PowerTrunk

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

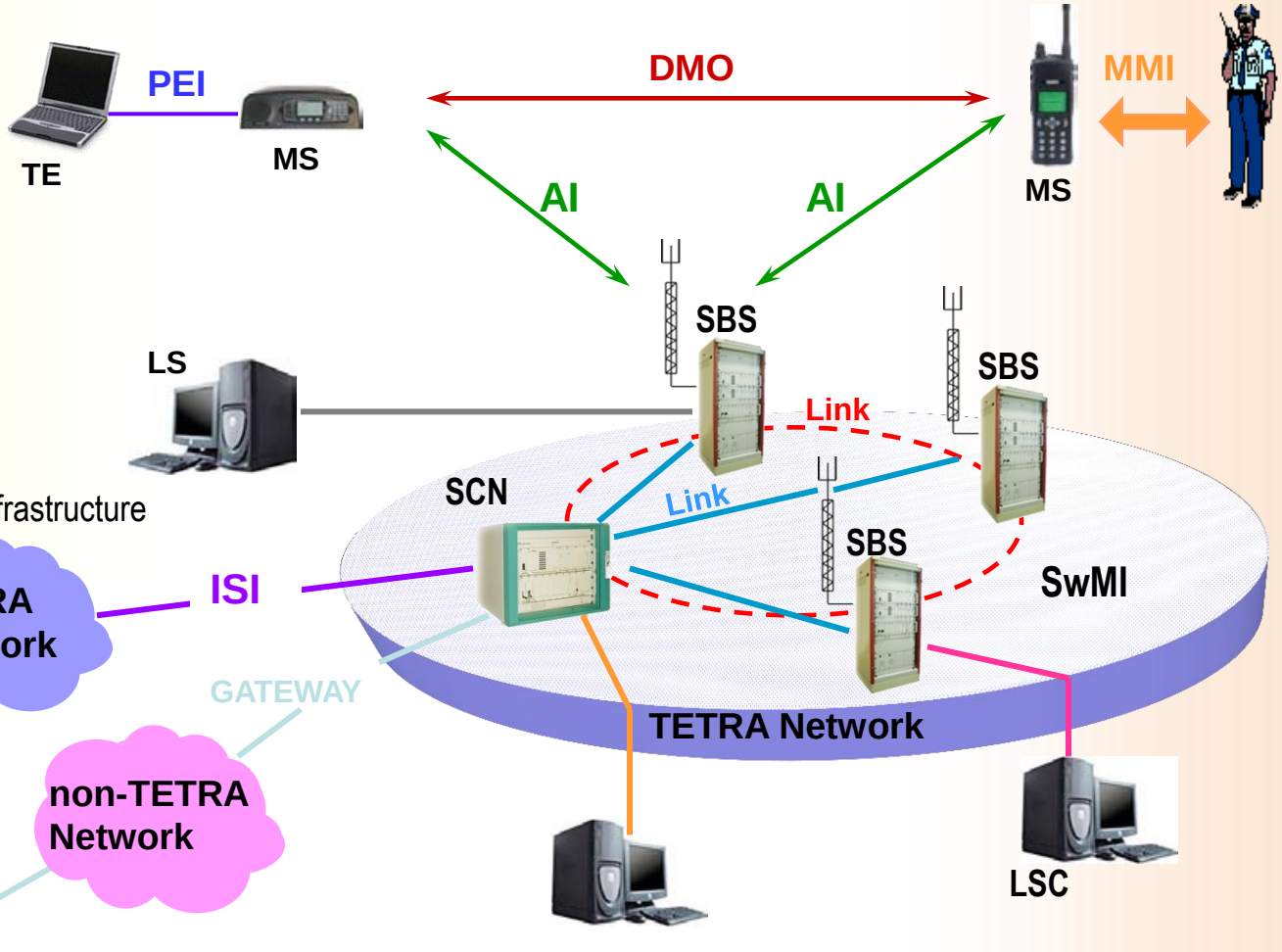
- TETRA
  - What is TETRA?
- P25
  - P25 Phase I / Phase II
- Comparison
  - Similarities and differences

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).

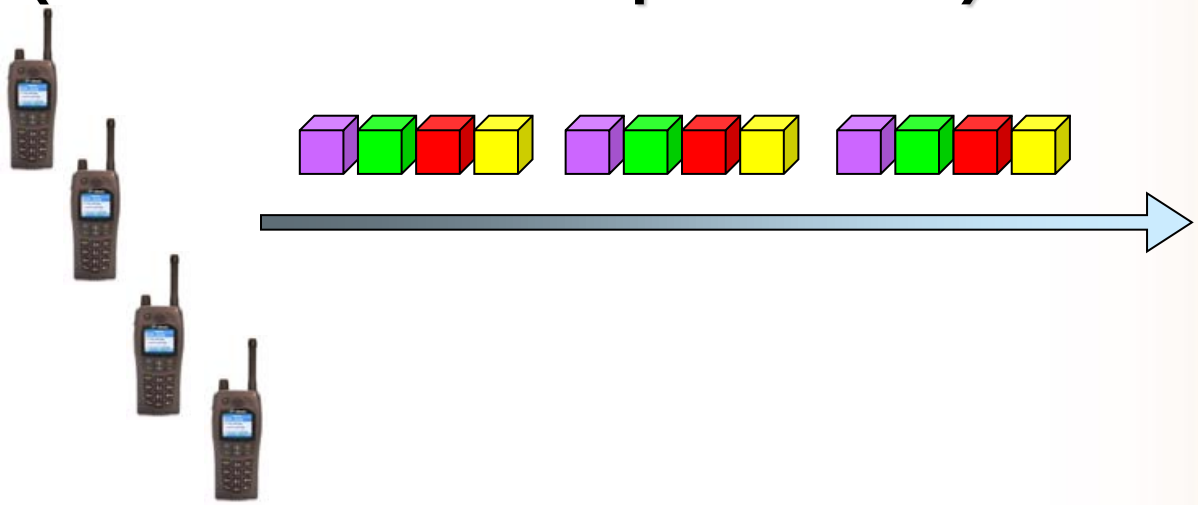
TETRA Standard Elements and Interfaces

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

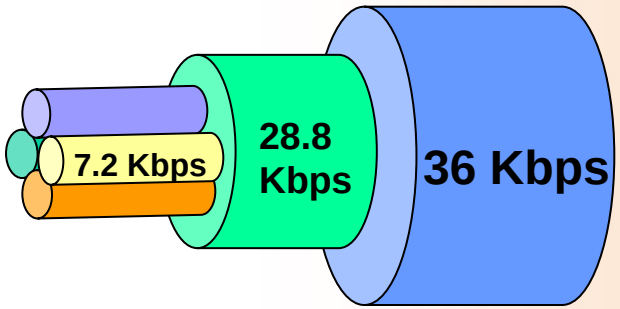


TETRA General Concepts

TDMA (Time Division Multiple Access)

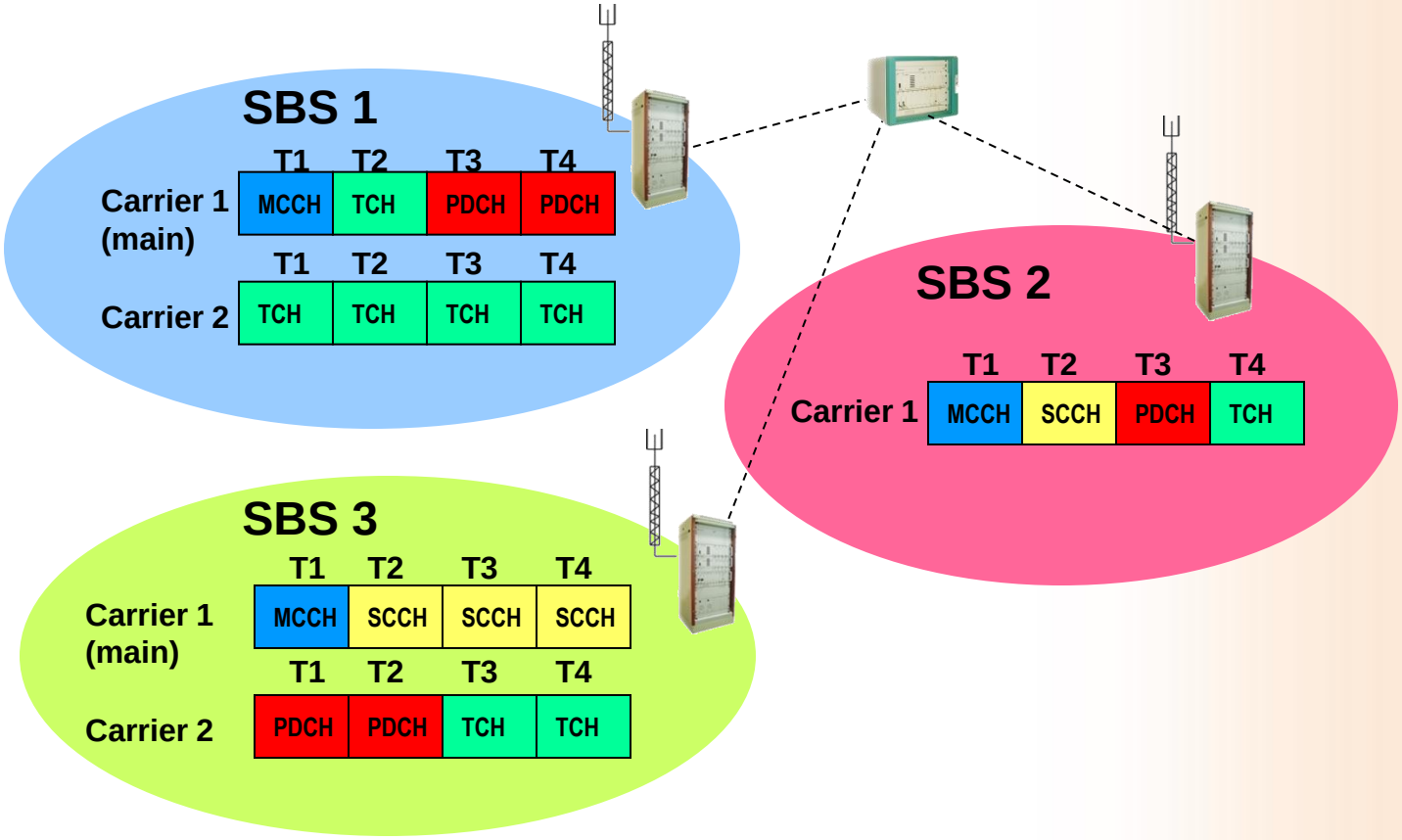


- Each RF carrier (radio channel) is divided into timeslots within a 25 KHz channel.
- The transmission rate is 7.2 Kbps per slot.



TETRA General Concepts

Example of channel distribution



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.

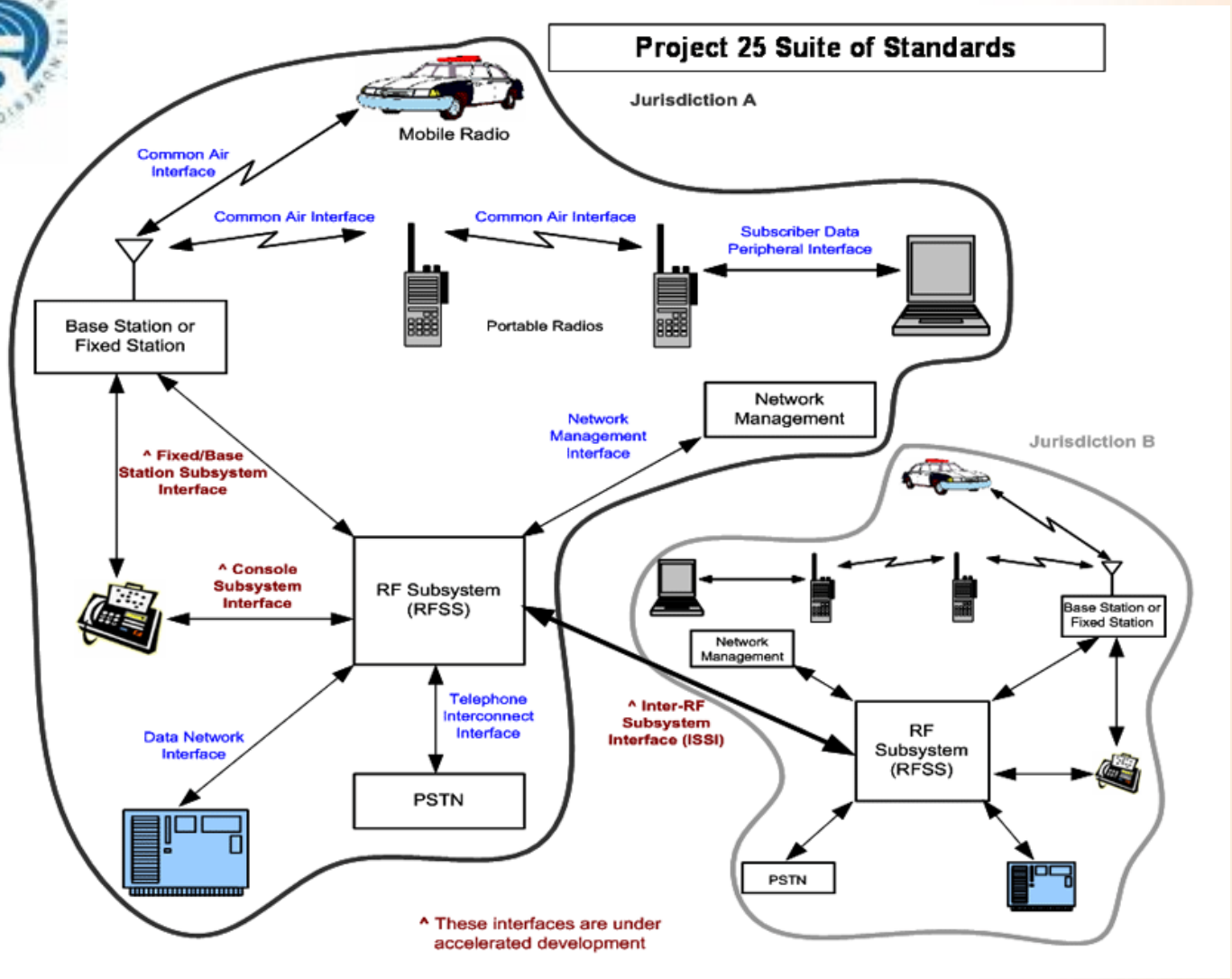
(October 2008 - latest data available)

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.


Project 25 Suite of Standards
Jurisdiction A
Mobile Radio
Common Air Interface
Common Air Interface
Common Air Interface
Subscriber Data Peripheral Interface
Base Station or Fixed Station
Portable Radios
Network Management
Network Management Interface
^ Fixed/Base Station Subsystem Interface
^ Console Subsystem Interface
RF Subsystem (RFSS)
Telephone Interconnect Interface
Data Network Interface
PSTN
^ Inter-RF Subsystem Interface (ISSI)
Jurisdiction B
Network Management
Base Station or Fixed Station
RF Subsystem (RFSS)
PSTN
^ These interfaces are under accelerated development

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

- Cons:
  - Limited data support
  - Delays in Phase II standard (projected 2011)

TETRA / P25 Comparison

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

PowerTrunk

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

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

PowerTrunk

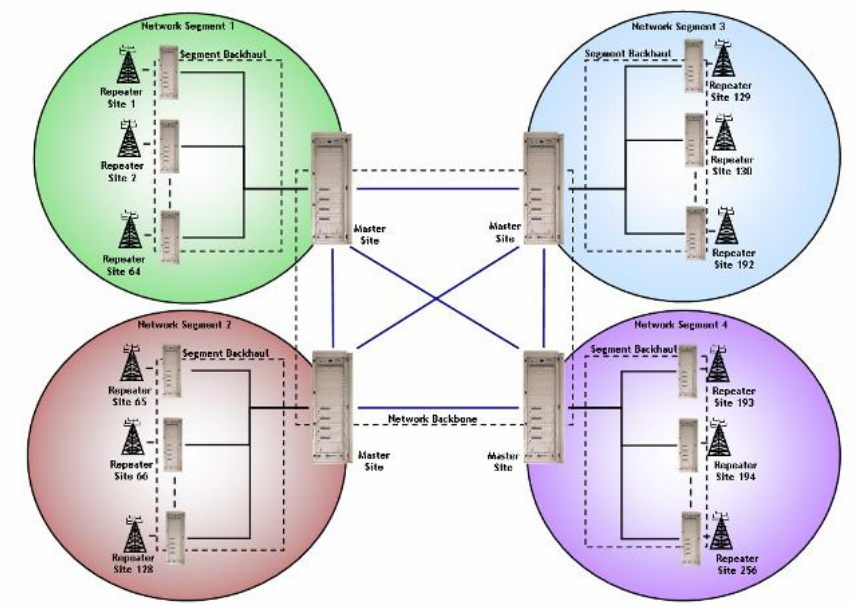
a) Synchronous & Asynchronous links
b) 3rd party portal
c) All TETRA Services Available

Flexible

a) Modern VoIP Line Dispatchers & Recorders
b) Friendly NMS
c) Hot Swapping & Plug & Play

Easy & Friendly

Common Architecture



- 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

NMS server

Master Site Controller

Local Site Controller (LSC)

NMS Client

Dispatching Console

PowerTrunk RF Unit / BSR

- 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.**

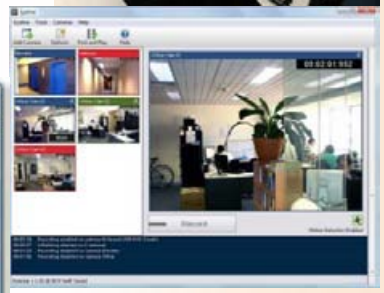
Mobile WiMax RFU

- **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

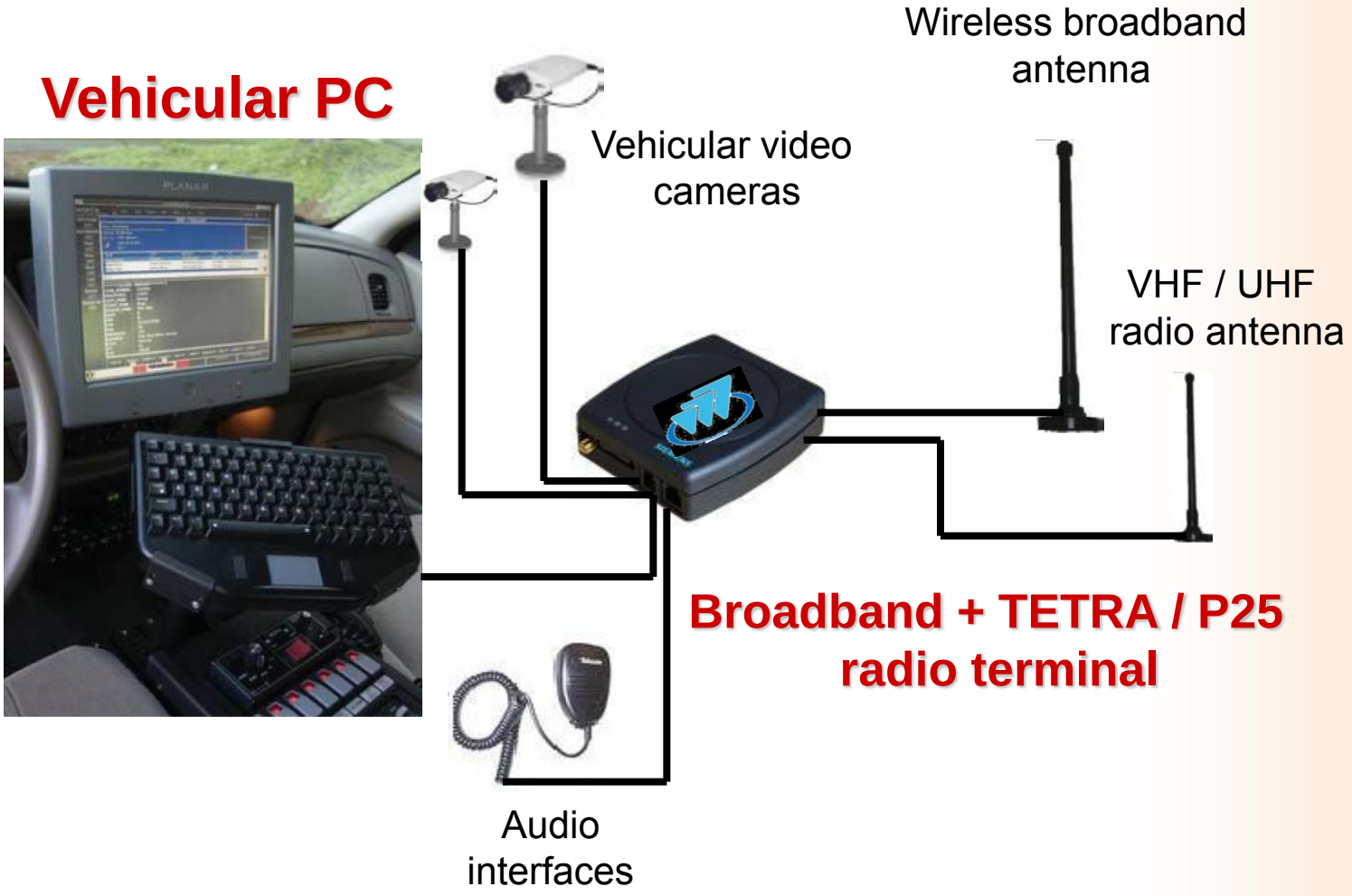
Broadband Performance

- 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

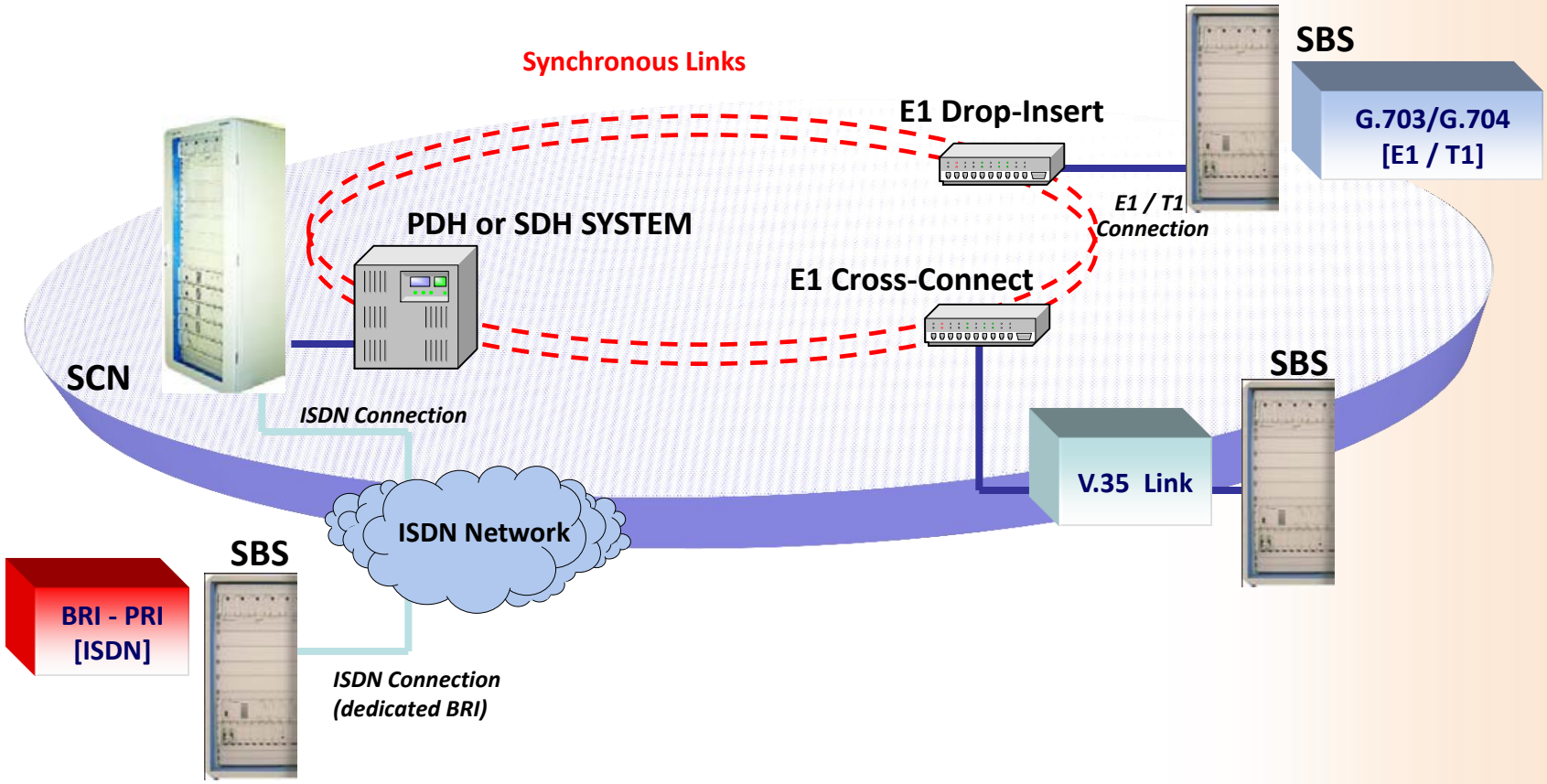


MVC-6000: System Elements



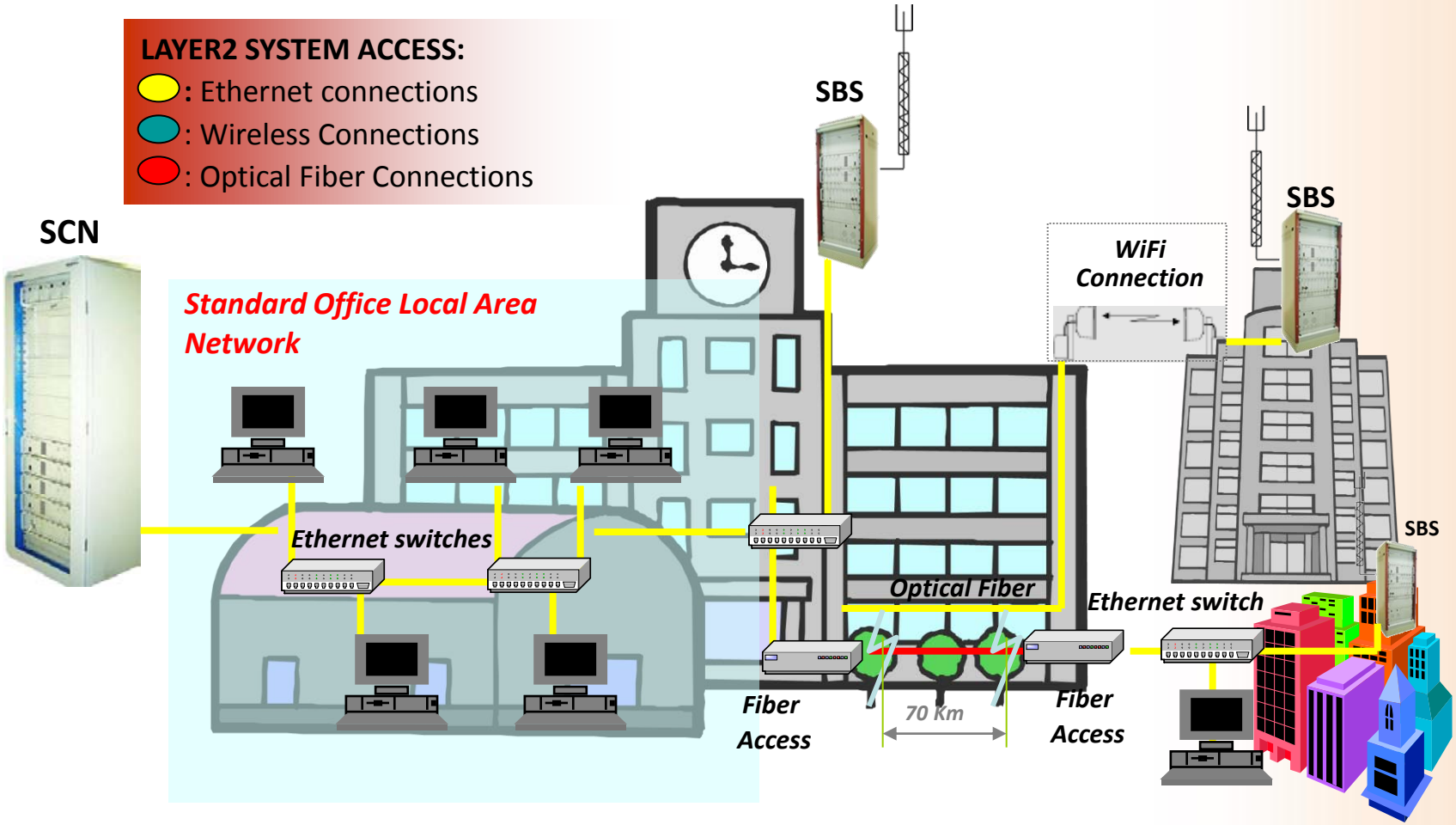
Flexibility in the Backbone Network

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



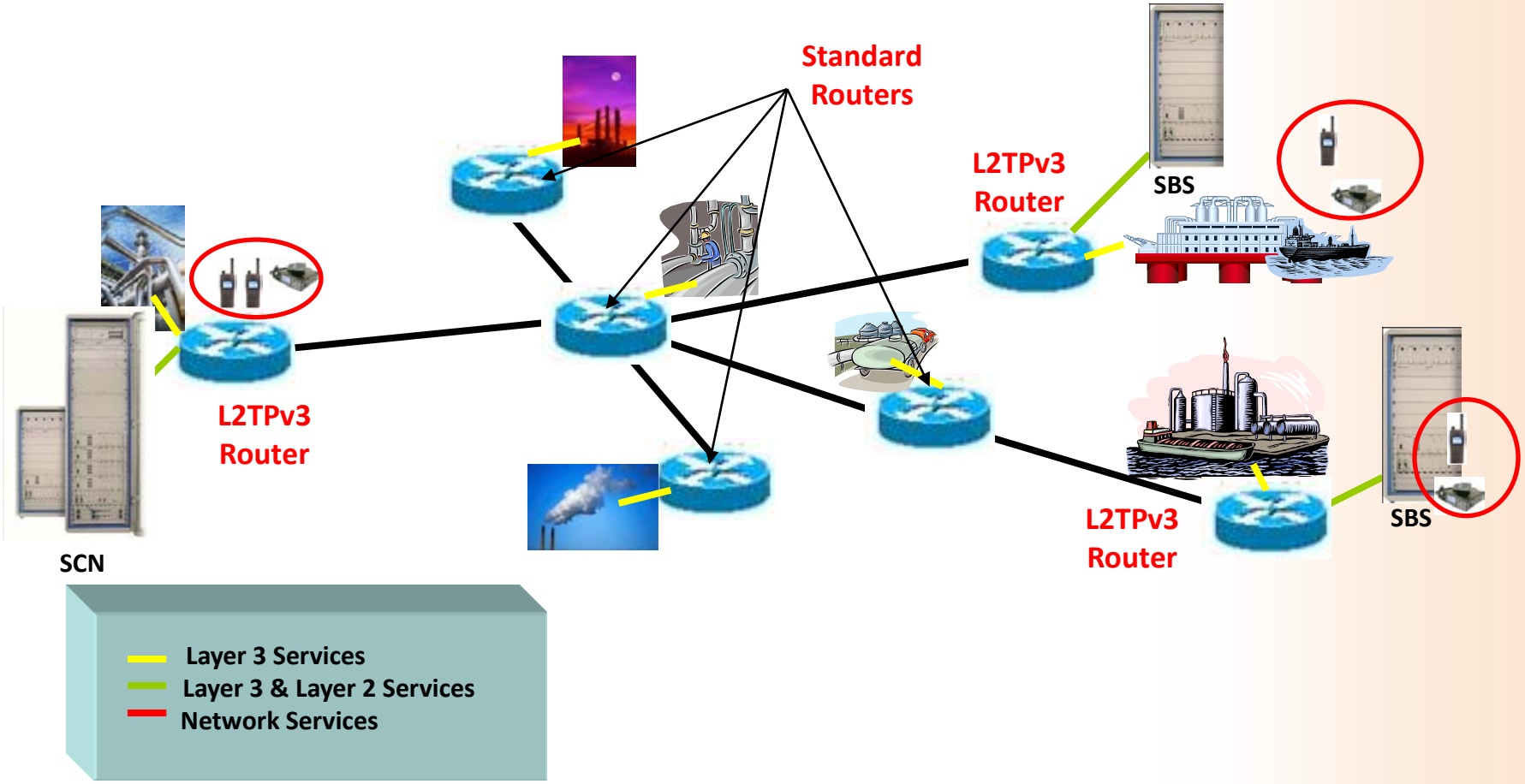
Flexibility in the Backbone Network

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

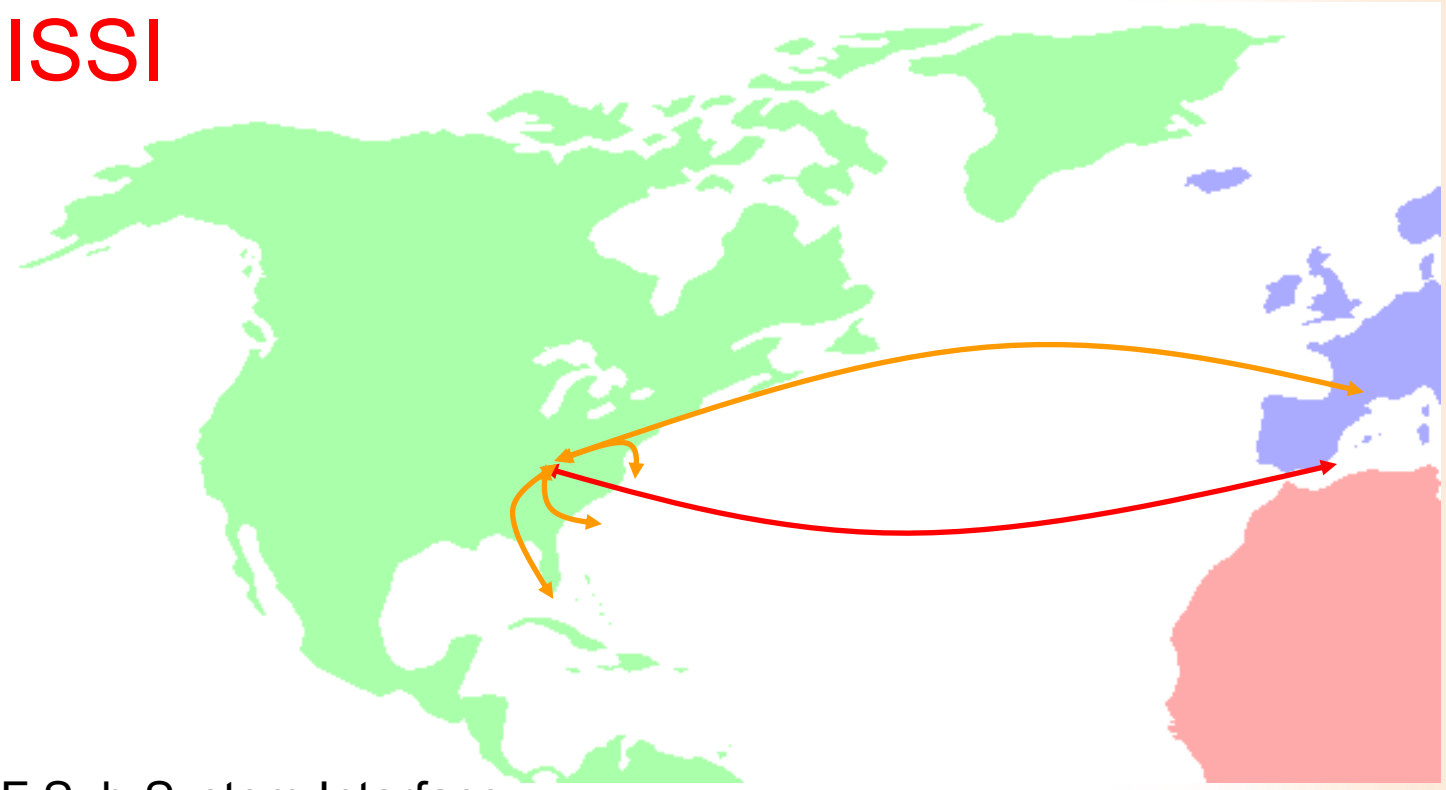


Flexibility in the Backbone Network

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



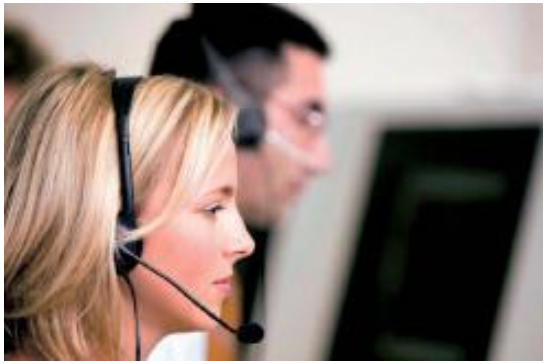
P25 ISSI



- 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.

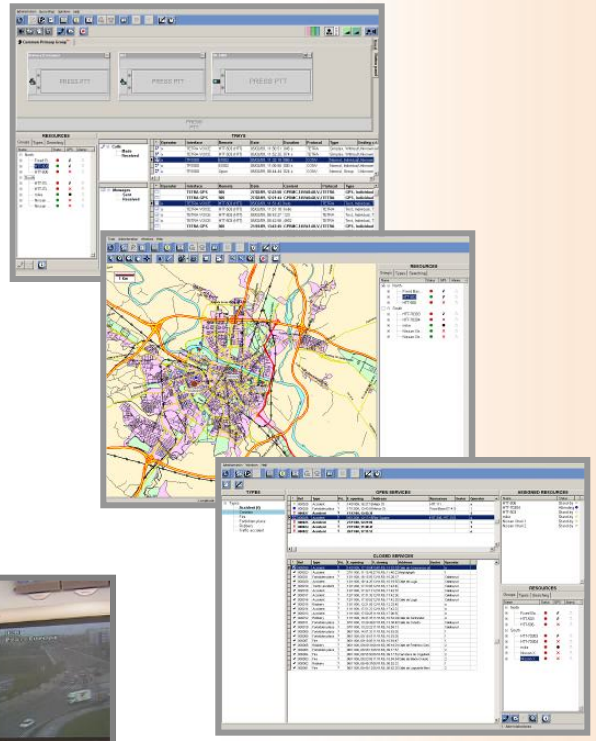
CeCoCo Series

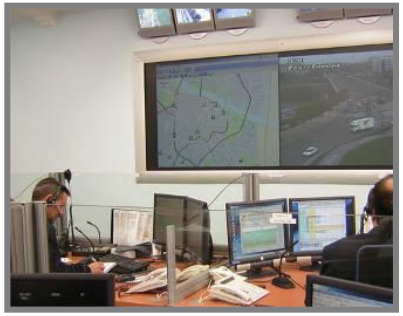
Computer Aided Dispatch Solutions



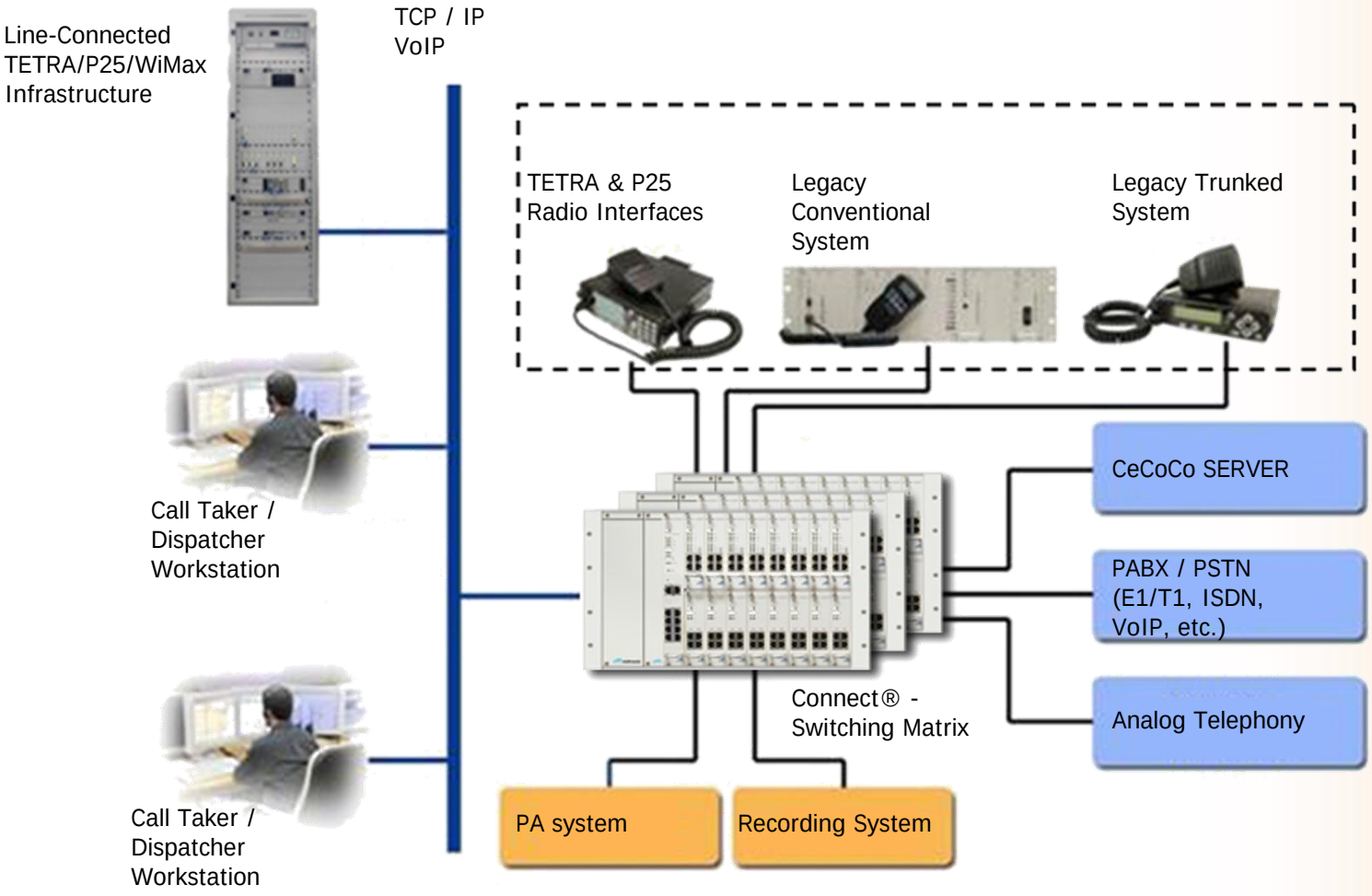
CeCoCo

- 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



TETRA for Transport

Metros / Subways

Trams

Railroads

Buses

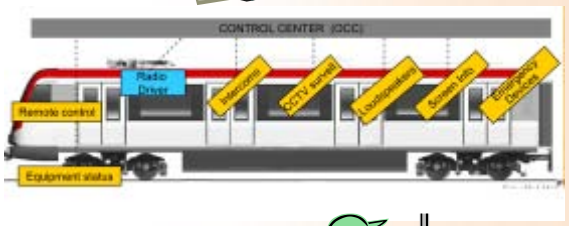
Transport Communications Requirements

- Voice communication between drivers, control centers, depots, and passengers.

- Location systems.

- Data services for remote monitoring of sub-systems.

- Railway signaling.



- Safety and security.

- Communication with maintenance crews.

- Communication with emergency services (police, fire, etc...)

Telecommunications Sub-systems Covered by TETRA

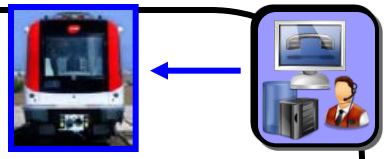
Remote Command and Control of Rolling Stock

Communication Management Sub-system

Interaction with Intercom System

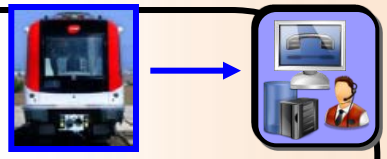
Integration with Public Address Systems

Examples of Remote Controls and Alarms



REMOTE CONTROL:

- Train On / Off
- Identification (Train number and service)
- Emergency brakes
- Brake bypass / Traction loop
- Fire estinguishing 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:

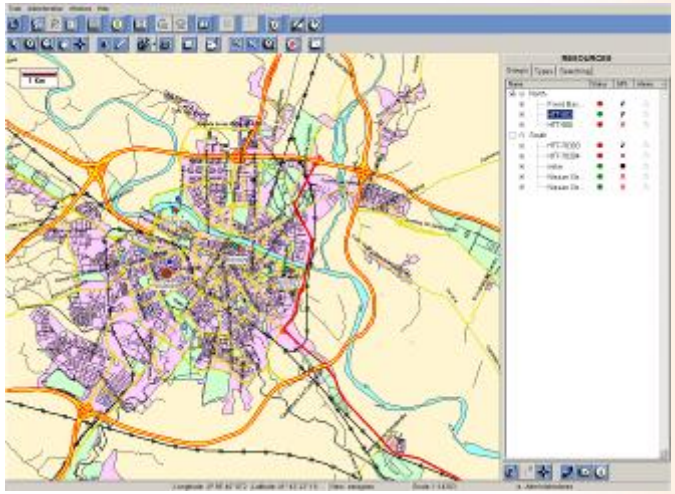
- Use of the **SDS (LIP) service with reservation of air resources,** permitting reception of GPS positions at the base station while avoiding collisions (synchronization concept).
- **Special software in the infrastructure and the terminals.**

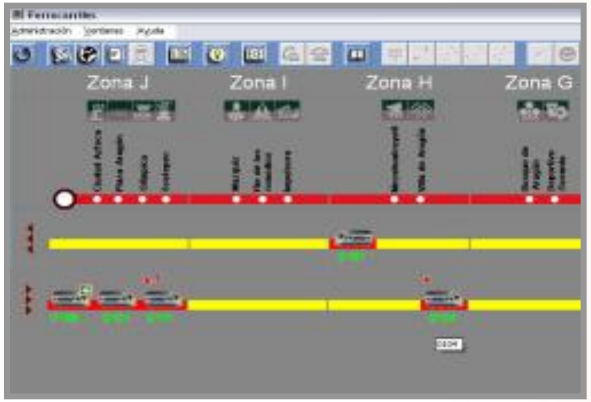
Speed of polling / reply:

- 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**




Zona J
Zona I
Zona H
Zona G

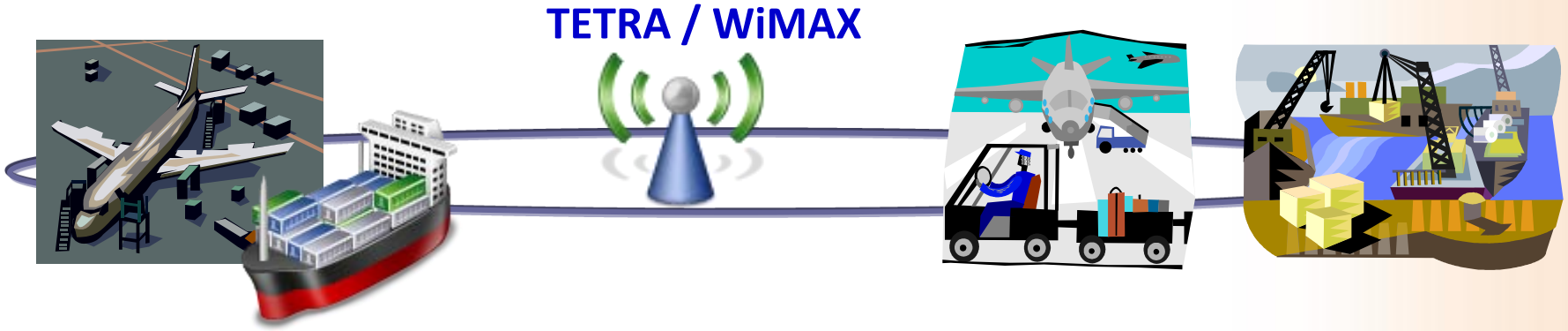
Transport Scenarios

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

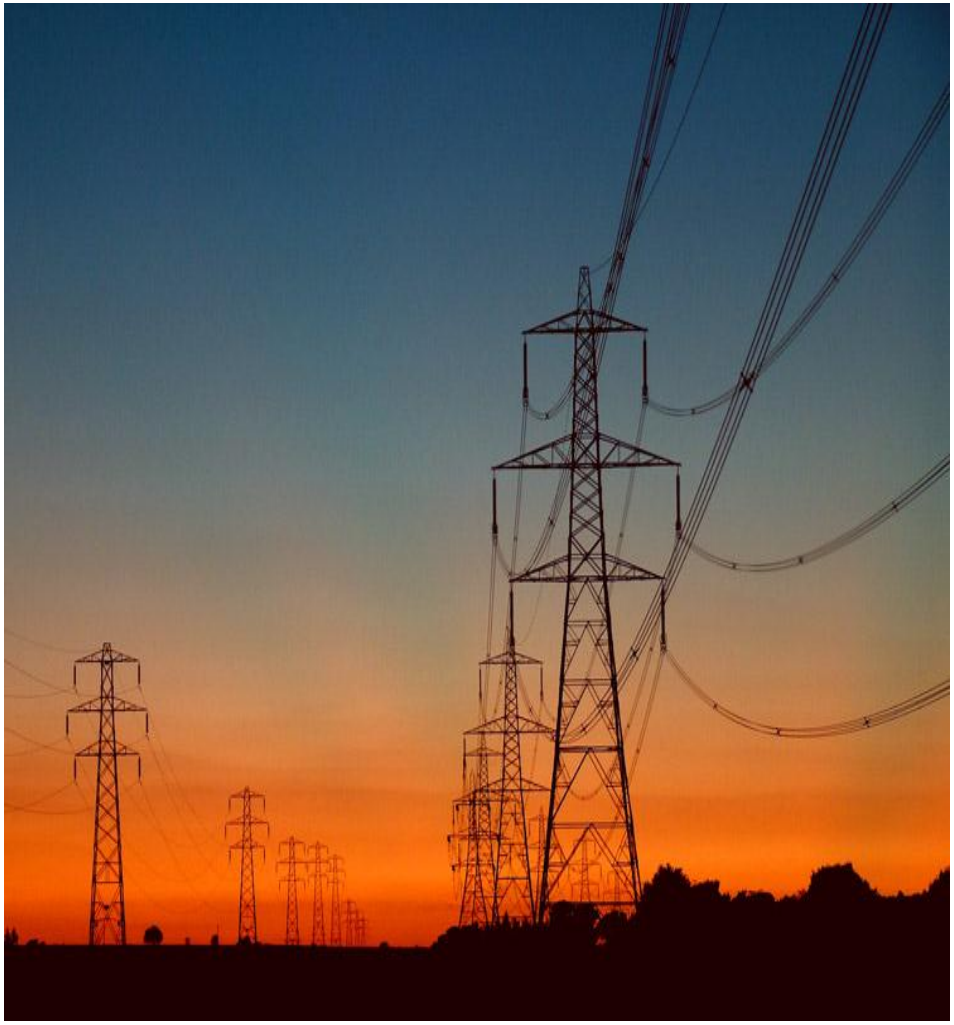
TETRA:
Voice and short data service for train operation
Security services in stations
Voice services for maintenance personnel

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



TETRA for Utilities

1. **Specific data transmission requirements for:**
   - ❑ Permanent monitoring and control of the network elements (Telemetry and Remote control)
   - ❑ Data bandwith 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?

1. **Private Network**
   - ❑ Total network control without depending on operators.

2. **Digital trunking system (cellular)**
   - ❑ 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.

3. **Avoids radio collisions in the air**
   - ❑ TETRA technology solves directly this problem.

4. **Network Growth capacity / Possibility of additional services (voice, etc..)**

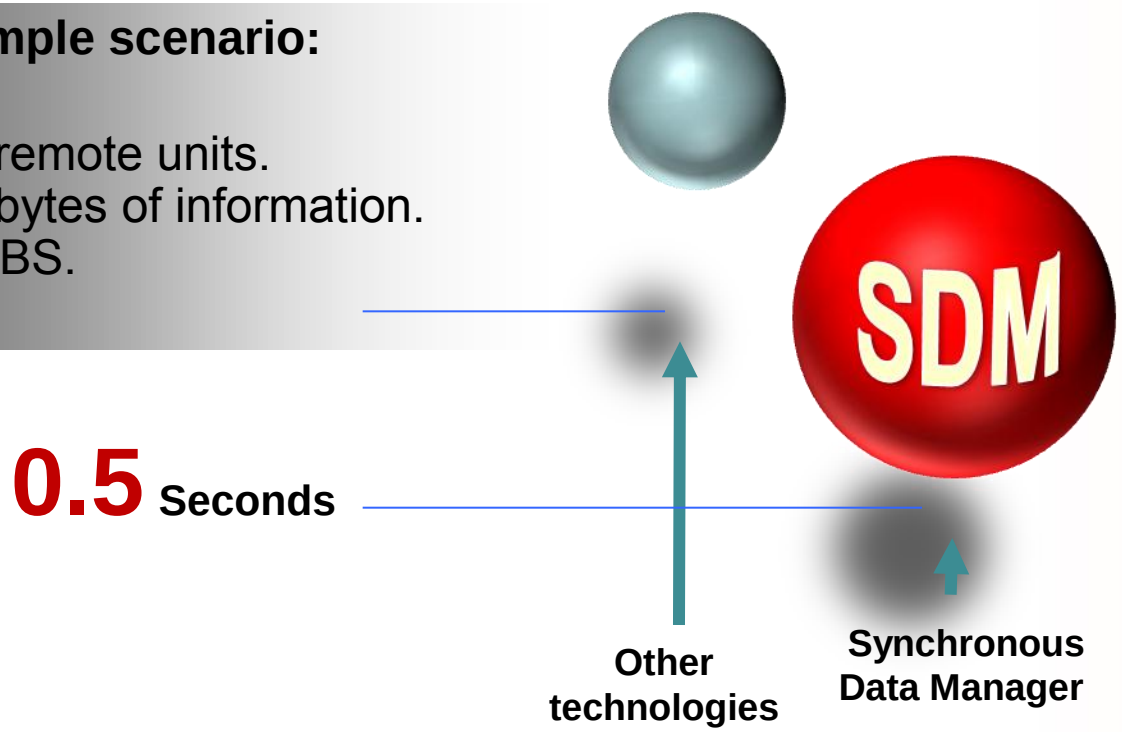
5. **Data services**
   - ❑ Availability of different data services to be adapted to communication needs:
     - Short Data Messages (SDS) and status messages
     - Standard Packet Data service (PD)
     - Circuit Mode Data (CMD)

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:

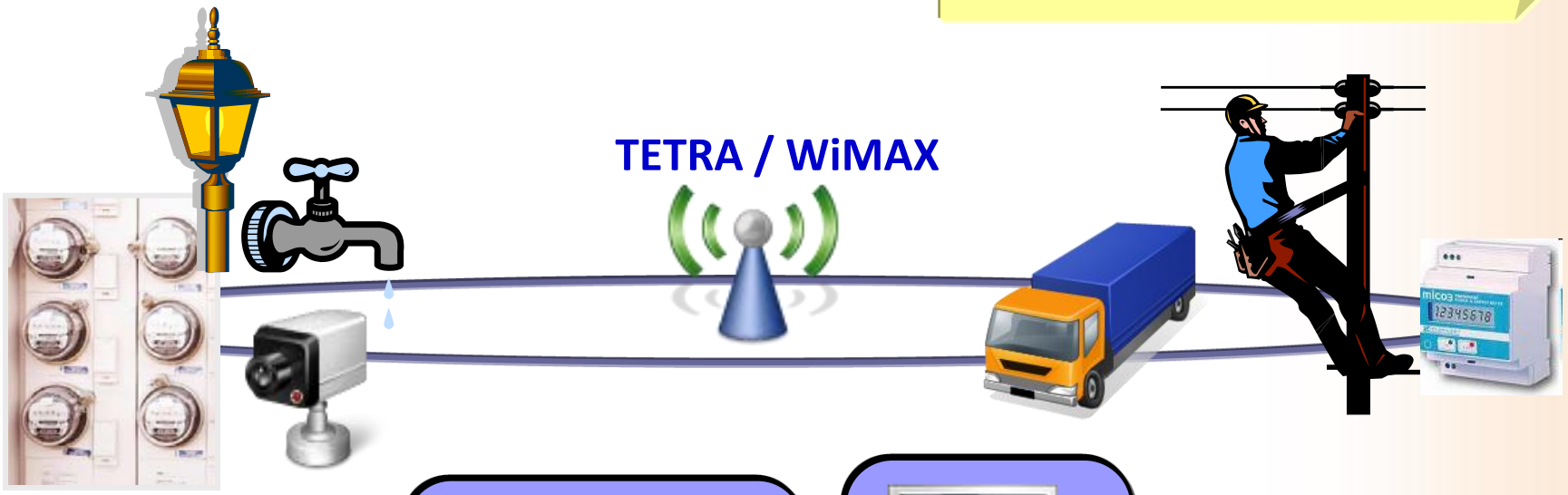
420 remote units.
420 bytes of information.
41 SBS.



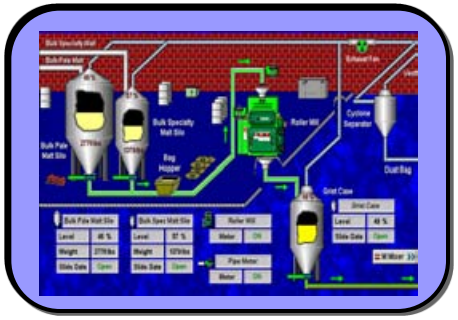
Utilities: Smart Grid Scenario

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



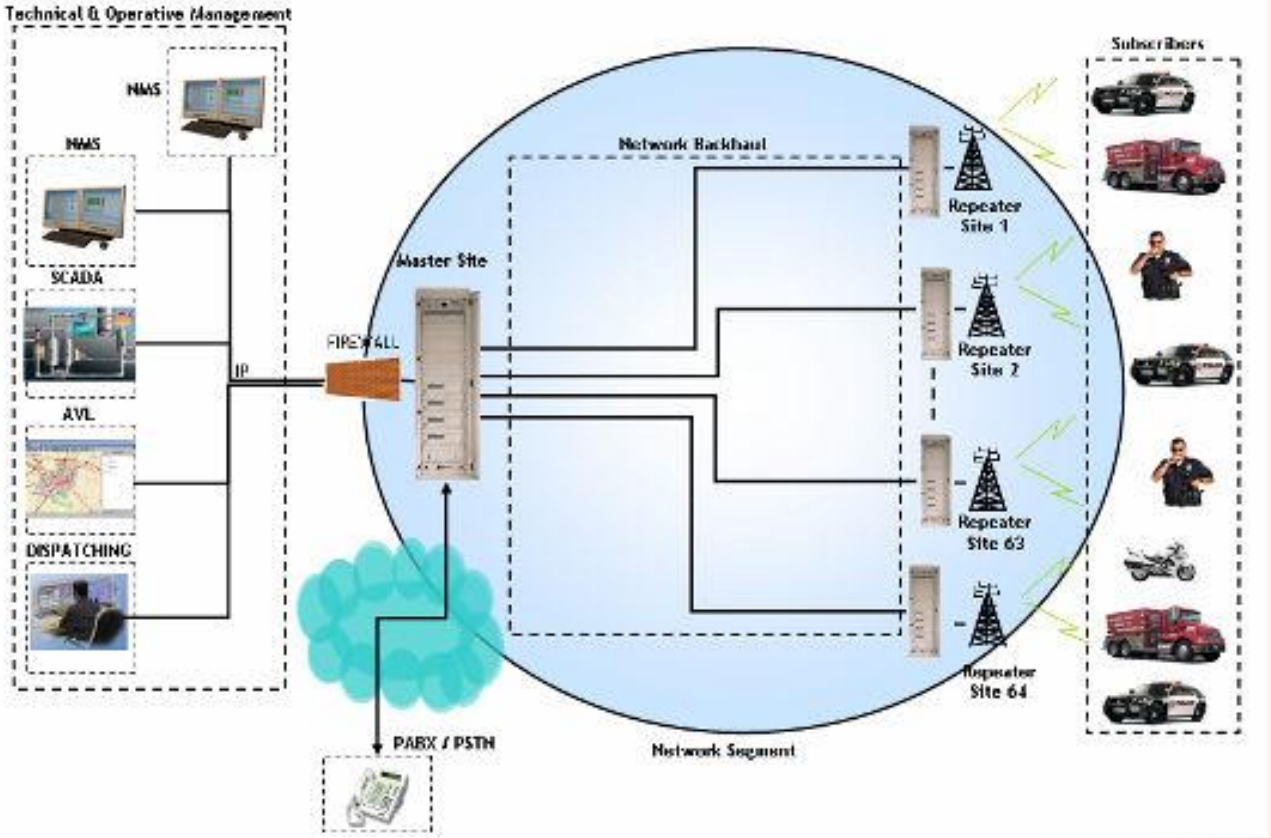
Computer Aided Dispatchers

P25 for Public Safety

Public Safety / Communications Requirements

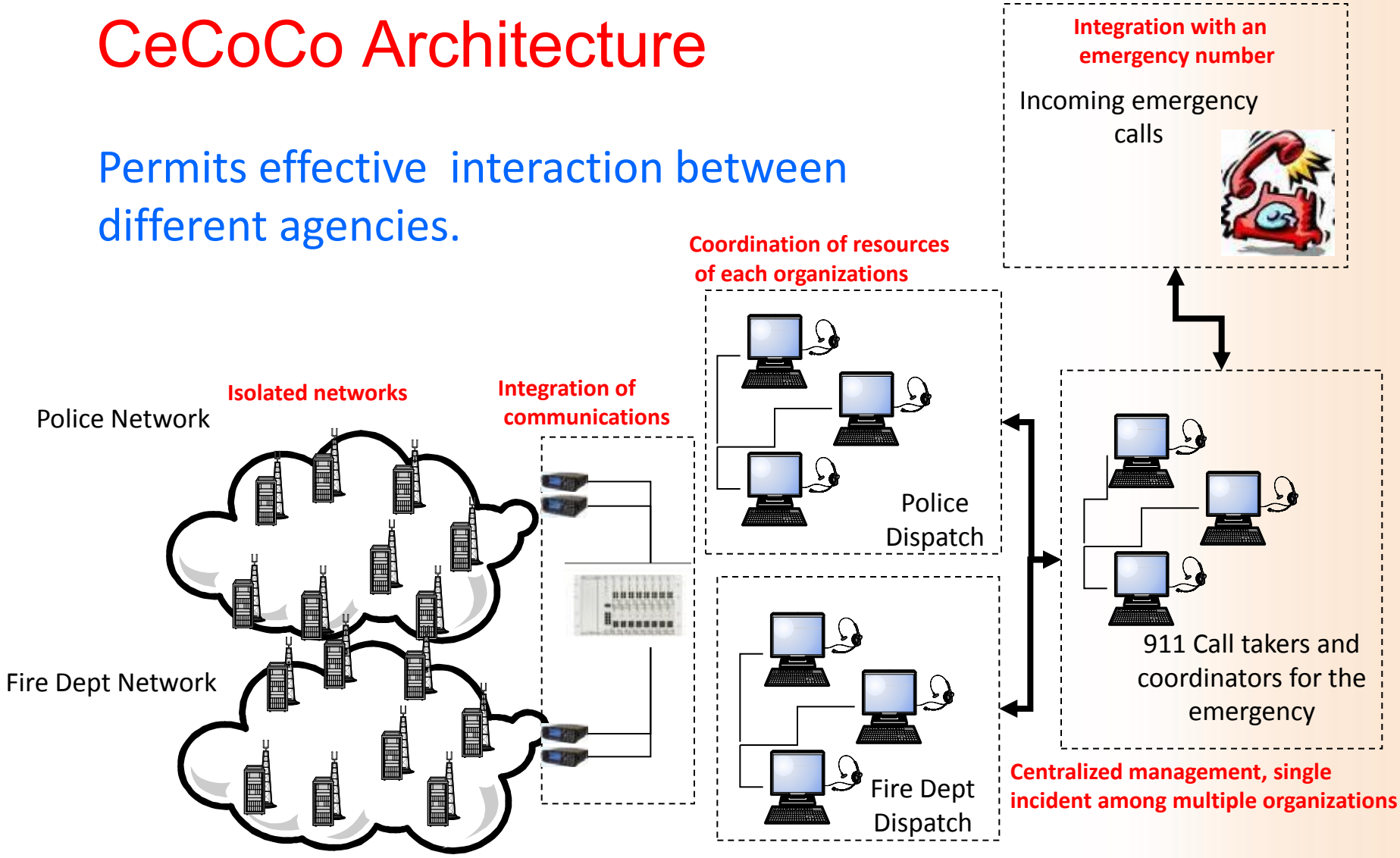
- **Integrated communications** system (radio, telephone, VoIP,..)
- Fast and reliable **voice services**
- **Data services** to improve traditional voice-based operational tasks
- No reliance on public based networks (**avoid saturation** during emergencies)
- **Minimize TCO** (Total Cost of Ownership) 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

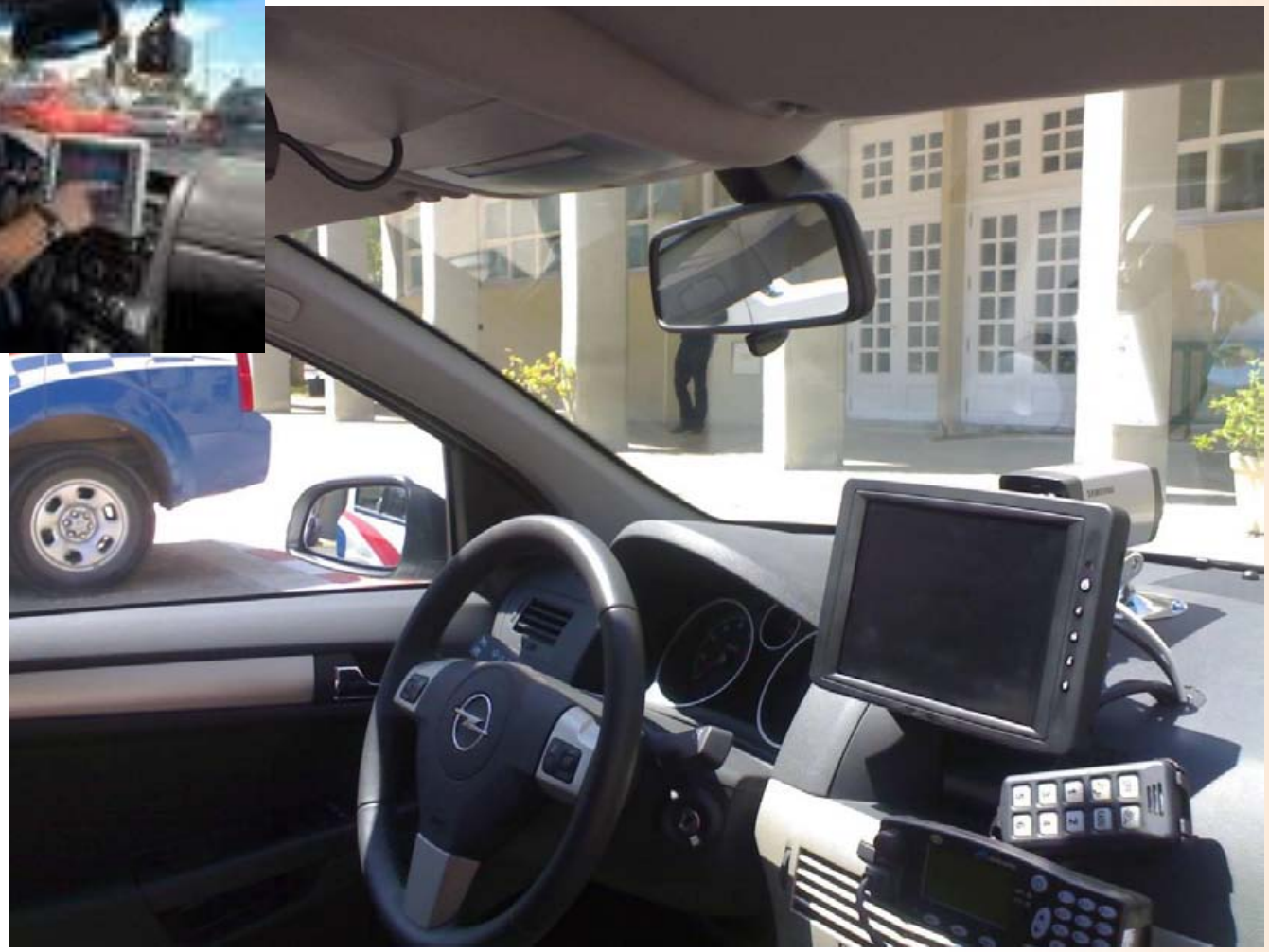


CeCoCo Architecture

Permits effective interaction between different agencies.



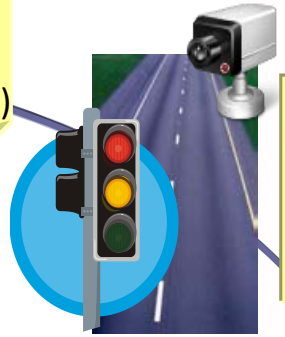
MVC-6000 Multi-Bearer Vehicular Console



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 / WiMAX

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

Integrated Computer Aided Dispatchers

Main Customer References

Transport References



Spain

Alicante Light Train, FGV (ETRA, Vosslogh-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

Mexico

Mexico D.F. Light Train (Alcatel, CAF)

Mexico D.F. Metro Line B (ALSTOM)

Mexico D.F. Metro Line 2 (ALSTOM)

Mexico D.F. Metro Line 12 (ALSTOM)

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

Utilities:

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

Sports Stadiums:

Real Madrid Football Club, Spain

Gas & Oil:

Repsol YPF (Intepla/Intema), Argentina

Operators:

Lig Mobile, Brazil

Airwaves, Auckland city TETRA operator, New Zealand
Telefónica Móviles España, 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

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”

Mobile Unit (in-vehicle)

Desktop Radio Dispatcher

Hand Portable Unit

Transportable Systems

Network Infrastructure

A COMPLETE PowerTrunk SOLUTION

Railway On-board Equipment

Radio Modems

Coordination and Control Center

Thank you for your attention