TETRA
Modern Radio Communication @ CERN

F. Chapron : Head, Communication Support
A. Pascal : TETRA Project Technical Coordinator
CS group, IT Department

CERN IT Department
CH-1211 Genève 23
Switzerland
www.cern.ch/it

Agenda

- Why a new radio communication network?
- What about other radio networks?
- Overview of TETRA technology
- Why is TETRA so successful?
- TETRA benefits for CERN
- TETRA limitations, CERN constraints
- TETRA implementation strategy
- Preliminary Schedule

Why a new radio communication network?

- The current VHF radio network needs to be replaced:
  - The infrastructure is difficult to maintain
    - recurrent problems due to ageing equipment
  - The infrastructure is not monitored
  - The network features do not match any longer the operational needs of the fire brigade
    - No direct inter-site communications
  - Rejuvenating and adapting the current network is not cost-effective
    - Rejuvenation would cost as much as new technologies !
    - More efficient technologies exist

What about other radio networks?

- The mobile network operated by Sunrise (GSM, UMTS) for general communication
  - Doesn't match the operational needs of the fire brigade
  - This mobile network is NOT A SAFETY SYSTEM!
  - Operated externally and not designed for safety needs
  - The mobile network can be a complement to the radio network
- Ad hoc portable mobile radios for security and crane drivers (UHF)
- Other radio communication network/tools are subject to IT/CS approval that coordinates on behalf of the OFCOM the radio frequency planning at CERN

(*) The WiFi network operated by CS for data exchange on site is not taken into account in this topic

OVERVIEW OF TETRA TECHNOLOGY

ETSI Standard

- **TE**rrestrial **T**runked **RA**dio (TETRA) standard developed by the **E.T.S.I.** in 1994.
- TETRA : **open standard, open interfaces, services and facilities**
  → Interoperability between each component of the network
  → ↗ competition between manufacturers ↘ prices of products
- **2 Versions** (phases) :
  - TETRA Version 1
  - TETRA Version 2
- Part of the Public Mobile Radio **(PMR)** technology oriented **group** communications
  - Other digital technologies = DMR, TETRAPOL (proprietary), P25 (U.S.)

Overview of TETRA technology

Evolving…

- ETSI Technical Committee **(TC)** TETRA :
  - → complying with new user requirements
  - → gleaning the benefits of new technology innovations.
- **TETRA MoU** : forum for user organizations, manufacturers, application providers, integrators, operators, test houses, regulators, consultants, etc.

… and World-wide oriented

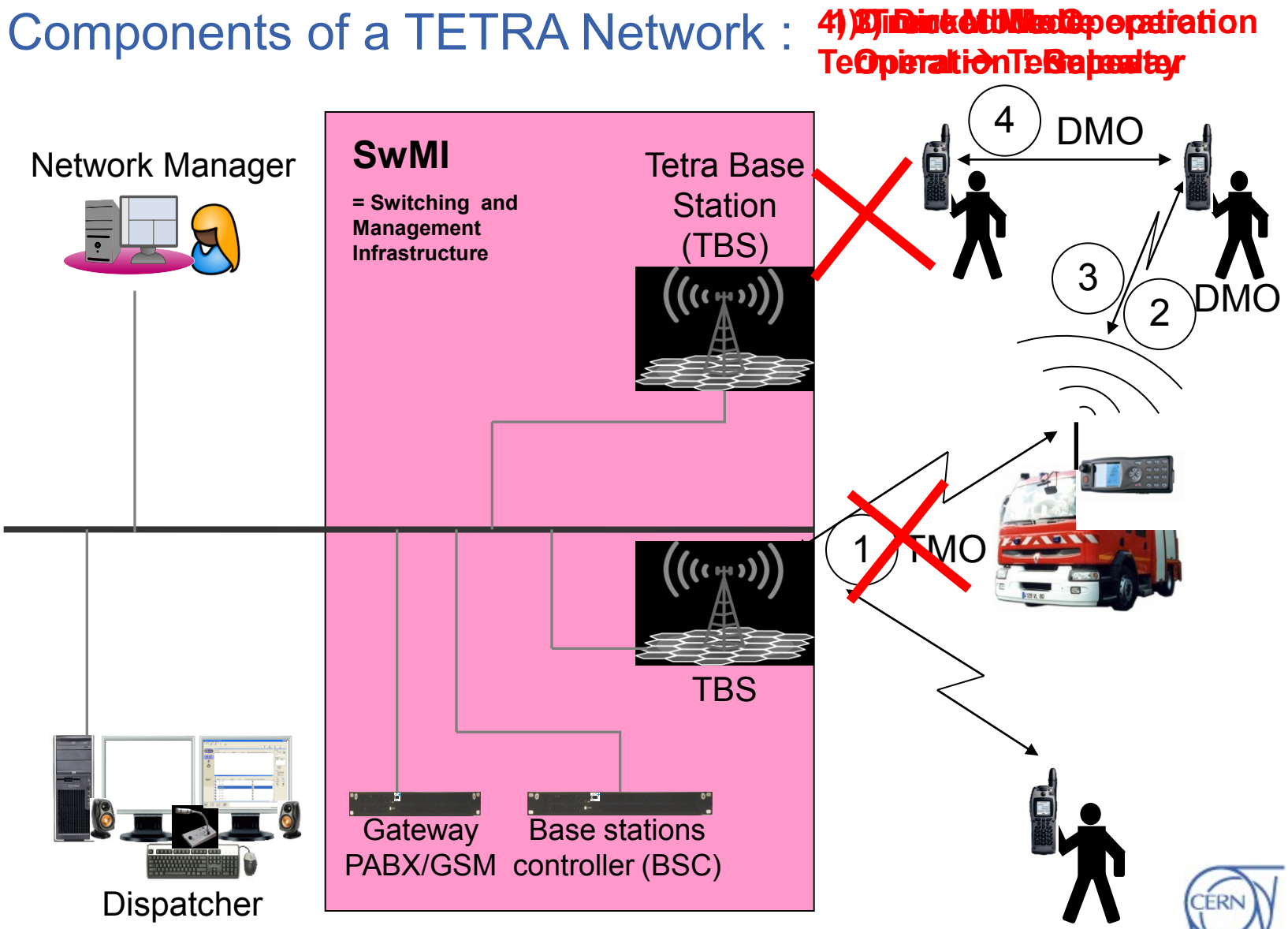
- Since 1997, **hundreds** of TETRA networks have been deployed world-wide :
  - – First networks deployed in **Europe**
  - → rapid uptake in the regions of **Asia, Middle East** and **South America**.

Targeted Market :

- **Public Safety** organizations → use TETRA or TETRAPOL (in E.U.)
- Transportation (airports, bus, metro..)
- Governmental institutions (police,...)
- Military
- …

Overview of TETRA technology

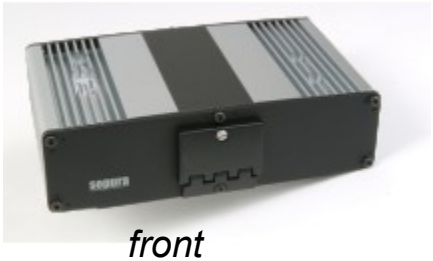
Components of a TETRA Network :



Overview of TETRA technology

Infrastructure (TBS, BSC..)

back



front

Fixed radios

(vehicles/control rooms)

Hand-portables

CERN IT Department
CH-1211 Genève 23
Switzerland
www.cern.ch/it

Overview of TETRA technology

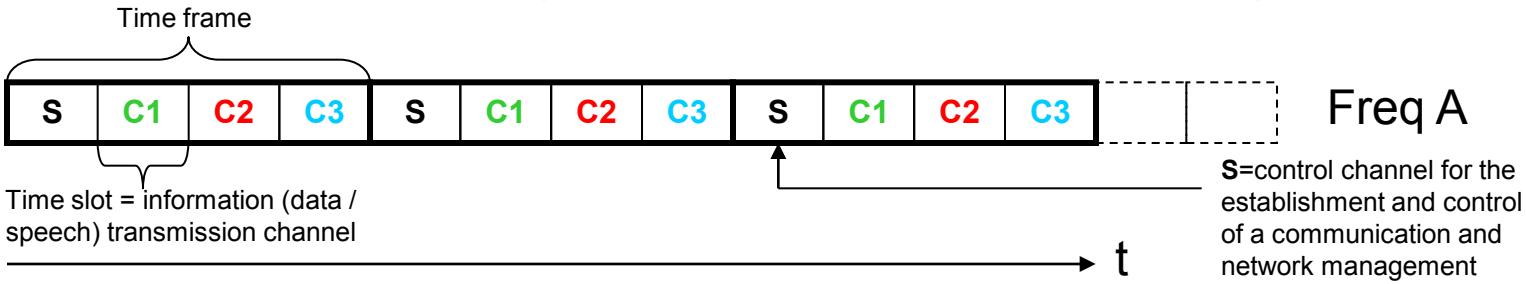
How does it work?

- **RF Spectrum :**

  TETRA for European market :
  - **410-430**MHz (25kHz bandwidth channels)

- **Digital Modulation :**
  - To transport signals **efficiently** (limits corruption of signals, synchronization problems..)
  - Uses pi/4 DQPSK to encode digital signals (**D**ifferential **Q**uaternary **P**hase **S**hift **K**eying) = **Phase** modulation

- **Multiplexing : TDMA (Time Division Multiple Access)**



→ Spectrum efficiency : more radio users per RF channel

→ Solves problems of contention, inefficient channel utilization (trunked mode), Manual Switching of Channels (cell handover), Radio User Abuse (localization of users)…

STANDARD Services

Voice services:

- Half and **full** duplex communications
- **Individual** calls : one to one
- **Group** calls → broadcast within group : one to everyone in a group
- Direct Mode Operation **(DMO)** (terminal-terminal**,** Gateway, Repeater)
- **Restricting access** to radio resources to only **registered** and **authenticated** radio devices
- **Pre-emptive priority** call functionality
- "**Busy Queuing**" to store calls (per user priority) in the controller during busy period
- "**Ambiance listening"** to enable the distant listening to background noises within the range of a radio terminal in case of incident

Overview of TETRA technology

Data Services :

Version 1 = current version

Short Data Service :

- up to 256 bytes of data
- basic status messaging, location information, call set-up configurations
- supported on TETRA control channel TDMA time slots

Packet Data Service:

- supported on 1 to 4 TDMA time slots with a rate of 4,8kbits/s to 19.2kbits/s

Version 2 = future version

TEDS (TETRA Enhanced Data Service) :

- maximum **538kbits/s** (in DL)
- TEDS uses different RF channel bandwidths (50 kHz, 100 kHz, 150 kHz) and modulation schemes to ↗ data rates

→ But as confirmed by the OFCOM (Office Fédéral des Communications in Switzerland) the current limitation caused by insufficient RF spectrum will probably limit early deployments to 50 kHz RF, indeed 25kHz, channel assignments only

Far future:

Integration of public mobile technologies such as **LTE** or **WiMAX** for High Data transfer rates ?

CERN IT Department
CH-1211 Genève 23
Switzerland
www.cern.ch/it

Overview of TETRA technology

Security :

- Authentication, Air Interface Encryption (**AIE**) and End to End encryption :
  - Four **AIE** TETRA Encryption Algorithms (**TEAs**) :
    - TEA1 : European commercial use
    - TEA2 : European public safety organizations
    - TEA3 : Public safety organizations outside Europe
    - TEA4 : Commercial use outside Europe
  - The Advanced Encryption Standard **(EAS)** is the default interoperability algorithm for **end-to-end encryption**

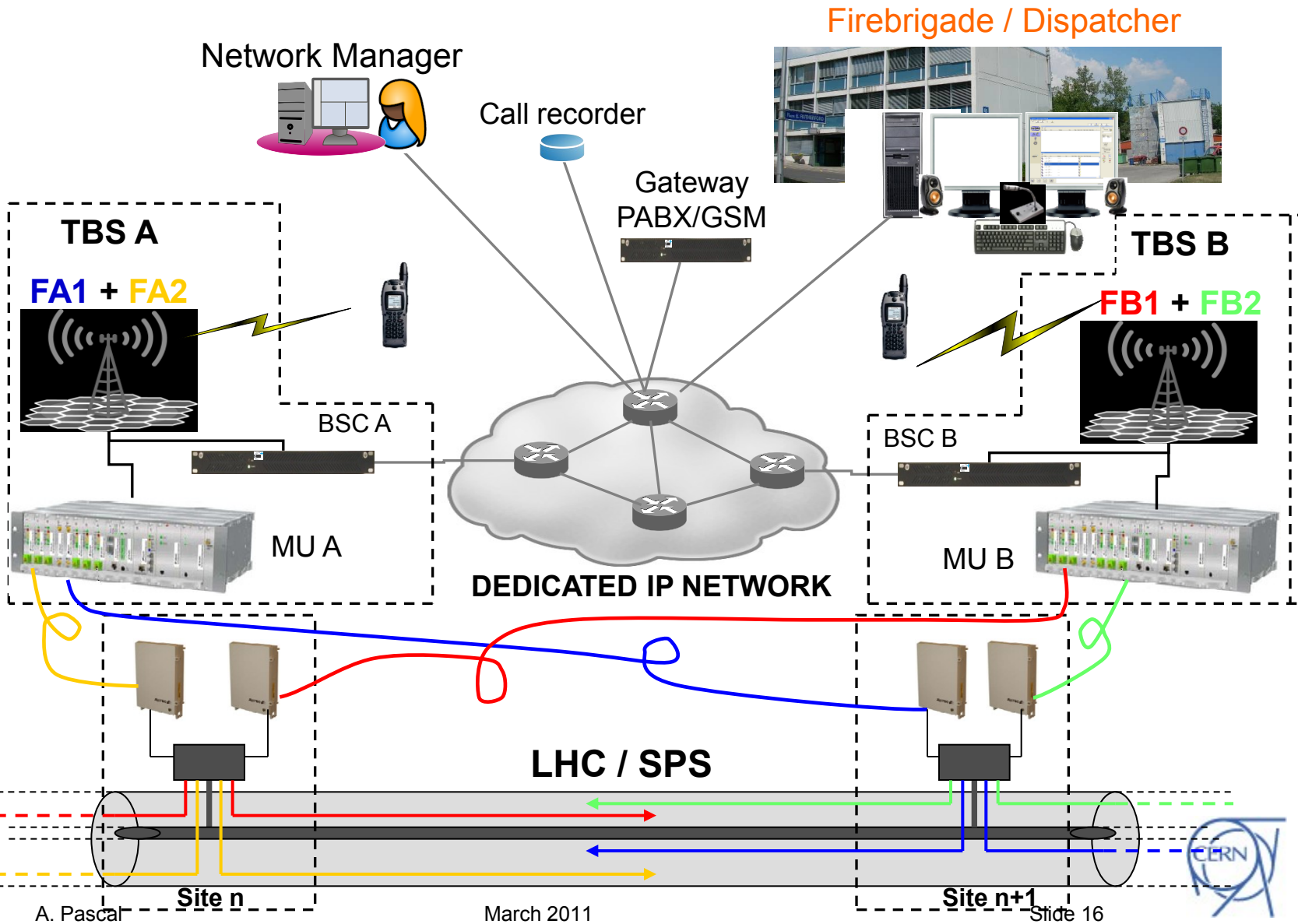
Overview of TETRA technology

NETWORK characteristics required by CERN

- **Redundant** architecture
- **4** TETRA frequencies : at least 2 TBS and 17 repeaters
  → allowing up to **14** simultaneous calls shared among all CERN groups
  → to ↗ this number → new study + additional equipment
- **Coverage** : surface (400km2) and tunnels (~50km of radiating cable)
- Interconnection with **PABX** for emergencies
- Relay of Swiss and French **TETRAPOL** frequencies
- Gateway with **VHF** frequencies :
  - CATASTROPHE : Swiss emergency frequency (Geneva airport fire brigade)
  - CASU : Swiss medical emergency frequency
- **Other users communities** (security, experiments, environment…) may be integrated in the network :
  → to facilitate maintenance interventions (+ telemetry)
  → to operate a remote monitoring
  → Cooperation with the fire brigade if required

Overview of TETRA technology

EXAMPLE OF POSSIBLE CONFIGURATION



CERN IT Department
CH-1211 Genève 23
Switzerland
www.cern.ch/it

Overview of TETRA technology

Which services for CERN ?

Preliminary requirements:

- General **Lone Worker Protection** service on radio terminals
  - Devices that automatically alert fire brigade in case of no body motion or verticality loss
- **SNMP** monitoring

Desirable:

- Geo-localization outdoor and **indoor**
  - To help rescue people
  - To broadcast messages to evacuate an area
- **Data** transmissions (telemetry)
  - Limited due to low data transfer performances on TETRA
  - Monitoring of critical or confidential services

Other TETRA services : management of groups, DMO Gateway and repeater services on mobiles, restricting access to radio resources, pre-emptive calls, priority calls…

STRATEGY OF DEPLOYEMENT

Why is TETRA so successful?

TETRA key points :

- Open standard
- Compatibility with the existing leaky feeder infrastructure
- A TETRA infrastructure can be used to carry TETRAPOL signals
  - This would allow French and Swiss firemen to use their communication equipment in the tunnels
- The TETRA market is “mature”
  - Hundreds of TETRA networks have been deployed across the world
  - Several competing manufacturers and service providers
- Availability to broadcast within groups
- Potential optimisation on costs and operation
  - Interconnection of several groups on the same infrastructure
- Custom Devices
  - Many robust devices designed for safety, security and collaborative works
  - Compliance with security norm ATEX (to intervene in “explosive” areas)

TETRA benefits for CERN

- Operation and monitoring will be performed by CERN
  - Allows CERN and the firemen to have a clear understanding of the availability of communication services at any time
- Support will be ensured 24/7 by an on-site CERN contractor
- At least 4 hours of power autonomy for the system
- Radio coverage
  - Would be improved to cover not only CERN sites, tunnels, but also roads to hospitals and Geneva surroundings
- Interesting features
  - Prioritisation: firemen will always have priority for network resources
  - Communication confidentiality
  - Several Groups: other CERN services could use this infrastructure
- More efficient for CERN Firemen who are used to working with similar technologies in their country of origin

TETRA limitations, CERN constraints

TETRA limitations:

- TETRA infrastructure and terminals are more expensive compared to GSM
- The technology offers many features but as a new activity at CERN we need to gain experience - in particular for operation and maintenance

CERN environmental constraints :

- We still have to validate electromagnetic compatibility between TETRA and all our experimental infrastructure
  - LHC experiments, Fixed-target experiments, accelerator complex (PS, SPS)
- Any equipment made of electronic components shall be located on the surface
- The future system shall be installed in parallel to the existing VHF radio infrastructure
- Wide coverage: roads to reach two distant sites to cover (hospitals)

TETRA implementation strategy

PHASE 1:

- Design the network architecture, services and resources usage to meet IN PRIORITY the fire brigade requirements
  - *I want to be rescued in case of incident!*
- Relay the radio services of the French and Swiss fire brigades in underground infrastructure
- Preserve interconnection with existing external rescue services
  - Airport and Geneva ambulances

TETRA implementation strategy

PHASE 2:

- Progressively integrate other CERN services such as :
  - Experiments' support
  - CERN site security services
  - Logistic services (crane drivers, etc.)
- Implement ONE communication group per experiment/service (for those interested)
  - Users would have to finance the radio devices
  - Radio Devices management under IT/CS responsibility
- Study a rental service for temporary needs
  - Example: Power maintenance during annual closure

PHASE 3: Advanced services

- Lone worker protection services
  - Build-up a “service” with the fire brigade
- Outdoor/Indoor geo-localisation
  - Indoor service is a challenging project for providers
- Secured telemetry (limited)

Preliminary Schedule

- An invitation to tender process is on-going
  - Response to Market Survey already being analysed
  - Call for tender before end of April 2011
  - Validate an evaluation system during Summer 2011
  - Issue a purchase recommendation for FC in December 2011
- Other activities in 2011
  - Prepare the required fibre infrastructure
  - Compatibility tests with experiments and accelerators
  - Prepare secured power distribution

Preliminary Schedule

- PHASE 1: First semester 2012
  - Implementation of the network infrastructure
    - In parallel to the existing VHF infrastructure
  - Implement the fire brigade services
    - CERN, French, Swiss
- PHASE 2: Second semester 2012
  - Aggregate existing radio services
  - Propose radio services to new groups
- PHASE 3: Be ready for 2013 maintenance activities
  - Fire brigade ready to use the new TETRA services
  - Lone worker protection services
  - Possibly device rental services

QUESTIONS

CERN IT Department
CH-1211 Genève 23
Switzerland
www.cern.ch/it