INTEGRATED IP COMMUNICATION SOLUTIONS FOR PUBLIC SAFETY

WORKSHOP ON THE RESULTS OF THE EU-PROJECTS U-2010 & HNPS

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Abstract

In a crisis communication and access to data and information, is critical for public safety services. Several EU projects tackle this topic. In this workshop, results from the u-2010[7] and HNPS[8] projects will be presented and discussed.

The u-2010 project's objective was to provide the most capable means of communication to everybody required to act in case of accident, catastrophe or crisis, as well as the most

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[8] Heterogeneous Networks for European Public Safety

effective access to that information,. The project aimed to use any existing or (future) planned communication infrastructure to do this.

The HNPS project's purpose is to design and implement interaction capacities for important public safety applications. These may be at a technical level (interaction between different radio technologies or different video applications) or at a functional level (the collaboration between different agencies).

The Workshop

"Integrated IP Communication Solutions for Public Safety" presents the u-2010 project's emergency communication solutions, illustrated with the "Fire in a Tunnel" scenario, as well discussing the first achievements of the HNPS project.

Five of the projects' partners will speak about the following topics:

- An introduction to the u-2010 and HNPS project and to the "Fire in the Tunnel" scenario
- The EPT Luxembourg (Telco) experience, building a test bed for public safety; lessons learnt
- Deploying ad-hoc communication in PPDR
- The architecture of a multi-service deployable Wireless Broadband Bubble (W3B) including results from the first integration tests of HNPS
- IP integration of PMR with the On-Demand Intelligent Network Interface

Introduction

Recent catastrophes such as Hurricane Katrina (September, 2005), the earthquakes in Haiti (2009) and more recently in China (2010), dramatically show the importance of communication in preventing the deaths of thousands of people.

Effective communication and access to information is a key requirement in crises. In New Orleans and Haiti especially nearly all communication broke down, with several days needed to re-establish effective links. Without communication an assessment of the situation is not possible, and it follows that the coordination of aid becomes very difficult. Having a readily available and flexible communication network would have helped the rescue teams that came from all over the world, to support each other more effectively.

However, one does not require a large catastrophe to make clear the need for improvements in emergency communication. This is true even in countries with a high coverage of modern communication networks.

In Luxembourg, a small country located at the heart of Europe, the national Telecommunications body[9] conducted a study in the years 2003/2004 to analyse the availability of means of communication in the case of a disaster. It was a" paper exercise" that simulated the rupture of a water reservoir in the North of Luxembourg.

The analysis of the resultant communication problems was the impetus for a research project under the 5th call of the 6th framework program of the European Union called "u-2010. The goal of the u-2010 project was to provide new concepts for communication solutions for emergency services. The u-2010 project started in May 2006 with 16 international partners.

The project developed prototypes and solutions based on IPv6 technology. It also implemented basic prototypes for network mobility (NEMO), mobile ad-hoc networks (MANET) and wireless sensor networks. Based on these network technologies the project

[9] La Comité Nationale de Télécommunications (CONATEL)

developed solutions that allowed the emergency services to access the information they needed in their headquarters as well as on site.

The project proved that its tasks had been successfully accomplished in a comprehensive public demonstration, made at a tunnel in Luxembourg on the 22nd of October 2009, which simulated a “fire in a tunnel” scenario. The feedback from the Civil Protection, who also participated in the demonstration and from the audience, was very positive, and furthermore, the interest in the demonstrated technologies was very high.

However, during the u-2010 project’s working lifetime it became clear that the project could not cover all the aspects of communication interworking and information access. New technologies were emerging and existing technologies were being combined to provide new solutions to existing problems. WiMAX, mobile WiMAX, LTE and Tetra are examples of changing network technologies that might extend the u-2010 integration for public safety solutions.

Therefore a new project, dealing with public safety communication and called “Heterogeneous Networks for Public Safety” (HNPS), was started in November 2008. 14 partners from Luxembourg, France and Spain are cooperating on this project. The goal of this project is to enhance the solutions created in u-2010 and to add new technologies.

U-2010 - Overview of the “Fire in a Tunnel” Scenario (and Demonstration)

The u-2010 project was given permission from the Luxembourg Ministry of Public Works to use a section of one tube of a highway tunnel that was still under construction. It is a modern two tube tunnel with a length of three kilometres.

A scenario was played out which simulated a car accident, followed by a fire, in one of the tubes, one and a half kilometres from the entrance. Existing emergency procedures were carried out as if in a real event. The scenario used the new communication technologies developed within the u-2010 project. Members of the Luxembourg Civil Protection and the Luxembourg Police also participated in this demonstration.

The “Fire in a Tunnel” scenario in more detail:

A car accident happens in the northern tube of the highway tunnel “Grouft” A fire breaks out.

The emergency centre 112 is alerted by exceeded thresholds for smoke and CO concentration which are monitored by fixed sensors inside the tunnel. 112 checks what happened via video cameras and alerts the civil protection and the police using the u-2010 alarming tool AlarmTilt.

The volunteers of the civil protection respond to the alert and hurry to the fire station. Thanks to the u-2010 localisation solution the commander can track the location of his team members and assess when his team will be complete to leave the station with a mobile command vehicle and a fire engine.

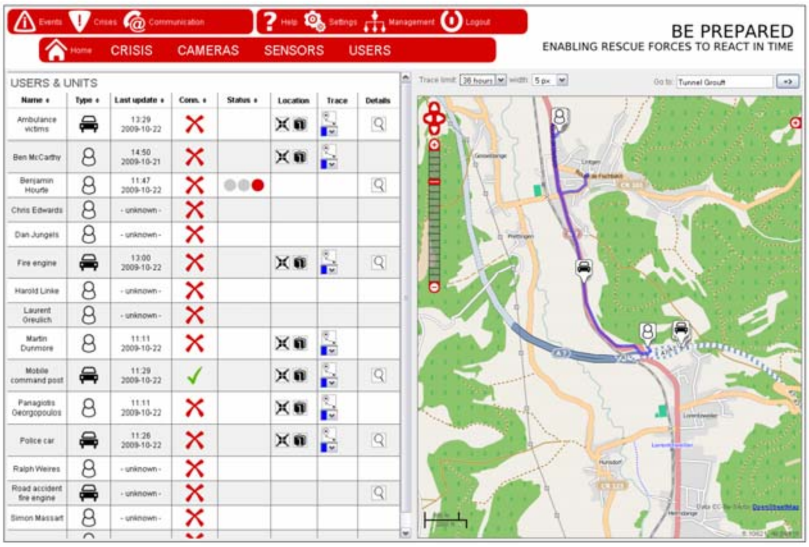
While on the move to the tunnel, the commander and Headquarters can monitor the video cameras and sensors inside the tunnel using a specially developed application; The Headquarters Service Portal, which is a web application, and which is available on redundant servers and is connected to a specific middleware. It allows access to several functions:

- Localisation
- Integration of various types of sensor data
- Video Streaming

It allows the operators to assess the situation in the tunnel by monitoring the sensor values of the fixed sensors and to access the video cameras in the tunnel. The portal also allows the operators to follow the approach of the mobile command post on a map and to access the video camera located in the mobile command post.

The rescue forces' trip to the incident site can be monitored in the portal, The following portal screenshot shows rescue forces on their way to the tunnel. In addition to showing the most recent location of all units, the small blue trace line shows the elapsed journey of a selected unit that has already arrived on site.

Figure 1: Users view of rescue forces on their way to the tunnel



On its approach the mobile command vehicle, with the commander, stops at the tunnel entrance and sets up a Mobile Command Post. To improve the connectivity to Headquarters a Nomadic Satellite Communication System is set up.

The Mobile Command Post stayed at the tunnel entrance, see Figure 2, It provided WAN[10] access to an off-site Fixed Crisis Centre and set up a broadband Incident Area Network (IAN) that shared the WAN.

An additional engine, Fire Engine 1, entered the rescue tube and stopped in front of Gallery 7 (just before the accident site) following the smoke evacuation plans.

The fire engine was connected to the Mobile Command Post via a broadband ad-hoc network, making up an Incident Area Network. This connection allowed the transmission of live video from the fire engine to the mobile command post.

Figure 2: Positions of Network Components in Tunnel Scenario

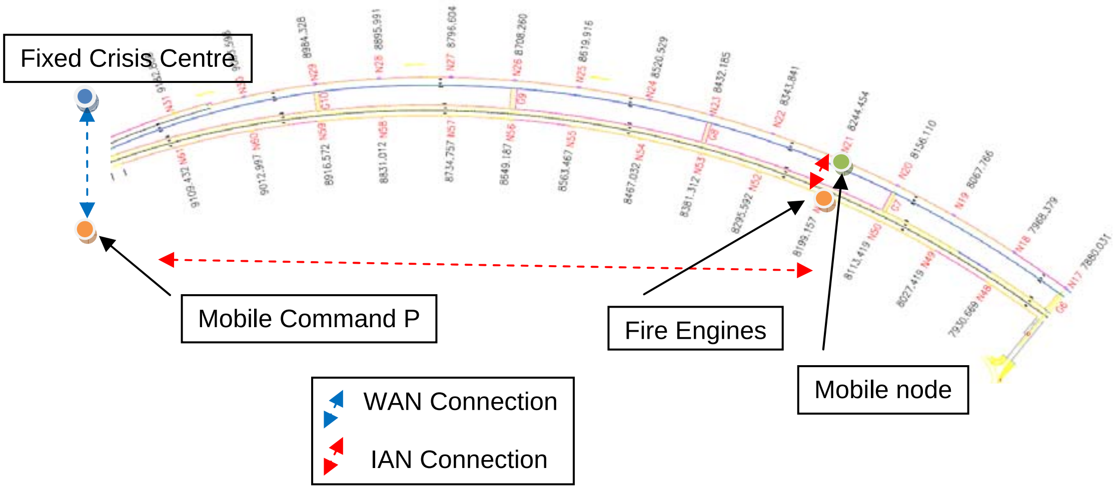
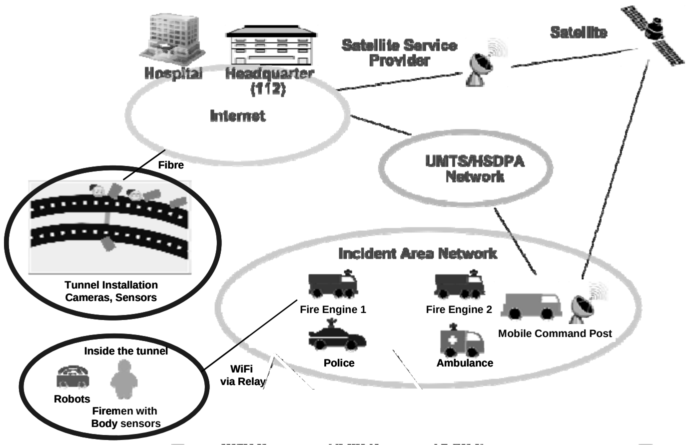


Figure 3 shows the general scenario concept used for the demonstration.

[10] Wide Area Network

Figure 3: General Communication Concept



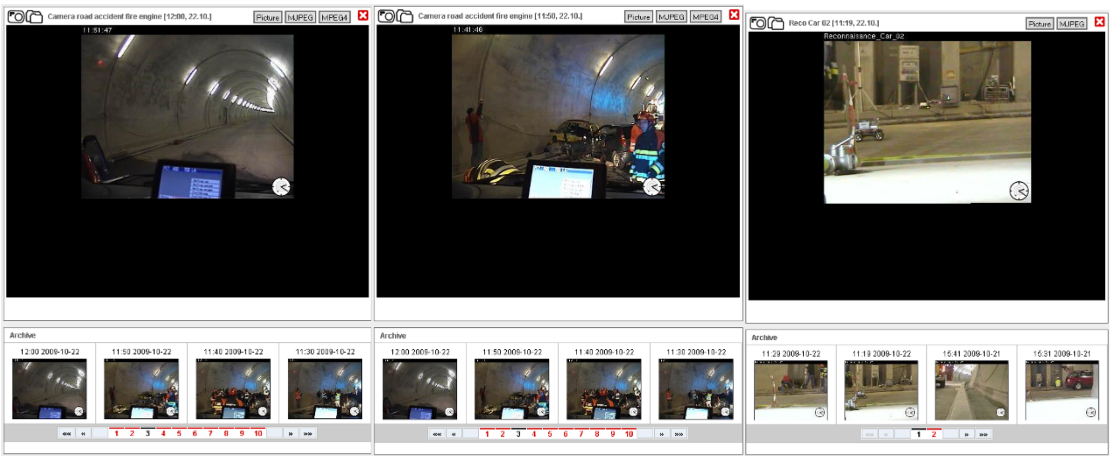
Two fire men with breathing apparatus entered the tunnel via the gallery. They carried a mobile node of the Incident Area Network, to establish a communication link between the tunnel's two tubes. This link allowed video transmission from the accident tube to the Mobile Command Post via the fire engine in the tunnel.

The firemen used two remote controlled robots equipped with video cameras to transmit pictures via Wi-Fi to a mobile node and from there to the Mobile Command Post. The commander could monitor the video directly on his mobile client.

The central point of this concept was the Incident Area Network which connected the involved entities on-site. It provided a broadband connection offering 2 Mb of bandwidth. This network allowed voice and video transmission.

The following pictures show detailed views from car cameras while the rescue forces are in vicinity of the tunnel, are entering it, are executing their rescue mission and are using the robots.

Figure 4: Visual information from different cameras during the rescue phase



The two firemen are equipped with body sensors and foot sensors that allow the commander to monitor the vital signs of his team members.

These body sensors have been designed to monitor the health of either the first responders or victims. Their function is shown in the table below;

Probes measure:	Sensors can transmit:
Heart beat, Body temperature (contact temperature), Foot pressure.	The heart rhythm, The body temperature, The number of steps.

The system is composed of several components:

Figure 5: Body Sensor overview and Integration into the uniform

Temperature probe Heart beat detector Heart beat receiver	Transmitter module ADC and Bluetooth transmitter Foot sensor connector

The values can be displayed by the portal or the mobile client.

The information send by the body sensors was very interesting to the commander, as he could assess the condition of his team much better than before.

After the reconnaissance and assessment of the situation the fire was extinguished. In the meantime the police, a third fire engine and an ambulance arrived on site. The police closed the highway and secured the way for the emergency services.

The unique approach in this scenario is that three voice communication systems are used on site: Voice over IP in the tunnel, TETRA for the police and analogue radio for the 3rd fire engine. The u-2010 solution allows integrating all three into one group call and a synchronisation between the different entities.

The arriving services were automatically integrated in the Incident Area Network. Furthermore, they were also integrated into a group call that allowed all the entities to communicate independently from their own technologies and systems.

As soon as the police acknowledged that the tunnel was completely blocked to traffic and the fire men in the tunnel reported that the fire was extinguished, the commander sends the third fire engine and the ambulance into the tunnel to rescue the victims.

The victims were transferred to the ambulance. Video cameras inside the ambulance and body sensors attached to the victims allowed a doctor at a remote hospital to monitor the victims and to give advice to the ambulance team.

Technically the Incident Area Network used in the demonstration was based on network mobility and mobile ad-hoc networks. These technologies are explained in brief in the next chapters.

Network Mobility (NEMO)

Network Mobility (NEMO) functionality was based on a Cisco Mobile Access Router (Cisco 3230) and on a Home Agent. Its role was to provide continuous access to the information centre whatever global network was used (e.g. GPRS/UMTS/HSDPA, Wi-Fi, Satellite, Ethernet…). This continuity of communication allowed applications (clients and server) to work without interruption when switching between the networks.

In the demonstration scenario NEMO was used to give the Commander access to video and sensor information whilst the Mobile Command Post was on the move to the accident. This allowed him to assess the situation before the teams arrived at the tunnel. In the presentation of the final demo we used the NEMO connection to the Mobile Command Post to show live video while the vehicle was approaching the tunnel area.

Mobile Ad-Hoc Networks (MANET)

The mobile ad-hoc network concept creates a new communication network without any specialised configuration in a situation without an existing infrastructure, or in situations where the existing infrastructure is destroyed or overloaded. Typically it consists of one or more mobile routers, placed for instance in cars, helicopters, or even in bags etc. They interconnect automatically to establish a local high performance communication network. This network can then be used by many end devices and applications via standardised wired and wireless interfaces. The transmission of signalling and user data is protected by strong encryption mechanisms.

The ad-hoc network solution is based on the HiMoNN ad-hoc routers developed by IABG. A typical range between two of these routers is around one to two kilometres depending on the topology of the site. For data transmission over higher distances, the router can also be used as a relay node, thereby bridging distance of n times one to two kilometres.

In the demonstration scenario the MANET was used to set up the Incident Area Network. One node was placed in the Mobile Command Post at the entrance of the tunnel, another one in the Fire Engine 1 at Gallery 7 near to the accident. The firemen in the accident tube used a backpack router to provide coverage within this tube. The coverage was very good and it was possible to transmit voice, video and sensor data with no problems.

The Luxembourg Test Bed

The prototype solution of the fire service scenario runs on a Luxembourg Test Bed. All communication facilities are connected to this test which is built around an MPLS IPv6 network that connects different sites in Luxembourg and is operated by EPT Luxembourg. The creation of the test bed provided an excellent permanent trial base that allowed global tests of different technologies and services. It facilitated the tests phases of the Fire Service Solution.

Three main sites were used for the creation of the network; the main hosting centre for the main servers and the link to PSTN and GSM networks, a secondary hosting site for the backup servers with the local DNS, network monitoring and the video encoding and streaming and a third site for peering, satellite connections and broking services. This third site makes the connection from non-native IPv6 connections.

Feedback from the “Fire in Tunnel” demonstration

The users from the Luxembourg Civil Protection who used the u-2010 solutions in the demonstration provided the following feedback:

It was interesting for the Civil Protection to see that the technology can really perform. They were impressed that the promises made about effective, innovative infrastructures and communication technologies were fulfilled.

The firemen asked if it was possible to receive video transmission inside the tunnel or accident site. Specifically the video images captured inside the tunnel would have been of great interest not only outside the tunnel in the Mobile Command Post but also to the teams inside the tunnel.

The firemen were astonished and grateful that the new technology did not hinder them doing their work as has happened before in trials of new technology. The applications were really easy to use and to understand. The remote controlling and monitoring of cameras was appreciated as really useful and good implemented.

They felt the scenario was realistic and reflected the way they worked accurately. A major difference between the demonstration and the reality was the timing; in reality everything is done faster.

According to their evaluation the Portal would be mostly used in Headquarters and in Mobile Crisis Command Centers. The Mobile Client would be used by the Commander of the operation. It should be also installed in every car which might be used by a Commander.

One problem that the Civil Protection saw was that the equipment (prototypes used in the demonstration) was too large and space consuming for day-to-day use. For real scenarios this should be much smaller and more robust.

Security and privacy is another issue that has to be handled very carefully. I.e. the volunteer has to switch on his localization device by himself, when he is on duty. The access rights are managed with a directory service.

The HNPS Project

A new project, called “Heterogeneous Networks for Public Safety” (HNPS), was started in November 2008 to continue the work of u-2010 and to integrate the technologies that came out during u-2010’s timeline, such as WiMAX, mobile WiMAX, LTE and Tetra. Fourteen partners from Luxembourg, France and Spain cooperate in this project: In the following pages we explain HNPS in more detail.

<u>IP Integration of PMR</u>

Virtually all network solutions for professional mobile communications are based on proprietary system architectures. Although the air interface may be compliant with open standards such as TETRA, internal interfaces are not. End-users requiring seamless nationwide coverage cannot use equipment from multiple suppliers and therefore have to depend on a single supplier for all TETRA requirements. This “vendor lock-in” unfortunately prevents system expansion, interworking between networks and migration to newer technologies.

The HNPS project conducts research to remove the barriers of closed system architectures. This means interoperability between PMR systems, including TETRA networks, on the basis of open standards. One part of the HNPS solution is the On-Demand Intelligent Network Interface (ODINI) that has been developed in close cooperation with end-users and independent system integrators.

<u>Architecture of a Multi-Service Deployable Wireless Broadband Bubble (W3B)</u>

The HNPS project is developing architectures that may be used to host voice, video and data services in a Wireless Broadband Bubble (W3B).

The W3B based on WiMAX or LTE, offers Point to Multipoint communication for end user equipment only. HNPS proposes a solution to dynamically interconnect several W3B in order to extend the coverage of the bubbles and to offer seamless interoperation between several public safety operators. The dynamics covers the radio configuration and the IP routing with QoS and allows a zero touch configuration of the system on the field. This W3B solution may be used in a crisis to set up communication networks where no communication has been previously available.

The HNPS project made some test sessions to cover several possible conditions of deployment in a highway tunnel in Luxembourg, in order to gain first-hand experience with high frequency wave propagation, signal strength, and available throughput in difficult HF situations. A WiMAX base station was set up in front of the tunnel and inside various client devices (CPEs) were used at various locations to provide values from both tubes.

Basic network functionalities were tested (raw throughput measurements) and the point of coverage loss was determined. In a second session different applications were used to validate the quality of the connection in a real life application scenario. The results of these tests will be discussed in the workshop.

Computer Vision-Based Alarm Detection System

Recent advances in Computer Vision have shown the capability of Automatic Incident Detection (AID) systems, integrated into control centres, to improve decision and response-cycle times in emergencies. Based on predefined user requirements, a Computer Vision based system can be used, not only to access signals coming from various cameras deployed along an infrastructure (which is a basic functionality offered by any video service), but also to centralise and process those video streams in order to detect incidents that may have occurred in the areas under video surveillance.

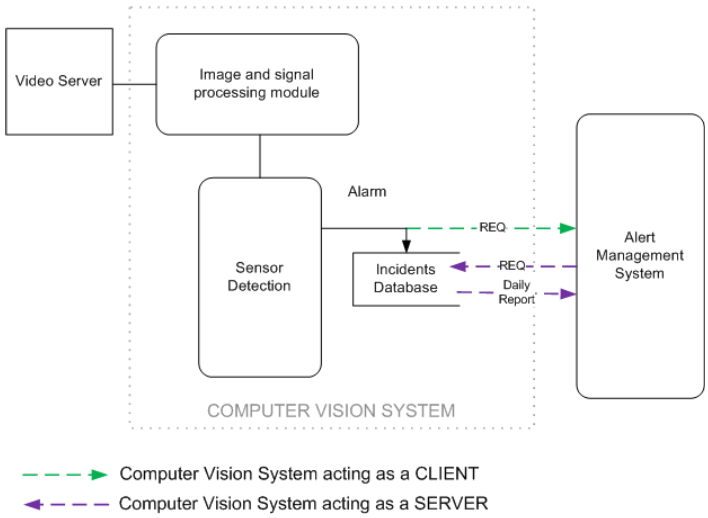
A broad set of scenarios in the field of Intelligent Transportation Systems may benefit from the development of different algorithms that detect, classify and track different objects present in any scene, and more interestingly, the events (abnormal or not) in which these objects may be involved. However, a problem still exists with the solutions, currently used in control centres, since the communication of an alarm to the corresponding entity relies on one operator only who is trained to follow an established emergency procedure. Without wishing to disregard the important role played by the operators in control centres, the proposed system aims to facilitate their work at different levels.

In the HNPS project, software will be developed, where incoming images will be analysed and once an abnormal behaviour has been detected, corresponding alarm messages will be sent asynchronously to an Alert Management System. This alert management system will process the provided information and continue to assess the situation automatically, until the incidents are resolved.

From a practical point of view, the video server, to which the HNPS developed Computer Vision system will be connected, will be available within the audiovisual network of the SGI operating environment, inside the Public Transport Management Centre (PTMC) in Madrid (Spain).

Figure: 6 shows the proposed HNPS solution.

Figure: 6 Proposed Computer Vision-based alarm detection system



Conclusion

The “Integrated IP Communication Solutions for Public Safety” Workshop gives an overview of the u-2010 and HNPS projects. It explains the shared goals of the two projects. It references scenarios from the two projects to either prove the project’s success or to explain on-going aims, and some of the projects’ partners speak about their project experiences.

Author Biographies

Harold Linke is the Head of the Software Engineering and ICT-Development Department of HITEC Luxembourg. He started his career after studying electronics in Munich at Siemens Germany as a software developer for communication systems. In 2004 Harold joined HITEC Luxembourg, where he is responsible for Software and ICT development. Harold is very active in EU-projects and was the technical coordinator of the u-2010 project and is the coordinator of the HNPS project.

Kate Yeadon is a senior Project Manager at EPT Luxembourg. She has a strong Telecommunications / project background and has worked in various projects and Telcos around the world, before joining EPT Luxembourg in 1994. She is a founding member of EPT’s new department “Service des Projets et Dossiers Stratégiques” and is currently working on EU sponsored Emergency communications projects.

Philippe Bereski joined Alcatel-Lucent in 1994. He held several positions in Research and Development, then in Research and Innovation, before leading the "Defence and Public Safety" laboratory of Alcatel-Lucent, in Villarceaux, France. This laboratory is responsible for the definition of new system solutions for this vertical market, based on Alcatel-Lucent of the shelves equipment. Philippe is involved in several national and European research projects such as 6DISS, SEINIT (IST), SIC (SYSTEM@TIC). Philippe is co-author of the book "IPv6 théorie et pratique".

Bert Bouwers joined Rohill in 1986, and was Chief Technology Officer from 2008. He manages a team of highly skilled engineers working on all aspects of trunked radio systems. Bert established the TetraNode system architecture at the early stages of the development, and has continued to adapt the architecture and design of TetraNode according the latest trends in the IP networking industry. Rohill has a reputation for delivering innovative and adaptable solutions. Bert has a profound knowledge of the TETRA standard and has delivered a number of presentations on the subjects of TETRA-over-IP, multi-protocol solutions and Softswitching Technology.

Wolfgang Fritsche received his Diploma in Electric Engineering from the Technical University of Munich and currently is the head of IABG’s Internet Competence Centre. Wolfgang has been responsible for several national and international projects and some of his recent activities include consulting to the Federal Ministry of the Interior of the Federal Republic of Germany in the area of Public Safety Communication, leading the ESA studies on “Programmable Active Networks for Next Generation Multimedia Services” and “IPv6 over satellite”. He leads IABG’s development of the ad-hoc networking solution Highly Mobile Network Node (HiMoNN) and coordinates its sales activities. Wolfgang represents IABG as a founding member in the Global IPv6-Forum and the German IPv6 Council.

Nuria Sánchez is a Telecom Engineer (with honours) by E.T.S.I. Telecomunicación (Universidad Politécnica de Madrid, Spain). Since 2005 she has been heavily involved in several R&D National and European Projects in relation to Intelligent Transport Systems, Safety and Audiovisual technologies. From 2008 on she has been participating in the CELTIC initiative HNPS "Heterogeneous network for European public safety" as one of the UPM Technical Managers. Her professional interests include image and digital video processing, remote sensing, Computer Vision and intelligent systems, mainly focused on human behaviour and scene understanding for video surveillance applications (video interpretation, spatiotemporal reasoning and event recognition mainly).