Advantages of a Multi-technology Platform for LMR Networks

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Advantages of a Multi-technology Platform

- Support for various radio technologies
  - TETRA
  - P25
  - Wireless Broadband
- Common architecture
  - Network structure
  - Common hardware
  - Flexibility
- Benefits and applications by sector
  - Public safety
  - Public transportation
  - Utilities
TETRA Highlights

- **High Quality** and **High Security** in communications.
- 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).
- **Wide area coverage**.
- **Emergency calls**.
- **Fast call setup**.
- **Simultaneous voice and data**.
- **Open standard** technology: protects investment.
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
TETRA General Concepts

TDMA (Time Division Multiple Access)

- Each RF carrier (radio channel) is divided into 4 timeslots within a 25 KHz channel.
- 6.25 KHz equivalent technology.
- The transmission rate is 7.2 Kbps per slot.
TETRA General Concepts

Example of channel distribution

MCCH: Main Control Channel
SCCH: Secondary Control Channel
TCH: Traffic Channel
PDCH: Packet Data Channel
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.
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
Hybrid LMR / Wireless Broadband Network

- **Control Node**
  - Base station mgmt
  - Subscriber mgmt

- **Application Servers**
  - Control Center Server
  - Video
  - WAP / WEB
  - Databases
  - E-mail...

- **User Interface**
  - Integrated vehicular console
  - Communication mgmt

- **TETRA/P25 – WiMAX/LTE**

- **IP Backbone Network**

- **Control Center**
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
Common Architecture

- Field-proven end-to-end IP design.
- Same network control and management structure for TETRA, P25, and Mobile WiMAX / LTE.
- Optimized voice packets reduce delays and lower link bandwidth requirements.
- Designed for interoperability.
- Easy scalability from single site to state-wide networks.
Complete Ethernet / IP Architecture

- Easy & Friendly
- Flexible

a) Distributed switching
b) Distributed intelligence
c) No need for GPS or external synchronization

a) Synchronous & Asynchronous links
b) 3rd-party portal
   Available

a) Modern VoIP
b) Dispatchers & Recorders
   Line
   NMS
   Avail
   Plug & Play

PowerTrunk
Common Hardware

- RF Base Station/Repeater
- NMS server
- Master Site Controller
- Local Site Controller (LSC)
- NMS Client
- Dispatching Console
Central Node / Master Site Controller

- The Central Node Controller (CNC) / Master Site Controller (MSC) is the core of the system. It manages call processing, subscriber unit registration / roaming, and system configuration.
  - The hardware consists of a high-performance, industrial-grade PC with real-time operating system.
  - It provides fast call set-up, seamless roaming, and automatic switchover to a redundant unit in case of failure.
  - Maintains information about the system topography and subscriber configuration.
Network Management System

- The Network Management System (NMS) is based on a client / server architecture.
  - Allows distributed management across multiple client workstations via standard IP protocols.
  - Designed according to the FCAPS model, it allows for different users access level privileges according to need, thereby permitting separate technical and operational management.
  - In multi-agency environments, the NMS enables organizations / users to share the network, yet keeps each agency’s subscriber management isolated.
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.
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.
Wireless Broadband RFU

- **Standards:**
  - 802.16e (Mobile WiMAX)
  - LTE

- **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
PowerTrunk Connect Module

- The PowerTrunk “Connect” module accomplishes two important tasks within the system:
  - It provides an interface for interconnectivity / interoperability with other systems, including analog systems and legacy trunking networks.
  - It is the VoIP gateway to the PowerTrunk computer aided dispatch (CAD) system.
    - One module allows networking up to 10 dispatch consoles and 20 radio interfaces.
    - All radio interfaces may be made available to all operators in order to work in a multi-system environment.
    - Additional modules can be added (cascaded) to expand dispatch operator and/or radio interface capacity.
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
CeCoCo

- Includes modules for communication management, location, and incident management
- Ethernet-based connection with the PowerTrunk network infrastructure
- Additional services:
  - Discreet Listening
  - Ambience Listening
  - Call inclusion / termination
  - Fleet monitoring
  - Priority calls
  - Emergency calls
  - Pre-emptive PTT
  - Call Patching
Flexibility in the Backbone Network

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

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

Asyncronous 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
- Optical Fiber
- WiFi Connections

70 Km
Flexibility in the Backbone Network

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

Layer 3 Services
Layer 3 & Layer 2 Services
Network Services

PowerTrunk
P25 for Public Safety
Public Safety / Communications Requirements

- **Integrated communications** system (radio, telephone, VoIP,..)
- Fast and reliable **voice services** (immediate push to talk)
- **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 among agencies
- **Interoperability** between different Public Safety agencies – **open standard**
- Comprehensive Computer Aided Dispatch
- Vehicle & Personnel **location services** (GPS)
- 100 % **availability**
- **Advanced security** mechanisms
P25 Network Elements
The PowerTrunk25 LMR infrastructure is 100% P25 compliant to ensure compatibility with any vendor’s P25 compliant subscriber equipment.

Our strategic partnership with Kenwood provides PowerTrunk25 customers with a range of fully tested and proven P25 radios to ensure ease of deployment of turn-key systems.
CeCoCoCo Architecture

Whether for only a single radio technology or for several, the CeCoCo series permits effective integration between different agencies.

1. Isolated networks
2. Integration of communications
3. Coordination of resources of each organization
4. Centralized management, single incident among multiple organizations
5. Integration with an emergency number
Dispatcher Workstation - Functions

Advanced functions for call attention and radio dispatcher operation such as:

- Automatic Call Dispatching (ACD) with queue monitoring
- Quick access to last call replay
- Phonebook management
- Unit routing and directions
- Unit status display
- Access to incidents records
- Advanced reports
- Web administration
Mobile Command Unit

- Argentina Federal Police
  - PowerTrunk25 P25 network
    5 channels, 800 MHz
  - Network Mgmt. System
  - CeCoCo (5 operators)
  - Digital recording
  - 40-meter telescopic mast
MVC-6000 Multi-Bearer Vehicular Console
MVC-6000: System Elements

- Vehicular PC
- Vehicular video cameras
- Wireless broadband antenna
- VHF / UHF radio antenna
- Broadband + TETRA / P25 radio terminal
- Audio interfaces
Public Safety Scenario

- Official building access: Video surveillance
- Service assignment
  - Vehicle Location
  - Medical data (photos, videos, patient history, remote diagnostics)
- Traffic signal control:
  - Traffic lights, radars, etc..
  - Traffic monitoring
- P25 / LTE
- Integrated Computer Aided Dispatchers
  - Service assignment (photos, video, audio files, map location)
  - Vehicle Location, Navigation maps
  - Mobile office
  - Portal Web access
  - Incident video
- Service assignment
  - Vehicle Location
  - Mobile office
  - Incident video
  - Building floor plans access
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...)
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.
**Wireless Broadband:** Video surveillance in trains and station platforms / bulk data transfer in depots

**TETRA / WiMAX-LTE**

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

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

**TETRA / WiMAX-LTE**

**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>
<td><strong>1. Private Network</strong></td>
<td>Total network control without depending on operators.</td>
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<td><strong>2. Digital trunking system (cellular)</strong></td>
<td>Robust communication. Several options for network coverage redundancy → If a repeater fails, modems roam and the monitoring system is not interrupted. High spectral efficiency → Cost savings.</td>
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<td><strong>3. Avoids radio collisions in the air</strong></td>
<td>TETRA technology solves directly this problem.</td>
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<td><strong>4. Network Growth capacity / Possibility of additional services (voice, etc..)</strong></td>
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<td><strong>5. Data services</strong></td>
<td>Availability of different data services to be adapted to communication needs:</td>
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<tr>
<td></td>
<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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PowerTrunk SDM Solution for SCADA

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:

- 20 remote units.
- 20 bytes of information.
- 1 SBS.

- **300 sec.**
- **0.5 Seconds**

- Synchronous Data Manager
- Other technologies
Utilities: Smart Grid Scenario

**TETRA / WiMAX-LTE**

**Wireless Broadband:**
- 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**
Summary / Conclusions
Advantages of a Multi-technology Platform

- Support for various radio technologies
  - TETRA
  - P25 (software-only upgrade to Phase II)
  - Wireless Broadband (WiMAX / LTE)

- Common architecture
  - Ethernet / IP-based network structure
  - Common hardware
  - Flexibility

- Benefits and applications by sector
  - Public safety
  - Public transportation
  - Utilities
“One Platform, Multiple Technologies”

Transportable Systems
Network Infrastructure
Mobile Unit (in-vehicle)
Desktop Radio Dispatcher
Hand Portable Unit
Motorcycle Kit
Railway On-board Equipment
Radio Modems
Coordination and Control Center
Thank you for your attention

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