Pros and Cons of TETRA vs. P25 and the Benefits of a Multi-technology Platform for TETRA, P25 Phase I / Phase II, and Mobile WiMax

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Pros and Cons of TETRA vs. P25

- **TETRA**
  - What is TETRA?

- **P25**
  - P25 Phase I / Phase II

- **Comparison**
  - Similarities and differences
What is TETRA?

- TETRA (Terrestrial Trunked Radio) is an open standard for digital mobile radio communication defined by ETSI (European Telecommunications Standards Institute).
- Originally conceived and developed for use by European Union government and public safety agencies. Later adopted as the worldwide “de facto” standard, except North America, for digital radio communications systems.
- Provides a high-end solution for small private systems up to large public networks, while preserving characteristics and advantages of private land mobile radio systems, such as fast call set-up, group calls, and direct mode communication (talkaround).
TETRA Standard Elements and Interfaces

AI - Air Interface (Trunked Mode)
DMO - Direct Mode Operation
ISI - Inter-System Interface
LS - Line Station (dispatcher)
LSC - Local Switching Controller
MMI - Man Machine Interface
MS - Mobile Station
NMS - Network Management System
PEI - Peripheral Equipment Interface
SBS - Site Base Station
SCN - Switching Control Node
SwMI - Switching and Management Infrastructure
TE - Terminal Equipment

REMOTE DISPATCHER

non-TETRA Network

TETRA Network

GATEWAY

REMOTE

TETRA Network

non-TETRA Network

TETRA Network

SwMI

SBS

SBS

SBS

SBS

SCN

Link

Link

Link

Link

Al

DMO

AI

AI
Each RF carrier (radio channel) is divided into timeslots within a 25 KHz channel.

The transmission rate is 7.2 Kbps per slot.
TETRA General Concepts

Example of channel distribution

- **Carrier 1 (main)**
  - **SBS 1**
    - T1: MCCH
    - T2: TCH
    - T3: PDCH
    - T4: PDCH
  - T1: TCH
  - T2: TCH
  - T3: TCH
  - T4: TCH

- **Carrier 2**
  - T1: TCH
  - T2: TCH
  - T3: TCH
  - T4: TCH

- **SBS 2**
  - T1: MCCH
  - T2: SCCH
  - T3: PDCH
  - T4: TCH

- **SBS 3**
  - T1: SCCH
  - T2: SCCH
  - T3: SCCH
  - T4: SCCH

- **Carrier 1 (main)**
  - T1: MCCH
  - T2: SCCH
  - T3: SCCH
  - T4: SCCH

- **Carrier 2**
  - T1: PDCH
  - T2: PDCH
  - T3: TCH
  - T4: TCH

- **Carrier 1**
  - T1: MCCH
  - T2: SCCH
  - T3: PDCH
  - T4: TCH

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Example of channel distribution

TETRA General Concepts
TETRA Highlights

- **High Quality** and **High Security** in communications.
- Double spectral **efficiency**.
- **Higher data** bandwidths (up to 28.8 kbps)
- Multiple **real-time data services** (status, short data, circuit mode data, packet mode data).
- Half-duplex and **full-duplex** communications.
- **Interoperable** with other networks (TETRA, ISDN, IP, GSM).
- Continuous coverage.
- Emergency calls.
- Fast call setup.
- **Simultaneous voice and data**.
- **Open standard** technology: protects investment.

Total 2258 contracts across 105 countries
Data provided by the TETRA Association Members.
(October 2008 - latest data available)
P25: Background

- Project 25 (P25) is a set of standards produced through the joint efforts of the Association of Public Safety Communications Officials International (APCO), the National Association of State Telecommunications Directors (NASTD), selected Federal Agencies and the National Communications System (NCS), and standardized under the Telecommunications Industry Association (TIA).
- P25 is an open architecture, user-driven suite of system standards that define digital radio communications system architectures capable of serving the needs of Public Safety and Government organizations.
- The P25 standard exists in the public domain, allowing any manufacturer to produce a P25 compatible radio product.
P25: Background

- P25 is defined for two different working modes:
  - Conventional: provides a simple infrastructure system that normally repeat radio calls from one frequency to another.
  - Trunked: a controller inside the infrastructure provides intelligence to manage call set up, subscribers roaming across the system, channel assignment,…

- Additionally, P25 conventional and trunked systems can be deployed in three different ways according to frequency usage:
  - Multicast: All adjacent repeater sites use different frequencies
  - Voting system: All adjacent repeater sites use different transmitting frequencies but the same reception frequency
  - Simulcast: All repeater sites use same Tx/Rx freqs.
P25 Phase I

- FDMA (Frequency Division Multiple Access)

- 12.5 KHz channels

- C4FM (Constant-envelope 4-level FM)

- Subscribers are backward compatible with analog radios regardless of the infrastructure. Repeaters can work in analog (not mandatory), digital or mixed mode.
P25 Phase II

- Phase II: Will be a 6.25 KHz equivalent system, meaning that 1 voice communication will fit within 6.25 KHz of channel bandwidth.

- For the above, P25 Phase II will use a 2-timeslot TDMA structure in 12.5 KHz channels.

- Control channels will support FDMA for backward compatibility with Phase I.
TETRA / P25 Comparison

Useful TETRA <-> P25 associations:

- NAC code in P25 is equivalent to MCC and MNC of TETRA
- TGID (Talk group ID) is equal to GSSI of TETRA
- UID (Unit ID) is equivalent to ISSI of TETRA
- ISSI (Inter Sub-System Interface) is equivalent to ISI of TETRA
- OTAR in P25 is the same as OTAK in TETRA as it is used for E2EE (OTAR in TETRA is used for Air Interface Encryption)
- Pre-programmed messages in P25 is the same as Status messages in TETRA.
- ESN (Electronic Serial Number) is equal to TETRA’s TEI
TETRA Pros and Cons

- **Pros:**
  - Optimized for high population density areas
  - Spectral efficiency (4 time slots in 25 KHz)
  - Data bandwidth on demand (up to 28.8 kbps)
  - RX diversity
  - Supports full duplex voice
  - Short data / status messaging
  - Packet data / circuit mode data

- **Cons:**
  - Not presently available in VHF band
  - No simulcast
P25 Pros and Cons

▪ Pros:
  o Optimized for wider area coverage with low population density
  o Greater range than TETRA in Phase I (FDMA), but nearly same in Phase II (TDMA)
  o Support for simulcast

▪ Cons:
  o Limited data support
  o Delays in Phase II standard (projected 2011)
TETRA / P25 Comparison

- Both technologies are valid solutions for modern professional-use digital radio communications systems.

OFFERS BOTH SOLUTIONS!
Benefits of a Multi-technology Platform for TETRA, P25 Phase I / Phase II, and Mobile WiMax

- **Common Architecture**
  - Support for TETRA, P25, and WiMax protocols
  - Interconnectivity
  - Common Computer Aided Dispatch (CAD) application

- **Benefits / Applications by Sector**
  - For Transport
  - For Utilities
  - For PSS
Complete Ethernet / IP Architecture

- Distributed switching
- Distributed intelligence
- No need for GPS or external synchronization

Flexible

- Synchronous & Asynchronous links
- 3rd party portal Available
- All TETRA Services Available

Easy & Friendly

- Modern VoIP
- Dispatchers & Recorders
- Line Dispatchers & Recorders
- Friendly, NMS
- Hot-Swapping & plug & play
Field-proven end-to-end IP design.
Same network control and management structure for TETRA, P25, and Mobile WiMax.
Optimized voice packets reduce delays and lower link bandwidth requirements.
Designed for interoperability.
Easy scalability from single site to state-wide networks.
Common Hardware

- RF Base Station/Repeater
- Local Site Controller (LSC)
- NMS server
- Master Site Controller
- NMS Client
- Dispatching Console
The PowerTrunk RF Unit (RFU) / Base Station Repeater (BSR) is modular and easy to maintain and deploy.

- Each module is plug-and-play containing different functional blocks and providing specific alarms to minimize in-the-field repair time.
- Designed to be future-proof, it contains all necessary hardware to support FDMA structure for P25 Phase I, as well as TDMA structure for a P25 Phase II or TETRA system.
- Software-only upgradeable to P25 Phase II.
- Can work in P25 conventional and trunked mode.
- Designed to tolerate high delays and jitter in the backbone links with the Master Sites (including for satellite links).
TETRA BSR

- **Frequency bands**: 350-370, 380-430, 450-470, 806-870 MHz
- **Channel spacing**: 25KHz.
- **Time Division Multiple Access (TDMA)**: 4 timeslots per RF channel
- **Modulation**: $\pi/4$-DQPSK
- **Digital Data Bit Rate**: 28.8 Kbits/s.
- **Ethernet interface**: IEEE 802.3u,x.
- **RF Unit is hot-swap capable.**
PowerTrunk25 RFU

- **Frequency bands**: VHF, 380-512 (*), 764-806, 806-870 MHz.
  (* consult for specific sub-bands)
- **Channel spacing**: 6.25KHz, 12.5KHz or 25KHz.
- **Frequency Division Multiple Access (FDMA)**: 1 channel per RFU
- **Modulation**: Digital C4FM.
- **Emissions Designator**: 8K10F1W.
- **Digital Data Bit Rate**: 9.6 Kbits/s.
- **Ethernet interface**: IEEE 802.3u,x.
- **RF Unit is hot-swap capable.**
Mobile WiMax RFU

- **Standard**: 802.16e (Mobile WiMax)
- **Frequency bands**: Initially for 700 MHz band.
- **Channel bandwidth**: from 1.25 to 10 MHz
- **Digital Data Bit Rate**: from 100 kbps up to 4 Mbps per user
Broadband Performance

- This is not narrow or wide band, this is **broadband**:
  - Mean typical data rate: 1Mbps / user
  - Peak data rate: up to 4 Mbps / user
  - Data rate can be managed dynamically

- Broadband provides the best capability to support the **most demanding applications**:
  - Video surveillance: remote monitoring for security and safety
  - Video recording and streaming on demand
  - Remote data base management
  - Mobile office: staff working at remote locations or on-board vehicles
  - Remote maintenance of terminals and systems
  - Web applications
  - Telemedicine, E-health
  - Biometrics, face recognition...
  - Automation and control
  - Smart metering
MVC-6000: System Elements

**Vehicular PC**

- Vehicular video cameras
- Wireless broadband antenna
- VHF / UHF radio antenna
- Broadband + TETRA / P25 radio terminal
- Audio interfaces
Flexibility in the Backbone Network

**Synchronous Links:** several types of links (V.35, E1 / T1, ISDN, ...)

- **Synchronous Links:**
  - V.35
  - E1 / T1
  - ISDN

- **Flexibility in the Backbone Network**
  - ISDN Network
  - BRI - PRI [ISDN]
  - E1 Cross-Connect
  - E1 Drop-Insert
  - G.703/G.704 [E1 / T1]
  - V.35 Link
  - ISDN Connection (dedicated BRI)
Flexibility in the Backbone Network

Asynchronous Links – Layer 2: LAN, WAN, Wi-Fi, WiMAX, ...

Layer 2 System Access:
- Ethernet connections
- Wireless Connections
- Optical Fiber Connections

Standard Office Local Area Network

Ethernet switches

Fiber Access

70 Km

Flexibility in the Backbone Network
Flexibility in the Backbone Network

Asynchronous Links – Layer 3: IP Networks, MPLS, L2TPv3, IRB, ...
P25 ISSI

- Inter-RF Sub-System Interface
- IP connection by VPN established between PowerTrunk and Motorola P25 systems to allow group call and emergency call communication by users of different networks.
- EADS, Harris, Tait, Raytheon, and Etherstack also participated in the tests.
- Demonstrates adherence to standards and capacity of interconnection to 3rd-party P25 networks.
CeCoCo Series
Computer Aided Dispatch Solutions
CeCoCo

- Includes modules for communication management, location, and incident management

- Ethernet-based connection with the PowerTrunk range of TETRA and P25 infrastructure

- Additional services:
  - Discreet Listening
  - Ambience Listening
  - Call inclusion / termination
  - Fleet monitoring
  - Priority calls
  - Emergency calls
  - Pre-emptive PTT
  - Call Patching
CeCoCo Architecture

- Line-Connected TETRA/P25/WiMax Infrastructure
- TCP / IP VoIP
- TETRA & P25 Radio Interfaces
- Legacy Conventional System
- Legacy Trunked System
- CeCoCo SERVER
- PABX / PSTN (E1/T1, ISDN, VoIP, etc.)
- Analog Telephony
- Connect® - Switching Matrix
- PA system
- Recording System
- Call Taker / Dispatcher Workstation
TETRA for Transport

Metros / Subways

Railroads

Trams

Buses
Transport Communications Requirements

- Voice communication between drivers, control centers, depots, and passengers.
- Location systems.
- Data services for remote monitoring of subsystems.
- Railway signaling.
- Safety and security.
- Communication with maintenance crews.
- Communication with emergency services (police, fire, etc...)
Telecommunications Sub-systems Covered by TETRA

- Remote Command and Control of Rolling Stock
- Communication Management Sub-system
- Interaction with Intercom System
- Integration with Public Address Systems
- Telecommunications Sub-systems Covered by TETRA
Examples of Remote Controls and Alarms

REMOTE CONTROL:
- Train On / Off
- Identification (Train number and service)
- Emergency brakes
- Brake bypass / Traction loop
- Fire extinguishing system
- Open / close doors
- Control of lighting, air conditioning, etc.
- TCMS configuration/ Driving mode
- Talkgroup selection (by DGNA, according to train location)
- Information panels
- Pneumatic suspension
- Etc...

ALARMS:
- Fire detection
- Emergency alarms
- Emergency brake
- Passenger SOS button
- End of line
- End of service
- “Dead man” alarm
- Train location
- Intercom failure alarm
- P.A. system failure alarm
- Change of driving mode
- Battery voltage
- Etc...
Buses & Trams – Optimizing AVL

- Automatic regulation – Efficiency mostly depends on the refresh period which can be achieved
- Old analog systems – Control of radio channels (PTT-CD signals) by AVL Applications
- TETRA = TDMA. How to overcome the gap between the AVL Application and TETRA transport layers?
Basic SDS Solution

Based on:
- Basic TETRA Short Data Service (SDS) for polling and transmitting GPS position in LIP format.

Speed of position polling / reply:
- The fastest rate is 1 position every 0.6 seconds.

Advantage:
- Supported by the majority of TETRA terminals in the market.

Disadvantages:
- Care must be taken to poll terminals one by one, otherwise degraded audio quality could result due to use of the TETRA stealing mechanism.
- Not appropriate for large networks.
PowerTrunk SDM Solution for AVL

SDM (Synchronous Data Manager) is based on:
- Use of the SDS (LIP) service with reservation of air resources, permitting reception of GPS positions at the base station while avoiding collisions (synchronization concept).
- Special software in the infrastructure and the terminals.

Speed of polling / reply:
- The fastest rate is 5 positions per second for each CCH (control channel) of the system, whether MCCH or SCCH.

Advantages:
- Acts in parallel for all zones simultaneously.
- Eliminates collisions in the uplink (synchronous).
- Efficiency increases with the number of zones.
- In traffic, GPS positions are sent between PTT change
Transport Scenarios

WiMAX: Video surveillance in trains and station platforms / bulk data transfer in depots

TETRA:
Voice and short data service for train operation
Security services in stations
Voice services for maintenance personnel

WiMAX: Video surveillance and other specific broadband applications, i.e. cargo details of ships, etc..

TETRA:
Voice and short data service for airport / port operation
Voice services for maintenance personnel
TETRA for Utilities
1. Specific data transmission requirements for:
   - Permanent monitoring and control of the network elements (Telemetry and Remote control)
   - Data bandwidth and reliability transmission. High availability.
   - Integration with SCADA applications

   → **Goal:** To support and improve the level of service to the users. To reduce CAIDI index.

2. Growth capacity:
   - To solve saturation problems and overcome limited growth capability of current communication networks.

3. Energy savings:
   - Obtain detailed information about subscriber consumption to allow customized tariffs and to avoid peaks of consumption during most critical time slots (Smart Grid concept).

   → **Goal:** Cost reduction.
# What does TETRA offer?

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<tr>
<th><strong>1. Private Network</strong></th>
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<td>✓ Total network control without depending on operators.</td>
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<th><strong>2. Digital trunking system (cellular)</strong></th>
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<td>✓ Robust communication. Several options for network coverage redundancy → If a repeater fails, modems roam and the monitoring system is not interrupted.</td>
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<tr>
<td>✓ High spectral efficiency → Cost savings.</td>
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<th><strong>3. Avoids radio collisions in the air</strong></th>
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<td>✓ TETRA technology solves directly this problem.</td>
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<th><strong>4. Network Growth capacity / Possibility of additional services (voice, etc..)</strong></th>
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<th><strong>5. Data services</strong></th>
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<td>✓ Availability of different data services to be adapted to communication needs:</td>
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<tr>
<td>- Short Data Messages (SDS) and status messages</td>
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<td>- Standard Packet Data service (PD)</td>
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<td>- Circuit Mode Data (CMD)</td>
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Time required to manage the generated Keep-alive and alarm signals for a set of 20 remote units registered in a network of 1 Base Station.

Example scenario:

420 remote units.
420 bytes of information.
41 SBS.

0.5 Seconds

PowerTrunk SDM Solution for SCADA
Utilities: Smart Grid Scenario

**WiMAX:**
- Video surveillance
- Smart metering and bulk data transmission for other specific applications

**TETRA:**
- Short Data Services for telemetry
- Security services
- Voice services for maintenance personnel
- AVL application for vehicles

**Integration with SCADA applications**

**Computer Aided Dispatchers**
P25 for Public Safety
Public Safety / Communications Requirements

- **Integrated communications** system (radio, telephone, VoIP,..)
- Fast and reliable **voice services**
- **Data services** to improve traditional voice-based operational tasks
- No reliance on public based networks (**avoid saturation** during emergencies)
- **Minimize TCO** (Total Cost of Ownership) by enabling network sharing
- **Interoperability** between different Public Safety agencies – **open standard**
- Comprehensive Computer Aided Dispatch for **resources coordination**
- Vehicle & Personnel **location services** (GPS)
- **100 % availability**
- **Advanced security** mechanisms
P25 Network Elements
CeCoCoCo Architecture

Permits effective interaction between different agencies.

Integration with an emergency number
Incoming emergency calls

Centralized management, single incident among multiple organizations

Coordination of resources of each organization

911 Call takers and coordinators for the emergency
MVC-6000 Multi-Bearer Vehicular Console
Public Safety Scenario

Official building access: Video surveillance

Service assignment (photos, video, audio files, map location)
Vehicle Location, Navigation maps
Mobile office
Portal Web access
Incident video

Service assignment
Vehicle Location
Medical data (photos, videos, patient history, remote diagnostics)

Traffic signal control: Traffic lights, radars, etc..
Traffic monitoring

P25 / WiMAX

Integrated Computer Aided Dispatchers

Service assignment
Vehicle Location
Mobile office
Incident video
Building floor plans access
Main Customer References
Transport References

**Spain**
- Alicante Light Train, FGV (ETRA, Vossloh-Bombardier)
- Palma de Mallorca Metro (Sampol, CAF)
- Barcelona Metro Line 9 (Tradia)
- Barcelona Buses (TMB)
- Madrid Metro (CAF, Ansaldo)
- Madrid Light Train T-2, T-3 (ETRA, ALSTOM)
- Parla Light Train (ALSTOM)
- Santa Cruz de Tenerife Light Train (Ikusi UTE, ALSTOM)
- Bilbao Airport

**Germany**
- Nuremburg Metro (T-Systems)
- KÖR Buses & Trams (T-Systems)

**Brazil**
- Supervia, Rio de Janeiro Railway
- Brazilia Tramway (ALSTOM)

**Russia**
- Moscow – St. Petersburg Railway

**Algeria**
- Algiers Underground (Siemens)
- Constantine Tramway (EFACEC)
- Oran Tramway

**Chile**
- Santiago Metro (Siemens)
Transport References

Colombia
Emcali
Bogota Buses (Transmilenio)

Malaysia
Tanjung Pelepas Port (J&J – Comintel)

France / Switzerland
TETRA on-board systems for Marseille, Nice, Grenoble, Bordeaux, Geneva, Lausanne, and 10 other French / Swiss cities.
Public Safety References

**Spain**
- Itelazpi, Basque Country
- EXPO Zaragoza
- Zaragoza City Local Police and Fire Brigades
- Cordoba City Local Police
- Canary Islands Regional Government
- Ceuta Regional Government
- Alcala de Guadaira City Local Police
- Telefonica Security Engineering (Guadarrama Tunnel)

**Brazil**
- Bahia State Public Safety Secretariat (SSP)
- Rio de Janeiro Public Safety Secretariat (SSP) (Pan-American Games)

**South Korea**
- Incheon Metropolitan Police Agency (KDN)

**Mexico**
- Federal District Public Safety Secretariat (Milpa Alta)
- City of Puebla

**Argentia**
- Neuquen Regional Government (Damovo)

**Colombia**
- Cali Government & Public Safety
Other References

**Mining:**
- Iron and Steel Company, CST Arcelor
- Mittal Tubarao, Brazil
- Rio Tinto, Australia

**Operators:**
- Lig Mobile, Brazil
- Airwaves, Auckland city TETRA operator, New Zealand
- Telefónica Móviles España, Spain

**Utilities:**
- COELCE, Brazil
- Federal Comission of Electricity -CFE-, Mexico
- Guadiana Hydrographic Authority (Adasa), Spain

**Others:**
- Música Funcional (sistema PAMR), Andorra
- Telecomunicación Sistematizada, Mexico
- Torre Picasso (Telvent), Spain
- Degussa (T-Systems), Germany
- Chemiepark Bitterfeld, Germany
- KVB Köln (T-Systems), Germany
- Bayerische Rieswasser (T-Systems), Germany
- Tetra Iceland (Niros), Iceland
- Information Industry Company, Russia

**Sports Stadiums:**
- Real Madrid Football Club, Spain

**Gas & Oil:**
- Repsol YPF (Intepla/Intema), Argentina
Summary / Conclusions
Pros and Cons of TETRA vs. P25

- TETRA
  - What is TETRA?
- P25: Phase I / Phase II
- Comparison
  - Similarities and differences

Benefits of a Multi-technology Platform

- Common Architecture for TETRA, P25, and WiMax
- Benefits / Applications by Sector
  - For Transport
  - For Utilities
  - For PSS
“One Platform, Multiple Technologies”

- Network Infrastructure
- Mobile Unit (in-vehicle)
- Desktop Radio Dispatcher
- Hand Portable Unit
- Transportable Systems
- Railway On-board Equipment
- Network Infrastructure
- Radio Modems
- Coordination and Control Center

A COMPLETE SOLUTION

PowerTrunk
Thank you for your attention