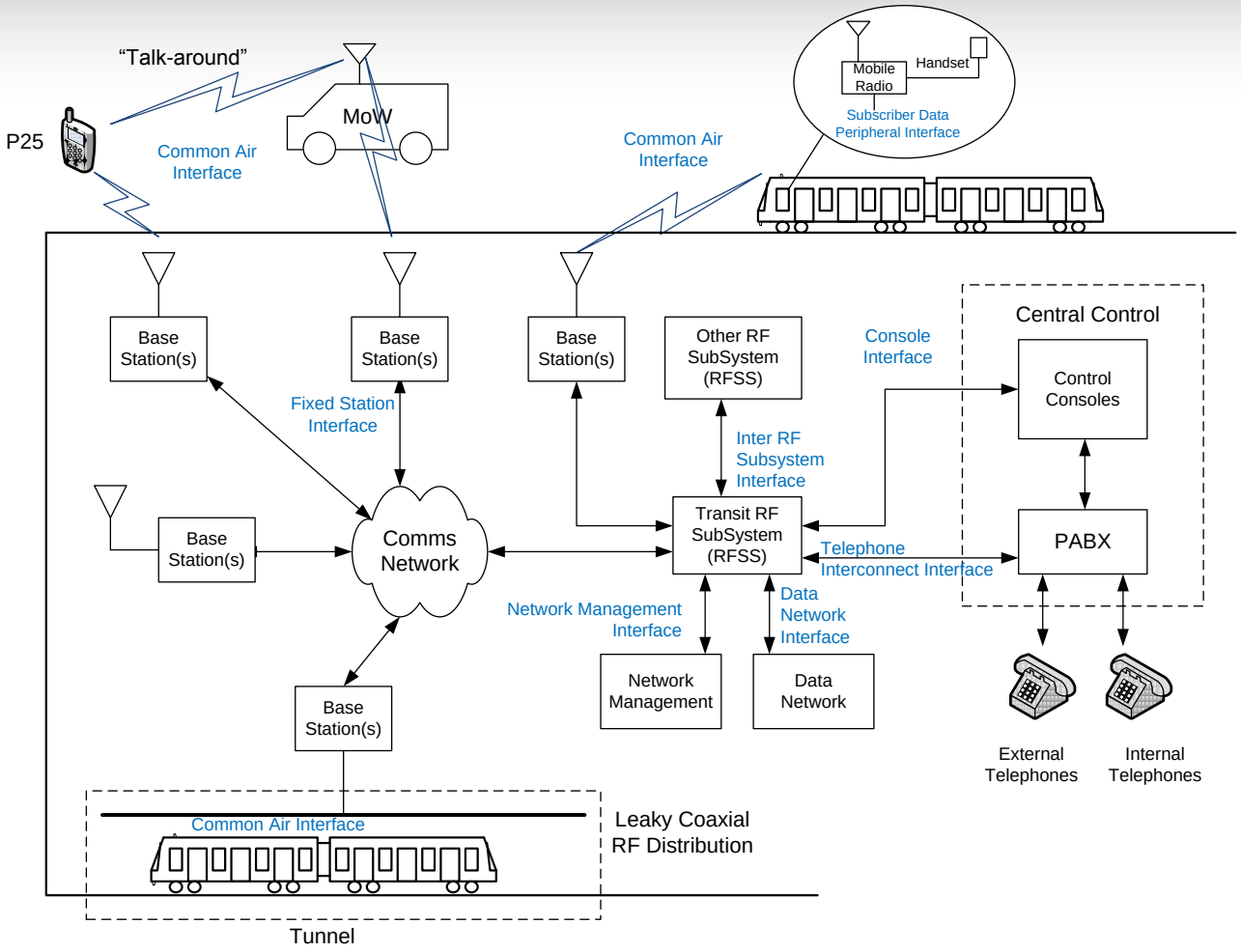
The digital solutions

- APCO P25
  - Association of Public Safety Communication Officials (APCO) Project 25 (P25) technology is emerging as the predominant digital trunked radio system in North America, providing both voice and low bandwidth data, and while primarily used by Public Safety and Security agencies - now appearing in Transit applications as a replacement for aging and obsolete analog systems
- TETRA (ETSI)
  - FCC has now allowed the European TETRA digital radio technology governed by the ETSI, to be licensed and used in the USA, offering an alternative to P25 for voice and data applications to provide narrowband voice and data channels
  - Now see use of TETRA to support both bus and rail transit applications (TTC, NJT)

APCO P25

- Project 25 – APCO strategy to meet FCC mandate and achieve narrowband spectrum efficiency:
  - Phase 1 (P25-1) initial implementation, offered the necessary technologies and standards to provide for channel reduction from 25 kHz to 12.5 kHz
  - **Phase 2 (P25-2)** systems entered service in 2011; will gradually replace Phase 1 systems and offer an additional 50-percent reduction in voice channel size to 6.25 kHz equivalency
  - Future Phase 3 is expected to address the growing need for high speed data
  - Backward compatibility between each Phase
  - Open and interoperable standards (TIA)

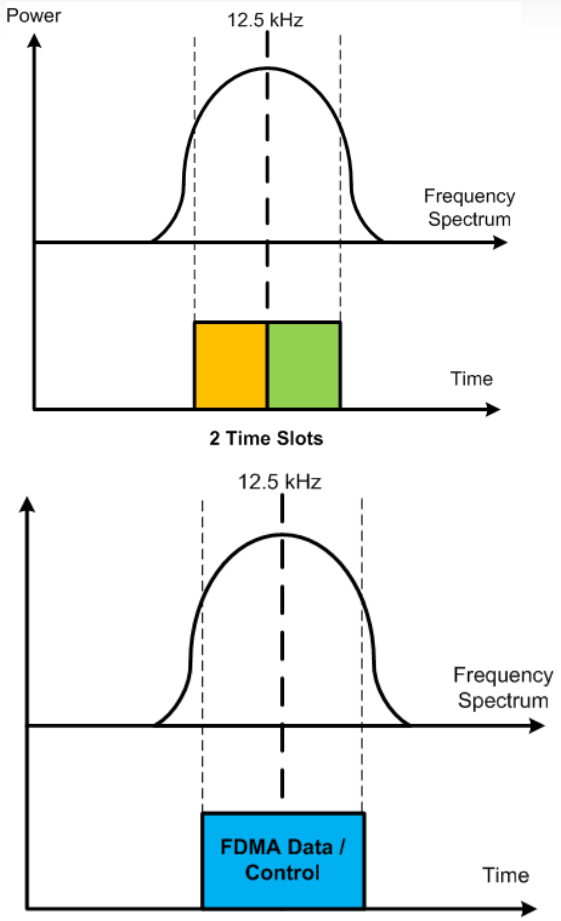
APCO P25



- RF Subsystem (RFSS)
- Common Air Interface (CAI)
- Inter-System Interface (ISSI)
- Telephone Interconnect Interface
- Network Management Interface
- Data Host or Network Interface
- Data Peripheral Interface
- Fixed Station Interface
- Console Sub-System Interface

APCO P25

- P25-2 is based on a 2-slot TDMA trunked air interface, providing two speech traffic channels in a 12.5 kHz channel allocation
- Data communications and control use P25-1 FDMA scheme
- Architecture provides both Multicast and Simulcast capabilities

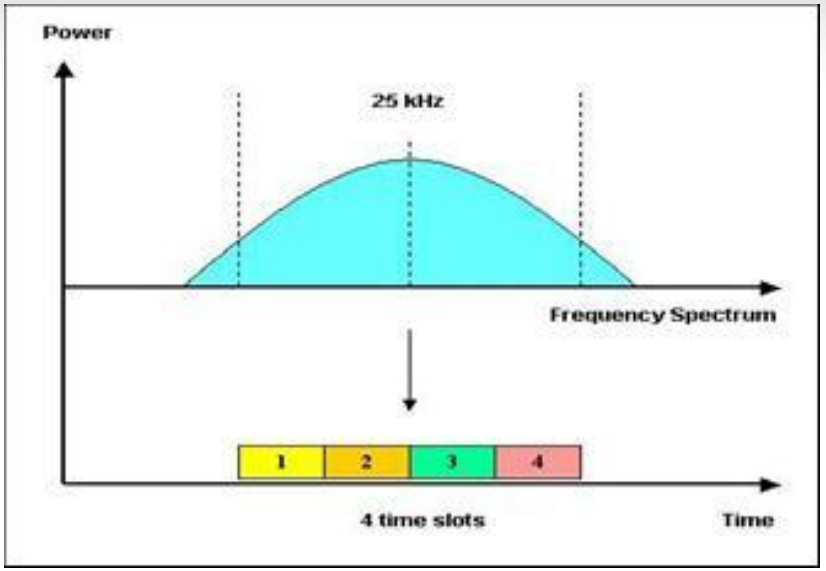


APCO P25

- Extensive global deployment – most frequently in public safety applications
- So far limited Transportation use
  - GO Transit (providing commuter transit in Greater Toronto Area)
  - Dallas Area Rapid Transit (DART), which uses P25 for both voice and data application
  - Golden Gate Bridge Highway and Transportation District of San Francisco including the Golden Gate Bridge, the Golden Gate Ferry and Golden Gate Transit

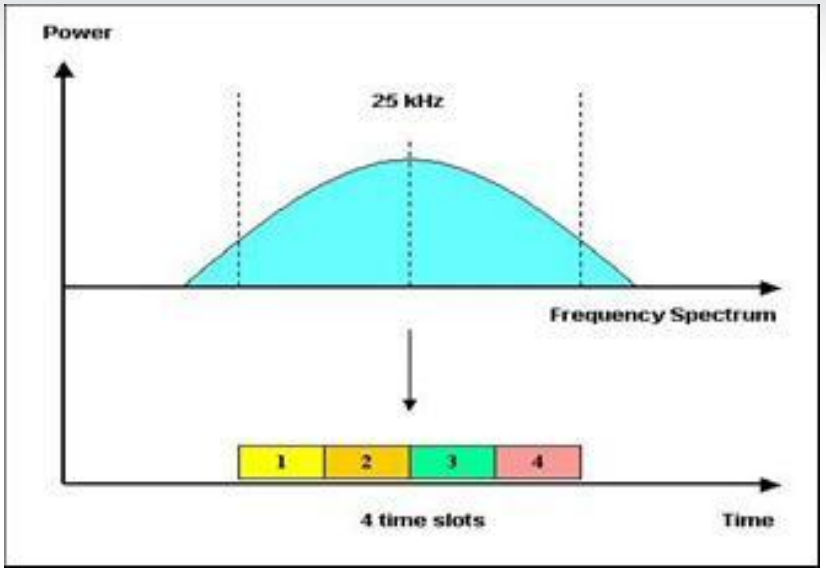
TETRA Radio

- Open, interoperable and continuously evolving set of standards
- Digital trunked TDMA technology
- Four time slots, providing 4 independent 6.25 kHz comm channels in a 25 kHz RF bandwidth Channel
- Using slot structure radios can communicate voice and data at the same time
- Full duplex communications
- Data Bandwidth on Demand – Up to four slots per 25 kHz channel can be combined to increase data throughput as required for specific applications

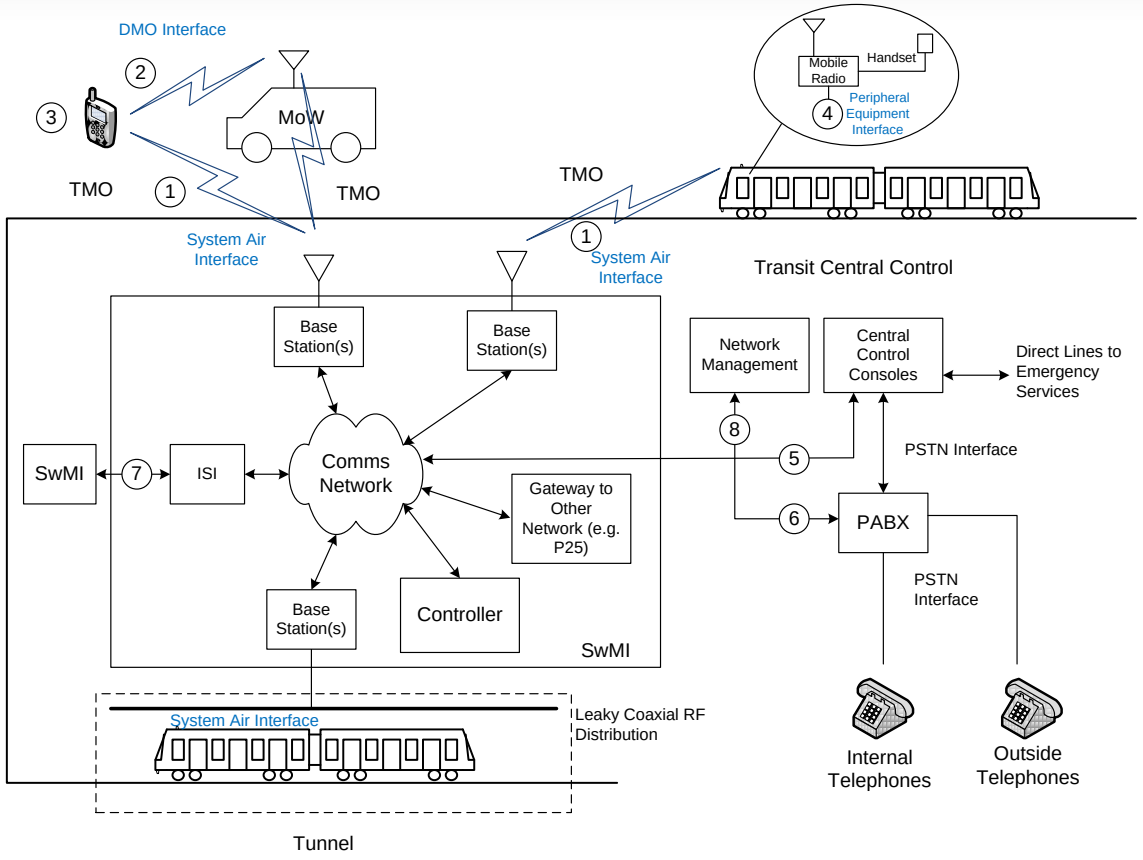


TETRA Radio

- Short Data Service (SDS) - supported on the TETRA control channel, can provide up to 256 bytes of data, for basic status messaging, location information and free form text message applications
- Point to point or point to multi-point
- For higher data rates the TETRA Enhanced Data Services (TEDS) uses multiple 25 kHz channels to provide 25, 50, 100 and 150 kHz bandwidths that will support data rates up to 500 kb/s



TETRA Radio



- Trunked (TMO) and Direct Mode Operation (DMO)
- Air Interfaces (1 & 2)
- Peripheral Equipment Interface (PEI) (4)
- PSTN/ISDN/PABX (6)
- Inter-System Interface (ISI) (7)
- Network Management Interface (8)

TETRA vs P25 Comparison

	TETRA	P25 Phase 2
• Interoperability	√+	√
• Maturity	√+	New
• Vendor base	√+	√
• Encryption and Security	√+	√+
• Grade of Service	√+	√+
• Spectral Efficiency	√+	√+
• Call Functionality	√+	√
• GPS Location Capability	√	√

TETRA vs P25 Comparison

	TETRA	P25 Phase 2
• System Expansion	√+	√+
• Reliability	√+	√+
• Failure management	√+	√+
• Multicast	√	√
• Simulcast	X	√
• Cost comparisons	Lower	Higher

How do we choose?

- Both P25-2 and TETRA
  - Are suitable for Transit applications
  - Provide open architectures, allowing interoperability with multiple supply options
  - Provide a level of service reliability, security and functionality not provided by public carriers
  - Can be integrated with gateways or other more simple solutions to public safety networks
  - Can be expected to meet the required design life of a Transit Agency's radio system, with upgrades and future migration paths to support future additional demand

How do we choose?

- Must consider:
  - Whole life-cycle costs
  - The degree of independence required by the Transit Agency (i.e. from other agencies)
  - The conditions of a service level agreement if shared with other agencies
  - Performance requirements and constraints, coverage area, multicast/simulcast etc.
  - Functional requirements

THANK YOU!