UNIVERSITÀ DEGLI STUDI
DI MODENA E REGGIO EMILIA

Large Scale Integrated Project

A holistic approach towards the development of the first responder of the future

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SEVENTH FRAMEWORK PROGRAMME

Introduction

- **Natural disasters, CBRN (Chemical, Biological, Radiological, Nuclear) and terrorist attacks using explosives can cause massive destruction, high mortality and many casualties not only in urban areas but also in critical infrastructures, usually, without warning; this is particularly true for earthquakes.**
- **Earthquakes involve more than 30% of the total fatalities from natural disasters the last 20 years. On average, about 7 lethal earthquakes were occurring each year in the 20th century.**
- **Terrorist attacks especially in high-rise buildings (e.g. telecom hotels, airports) can be responsible for a large number of entrapped people. The 9/11 event was such a case.**
- **Entrapment is also the result of collapsed structures due to accidental or deliberate explosions (e.g. collapsed mines, technical failures, confined spaces).**
- **Disaster impacts are high in Critical Infrastructures for a number of reasons; CIs are positioned over large regions, are overpopulated, have very tall and extended building blocks with complicated street patterns**

Introduction

Current solutions for Emergency Networks:

1. **Lack of interoperability among systems of different organizations:**
   - **Lack of specific standards;**
   - **Proprietary solutions often not compatible;**
   - **E.g.: World Trade Center, 9/11/01.**

2. **Lack or limited data service and applications:**
   - **Compared to recent wideband wireless networks;**
   - **E.g.: important data such as maps, building plants, videostreaming systems.**

3. **Excessive trust in fixed infrastructures:**
   - **Communications towards hit by destructive events;**
   - **E.g.: Katrina, New Orleans, 2005.**

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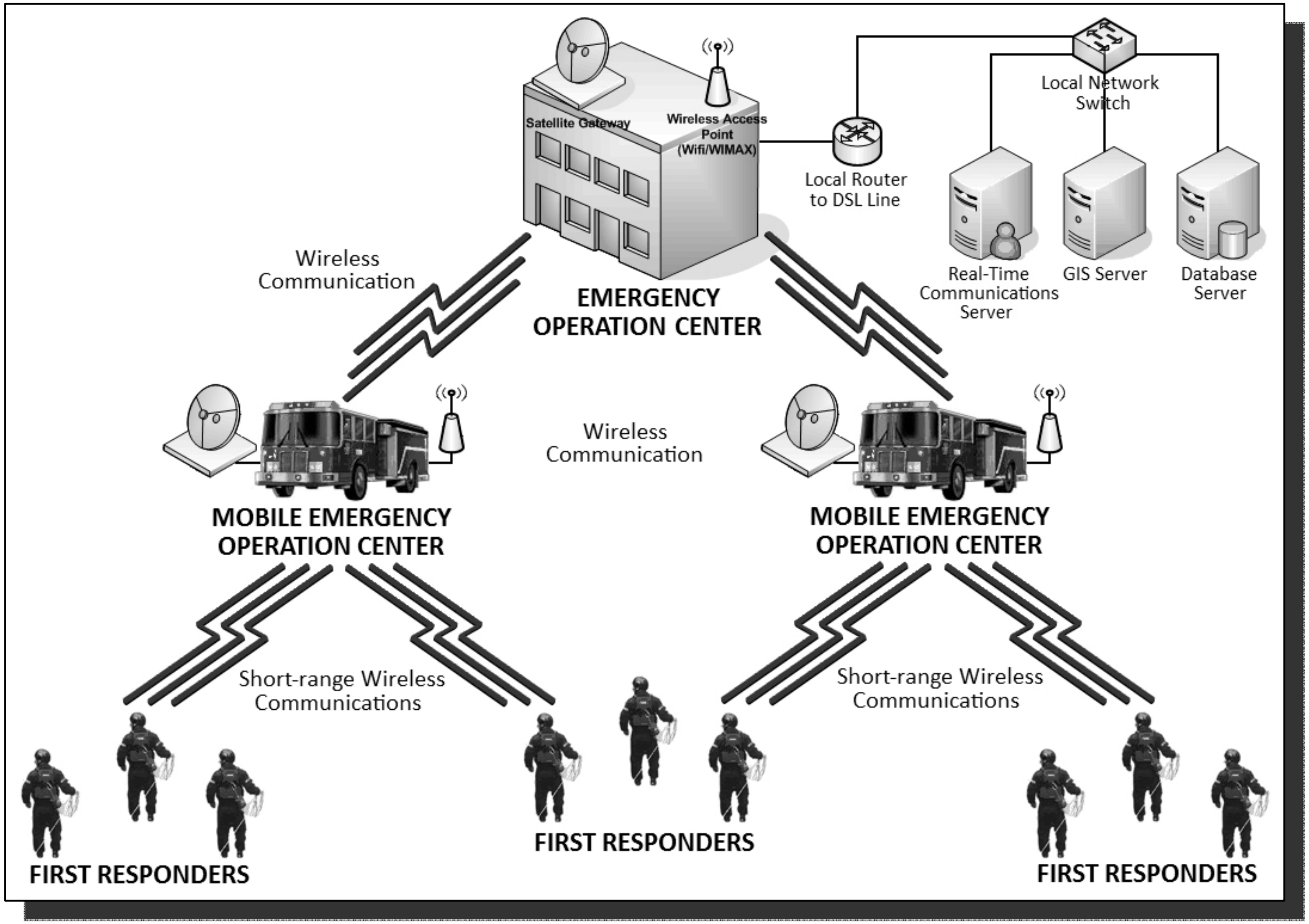
Main Operating Elements in a Crisis Scenario



eSPONDER

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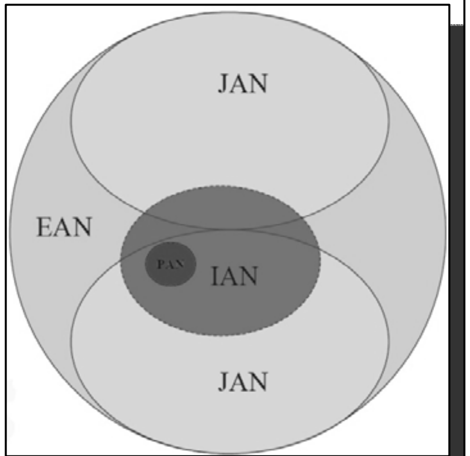
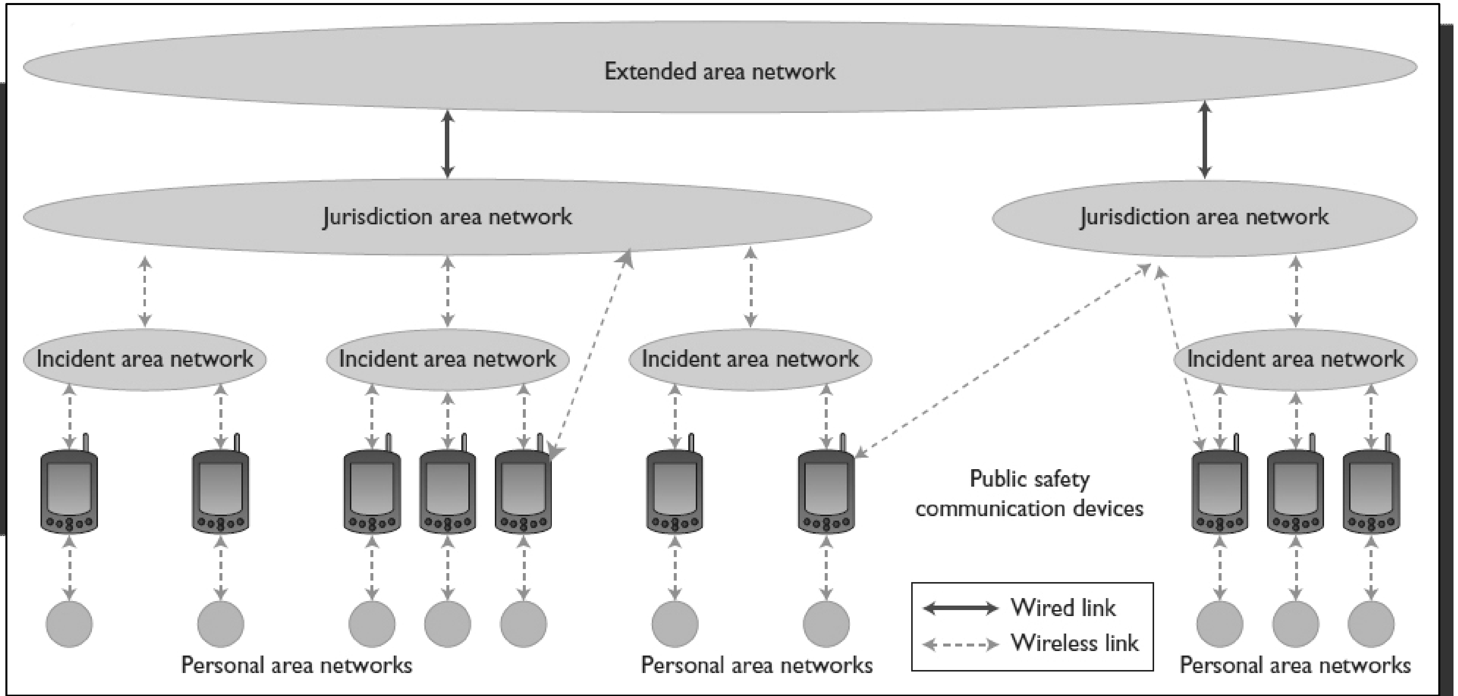
Public Safety System Architecture



"system of systems" architecture



Personal Area Network

- First responder personal network;
- interconnects terminals, sensors,…

Incident Area Network

- Temporary network;
- Set up by MEOC;
- Dati between users and MEOC;

Jurisdiction Area Network

- Main Emergency net;
- Fixed infrastructures;
- IAN traffic managmnt;

Extended Area Network

- Nation wide optical fibre network
- Backbone for First responders, IAN, JAN

APCO Project 25

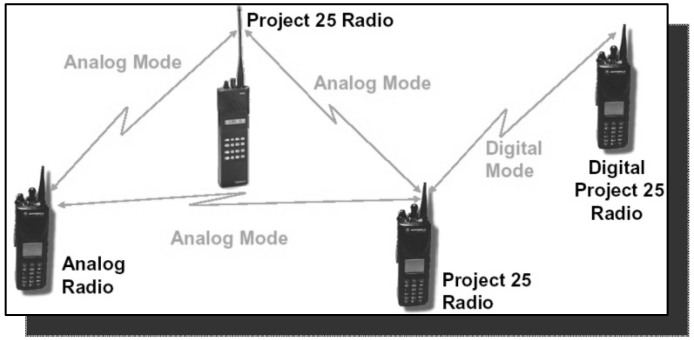
•Standard for digital narrowband PMR, jointly developed by APCO (Association of Public Safety Communications Officials) and TIA (U.S.A.)

•Published in 1998 in TIA-102

•Compatible with analogue PMR at 25 KHz

•Operating in conventional–trunked dual mode

P25 Phase 1:
- 12.5 KHz channels
- FDMA
- Data rate 9600 bps



P25 Phase 2:
- 6.25 KHz channels
- TDMA
- Data rate 4800 bps

FCC standard for interoperability in the (746-806) MHz band

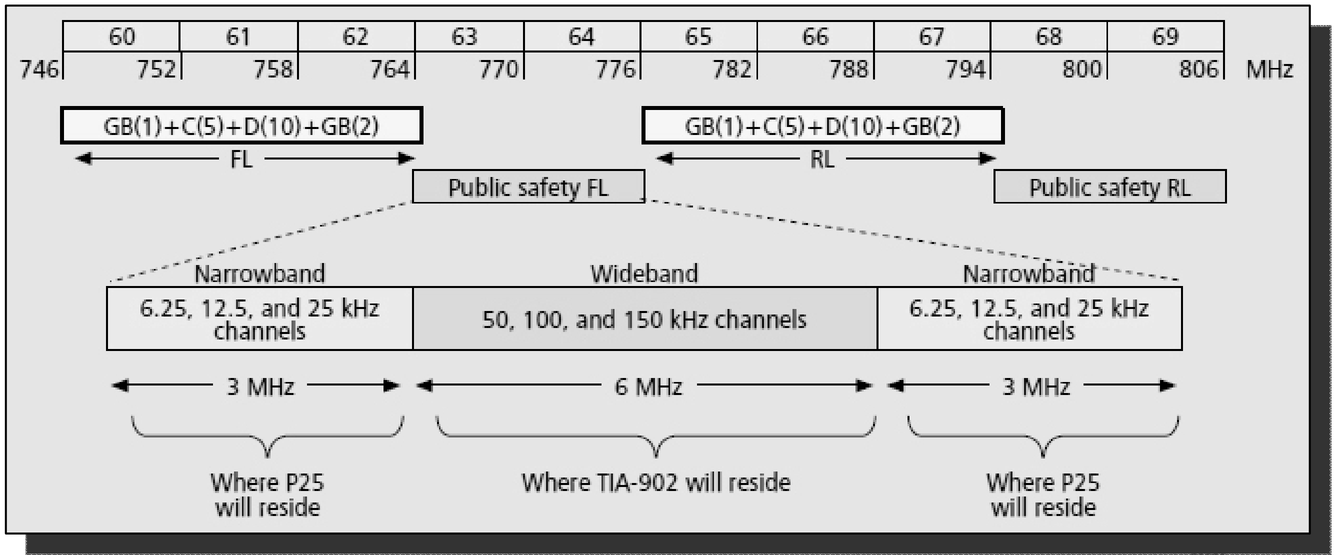
APCO Project 34

- Standard for wideband digital PMR systems (TIA-902, 2003)
- Scalable Adaptive Modulation
- Data rates up to 691 Kbit/s

	50KHz	100KHz	150KHz
QPSK	**76.8**	**153.6**	**230.4**
16-QAM	**153.6**	**307.2**	**460.8**
64-QAM	**230.4**	**460.8**	**691.2**

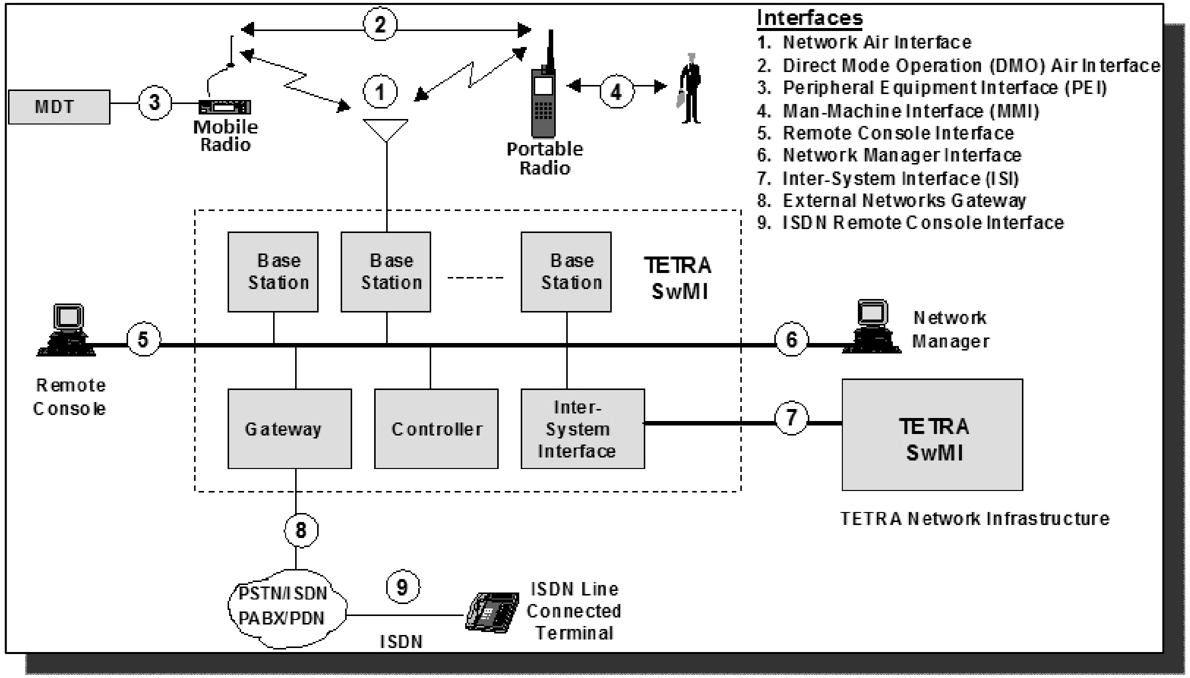
Interoperability
between P25 and P34

700 MHz radio spectrum
In USA for public safety:
3+3 MHz → P25
6 MHz → P34



TETRA (Terrestrial Trunked radio)

- Standard ETSI (1996) for digital trunked PMR systems
- 25 KHz channels
- TDMA with 4 timeslot per channel
- Up to 28.8 Kbit/s per channel
- Range: up to 58 km



Operation modes:

<u>Trunked Mode Operation(TMO)</u>

voice and dati services
Group calls
Emergency calls
Dynamic groups managmnt

<u>Direct Mode Operation(DMO)</u>

Repeater DMO
Gateway DMO

TETRA Release 2

- Standard ETSI (2006) digital trunked **wideband** PMR systems
- TEDS – TETRA Enhanced Data Service;
- Adaptive selection:

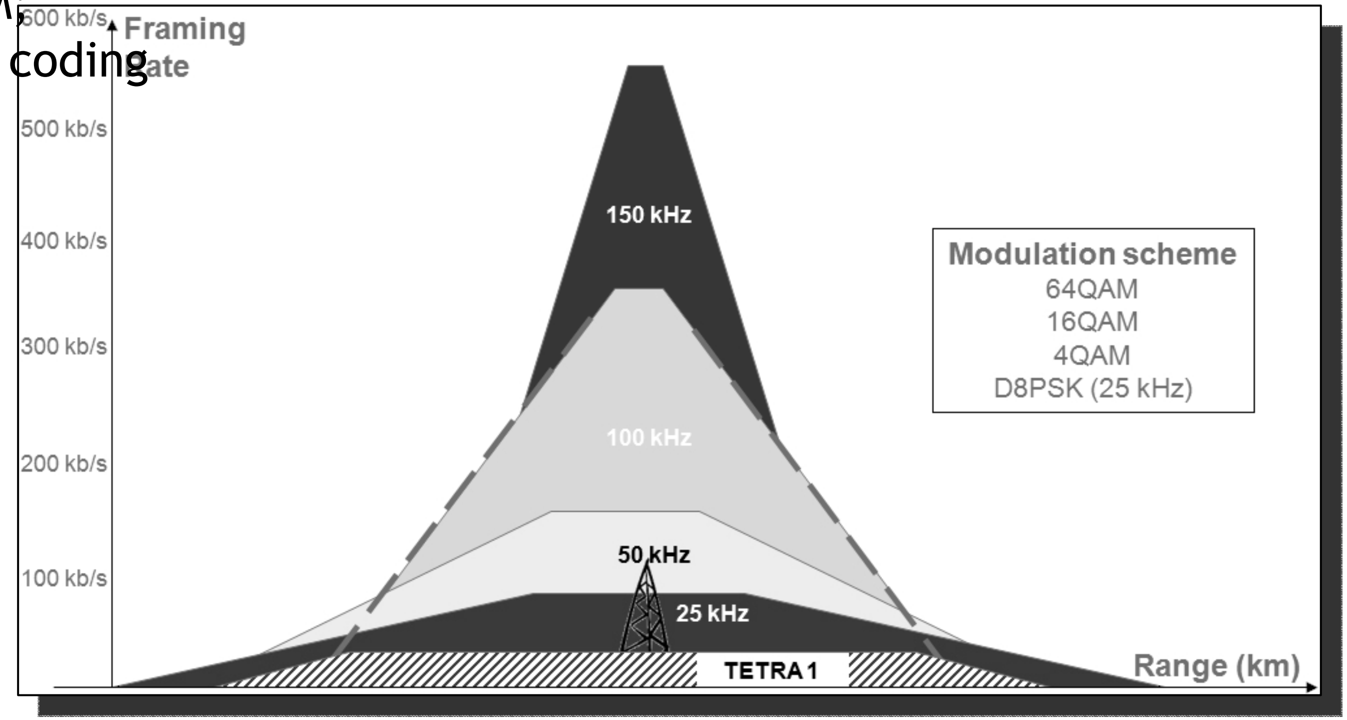
    channel: 25, 50, 100 e 150 KHz;

    Modulation scheme: π/4-DQPSK, π/8-DQPSK, 4-QAM, 16-QAM, 64-QAM;

    Channel coding

Range up to 83 km
(for 25KHz)

Data rate 500-600 kbps;



Rete Radiomobile Regionale Emilia Romagna

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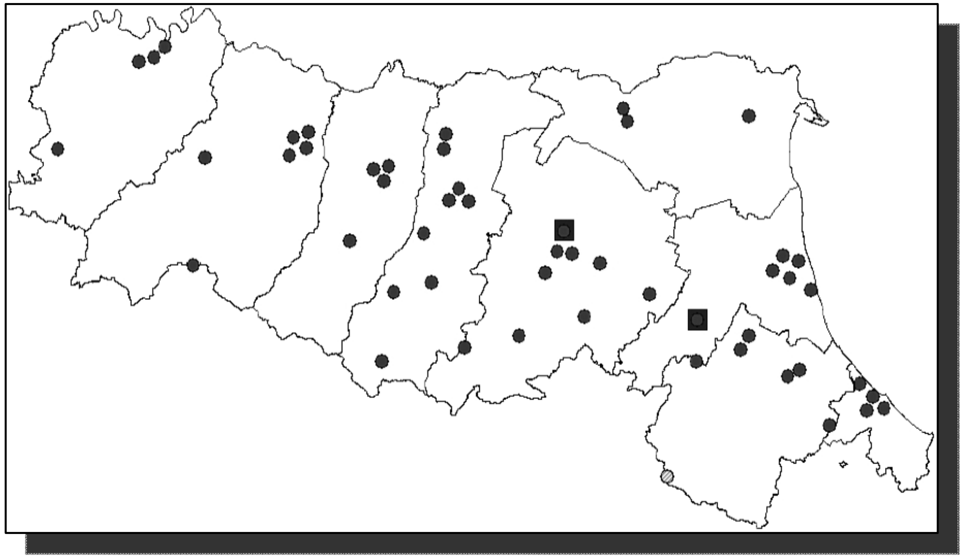
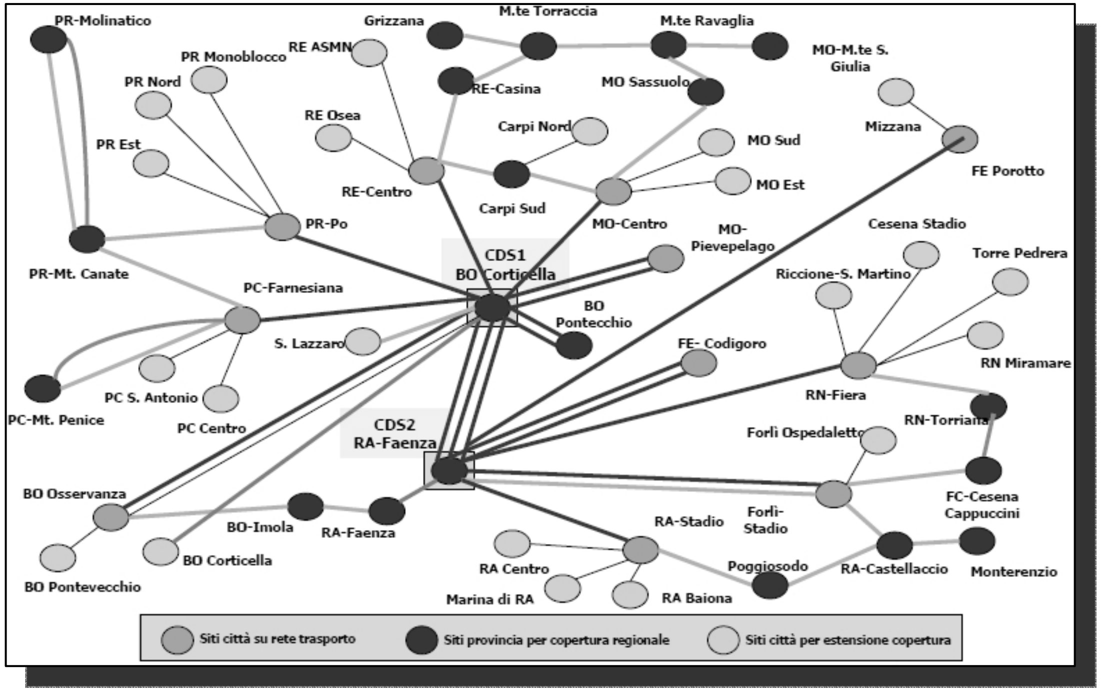
Emergency services:

- County Police
- Civil Protection
- 118

- Standard TETRA
- Since 2007





- Coverage at 85-95%
- Planned update to TETRA 2

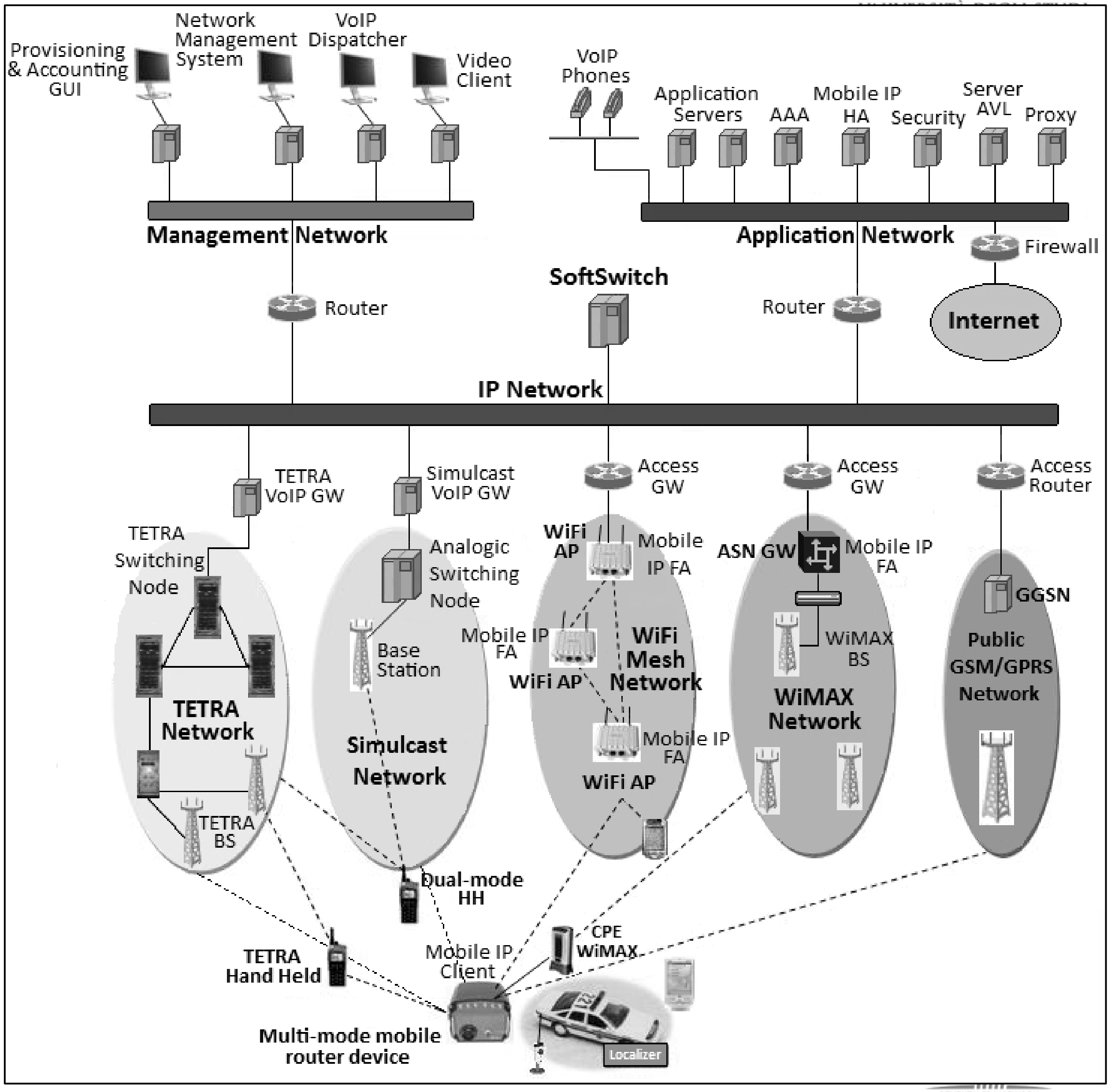
SEVENTH FRAMEWORK PROGRAMME

PERSEUS – Selex Communications

Professional and **E**mergency **R**esilient **S**ystem **E**nabling **U**biquitous **S**ervices

Modular and Scaleable multi-service system
Interoperability and Integration of systems
- Narrowband
  - BWA
  - Cellular

VoiP e Access Gateway
IP platform
SoftSwitch for VoiP
Netw. Access through:
- Tradtional terminals
- Multim. Mobile router
- Multimode terminals



eSPONDER

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Abstract

The *ESPONDER* is a suite of real-time data-centric technologies which will provide actionable information and communication support to first responders that act during abnormal events (crises) occurring in critical infrastructures.

This information will enable improved control and management, resulting in real time synchronization between forces on the ground (police, rescue, firefighters) and out-of-theater command and control centers (C&C).

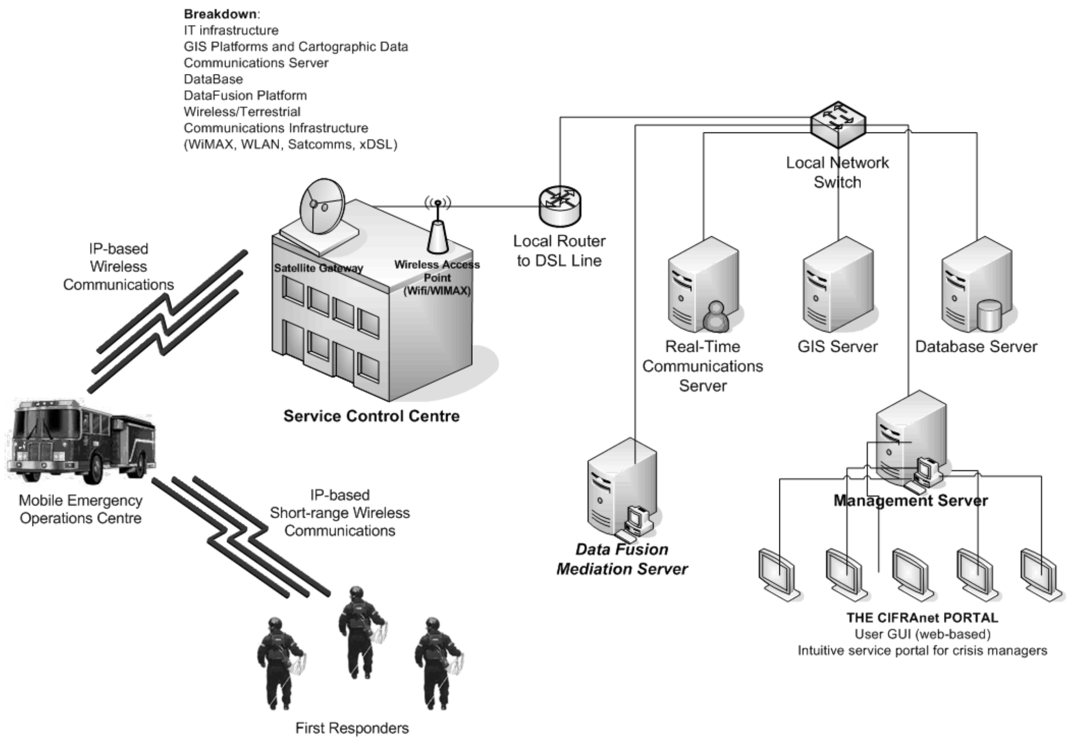
The key concept behind all envisaged work of the ESPONDER project is the facilitation of effective first responder work through the employment of advanced and revolutionary ICT systems, applications, services and concepts

SEVENTH FRAMEWORK
PROGRAMME

ESPONDER High level view

ESPONDER's main objective is to research, develop and demonstrate the capabilities of a framework and congruent prototype that will enhance the effectiveness of operations of first responders operating in Critical Infrastructures

The Emergency Operations Control Centre, the Mobile Emergency Operations Control Centre and the First Responder Unit



The First Responder Unit

- **FRU Wearable Computer**

- **Integrated Navigation and Positioning Module**
- **Outdoor:** GPS/DGPS, **Indoor:** LPS, microwaves, ultrasonic and/or laser)

- **Communications Component**
 BT, Wifi, 3G, Mobile WiMax, LTE, GSM

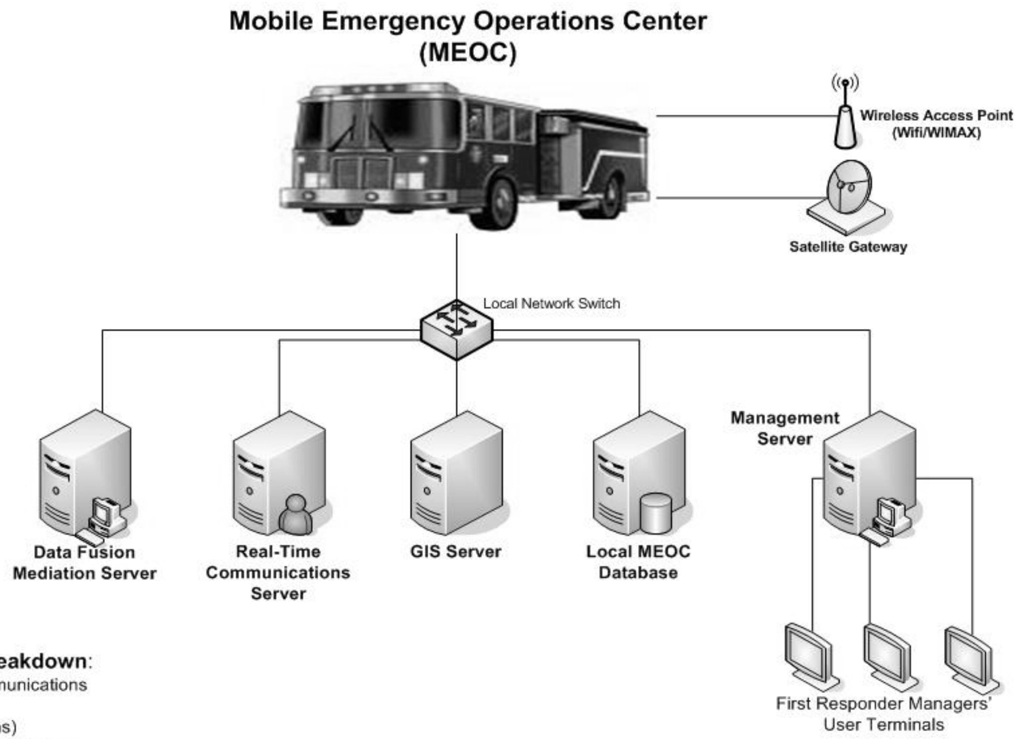
- **Application Specific Sensors**
 measure physiological parameters in real-time

- **Textile Integration**
 FRU local network for unobtrusive operations

The eSPONDER helmet and wearable user terminal

The system consists of a helmet mounted microphone and ear speaker assembly that easily snaps onto the user's fire helmet.

The E-SPONDER MEOC components



E-sponder MEOC Breakdown:
IT infrastructure and Communications
Infrastructure
(WiMAX, WLAN, Satcomms)
GIS Platform and Cartographic Data
Communications Server
Local MEOC Data-Base
Data Fusion Mediation Server
Management Server
First Responder Managers' User Terminals
E-SPONDER Portal

The eSPONDER EOC

•**Data Fusion and Mediation**

Portal and Back-Office Applications

•**Real-time Communications Server**

Wifi, 3G/UMTS, WiMax, VHF, UHF, Tetra, Satellite

•**3-D GIS platform**

Static geographic and environmental information

•**Emergency Response Planning - Execution**

Overall command of processes and resources

The eSPONDER EOC
Sharing a common operational picture.

eSPONDER in practice

- 2 Major Pilot Events

- 3 Simulated Scenarios covering end-to-end activity of first response work

- Simulated events cover both normal and abnormal types of crisis

- Total of 150 First Responders participating

- eSPONDER-based Training to involved personnel

WP7: System Architecture

This is a work-package of fundamental significance to the project because the overall architecture of the E-SPONDER platform has to be defined. All issues from application down to physical layer have to be taken into account, keeping in mind to define secure, robust and resilient solutions, suitable for the above defined scenarios.

T7.1 Design of the FRU
T7.2 Design of the MEOC
T7.3 Design of the EOC
T7.5 Communication Security and Interoperability

Our planned activity

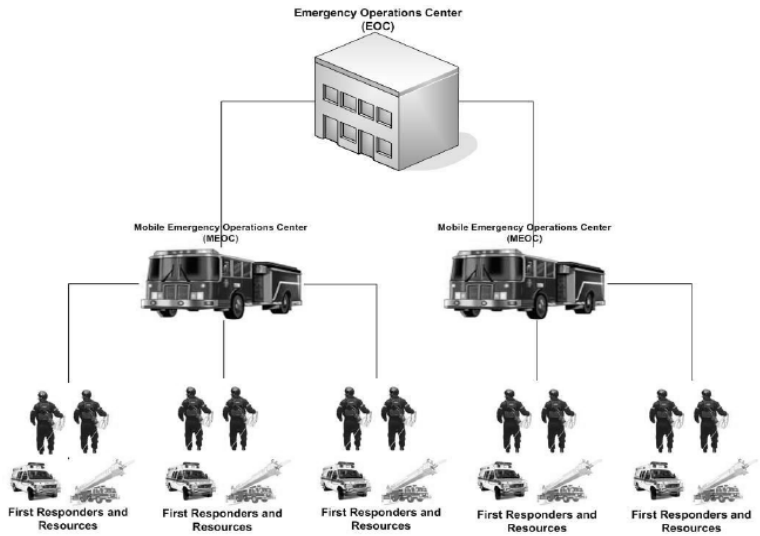
Three main directions:

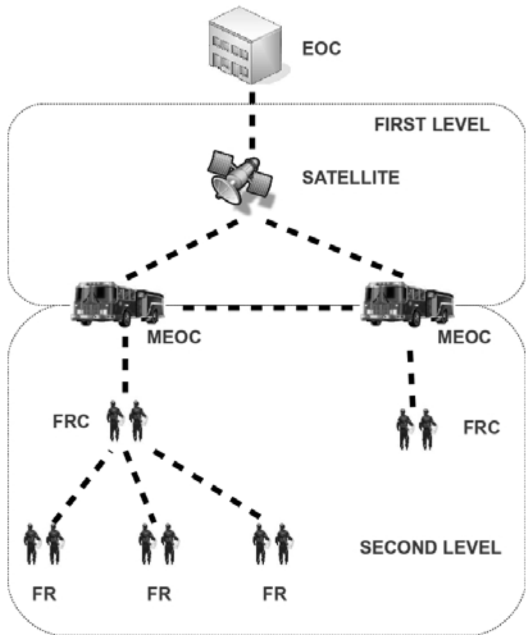
- **Proposal and evaluation of new wireless solutions to prioritize emergency applications and first responders terminals**
- **Evaluation and development of a modular, multiplatform router as MEOC**
- **Evaluation and development of QoE assessment tools**

General Architecture

FRs normally act either in remotely located areas with limited or disrupted communication infrastructures.

They need to exchange information with the Mobile Emergency Operation Centre (MEOC) and with the remote Emergency Operation Centre (EOC), to enable cooperation at all levels with the target to minimize the uncertainty typical of crisis events.





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The E-SPONDER Network Architecture

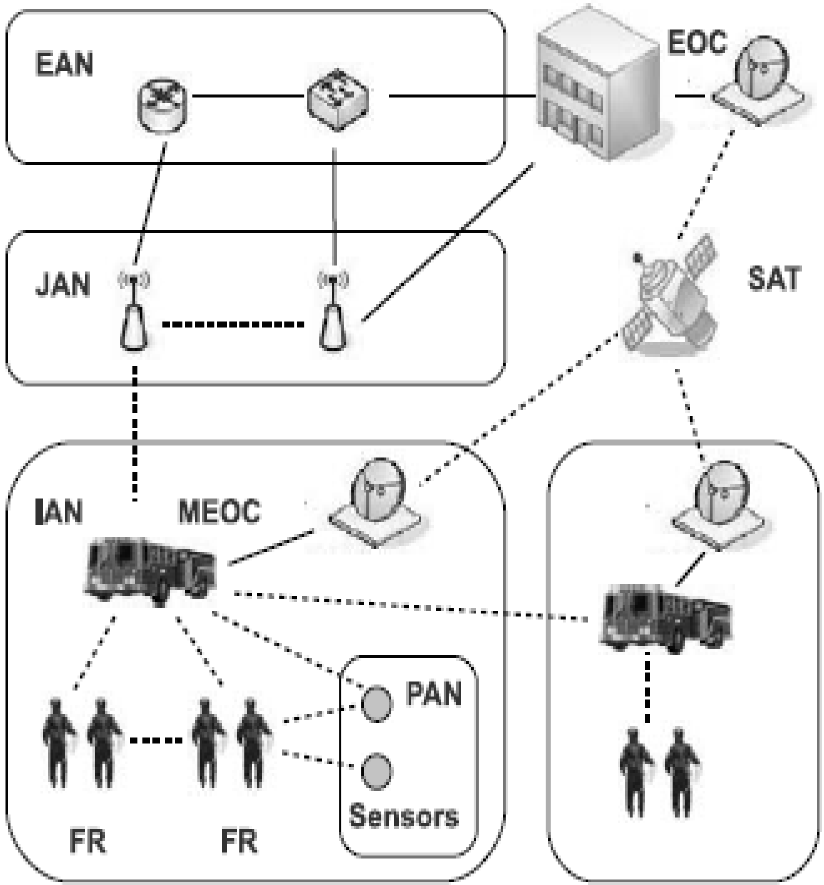
Main backhaul link via satellite

Extended area network (EAN), acts as a backbone for JANs

Jurisdiction area network (JAN), fixed infrastructures, eventually used as backup backhaul links

Incident area network (IAN), mesh network serving on-field FRs

Personal area network (PAN), wireless sensors collecting environmental information



Mobile Emergency Operation Centre

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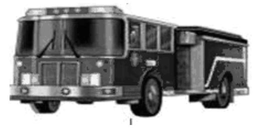
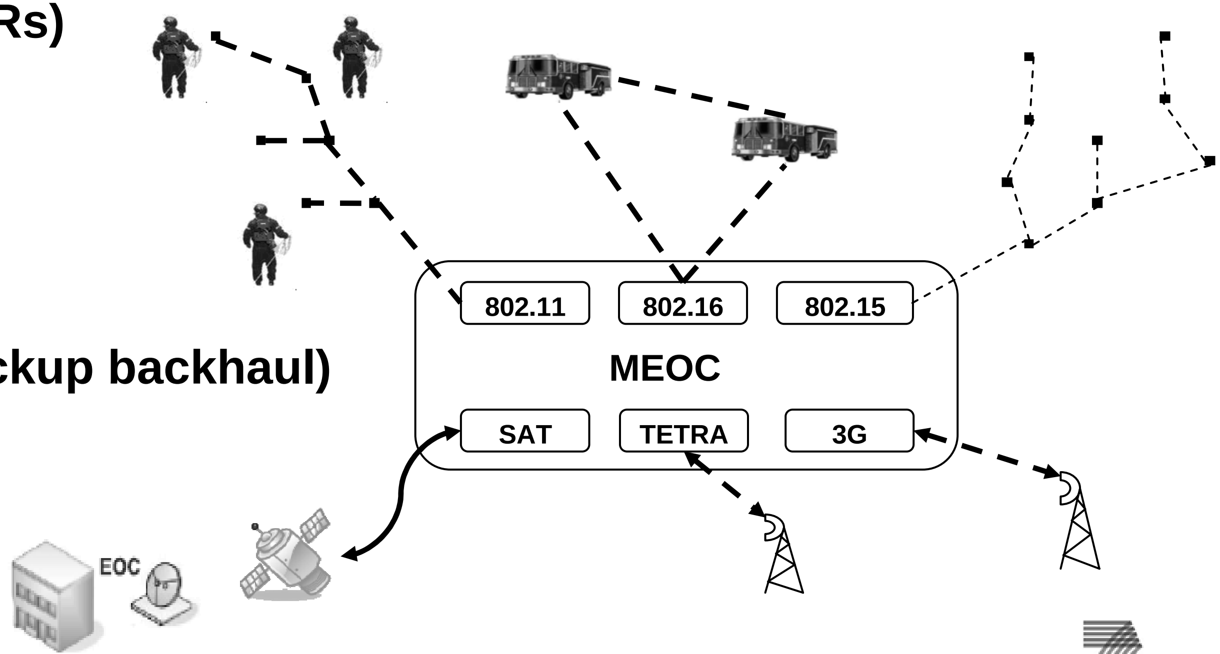


A vehicular communication infrastructure to support communications among FRs, other MEOCs, and the EOC

Possible technologies:

- **DVB-RCS NG (main backhaul to the EOC)**
- **WiMAX (inter-MEOC mesh)**
- **WiFi or femtocells (FRs)**
- **Bluetooth (sensors)**



- **3G, 2.5G, TETRA (backup backhaul)**

Possible Approaches for Performance Evaluation

Analysis: traffic theory

- Ideal but difficult for complex scenarios

Simulation

Pros: flexible, repeatable, cheap

Cons: huge amount of time and computing resources for complex scenarios, not so accurate and useful for implementation

Physical test-bed

Pros: realistic

Cons: expensive to deploy, not suitable for “a priori” evaluations

Hardware emulators

Pros: based on “ad hoc” devices: realistic and suitable for heterogeneous network studies

Cons: expensive and usually not open to research community