A Satellite Based System for Managing Crises Scenarios: the E-SPONDER Perspective

G. Calarco, **Maurizio Casoni**, A. Paganelli, D. Vassiliadis, M. Wòdczak

Department of Information Engineering
University of Modena and Reggio Emilia
Italy

Outline

- Introduction: Emergency Networks
- General Architecture for Emergency Networks
- The E-SPONDER Vision and Network Architecture
- Enabling Communication Technologies
- Focus on Open Platform for the Mobile Emergency Operation Centre
- Conclusions

E-SPONDER

Title:

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

(Large Scale Integrated Project)

Objective:

SEC-2009.4.2.1: First Responder of the future

Duration of the project:

48 months (started July 1st 2010)

ESPONDER: list of participants

1. EXODUS S.A. (coordinator) (Greece)
2. University of Modena and Reggio Emilia (Italy)
3. CrisisPlan BV (NL)
4. PROSYST Software GmbH (D)
5. Immersion S.A. (F)
6. Rose Vision (SP)
7. Telcordia Poland Sp. z o.o. (POL)
8. Centre Suisse d'Electronique et de Microtechnique SA (CH)
9. SMARTEX (I)
10. Technische Univesität Dresden (D)
11. YellowMap (D)
12. PANOU S.A. (GR)
13. Telcordia Taiwan (TAIW)
14. Institute for Information Industry (TAIW)
15. Centre d'Essais et deRecherche de l'Entente (F)

Emergency Networks: past experience

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**

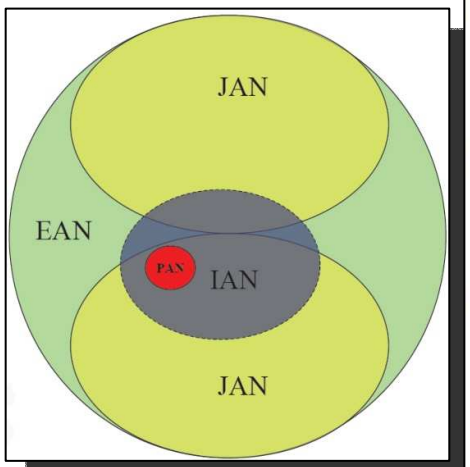
Lack or limited data service and applications:

- **Compared to recent wideband wireless networks;**
- **E.g.: important data such as maps, building plants, videostreaming systems**

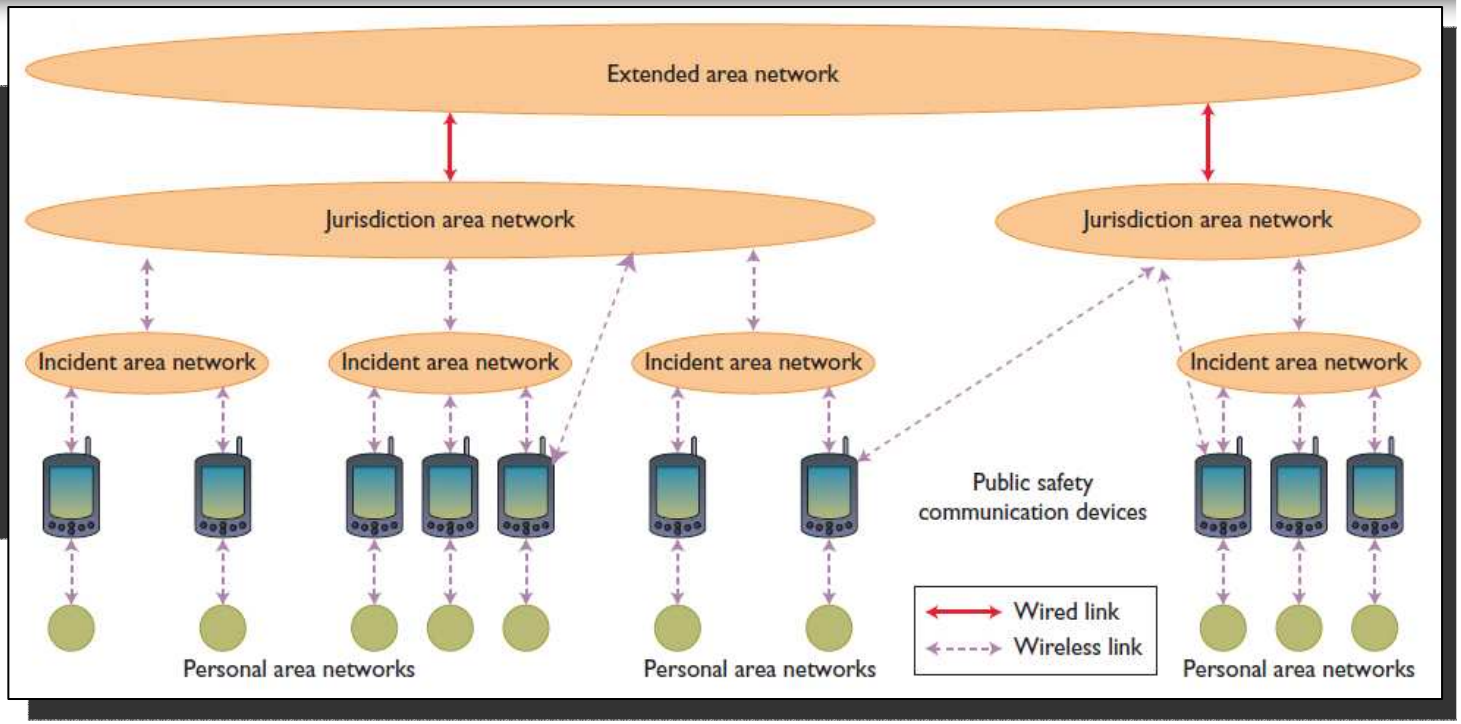
Excessive trust in fixed infrastructures:

- **Communications towards hit by destructive events;**
- **E.g.: Katrina, New Orleans, 2005**

Public Safety System Architecture



"system of systems" architecture



Personal Area Network	Incident Area Network	Jurisdiction Area Network	Extended Area Network
▪ First responder personal network; ▪ interconnects terminals, sensors,…	▪ Temporary network; ▪ Set up by MEOC; ▪ Dati between users and MEOC;	▪ Main Emergency net; ▪ Fixed infrastructures; ▪ IAN traffic managmnt;	▪ Nation wide optical fibre network ▪ Backbone for First responders, IAN, JAN

Emergency Networks: basics (1/2)

- **Communication** is a vital part of the First Responders' (FRs) operation, to connect them with the on-site (mobile) and remote (fixed) operations centres.

- Communications interoperability: major concern in emergency networks as there is the need to follow the "always-connected" approach.

- Therefore, a flexible, scalable and open emergency network should be based on standard radio access technologies, and provide the most reliable connectivity taking into account location, network availability and service characteristics.

Emergency Networks: basics (2/2)

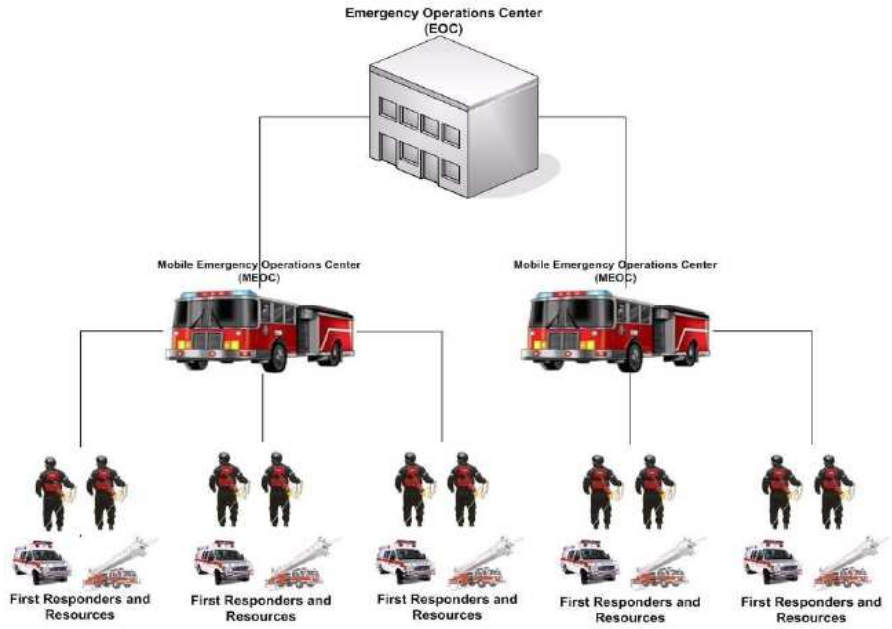
Integrated communications platform should be designed on the following criteria:

- channel rates for data and voice communications (bandwidth)
- range of communication
- size and weight of equipment
- power consumption

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.



The E-SPONDER Vision

E-SPONDER aims at achieving enhanced ICT support for first responders in the view of increasing their security and operational effectiveness:

- Improving front end data collection
- Fusing and analyzing data to provide real-time decision support
- Enabling collaboration at all levels
- Providing secure communications

E-SPONDER will make extensive use of wireless networking to provide a seamless communication platform across all system levels

The E-SPONDER Vision

- E-SPONDER: a suite of real-time data-centric technologies

- It will adopt standard and widespread technologies
  - ✓ e.g. TCP/IP: to facilitate the network interoperability between first responders and offer a flexible transport mechanism that is independent of the required service

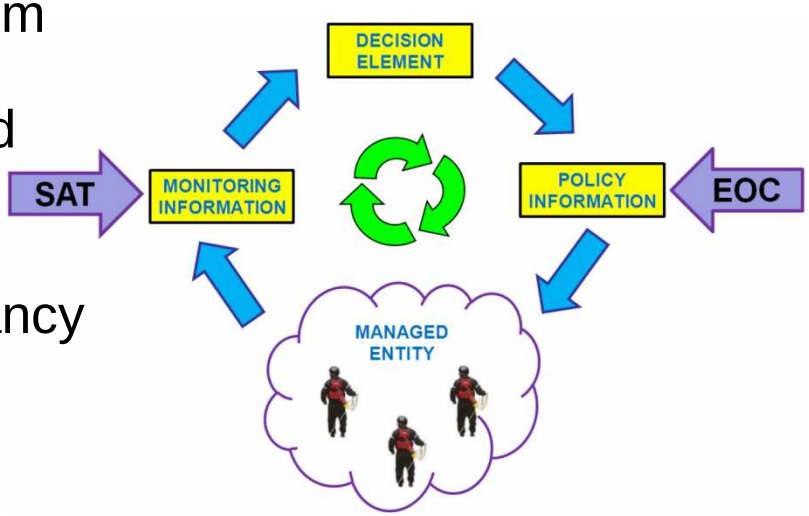
- with a hierarchical organization and a modular infrastructure to fulfill flexibility and scalability

- which aims to achieve reliability and resilience by employing multiple technologies

Autonomic Networking

- Capability of self-manage: devices set a networked system which, depending on the circumstances, can be organized in different ways so that unique demands arising from given crisis scenarios can be met
- This can be achieved via the incorporation of the paradigms of autonomic networking - generally an autonomic system is expected to act as a living organism so that all the activities can be carried out without any explicit need for external intervention

- Monitoring information may be coming from a satellite and it may occur to be a crucial indicator on how to deploy the system and how to arrange the network
- The added value provided by satellites should be considered in terms of redundancy or possibility of refining performance



The E-SPONDER components

- EOC, located at the headquarters, is the backbone for the operation of the E-SPONDER system. It will be responsible for the collection of all data transmitted through the MEOC.

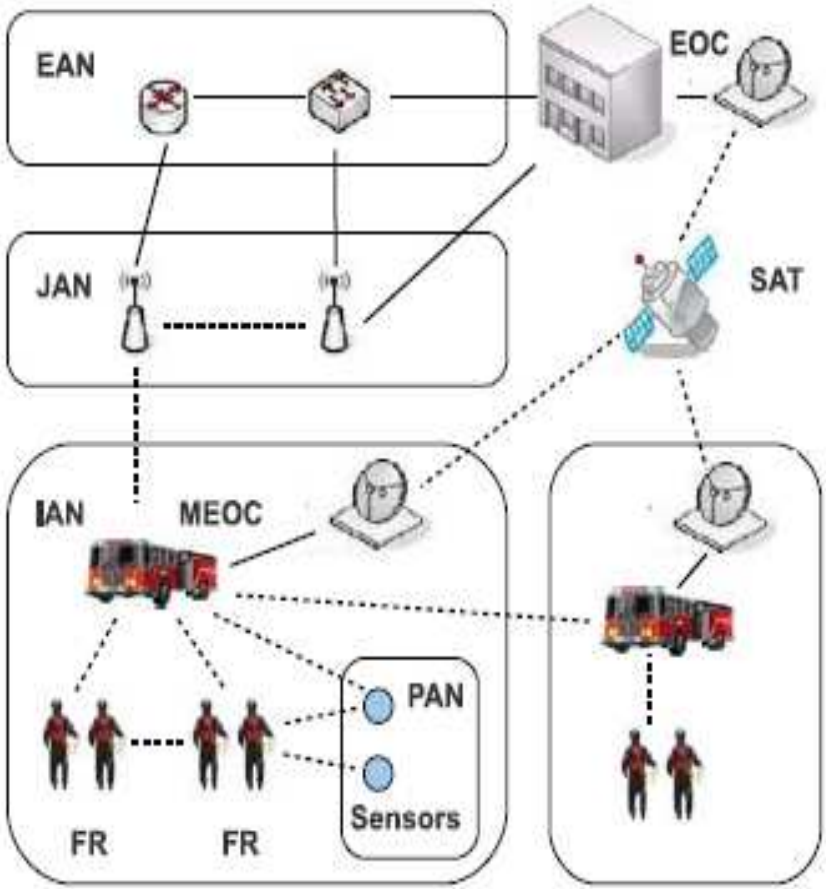
- MEOC, the mobile local unit, acts as a bridge between the first responders in the incident field and the EOC located at the headquarters

- FRs (police, firefighters, etc.), operating on the field, should be provided with the best mobile hardware system according to the user needs and constraints (e.g. 3D visualization module, multi-radio module, etc.)

- It is necessary to design the overall integrated E-SPONDER system and define the interactions between the FRUs, MEOCs and EOC

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



E-SPONDER Communication Technologies

Enabling wireless technologies are:

- MEOC-EOC (via Satellite): DVB-RCS (and evolutions) to provide a full-duplex satellite link
- IAN: IEEE 802.11x for access network and IEEE 802.16 for inter-IAN communications
- PAN: IEEE 802.15.1 (Bluetooth) and IEEE 802.15.4 (ZigBee), for wireless sensors data collection
- EAN/JAN: (as backups) ITU IMT-2000 (UMTS), 2.5G, TETRA and/or other accessible wired infrastructures

General Design and Performance Evaluation

Main goals:

- verify if the E-SPONDER technical proposal can match the operational needs in terms of flexibility, scalability, reliability and redundancy
- determine performance limits in terms of throughput
- study and employ end-to-end QoS schemes
- All communications must be secure (QoS vs Security)

and, in a realistic manner,

- with respect to the traffic pattern of the applications we want to support
- with respect to the uncertain nature of the communication channels

The E-SPONDER MEOC

The Mobile Emergency Operations Centre:

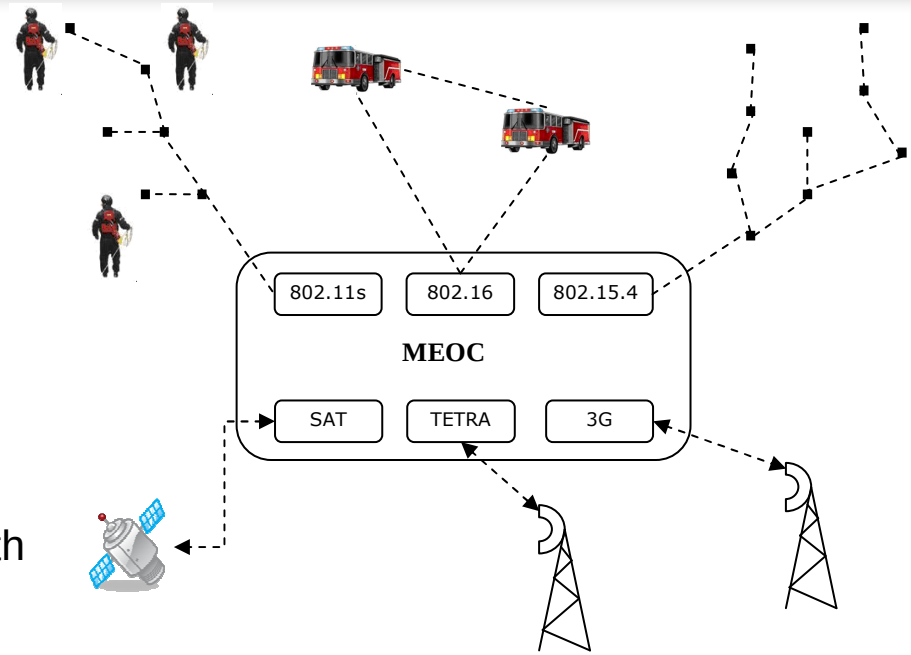
An operational centre capable of enabling and supporting communications among FRs, other MEOCs and EOC through a variety of possible network technologies and infrastructures, such as:

- DVB-RCS (main backhaul to the EOC)
- WiMAX (inter-MEOC mesh)
- WiFi (FRs mesh)
- 802.15.x (sensors)
- TETRA, 2.5, 3G (as backups)

A testing framework for the MEOC

How to implement it ?

- Physical testbeds: realistic, but expensive, not reproducible testing, man-power expensive with no clear perspectives
- Simulation tools: cheap, adaptable, repeatable and scalable modeling of a network scenario, but not so accurate and not so useful at the implementation stage



Hybrid approach: using emulative traffic generators and network simulators jointly with a real **software router**

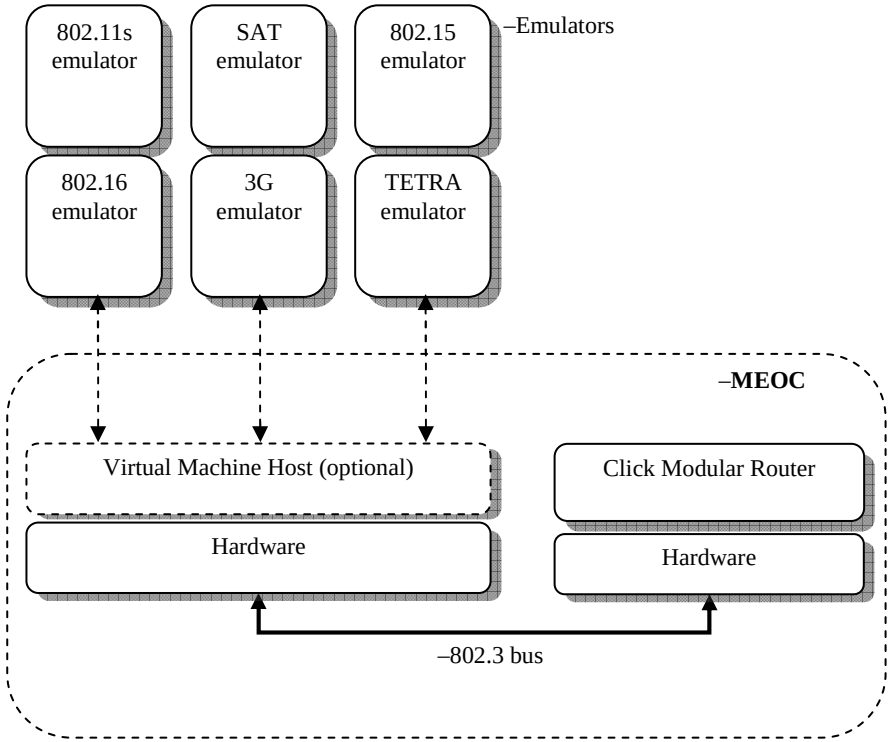
Advantages:

- flexible, open to future integrations
- offer realistic forwarding performance and repeatable evaluations
- traffic differentiation and QoS policies capabilities
- technologically closer to the final equipment installed onboard the MEOC
- better yet, allows a step-by-step deployment

Emulation/Integration testbed

Step-by-step deployment:

1. insulate the core MEOC tasks, with conventional router interconnected to external “network portals”
2. substitute the network portals with network emulators, for generating or gathering traffic flowing through the router, to evaluate the most advantageous design choices for our infrastructures
3. final step: emulators substituted by the real networks, bringing all the MEOC functionalities inside the all-in-one equipment



Conclusions

The E-SPONDER project aims at developing a secure, interoperable and reliable ICT infrastructure that will provide communication and decision support to the first responders operating in every possible future crisis scenario, by adopting state of the art wireless technologies and advanced information systems.

Within E-SPONDER, Satellite Communications will play a fundamental part.

They are the backbone for communications from the operation theatres to any given and remotely-located Emergency Operations Center.

The current status of the project has been shown and possible solutions regarding system design, network architecture and Mobile Emergency Operations Center architecture have been proposed.

For any further information:

www.e-sponder.eu

E-SPONDER Project Coordinator:

Dimitris Vassiliadis

dvas@exodussa.com

THANK YOU FOR YOUR ATTENTION

maurizio.casoni@unimore.it
casoni@ieee.org

http://www.dii.unimo.it/casoni

… suggestions are very very welcome