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

1 Summary

E-SPONDER addresses the operational challenges that involve better understanding of the complexity of large-scale disasters by identifying, prioritizing and connecting the various heterogeneous domains involved. The project tackles a wide series of practical operational challenges in order to reduce operating costs, increase effectiveness in resource allocation, enhance situational awareness for crisis personnel, enable application of effective and safe tactics and strategies during operations, but also facilitate uninterrupted flow of information and decision making through different levels of command and logistics organization.

E-SPONDER is a suite of real-time data-centric technologies which provides actionable information and communication support to first responders that act during abnormal events (crises) occurring in critical infrastructures. This information enables improved control and management, resulting in real time synchronization between forces on the ground (police, rescue, firefighters) and out-of-theatre command and control centres (CC).

The approach guiding the E-SPONDER project is based on the fusion of variable forms of field-derived data within a central system which provides information analysis and decision support applications at designated CC locations in order to provide in situ support to first responders that operate in Critical Infrastructures. Statistics show that efficient emergency system can reduce accident losses to 6%, compared with situations without emergency system. As a result, an efficient emergency system is a key to cope with all kinds of sudden events and improve safety of cities and countries.

To do this, E-SPONDER has achieved the following objectives:

1. Improvement of front end data collection technologies installed both on portable and fixed platforms, providing a flexible yet comprehensive coverage of the affected area;
2. These data are fused and analysed to provide real-time decision support;
3. E-SPONDER makes these resources readily available to commanders through the use of easily accessible web-portals but lastly and most important it provides significant support based on Information and Communication Technologies to the First Responders.

Thus, E-SPONDER minimises the uncertainty that characterizes crisis events, thereby limiting their scope. Now that E-SPONDER has been completed its elements are ready for deployment, since they have been integrated and extensively field tested.

2 Context and main objectives

E-SPONDER addresses the *operational* challenges that involve better understanding of the complexity of large-scale disasters by identifying, prioritizing and connecting the various heterogeneous domains involved. E-SPONDER tackles a wide series of practical operational challenges include reduced operating costs, increased effectiveness with the same number of human resources, enhanced situational awareness, effective and safe tactics, effective medical support of the victims during and after extrication, and uninterrupted flow of information and decision making through different levels of commandment and logistics organization.

An internationally diverse and functionally proficient end-user group has been established in order to:

- assist with the collection of end-user requirements that enabled and facilitated the effective development of useful products;
- continuously evaluate developments by periodically bringing together the end-user group, which ensured that the product meets the requirements of users in practice; This has been actively pursued during the project execution engaging the end users in: a) gathering requirements; b) validating the prototypes; c) training activities; and d) testing the E-SPONDER system during realistic field tests.
- By accommodating the continuous participation of end-users in the development of the E-SPONDER Platform we have ensured increased levels of acceptance by these particular end-users.

This research effort helps save lives. These being the lives of victims through more efficient operations, but also the lives of first responders that are called upon to operate in the hardest of conditions. Statistics show that efficient emergency system can reduce accident losses to 6%, compared with situations without emergency system. In addition, the E-SPONDER system after its completion (FRU and backend software at EOC and MEOC) can serve as an ideal testing ground for new software and hardware. Emergency response is a time and safety-critical work practice, where periods of relative low-intensity work are rapidly shifted into high-intensity work associated with a high degree of ambiguity. Emergency response is therefore a valuable setting for investigating new design of information technology for time-critical work practices, providing an area where ICT can demonstrate more value and help reduce uncertainty and/or lack of exact information by improving quality of available data and information to first responders.

2.1 Scientific and Technological Objectives

The main objective of E-SPONDER is to ensure that no illnesses or injury occurs to any first responder, first receiver, medical facility staff member, or other skilled support personnel as a result of preventable exposure to secondary trauma, chemical/radiological release, infectious disease, or physical and emotional stress after the initial incident or during decontamination and incident follow-up.

E-SPONDER’s overall objectives are:

- 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 an emergency situation. This goal has been achieved taking under considerations constraints such as: environmental conditions in the operating theatres of first responders, autonomous operation with extended duration, reliability of system, and effectiveness of system to support crisis operations, interoperability with crisis management systems, open information exchange capability and collaboration among First Responder groups and involved players across Europe.
- To set-up visible demonstrations of innovative First Responder Support Systems in realistic situations.

The methodology employed in the E-SPONDER project lifecycle, brings the first responders in the spotlight of all envisaged systems’ development and evolution. From the collection of user requirements, to the iterative development and validation of the system’s technical specifications and the performance of pilot demonstrations, the user groups affected by the developments of E-SPONDER – first responders, crisis managers, resource/infrastructure managers, and public agencies – hold key roles in the overall process.

The project had a three-fold focus linked to fully quantifiable results from a coherent set of properly scheduled research and innovation related activities.

1. E-SPONDER provided a new generation First Responder Support Platform, comprising of a full-set of systems and services built in accordance to innovative, integrated standards and peer-to-peer architecture, supporting a vast variety of first responder operations. This has been achieved by:

   a. Developing and delivering a complete First Responder Unit which aims at the total support and increased effectiveness of the First Responders' critical work. This comprised of:

      - Interoperable wireless communication system for the provision of continuous communication service to the first responder in the field of operations. The communication system encompass: a) Standard of-the-shelf wireless communication interfaces and capabilities (e.g. GSM, 3G, WiFi, Mobile-WiMax) to communicate through commercial networks to the MEOC, EOC and external nodes; b) ad-hoc and mesh networking capabilities to enable communication where there is no infrastructure or the infrastructure is severely damaged; c) communication management agent to manage interfaces and configure the communication system.

      - An ubiquitous and seamless localization and navigation based on GPS/EGNOS/GALILEO receivers for long range outdoor applications, and LPS (Local Positioning System) with high 3-D accuracy and real-time ability for short range indoor scenarios.

      - Protective garment specially engineered to seamlessly accommodate:

        1. Wearable chemical sensors for the continuous scanning of the surrounding environment; the detection of environmental temperature changes, toxic and inflammable chemicals

        2. Wearable physiological sensors to continuously monitor the health status of the First Responder; parameters such as the skin temperature, the heart rate and the respiration rate are measured, and significant trends and features are be extracted by the wearable system

        3. Wearable motion detection and activity classification is performed to ensure that the first responder is still active and able to achieve their duty as expected while providing increased protection against the harsh operating environments of first responders.

      - A mobile computing element in the form of a covert ruggedized PDA interfacing:

        1. between the previously described subsystems and the first responder, in order to provide local data fusion and user interaction, to enhance the evaluation of the situation by a multi-parametric approach and to record the actual signals for later off-line analysis of the intervention outcome

        2. between the FRU and the MEOC and EOC in order for better coordination and decision support,

   b. A centrally-located Emergency Operation Centre having control over remotely-located operations during crisis situations and providing the necessary executive support in occurring crises and will facilitate collection, monitoring and planning in periods of low-intensity work.

      - Communications infrastructure that allows the communication with the MEOC and other civil and military response units.

      - Communication management agent capable to remotely configure communications devices in the FRU and the MEOC taken into account global situation awareness information and implement an Emergency Plan context communication.

      - Logistics Management System that allows the establishment of scientific and reasonable reservation and distribution network of urgency rescue materials to help shorten emergency rescue radius, shaping an emergency logistics network with high timeliness and reducing losses caused by sudden disasters and public heath event to minimum.

c. A Mobile Emergency Operations Centre (MEOC), acting act as an ad hoc replica of the headquarter-based Emergency Operations Centre. This will have all the necessary Information and Communication Technology equipment (Computer workstations, communication platforms, necessary software), in order to provide the bridge between the operating First Responders and the main headquarters (e.g. main building of Civil Protection Agency), thus increasing situational awareness at the back-office.

d. Defining (design and development) of a full architecture and develop underlying necessary technological backbone, designed to provide improved data fusion, interconnection and interoperability between the different system elements and layers reducing data ambiguity to a minimum. A peer-to-peer architecture of information processing, the result of which will be accessible in a ubiquitous manner by all the actors involved, through the E-SPONDER portal.

e. Integration of different innovative and existing devices (sensors, positioning, communications, smart phones and garment textiles) and perform the necessary hardware and software enhancements to the aforementioned architecture so that all involved system elements can be seamlessly integrated to the main platform.

2. Study and develop the underlying socio-economic environment where the above technology may operate by addressing:

   a. The emerging training needs for increased operational efficiency of FR Operations of involved players (operating crews and supporting personnel). E-SPONDER developed a computer-supported simulation environment with an optimization module, to facilitate emergency response planning and training of first responders.

   b. the logistics by designing, developing and running simulation data on an optimization module to precisely identify size, parameters and risk of “disaster area”.

   c. The regulation framework, legal aspects, and the standardization issues of operational procedures (including the certification of First Responder equipment) as well as the societal and procurement implications so as to generate an initial framework for the design and development of suitable First Responder approach in Europe.

3. Demonstration of the developed system and validation of its operational characteristics in full-scale field trials that will simulate realistic emergencies and crises.

   The whole system has been tested against a variety of events in 2 countries. A specific testing users group has been engaged, covering the diverse nature of different first responders. Different scenarios simulating real life situations have been considered highlighting the added value the E-SPONDER system that can bring for European or International cooperation.

3 Description of main S&T results/foregrounds

The methodology employed in the E-SPONDER project lifecycle, had the FRs in the spotlight of all envisaged systems’ development and evolution. From the collection of user requirements, to the iterative development and validation of the system’s technical specifications and the performance of pilot demonstrations, the user groups affected by the developments of E-SPONDER – first responders, crisis managers, resource/infrastructure managers, and public agencies.

3.1 Concluded project activities

E-SPONDER has completed the final period of activity exhibiting significant results. Work started in the first year with a thorough State-of-the-Art (SOTA) analysis in relevant scientific and technical domains, executed in parallel with a user requirements analysis covering operational/mission aspects. The SOTA report provided insights on decision support systems, information management systems and crisis communication systems and ends with 14 specific recommendations for the E-SPONDER system (already taken into account in the design activity). User Requirements collection has been performed through real users interviews; Interviewed users came from various disciplines and operate in multiple levels of the crisis management hierarchy (First Responders, Incident Commanders and top level Crisis Managers). Three scenarios were developed; a base scenario of an aircraft crash to exhibit core features of the platform, a building collapse scenario to cover advanced features (such as 3D and LPS), and a large scale scenario covering a forest fire to investigate scale and complexity increase implications. All these scenarios correspond one-by-one to the pilots foreseen to be demonstrated at the end of the project. An additional part of the work performed dealt with the development of the operational concept of E-SPONDER, namely the definition of the different emergency phases that will allow deriving the role and functions of E-SPONDER in each of the crisis response phases, the definition of the actors and layers in place, their role and responsibilities and the definition of the flows of information and the level of interaction between the actors and the layers in place. Following the requirements analysis phase, the work continued with the definition of architecture and the design of the system. This activity commenced with the high level description of the envisioned system and the definition of Use Cases for the system.

During the second year the definition of the Integrated System Architecture and Interfaces Definition, and Communication Security and Interoperability aspects of the platform have also been finalized resulting in the in depth design and specification of the platform components. Development of various FR-equipment has also started since first year and two prototypes have been developed. Prototype development is executed in validation cycles during which various integration steps are performed. During the second project year, validation procedure has been executed by collecting feedback during a specifically organized by the project Workshop during which available prototypes were demonstrated to real FRs. First prototyping experiments have been conducted, especially for the breath-rate extraction from body impedance signals, the potential outer garments of the First Responder uniform. Additionally a prototype board enabling (indoor) positioning has been produced and first evaluation has taken place.

During the third year of the project’s lifetime the project focused mainly in finalising the implementation of the functional components of the platform. The E-SPONDER EOC and MEOC software components have been finalised as well as the web portal, the logistic support (OPTIMIZER tool), VOIP communication using push-to-talk and the core components responsible for the data fusion and information flow. Through these components the crisis management personnel is able to manage all monitored resources and thus obtain all available information from the crisis field. This information includes the 2D and 3D Common Operational Picture. In addition the development of the sensors for the First Responder Unit (FRU) has progressed as planned regarding the garment design, the local positioning sensor and the software component for the for the mobile devices which the sensors interact with. In parallel the training activities for the developed system have commenced. Regarding the standardisation activities, the project achieved a clear identification of the context where standardization activities of E-SPONDER should be concentrated.

The activities of the final year of E-SPONDER were focused on the completion of the integration and validation activities, the completion of the training and standardisation activities and the organisation and execution of the three challenging pilots.

Figure 1: Scenes from the challenging E-SPONDER field tests. Left: the FRs have entered the aircraft (1st field test); Centre: debriefing at the EOC using the collaborative touch table (3rd field test); Right: the FRs have entered the burning vessel (3rd field test). More photographs and videos can be seen at the specific page of the projects' website.

3.2 Final results

The project had a three-fold focus linked to fully quantifiable results from a coherent set of properly scheduled research and innovation related activities. E-SPONDER during its execution managed to:

1. Provide a new generation First Responder Support Platform, comprising of a full-set of systems and services, built in accordance to innovative, integrated standards and peer-to-peer architecture, supporting a vast variety of FR operations. This will be achieved by:
    a. Designed and developed a complete First Responder Unit (FRU) which aims at the total support and increased effectiveness of the FRs' critical work, comprising of:
        a1. Interoperable wireless communication system; enabling the provision of continuous communication services to the first responders in the field of operations. The communication systems encompass: a) Standard of-the-shelf wireless communication interfaces and capabilities (supporting GSM, 3G, WiFi, and Mobile-WiMax) to communicate through commercial networks to the headquarter-based Emergency Operations Centre (EOC) and a Mobile Emergency Operations Centres (MEOC) located close to the field of operations; b) ad-hoc and mesh networking capabilities to enable communication where there is no infrastructure or the infrastructure is severely damaged; c) communication management agent to manage interfaces and configure the communication system.
        a2. Ubiquitous and seamless localization and navigation based on smart phone GPS receivers for long range outdoor applications, and LPS (Local Positioning System) with high 3D accuracy and real-time ability for short range indoor scenarios.
        a3. Protective garment specially engineered to seamlessly accommodate:
            - Wearable chemical sensors for the continuous scanning of the environment;
            - Wearable physiological sensors that will continuously monitor the FR's health status;
            - Wearable motion detection and activity classification.
        a4. A mobile computing element in the form of a smartphone and a custom designed communication board/embedded device (called special node) interfacing between:
            - the above described subsystems and the FR in order to support local data fusion and user interaction, enhance the evaluation of the situation by a multi-parametric approach and record the actual signals for later off-line analysis of the intervention outcome;
            - the FRU and the MEOC supporting coordination and decision support.
    b. The consortium has designed and implemented a centrally-located Emergency Operation Centre (EOC) having full control over remote operations. The main features of the EOC comprise:

- b.1 Flexible communications infrastructure that allows the communication with the MEOC and other civil and military response units.
- b.2 A customizable communication management agent capable to remotely configure communications devices in the FRU and the MEOC.
- b.3 A Logistics Management System allowing the optimization of the resource usage during crisis situations.

c. A Mobile Emergency Operations Centre (MEOC), which acts as an ad-hoc replica of the headquarter-based Emergency Operations Centre (EOC). The consortium designed and developed a mobile command post (a vehicle) with power generation capabilities and rich communication interfaces.

d. The partners have defined (design and implementation) of a full architecture and developed underlying necessary technological backbone, offering improved data fusion, interconnection and interoperability between the different system elements, providing an accurate picture of what is happening in the field of operations.

e. The consortium has spent significant effort on the integration of different innovative and existing devices (sensors, positioning, communications, smart phone devices and garment textiles) and performed the necessary hardware (such as the custom special node) and software enhancements to the aforementioned architecture so that all involved system elements are seamlessly integrated to the main platform.

2. Studied and developed the underlying socio-economic environment where the E-SPODER technology may operate by addressing:
   a. The emerging training needs for increased operational efficiency of FR Operations of involved players (operating crews and supporting personnel). E-SPONDER developed a computer-supported simulation environment with an optimization module, to facilitate emergency response planning and training of first responders.
   b. Studying the regulation framework, legal aspects, and the standardization issues relevant to the project's objectives and research.
3. Demonstration of the developed system and validation of its operational characteristics in full-scale field trials that will simulate realistic emergencies and crises. The whole system has been tested against a variety of events in two countries, the Netherlands and France. A specific testing users group has been setup, covering the diverse nature of different FR disciplines. Different scenarios simulating real life has been considered in order to highlight the added value the E-SPONDER system brings for European or International cooperation (aircraft landing, collapsed building and vessel on fire incidents).

3.2.1 First responder unit

The First Responder Unit, or FRU for short, is one of the basic elements of the E-SPONDER system, which is worn and used by the First Responders of the different disciplines (police, rescue, firefighters, etc.). As such, the FRU is a sub-system of the E SPONDER system, which also comprises the Mobile Emergency Operations Centre (MEOC) and the Emergency Operations Centre (EOC). An overview of the complete FRU system architecture and its components is provided in the following figures and sections.

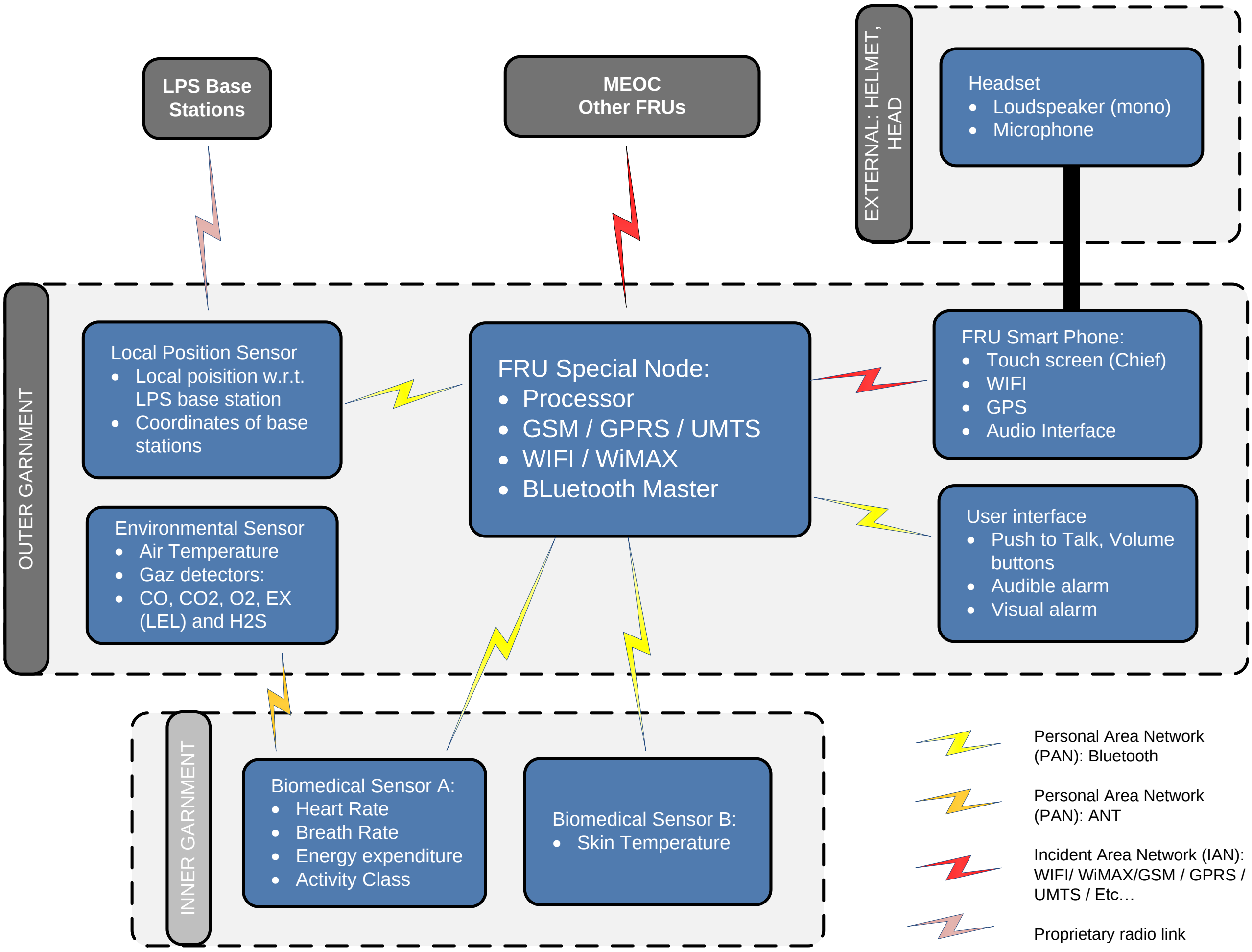

Figure 2: Overview of FRU system architecture

The FRU special node acts as a centralizing data hub, gathering and distributing data from and to the different peripherals connected to it. This central processing and communication unit communicates over a high data rate wireless link with the other FRU's of the group and the MEOC. The FRU smart phone is responsible for handling the voice communications of the FR:

- When the FR is talking to the FRC
- When the FRC is talking to the team (other FRs)
- When the FRC in talking to the MEOC

Inside this architecture, it is important to notice the presence of the LPS base stations which are required for the local positioning system (LPS). The "optimised" FRU prototype is an improved version based on the first FRU prototype developed in the first phase of the project including several additions or re-design of certain critical parts. The final version of the integrated system is shown in Figure 3.

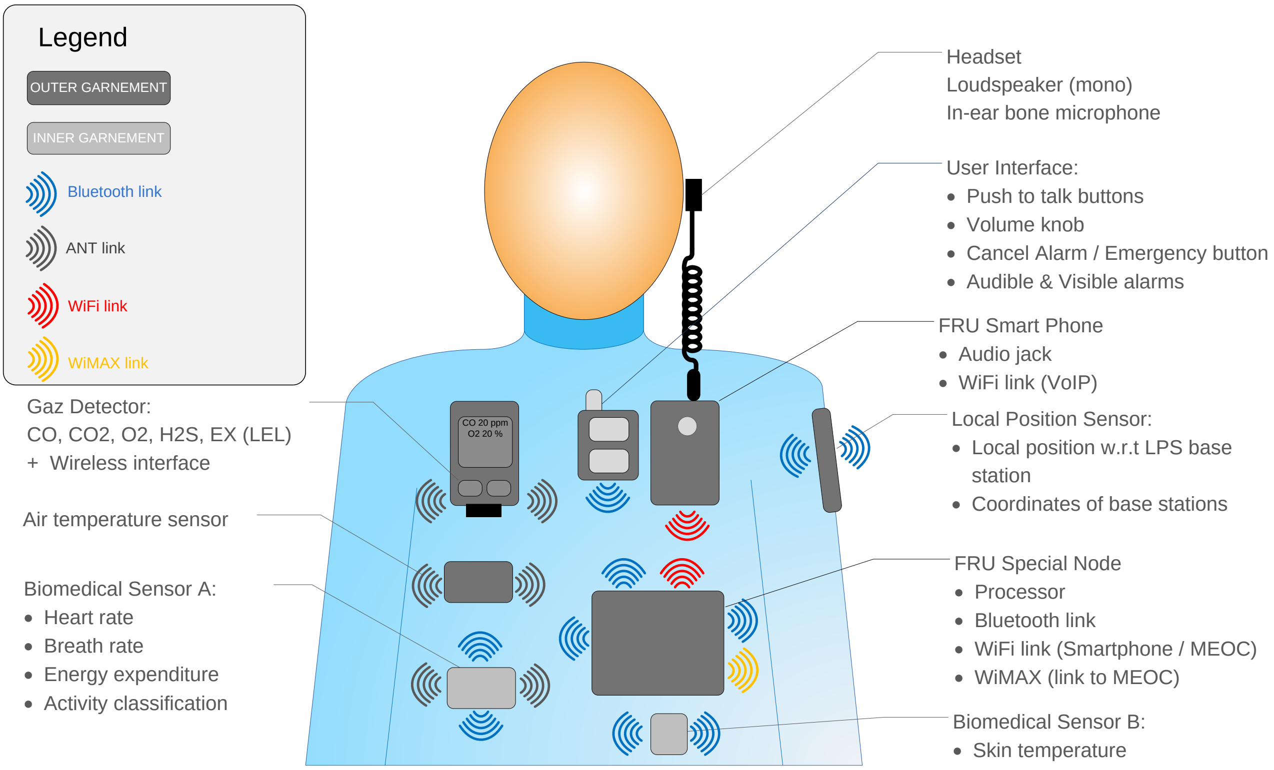

Figure 3: FRU system components.

The deployment of the FRUs is shown in Figure 4. The FRUs equipment is arranged over the preparation area where the units are lined up. The sensors, the smart phones and the special nodes are over the table, the LPS base stations can be seen in the background of the photo. The t-shirts and the protective jackets (of various sizes) can be seen as well.

Figure 4: Deployment of the FRUs during the 3rd field test.

3.2.1.1 Inner and outer garment of the FRU

E-SPONDER has produced 12 T-shirts (male and female models in different sizes) to use during the pilot demonstrations in The Netherlands and in France. The following list summarises the characteristics of the shirts:

- **Safety:** the textile used to manufacture the shirts, respects: the norm EN1149, for the fabrics against the electrostatic discharge, and the norm UNI ENISO11612 that rules the production of the garments used for the protection against heat and flame. The fabric is flame retardant
- **Comfort:** the shirts have been produced in three different sizes (S, M and L), in order to cover the sizes of the fire fighters who participate to the tests, and to improve the comfort of the FR. The textile used is as light as possible.
- **Shirt pocket (front):** the pocket containing the device (sensor A) to detect the physiological parameters (ECG, BR) is provided of a fire retardant zip, to avoid the device falls out during movements. Its central position was chosen to avoid that the oxygen belt overlaps with the device.
- **Closure system:** this system is improved on respect to the previous version, according to the requests of the firemen who wore the shirt during the user tests. In this final product, the sensorized part is completely sewed to the inner part of to the shirt.

Figure 5: Inner garments: left: external view of male and female models; right: internal side with sensing part.

E-SPONDER has produced 10 Jackets in two models (Firefighters Team, and Chief), in three sizes: S, M and L. The models are shown in the pictures below:

Figure 6: Outer garments.

The characteristics of the jacket are listed below:

1. Inner pockets for LPS and Smartphone:
    - Two inner pockets are sewed in the internal part of the Jacket to hold the Smartphone and the Local Position Sensor (LPS) devices. These pockets are manufactured with the same fabric as the outer shell of the jacket.
    - Fire resistant zippers permit to remove the devices from the pockets, in case of problems, maintenance or cleaning.
    - It isn't foreseen the manual interaction of the FR with the devices, only the Chief can use the Smartphone during actions in order to interact with his team.
2. Internal bus to recharge batteries:
    - A flexible cable connecting the different devices permits to recharge Smartphone and LPS simultaneously. The fabric between the two pockets protects this cable. Each jacket is provided by the internal bus with the right connectors.
3. Fabric belt to hold the gas sensor:
    - A fabric belt is sewed on the jacket, to hold a gas sensor.
    - Many additional tags are sewed in different places of the outer garment as requested from the fire fighters during the last ergonomics trials.
4. Big fire retardant pockets to hold the Special Node:
    - The two pockets placed on the bottom of the jacket have been enlarged as much as possible, to contain the special node device; an internal hole has been done in the inner part of the pocket to permit to the connecting cable to reach the Special Node.
5. Fire retardant pocket to hold the external temperature sensor:
    - The pocket is sewed on the left side of the jacket; the hole of the pocket (from which the sensing tip of the device comes out) is positioned in order to avoid that the arm hits the sensing tip of the device during movements.
6. Fire Retardant net pocket for User Interface device:
    - The pocket is sewed on the jacket, in the position suggested by the end users.
    - The user can push the buttons of the device also with the gloves thanks to the holes done on the pocket.
    - The net permits the other members of the team to see the visible alarm produced by the device when the button is pressed.
    - It is possible to push the buttons of the device and adjust the volume through the pocket, without opening it.
7. Two internal labels, placed in the inner part of the jacket, provide information on the First Responder garment, as well as about the composition and washing instructions.

3.2.1.2 Mobile phone and special node

A mobile phone has been chosen having in mind the special requirements for the Bluetooth and the Wi-Fi operations. The Bluetooth operation is based on version 4.0 with A2DP functionality. The Wi-Fi capability is fully covered since it operates in 802.11 a/b/g/n/ac. The phone is dual band, and supports Wi-Fi Direct and Wi-Fi hotspot. In addition it is LTE (4G) capable with internal memory of 16GB and 2GB RAM. The display (which is needed for the FRC) is True HD IPS+ capacitive touchscreen with 16M colours and 1080x1920 pixels and protective glass making it quite efficient for difficult environments (Contrast Ratio: 967:1 nominal and 2228:1 for sunlight). The OS that has been loaded is Android v4.4 (Kitkat) and the CPU is quad-core running at 2.3GHz (Krait400). One of the major operations of the smart phone is the VoIP communications between the FRs and the FRC-to-MEOC. Its sound performance (based on comparative real tests) is very good with active noise cancellation (if an extra dedicated microphone is used). The audio quality is characterised by noise -93.3dB and crosstalk -94.3dB. The battery is Li-Ion 2300mAh which gives to the smart phone a large autonomy covering all the user requirements (as they have drawn from the E-SPONDER end users).

The role of the special node in the E-SPONDER platform is 8-fold:

1. It operates as a local portable access point, providing IEEE 802.11b/g Wireless LAN connectivity to the FR smartphones. This functionality is particularly important in cases where the MEOC is unavailable, out of range, or in special cases where connectivity is limited.
2. It operates as a communication relay between MEOC and the FR team. Especially if MEOC-FR team communication is based on a radio wideband technology that it is not supported by the majority of commercial smartphones e.g. WiMAX, the special node is operating as a router that bridges WiMAX traffic to Wi-Fi traffic and can interconnect the FR smartphones, applications and sensors with MEOC and EOC servers.
3. It operates as a portable VoIP server. In order to ensure voice communications between FR team members when MEOC is not present or the communication link capacity is limited, the FR chief special node hosts an Asterisk SIP server. The FR team member VoIP clients (installed at the FR smartphones) are registered users. The FR team Asterisk SIP server is the most reliable VoIP host since in many cases the FR team is deployed in rough and inaccessible areas that MEOC coverage may be limited.

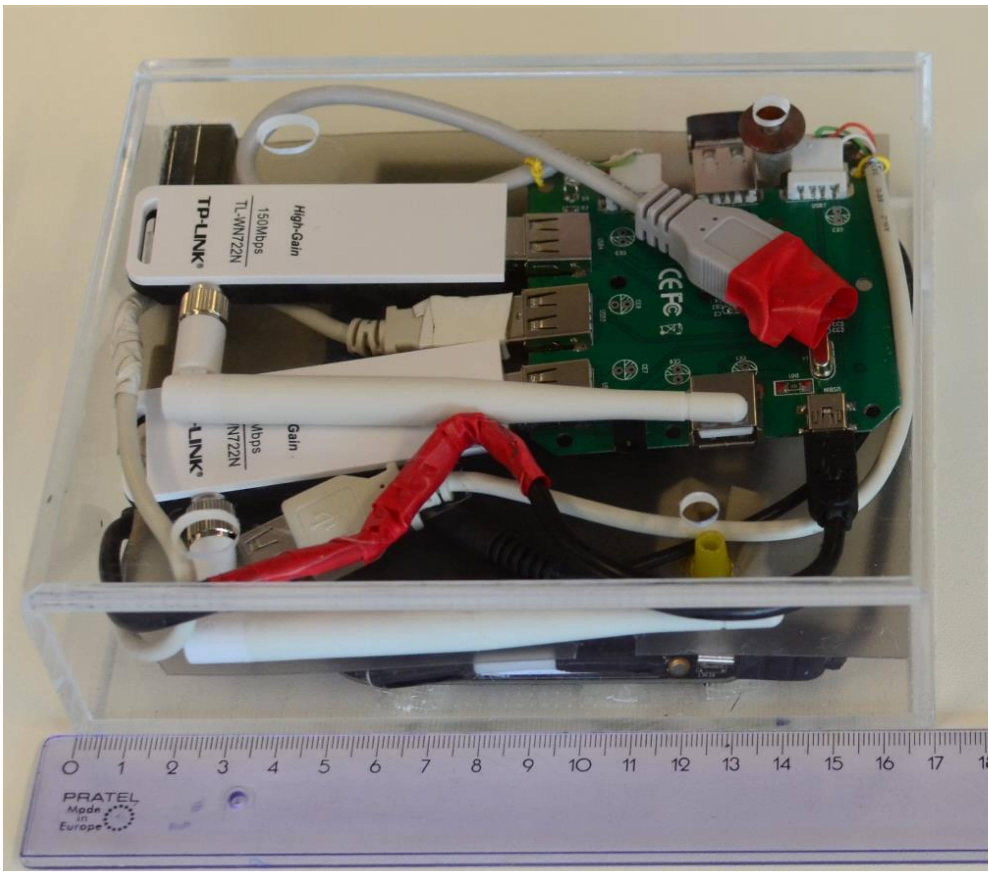

Figure 7: Special node prototype implementation.

4. It operates as a Bluetooth hub that collects the measurements from the FR sensors. The existence of the special node Bluetooth hub is considered necessary, since the Bluetooth interfaces of the commercial smartphones cannot effectively support multiple connections with multiple Bluetooth devices like the FR sensors, i.e. the smartphone cannot efficiently operate as a Bluetooth hub.
5. It operates as the sensor measurement collector. A service that collects all the measurements from the FR team members is installed at the FR chief node. The measurements are sent through the E-SPONDER

network from the FR team member equipment in specific network ports of the FR chief special node that listens to the specific port. The service manipulates the sensor data, stores them and forwards them towards MEOC through the wideband radio network (in the demonstrated case, the WiMAX network).

6. It operates as a Wi-Fi client connected to the FR team Wi-Fi, i.e. the FR chief special node access point. This functionality provides the required connectivity among team members when MEOC is unavailable in order for the FRU sensor data to reach the FR chief special node.
7. It operates as a Wi-Fi client connected to the access point of the FR Chief camera. Images captured by the camera can be forwarded to MEOC.
8. It operates as an application server on the FR team level that checks for network and connectivity issues and provides additional capabilities to the FR team members. Since, the special node is practically a small computer; it can be used to offer additional adaptivity and reconfigurability to the system.

The special node has been constructed using commercial-of-the-shelf components. It is compact enough to fit in a pocket of the FR jacket. The special node prototype packaging was made with plexi-glass and its dimensions were: 16.8 x 14 x 4.5 cm.

3.2.1.3 LPS component

The complete dual band localization system consists of mobile stations and base stations. Since a secondary radar topology was chosen according to the specifications, the mobile stations only receive signals from the base stations and calculate their own positions. The architecture and a photograph of the developed mobile station are shown in Figure 8.

It consists of two connected printed circuit boards (PCBs), where one is the carrier board containing the analogue front end and the other is the field programmable gate array (FPGA) board, which performs the necessary digital base band, processing and control functions. The analogue front end is designed to use a custom integrated circuit for radio frequency signal processing. A dual-band receive chain is implemented, containing two switchable band pass filters for both ISM bands. Furthermore, an IF filter, VGA, and ADC with anti-aliasing filter are added. The digital signal is then processed further in the FPGA for position calculation. Also a frequency shift keying (FSK) module for communications and protocol handling between the components of the system is mounted on the carrier board.

To communicate with the FRU of the E-SPONDER system, a Bluetooth module is included. Using the serial port profile, the calculated positioning data is transmitted as a text string with a constant update rate and received by the FRU, which can be the smart-phone of a first responder team member. From there, the data is forwarded through the E-SPONDER network. Power supply is provided by a 3.6V LiPo battery, which is connected to an integrated charge and power management circuit. It allows the module to be powered and charged by a wall supply.

The developed base station is depicted in Figure 9. It also uses a custom system chip to implement a multi-band and multi-channel architecture. The front end architecture is similar to the mobile, except it has four channels which are capable of receiving and transmitting. A GPS module is added to provide a global position to the base station which is used to reference the local coordinate frame of the system to a global coordinate frame. As a result, the system can output local and global coordinates, which can be used directly by the E-SPONDER system. The system is powered by a high-capacity 12V lead battery to provide energy autonomy for a long period.

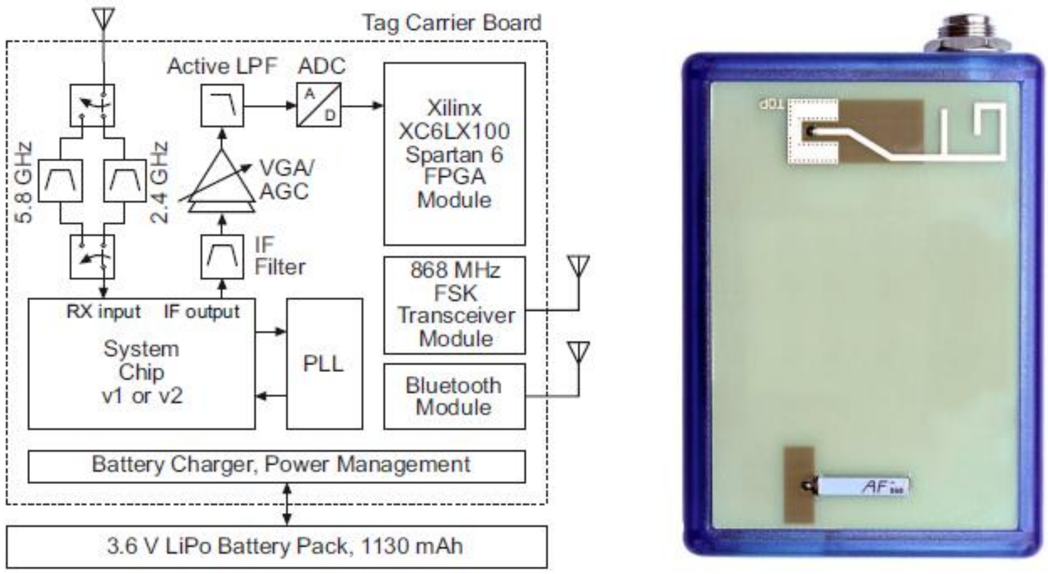

Figure 8: Mobile station architecture and photograph, size 65 x 90 x 28 mm³

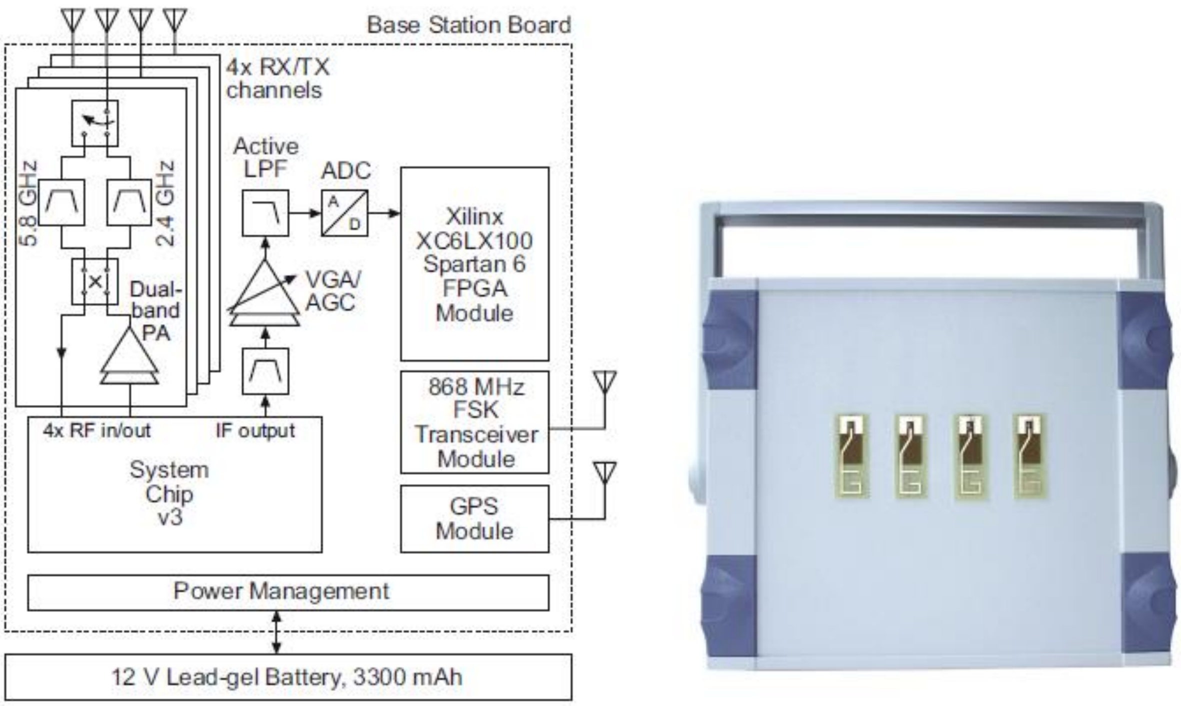

Figure 9: Base station architecture and photograph, size 235 x 195 x 135 mm³

3.2.2 Emergency operations centre (EOC)

The EOC is the strategic level during rescue operations, located out of the crisis site at a crisis management centre (for example a prefecture in France, or a regional coordination centre in The Netherlands), which elaborates the response planning. The EOC takes into account regional effects of a crisis on a multidisciplinary basis (whereas the MEOC deals with local effects of a crisis, and is not necessarily multidisciplinary).

In E-SPONDER, the EOC level includes operational strategic actors (operational intervention) from the first and second cores of intervention, but also political ones (political intervention), as they are not really distinguished in practice. The EOC teams includes superior officers from the disciplines present on the field (at least medical services, fire brigade, police), representatives from the region or the city who have a larger and multidisciplinary authority (for example, a prefect), communication experts, specialists needed in the crisis resolution (e.g., hazmat expert in case of CBRN accident, meteorologist during a forest fire, etc.). Moreover, in E-SPONDER, the so-called "external entities" will be represented at the EOC level; these entities practically take care of the political decisions and political implications of the crisis, yet they change depending on the crisis type and the size of the incident. It has to be noticed that information and communication needs with authorities and media are managed at the EOC level. In the E-SPONDER platform, the EOC provides the necessary executive support during crisis situations, thanks to the E-SPONDER ICT systems, mainly computer workstations, communication infrastructure, 3D table, and all specific software and applications.

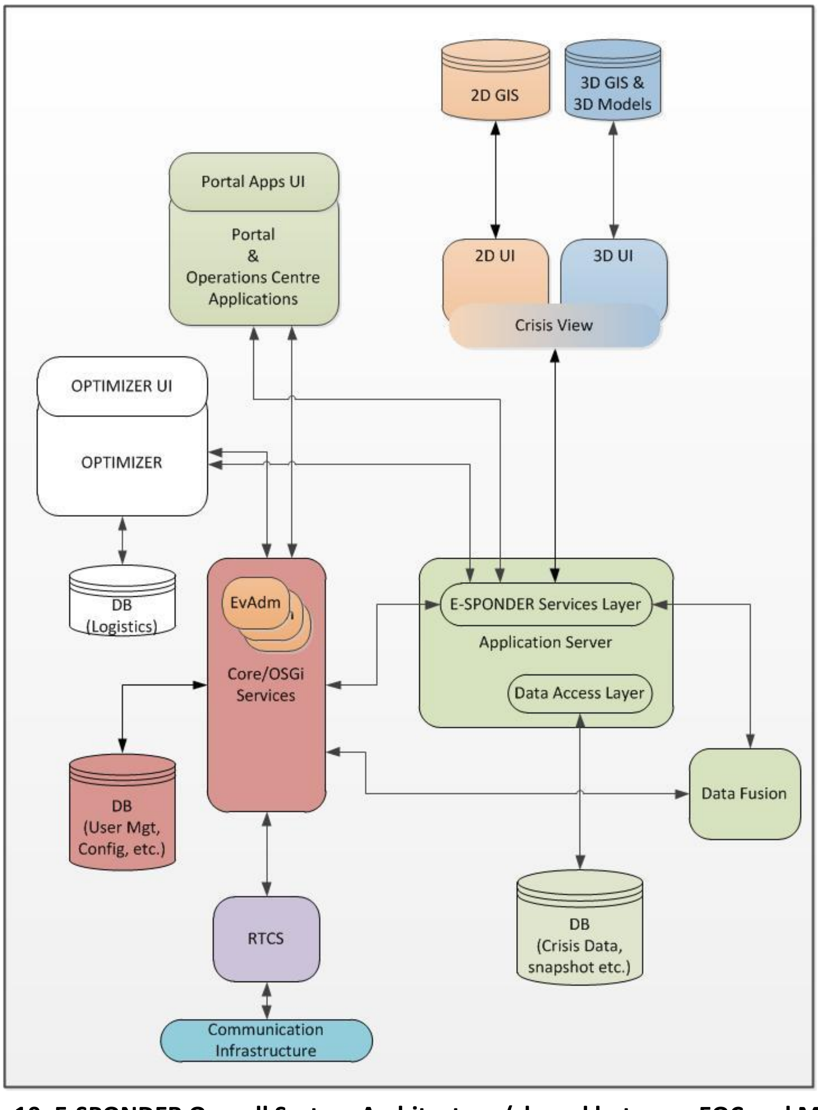

Figure 10: E-SPONDER Overall System Architecture (shared between EOC and MEOC).

The E-SPONDER consortium decided on the strategy to adopt to solve the crisis with a multidisciplinary expert point of view, taking into account potential regional damages at the largest scale. As at the EOC level, a **Common Operational Picture (COP)** is used as a basis of work, but it is of larger size than the one shared with MEOC and allows a multidisciplinary view, with the representation of the regional effects of the crisis, and not the local details. For example, if at the MEOC level, information about FR health status and exact positioning is needed, at EOC level this is of no importance; only the results of their actions, that is to say the progress of the crisis resolution, needs to be represented. On the same way, if at the MEOC level fire-fighters and policemen do not need all information to be shared (so to be represented on the map), EOC has to coordinate the actions of both entities, and needed to differentiate (thanks to different colours used for example) actions done and to come of fire-fighters and policemen.

Finally, as different entities and different kinds of actors are present at the EOC, intuitive, easy-to-use and user-friendly interfaces are of most importance at this level. Of course usual actors (such as fire-fighters commanders, police representatives) are trained and are familiar with the EOC management and tools, but political staff or very specific specialists will not be necessarily familiar with, yet will need to understand at one glance, and communicate quickly and easily using E-SPONDER support system.

Starting from the users' viewpoint, the system's viewpoint about the COP is much more complex. In principle the complexity has two dimensions. The first one deals with the domain model associated with the entities managed by the E-SPONDER platform (e.g., FRs, equipment, logistics, organizations) but also with the hierarchy introduced by the E-SPONDER itself, namely EOC, MEOC and FRs. The second one refers to the fact that for most of these entities the system is required to monitor and persist real-time information that is relevant to reveal what is actually happening (i.e., what COP is all about). It is the E-SPONDER's platform core objective to model and associate all entities and filter out the information handled in a smart and efficient way not only in the level of User Interface but also internally in the backend systems and down to the database level.

E-SPONDER is a platform integrating a multitude of advanced Information and Communications Technologies (ICT) in view of developing a data-centric platform fulfilling two core objectives: to collect information from the crisis theatre – field of operations – e.g., from sensors attached at First Responders apparel and protective equipment/clothing, process it, extract inferred information and present it (in raw or inferred form) to people away from the field; the objective is to develop their awareness level concerning of what is actually happening at the field (Monitoring Flow) and thus aid them in decision making. Secondly to enable the dissemination of appropriate information from central points (where decision makers are located) towards the field of operations, enabling in such a way the efficient organization of the resources involved in the actual emergency handling operations (Control Flow).

From the technology viewpoint, E-SPONDER could be separated into two major sectors: the communication infrastructure and the information platform. The former bundles all communications hardware and software used to enable the communication among the various nodes of the system. E-SPONDER is in principle an All-IP communication platform, with this meaning that an IP network is exploited over which voice, video and data communication services are offered. The Information platform is the systemic part of the entire platform that is overlaid the communication infrastructure and is responsible for the actual processing of the data exchanged among the system nodes and their presentation to end users. The present section refers to this information management platform and more specifically to the presentation part for the Monitoring Flow on the one hand, and to the management of the disseminated information (mainly in the form of composition of appropriate messages) across the platform nodes, on the other.

According to the basic E-SPONDER architecture and with reference to the information management platform developed, EOC and MEOC have equivalent roles in terms of the system functionality implemented at each one. This becomes more relevant when considering that MEOC is required to operate autonomously, namely regardless of whether connectivity with the EOC is enabled. For this reason the basic requirement for the tools developed is to allow for bidirectional information replication among EOC and MEOC(s) while not limiting the independence in operation of each one. What is different is the view that each level obtains about the crisis; the EOC covers the top-level strategic view of the Monitor and Control flows whereas MEOC the middle-level tactical one. As a result, the E-SPONDER Information platform has been developed by taking into account these critical aspects, namely all components are developed to be operating at both the MEOC and the EOC but customization of the views enabled for each one, especially in terms of the granularity of information displayed at each level, has been considered.

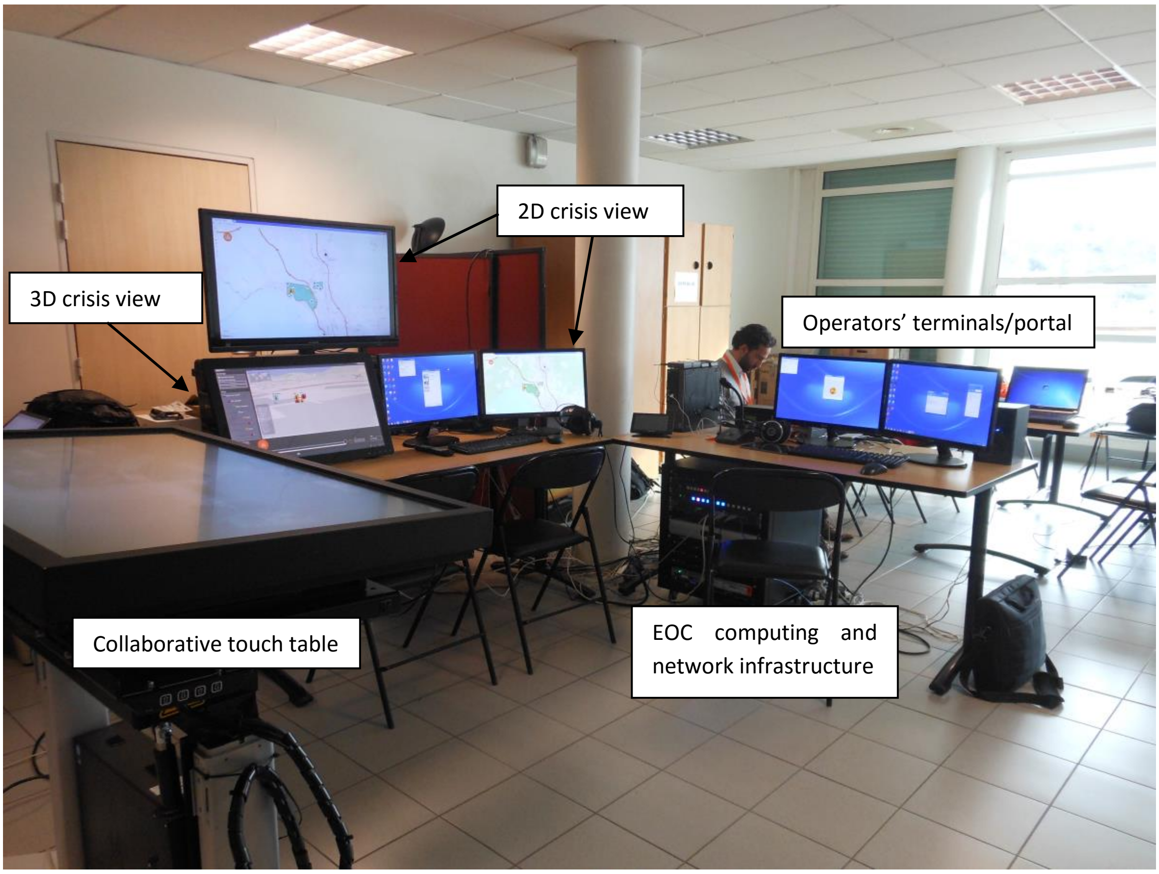

Figure 11: The EOC setup during the 3rd field test. In front the collaborative touch table is visible, whereas in the back the operators' terminal can be shown hosting the functionalities of the 2D crisis view, 3D crisis view, OPTIMIZER and E-SPONDER portal.

3.2.2.1 2D Crisis view

The crisis view provides a map-based 2D overview of the crisis area, where the relevant information for the user in the EOC is displayed. Specifically this is data from MEOCs and the related teams of FRs, for example their position, a description and relevant sensor data. The data are received from the Data Fusion Server using the DCI/DRI interface. From a UI perspective the 2D crisis view in the EOC and MEOC are very similar. The difference to the crisis view in the MEOC is a different level of granularity. While the focus of the MEOC crisis view is on a detailed description of the first responders related to the MEOC, the EOC crisis view provides a larger picture of the general crisis situation.

3.2.2.2 3D Crisis view

Access to maps during emergency management is of main importance, but is not always easy and systematic. The 3D Crisis View appears therefore in the management process as a critical point of reflexion. It gives a 3D access to the Common Operational Picture which is enriched by FR sensors and by EOC/MEOC users through the 2D Crisis View.

3.2.3 Mobile emergency operations centre (MEOC)

The MEOC has similar functionality as the one offered by the EOC, though it can serve a limited number of operators due to its space constraints. In addition, the MEOC does not have the collaborative touch table that the EOC has.

The operators' area has been designed in order to serve 3-4 sitting operators inside the vehicle, and another 4 standing operators outside the vehicle. The sitting operators have their dedicated workstation. The standing operators outside the vehicle will be able to watch the camera video and the data displayed at the display monitor installed at the sliding door window. The design of the operators' area allows a pleasant stay in the vehicle during their mission and the better equipment allocation to the specially constructed equipment racks. The electronic equipment has been installed into specially constructed racks at the operator's area. Furthermore, apart from the equipment that is located inside the vehicle, there is equipment placed on the vehicle's roof, like a high resolution day/night camera, a weather station, a Satellite antenna, a WiMAX antenna and other communication antennas (GPS, 3G/4G USB dongles, WiFi, etc.) and the air conditioning for heating and cooling in the operators' room.

The MEOC, apart from the necessary and conventional equipment, it also has further equipment, which is placed in the MEOC vehicle for the better performance of the systems and for the better accommodation of the operators according to their operational needs and their convenient stay into the vehicle during a mission. This further equipment includes: lighthouse and siren, alarm for the vehicle protection, camera controller for the easy and simple operation of the camera, GPS system, UPS for the stabilization of the supplied voltage in the electronic equipment, electrical fuse panel for the activation/deactivation of the equipment, emergency stop switch for the immediate stop of electrical power supply to the equipment in case of an emergency (emergency stop mushroom), and TV tuner. The necessary precautions for the grounding and anti-lighting protection of the equipment and the stuff have been taken as well. The power supply system - generator are installed into a trailer due to space limitations of the specific vehicle. Also at the engine trailer an extra storage place has been provided for the storage of the electrical power cable (shore connection), telescopic ladder, gas dispenser and the stabilization system.

Figure 12: MEOC workstation arrangement (photo taken during the 1st field test).

3.2.4 Standardization

During the project execution the consortium has made contributions to Mandates from EC (M/415, M/496 dossier 9 on emergency standardization needs, M/487) and WRC'15. Furthermore the consortium has finalized the CEN technical report and the studies regarding the regulatory framework, the pre-commercial procurement in the security field and the analysis of the concept of security in a free democratic society, focusing on security architecture and security culture.

3.2.5 Training and logistics support

Based on the information and expertise gathered in this research, the following training cycle is recommended in order to enhance training effectiveness and for additional opportunities for monitoring, evaluation and lesson-drawing to arise:

- Define challenges facing First Responders;
- Define training goals for E-SPONDER in precise and measurable terms prior to the training;
- Decide on the type of training of the E-SPONDER tools;
- Design planning for training with the E-SPONDER tools;
- Prepare instructions and validate;

- Execute planning for training with the E-SPONDER tools;
- Evaluate.

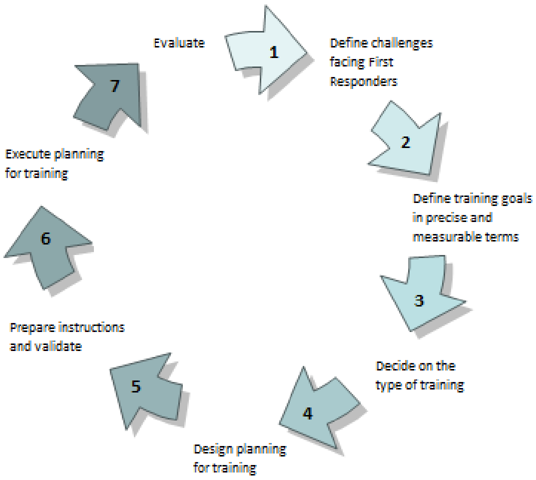

Figure 13: E-SPONDER training cycle.

The end-users in the E-SPONDER project were familiarised with the E-SPONDER system and tools. They prepared for the field tests through two types of training activities – a training portal, containing training manuals for all tools and components of the E-SPONDER system, and three training events. These training events took place in May 2014 at Amsterdam Schiphol Airport, the Netherlands, in September 2014 in Volx and Villeneuve, France and in November 2014 in Marseille, France, and were organised by the end-user partners in the E-SPONDER consortium. In the course of the E-SPONDER project, each partner contributed one or more training manuals or videos on a specific E-SPONDER component, tool or event to the training portal. Browsing through the training manuals, the participants were thus able to familiarise themselves with the E-SPONDER tools prior to each training event.

The first E-SPONDER training event for end-users was organised at Amsterdam Schiphol Airport, the Netherlands. The goal of the training event was twofold. Firstly, the training event served to provide trainees – i.e. end-users planning to participate in the E-SPONDER field test at Amsterdam Schiphol Airport in June 2014 – with the information they needed to arrive at the field test well-prepared (e.g. set-up, purpose, scenario, roles and expectations). The second aim of the training event was to familiarise trainees with the E-SPONDER system and tools. From the part of the trainees, no specific preparation was required.

Figure 14: End-users trying on the E-SPONDER FRU (1st training).

Figure 15: End-users receiving instructions on the EOC (1st training).

Figure 16: Presentations by Crisisplan BV and EXUS (1st training).

The second training event took place in Villeneuve fire brigade and Volx quarry, near Manosque (Alpes de Haute Provence) in the south east of France. This training event was useful from two points of view: it was an opportunity for the end-users that will be involved in the second field test (organized at the end of September 2014) to try and start testing the E-SPONDER materials in real conditions, and for the consortium members to adjust the system to this new location. As for the first training event, no specific preparation was necessary for trainee end-users.

Figure 17: Presentation and use of the MEOC by end-users at Volx quarry (2nd training).

The third and last training event took place at Saumaty fire brigade and CETIS training centre in Marseille (France). Once more, it was the occasion to gather the end-users that will participate to the last field, and some members of the consortium, in order to familiarize with the tools for the first ones, and made the final adjustments of the system for the second ones. As for the two previous training events, no specific preparation was necessary for trainee end-users.

Figure 18: Equipment of trainees with the FRU sensors by E-SPONDER members (3rd training).

Figure 19: Testing of the FRU by the end-users inside the vessel fire simulator (3rd training).

Training activities proved to be a very important aspect of the E-SPONDER project. Each component that users interact with, from the EOC to the MEOC to the FRU, was designed to be easy to use and quickly understood. However, E-SPONDER is a complex system, and to fully grasp all of its capabilities and see how various devices work together to share information, end-users need to comprehend at a basic level how these components interact. Furthermore, if training is done poorly, end-users will not understand or trust the system.

3.2.6 Emergency Response Support & Logistics System

OPTIMIZER (OPTIMIZation of Resources and Logistics for Emergency and Recovery First Operations) is the E-SPONDER Decision Support tool to plan and optimize ERS&LS (Emergency Response Support & Logistics System) activities in order to fight against the crisis. OPTIMIZER is a Decision Support System that integrates a planning model for transportation and delivery of logistics and commodities:

- Operations planning and scheduling system.
- Resource optimization.

The OPTIMIZER will receive the Crisis Snapshot from the Data Fusion Management System (DFMS) with the elements defining the crisis. From the Crisis Snapshot, the OPTIMIZER will analyse the situation of the crisis and derive the needs to fight against the crisis. The OPTIMIZER will produce the Crisis Action Plan (CAP) that is the list of operations or activities to be executed in a timing sequential order making use of the necessary resources to fight against the crisis.

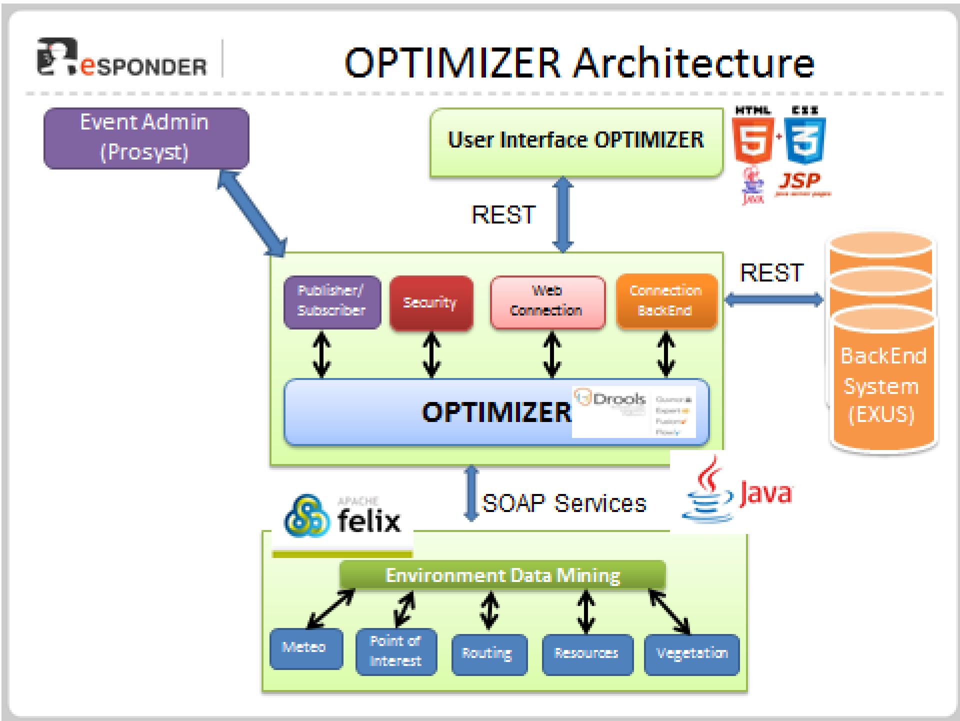

Figure 20: OPTIMIZER Architecture

It is necessary to know how to act in certain risk situations and how OPTIMIZER can be used for this purpose. When a user is faced to a problem or an incident, this tool facilitates him/her to make correct decisions and to act as it must do. Moreover, training with past incidents helps the crisis manager to better anticipate events when they occur and to predict the resources to be used to resolve the crisis more reliably than if the manager was faced with a crisis without knowing what happened or what resources were needed in the past to resolve such type of incidents. This acquisition of knowledge remains the base to help in other similar crisis situations.

Training helps greatly to perform and handle better crisis situations. First Responders are used to train regularly, on new tools or old ones. Appropriate training has to be performed for the personnel located at the EOC and MEOC levels, crisis managers, which have an overview of the situation and the resource availability and utilization. To help crisis managers in this role E-SPONDER has developed OPTIMIZER, a resource optimization tool, which can also be used in training situations.

3.2.7 E-SPONDER network

Information and data exchange in the E-SPONDER platform is carried out and supported by a hierarchically organized network, the E-SPONDER Communications Network. The E-SPONDER Network is based on an all-IP architecture that uses existing heterogeneous networks (wireline and wireless infrastructure). Moreover, new autonomous, standalone, interconnected sub-networks are developed, capable to reliably transfer information from the incident area to the Operation Centres. A general overview of the E-SPONDER network as a descriptive block diagram is presented in Figure 21. It must be emphasized that the network description of Figure 21 presents the physical network and radio access technologies that implement the E-SPONDER Network, and not the logical, hierarchical interconnection of the E-SPONDER entities. The physical networks provide the means to implement through logical rules the E-SPONDER hierarchical scheme. For example, EOC and FRUs can be both connected in a 4G/3G Network provided by local operators, and thus a physical path between the entities exist. However, direct voice communication between EOC and FRUs is prohibited (based on the E-SPONDER hierarchy) through rules associated with the operation of the EOC VoIP/Communication Server. Nevertheless, since there is a physical interconnection of the entities, data transfer (sensor data, alarms etc.) can be performed directly to EOC in the cases where MEOC is absent, without the need to tunnel the information through relays (e.g. Special Node – SN). It must also be noted that although Figure 21 presents the interconnection between EOC – a single MEOC – and a single FR Team, EOC is able to interconnect with multiple MEOCs and each MEOC can communicate with multiple FR Teams. As far as the EOC is concerned the following physical networks and radio access technologies are available:

- Wide Area Network (WAN) connection through landline infrastructure (Internet gateway).
- The Satellite Subnetwork
- A 4G/3G connection
- The EOC Local Area Network
- The EOC IEEE 802.11 b/g/n network (WiFi)

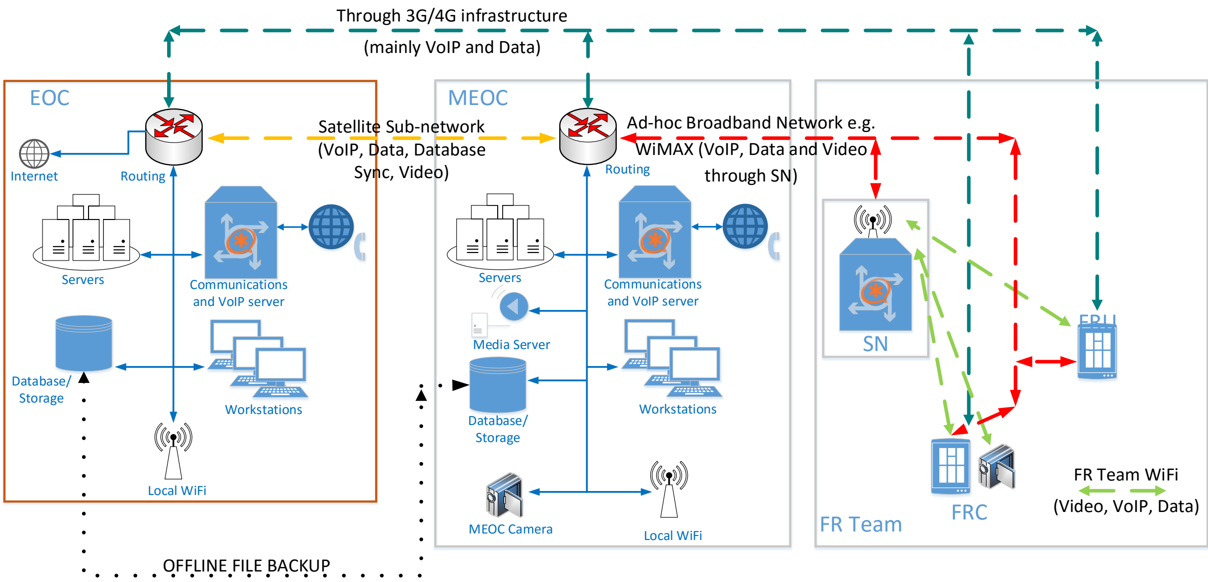

Figure 21: E-SPONDER network.

Each EOC device or system connected in the E-SPONDER network should have direct authorized access to one of the above mediums. Moreover, a connection with a specific network does not imply connection with the E-SPONDER services since the user/device should pass through an authentication procedure at the application level, in order e.g. to communicate through VoIP with other E-SPONDER entities.

EOC is the upper layer in the logical hierarchy of E-SPONDER communications network. Regardless of the technologies and infrastructure used for information exchange, the complete E-SPONDER Network can be logically divided in the following networks: The Core Network, the Incident Area Network (IAN), the FR Team Network and the Personal Access Network. All the logical networks are implemented using the physical networks described in Figure 21. Due to its role, EOC is the centre of the Core Network (CN). The E-SPONDER CN implements the data transfer from the crisis area where the FR teams are deployed to the EOC. The EOC uses the CN to collect information and coordinate actions through the relaying MEOCs. A MEOC operates as the gateway from IANs to the CN. Direct real-time communication between EOC and the FR teams is not allowed, but in cases that the MEOC is unavailable, EOC collects data from the specific FR teams (operating as a substitute MEOC). Moreover, in cases that the MEOC is deployed, direct data transmission from FR teams to EOC is avoided. Data base synchronization and information exchange between EOC and MEOCs is performed through specified E-SPONDER network routes.

3.2.8 Validation of the system through demonstrations

The test and validation of the first integrated FRU prototype have been performed during the third year of the project. The purpose of having two prototype phases was to be able to design and evaluate a first version that would allow for improvements in its second release based on the feedback collected both inside the project consortium and among end users that had an opportunity to see and use (partially) the preliminary FRU prototypes during workshops and other meetings. The main changes compared to the first prototype are:

- Inner garment: several improvements have been implement in different phases, the final version includes all changes (improvement in fabric quality, skin contacts, closure system)
- Outer garment: The first FRU was based on a modified second hand firefighter jacket, the final version jackets are tailor made based on the specification agreed at the end of the preliminary prototype phase (special pockets and wire paths for simultaneous recharging of all devices)
- LPS: The major change certainly is the availability of the LPS system. Due to the long design and IC fabrication delays, as expected, the preliminary FRU was relying on a “LPS mock up” sending pre-recorded data moving pseudo-randomly around a given starting point.
- Smartphone: Another major change is around the smartphone. The initial Nexus S had to be replaced because of its limited performance and also because it had become obsolete. The next step was to select a WiMAX smartphone, available only through Asian channels, which turned out not to fit the project needs, and the final choice led to LG NEXUS S5 as explained in D8.3. Nevertheless this was not enough to operate all the required communication reliably since commercial Smartphones have limited capabilities, therefore the “Special Node” solution was designed and implemented. The “Special Node” is also carried by the FRU and it takes over the main communication tasks and services from/to the FRU.
- User Interface: The buttons of the first version have been considered as inappropriate for using the device with gloves. A new version has been designed with a single large button (for the FR team members), with a PEEK housing offering improved heat resistance. Finally, because of the major network change around the smartphone and the “Special Node”, the ear set is connected to the smartphone and not to the UI as initially planned (to reduce the number of Bluetooth links), therefore its functionality is now limited to remote control and alarm interface (no audio).

The first E-SPONDER field test, organized by Crisisplan BV in cooperation with all E-SPONDER partners, took place on 13 June 2014 at Amsterdam Schiphol Airport at the Safety Training Centre (VTC) Post Sloten (Sloterweg 432, 1171 VL, Badhoevedorp). The first step in the preparation phase was based on the decision from the E-SPONDER consortium to make an effort to try to organise the first field test at the Schiphol Airport Safety Training Centre in order to test E-SPONDER during a simulation of an emergency response to an aircraft landing incident. This decision was based on the one hand on the fact that the actual crash of the Turkish Airlines flight (TK1951) on February 25, 2009 in the Netherlands provided relevant input and suggestions for a realistic test scenario. On the other hand, a test at an airport location challenged E-SPONDER regarding the communication network, since satellite and WiMAX are not allowed due to the airport and air traffic control regulations (if the system can work at an airport with many restrictions, it can work everywhere).

Figure 22: Briefing of the end users before the 1st field test.

The field test offered a great opportunity for guests to understand the project and its objectives, and for the fire fighters who participated to see the added value that E-SPONDER can bring to their operations. The participating end users and invited guests were very enthusiastic about the concepts driving E-SPONDER and the potential it has as a system for dramatically improving the response to a various types of incidents, in terms of efficiency, safety, as well as improved sense making, decision making, and the creation of a common operational picture. Furthermore, the field test gave E-SPONDER partners a chance to come together with all of their contributions, and work to integrate all of the complex systems. It also served as a networking opportunity, as E-SPONDER partners had the opportunity to meet people working on other FP7 projects, and end users collaborated with each other and learn more about FP7 and Horizon 20/20 programs.

Figure 23: Presentation of the E-SPONDER system to the fire fighters and testing of the garments during the training event (1st field test).

During this field test, satellite link was not available between EOC and MEOC, thus a Wi-Fi connection was established, EOC being near MEOC. Moreover the Wi-Fi link between MEOC and FRC was used as a backup solution.

Figure 24: The operational level: FRs responding to a call wearing the E-SPONDER FRU (1st field test).

The second field test, organized by EPLFM in cooperation with E-SPONDER partners and SDIS04 (*Service Départemental d'Incendie et de Secours des Alpes de Haute Provence* – Departmental Fire and Rescue Centre of "Alpes de Haute Provence"), took place on Friday, September 19th 2014 at Villeneuve fire brigade and Volx quarry, in Alpes de Haute Provence department (France). This field test was organized during an operational search and rescue exercise for volunteer fire fighters. Thus, operational reality was taken into account in scenario design. Each action was planned and detailed with a SDIS 04 representative, in order to demonstrate at least one feature of the E-SPONDER system by action.

Figure 25: Deployment of MEOC and fire fighter command post on the bridge (2nd field test).

The second field test was an opportunity to share the project with end users and potential customers of the E-SPONDER system (as a whole solution or only some components), and evaluate the added value of such a system compared to the one currently used by first responders and crisis managers. Overall, the E-SPONDER system was well received and evaluated. However, some problems occurred during the field test, and prevented a full success for this second field test. Robustness and stability of the system still needed to be improved before the final field test.

The EOC functionality was evaluated during the FT session by E-SPONDER end-user representative achieving:

- Good quality for voice communication with the MEOC,
- The capacity to update the 2D COP, with the dedicated symbology,

- A refresh rate of the satellite link of about 2 minutes, with the possibility to see on 3D COP the FRs moving from a place to another.

Overall, the EOC was working well and was ready for the next field test. At MEOC and FRU levels, results were less positive. Overall, stability issues prevented the field test from being a complete success. Satellite connection and MEOC worked correctly: MEOC was fully deployed and operational in about 15 minutes. Only 4 FRUs were planned to be used in order not to overload the system and to keep an acceptable quality for voice communication. Unfortunately, at the field test time, only 3 were functioning. Moreover, communication problems between FRCs and MEOC occurred about 15 minutes after the STARTEX point. One FRC completely lost communication with MEOC, and the other FRC had a bad quality voice communication (cut and too low volume). Simultaneously with the voice communication loss, physiological data transmission to MEOC stopped as well and did not come back. However, LPS gave good results, FRs on the field being followed at MEOC level during the whole exercise; moreover, when communication was lost, positioning came back automatically.

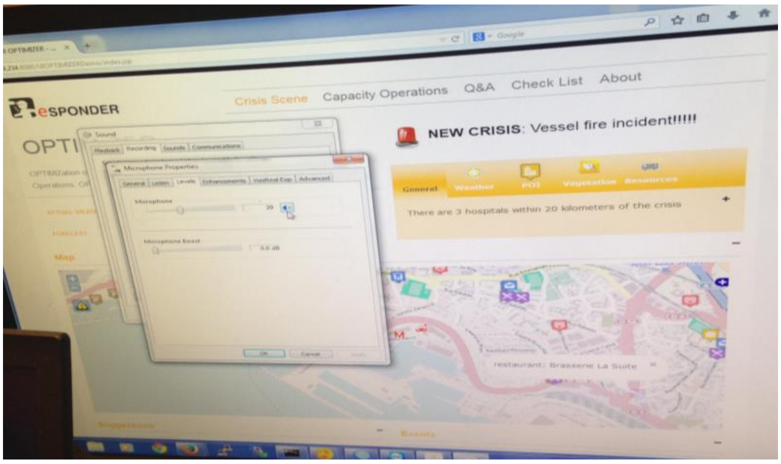

Figure 26: Crisis creation thanks to OPTIMIZER inside the MEOC at the STARTEX (3rd field test).

The third field test, organized by EPLFM in cooperation with E-SPONDER partners and BMPM (*Bataillon des Marins-Pompiers de Marseille* – Marseille fire fighter battalion), took place on Thursday, November 27th 2014 at the BMPM training centre, CETIS (*Centre d'Entrainement aux Techniques d'Incendie et de Survie* – Centre of Training to Survival and Firefighting Techniques), in Marseille (France). The scenario of this last large exercise assumes that a fire starts in the engine room of a vessel docked in Marseille harbour near Saumaty port. No crew is on board, the fire propagates in the different decks, and a large plume of smoke spreads from the vessel. A west-oriented wind blows in the area. As soon as they see it, harbour surveillance sends firefighting teams. The district is highly populated and contains different transportation means. Thus, distant operational command centre is immediately activated.

Figure 27: Deployment of FRs outside and inside the vessel to extinguish the fire during the 3rd field test

Figure 28: IC briefing his manager in presence of the 'prefet' during the 3rd field test thanks to the E-SPONDER collaborative table. This activity takes place at the EOC and satellite images of the affected area are used, where the FRs have the ability to annotate areas according to the operational needs.

Real progress was made compared to FT1 and FT2, and more features were functioning. Once more, E-SPONDER's added value was highlighted by BMPM end users and invited persons. However, some problems clouded the success of this final exercise.

For this final field test, EOC was extensively used during the last part of the exercise. Overall, nearly all tested EOC features successfully worked during the field test. Voice communication with MEOC was not used, as the IC came directly in the EOC room for a better demonstration of the 3D collaborative table. The main results concerning EOC were:

- A very functional use of the 3D collaborative table, all involved levels being able to use it successfully
- A simultaneous update of the 2D COP, with the dedicated symbology, by an E-SPONDER operator,
- The transmission of a video for MEOC (thanks to the satellite link).

EOC set up was thus a success and could be used in its state by potential customers.

Results at MEOC and FRU levels were less positive than at EOC level. Communication was established with 6 FRSs (2 teams, each one composed of 1 chief and 2 team members), but lasted for approximately 30 minutes. Moreover, because of Bluetooth interferences issues appearing with integration process, Biomed

B (body temperature) was not set up in the FRU. Finally, LPS did not function in this particular challenging environment (reinforced concrete building). On the other hand, satellite connection and MEOC deployment were once more successful, and physiological data transmission was working during the field test (heart rate, breath rate and activity). External temperature was transmitted from FRUs to the MEOC. Data transmission worked during the whole exercise, and re-started automatically if disrupted. Alarms of lying activity for 20 seconds and emergency geolocalization were also displayed on the MEOC 3D COP, and heard by the FRC. Thus, the main positive results for this field test on the field side were:

- The MEOC deployment and packing,
- The satellite connection,
- The building creator tool on the 3D COP,
- The health follow-up of FRs positions with their heart rate, breath rate and activity status,
- The alarm transmission at the FRC level and the MEOC level.

Taking into account the constraints and the status of the system not only during the field test snapshots, E-SPONDER validation obtained very good results. Indeed, more than half of the mandatory requirements were validated as complete, and 42% were partially completed, but acceptable according to the end user community, leaving only 2% of user requirement not sufficiently met, or with an unknown status. Results concerning important requirements are impressive as well, 68% being validated as completed, and 16% more (i.e. 84%, more than 4 out of 5) being acceptable.

Overall, E-SPONDER system performs correctly, and is validated for operational use, with of course some improvements needed before a possible commercialization of the product. Stability issues on the field still remain after the final field test, and miniaturization and integration need to be fully completed. The stability issues can be resolved by using mission critical electronic components, which are more expensive and have a smaller size than the commercial components used for the demos.

3.2.8.1 Lessons learnt from field test activities

Field tests gave the E-SPONDER consortium not only feedback about the added value of the system and validation outcomes, but also some lessons learned related to preparation, organization and deployment. They are based on experience and information collected during the events during debriefing sessions with end-users, but also with consortium members. Lessons learned are listed below.

- It is necessary to focus on the state of the art throughout the project life, in order to adopt newly emerging technology, while overcoming potential new problems created by this adoption. For example, the creation of the special node helped to solve WiMAX issues and interferences problems between the various sensors composing the FRU.
- Integration must be a high priority as soon as the project starts: tests on individual system components need to be done as soon as possible, in order to identify possible problems as early as possible and leave enough time to fix them permanently instead of patching them for a short time. Moreover, having a common test lab, locate close to the main partner(s) responsible for integration is of high importance as well, in order to facilitate testing by the different involved partners. Finally, partners in charge of integration have to be as flexible as possible, willing to travel and do changes at the very last minute.
- During the whole life of the project, and the prototype development, feedback loops must exist between technical partners (in the lab), and end-user partners (in the field), in order to constantly check that users' needs and requirements are aligned with developed technology.
- The prototype for field testing must be sturdy and stable, even if the project is very complex, and the integration work is huge. Indeed, E-SPONDER prototype showed increased performance between each field test, integration progressing step by step each time, but stability prevented the project from having a completely successful demonstration.

- Small-scale field testing should start earlier in the project, for example during the third year for a 4-year project as E-SPONDER. Even if the system is not 100% ready, this would force all partners to focus on integration, and early development, and decrease, or even eliminate system vulnerabilities.
- Stakeholders show high expectations and lots of curiosity. In general, actors or invited persons come because of curiosity. For these field tests, all actors volunteered themselves and were very enthusiastic to participate to advanced new technology testing. All were very impressed by E-SPONDER added value such as
    - FR status follow-up from an environmental, a physiological and a localization point of view, improving his/her security
    - All-in-one and autonomous command post, with autonomous communication system not relying on existing infrastructure network,
    - The tactile 3D collaborative table with its 3D COP,
    - The state of the art (in terms of techniques, options, intel sharing)
- Capacity of adaptation from both sides (consortium and end users) is highly needed. The consortium members must understand how to demonstrate by adapting themselves to the "real" end users, taking into account their usual way of working; but end users also need to adapt to the system, fighting against their habits. For example, this includes talking into the microphone instead of yelling, or actively checking their team's statuses displayed on the Smartphone.
- Field tests and demonstrations are the most powerful dissemination channel: the system is used by "real" end users, in nearly real operational conditions, and inviting authorities promote system adoption and this, even before its commercialization. The E-SPONDER concept was met with a lot of enthusiasm.

4 Potential impact and main dissemination events

4.1 E-SPONDER mission and vision

E-SPONDER started with the mission to research, develop and demonstrate the capabilities of a suite of software elements needed for all involved actors and a congruent prototype that will enhance the effectiveness of first responders operating in an emergency situation. The developed system is able operate under constraints such as: environmental conditions in the operating theatres of first responders, autonomous operation with extended duration, reliability of system, and effectiveness of system to support crisis operations, interoperability with crisis management systems, open information exchange capability and collaboration among First Responder groups and involved players across Europe.

E-SPONDER's vision is to disrupt the current business models with closed and proprietary solutions on the market by providing an open software environment that enables civil protection organizations to avoid vendor lock-ins from their traditional suppliers in order to become the independent, open communication and information platform for crisis management in Europe that helps to overcome the issues of the highly fragmented market as well as the national and regional boundaries. The project partners explore various joint and individual exploitation strategies to achieve this goal.

E-SPONDER developed a very complex and distributed system comprising many hardware and software components in order to realize the projects objectives. However, the joint exploitation plan will be about the core software environment only. The reasons for this decision can be summarized as following:

- The development of software environments for the FRU, MEOC and EOC has been the core of project.

- The necessary funding in order to develop and maintain a fully integrated end-to-end solution providing also all necessary hardware equipment.
- Already established competition for most of the used and developed equipment such as base-stations, sensors, etc.
- At the same time civil protection organizations can benefit from much higher control over choosing their suppliers and avoid unnecessary and costly vendor lock-ins.

The software developed in E-SPONDER has been demonstrated/used with the fire brigade in three field trials in the Netherlands as well as France. However, many of the use cases that have been defined for the development of the E-SPONDER software environments apply for the use in other civil protection organizations as well. In addition there is so much more that can be realized with E-SPONDER software environment. As such E-SPONDER should not be seen as ready-to-use product, but more as a tool that facilitates the development of solutions for civil protection organizations. In fact it should become the foundation for building an open, non-discriminatory ecosystem in that all involved parties can participate and benefit from each other.

4.2 Main features of the E-SPONDER solution

Because of the complexity of the overall E-SPONDER system we cannot describe all features in detail but we want to highlight the following ones that we consider the most important:

4.2.1 End-to-End Platform for all involved actors in a crisis event

On the highest level, E-SPONDER provides a suite of software elements that connects all involved actors in a crisis event. This leads to higher transparency that in turn means increased situational awareness, improved command and control decision-making as well as better coordination of emergency services in real time. At the same time, the system is also expected to save lives by supervising the health condition of the first responders and avoiding that they run in to dangerous situations.

4.2.2 Unified Domain Model

E-SPONDER has developed a domain model specific to the requirements in the context of crisis management. A domain model defines the scope and meaning of the problem domain and can be understood as contract between all involved stakeholders (in this context software developers from possibly different organizations). The E-SPONDER domain model is comprised of an entity domain model that describes the crisis context, resources, actions, action resources and objectives, snapshots as well as the event domain model. The domain model will facilitate the continues development and maintenance and also enables other organizations to provide interoperable extensions.

4.2.3 Open and Extendable

For software development E-SPONDER applied standards where possible, such as OSGi and ETSI EMTEL. OSGi is a collaborative software environment that follows the principles of Service Oriented Architectures (SOA). Applications can be dynamically composed of many different reusable software components (separation of concerns). Development, integration and maintenance efforts can be significantly reduced as a Service Oriented Architecture allows to dynamically react to changing requirements. Instead of updating the overall system, only several or single components need to be added or modified. OSGi including several other specifications have been used for the development of the software environments in FRU, MEOC/EOC.

4.2.4 Interoperability

E-SPONDER was from the beginning all about interoperability, which is crucial in building complex distributed systems. We provide interoperability on different levels. At the FRU we apply the OSGi Device Abstraction Layer specification, which has also been influenced by the work in E-SPONDER. The device abstraction layer simplifies the integration of new sensors and devices as well as the development corresponding applications and services. Developers don't have to deal with the details for each of the communication protocols, such as ANT, Bluetooth, ZigBee. Instead they develop against device representations (device functions) via one standardized interface. E-SPONDER also provides interoperability for the integration with external systems via standardized interface such Java Connector Architecture and Java Messaging Services. Custom interface for legacy or proprietary systems can also be implemented.

4.2.5 No dependency to existing communication infrastructure

E-SPONDER has been designed in such a way that it does not depend on an existing telecommunication infrastructure, which may not provide that necessary bandwidth or might even not be available at all after a catastrophic event, such as an earthquake. In the so-called "infrastructure-less mode" E-SPONDER can operate. In the project WiMAX was used to build an independent communication infrastructure between first responders and the MEOC as well as satellite communication between MEOC and EOC. However, this could also be realized with other communication technologies, such as LTE which a provides much higher bandwidth.

4.2.6 Non-discriminatory

All of the above-mentioned features support the fact that E-SPONDER developed a non-discriminatory system. It not only frees civil protection organizations from costly vendor lock-ins, it also opens up the market for other players providing new equipment, applications and services. In fact it would allow growing its own ecosystem that everybody can benefit from. With E-SPONDER civil protection organizations can choose their equipment based on their own requirements, such as pricing, performance, bandwidth, etc.

4.2.7 Communication Services

Communication between all involved actors is one the key elements in E-SPONDER. The Communication Architecture in E-SPONDER has been designed to allow the highest flexibility with respect to communication. E-SPONDER supports audio and video communication between involved actors (keeping the chain of command) as well as the synchronization of data from various sources (e.g. FR sensors) and the exchange of messages (e.g. commands for FRs). For audio and video communication the Session Initiation Protocol (SIP) is being used. Because the MEOC usually arrives after the first responders at the crises scene and the fact that no public telecommunication infrastructure may be available, one of the first responders will act as SIP proxy and SIP registration services. Voice communication among the members of the FR team is realized via IEEE 802.11 until the MEOC arrives at the crisis scene, which then takes over the responsibility of the SIP proxy and SIP registrations services.

4.2.8 OPTIMIZER

The OPTIMIZER addresses issues related to the location, allocation and management of resources (e.g. personnel, medical supplies, facilities and humanitarian aid) used in emergencies in order to minimize the risks of casualties. Another objective of the tool is to put in place comprehensive logistic and resource planning functions to enable crisis managers in fulfilling resource management tasks such as:

- Identification
- Mobilization
- Distribution
- Procurement
- Delivery
- Maintenance
- Facility Activation
- Staging
- Demobilization
- Tracking
- Warehousing
- Recovery

The OPTIMIZER (*OPTIMIZation of Resources and Logistics for Emergency and Recovery First Operations*) is a resource planning and activity scheduling tool to be used for this purpose. The OPTIMIZER will receive as inputs the Crisis Snapshot, with the parameters defining the crisis, and will produce the Response Action Plan (RAP), that is the list of operations or activities to be executed in a timing sequential order. Each operation will make use of the resources available to fight against the crisis. Profiles can be associated with the resources, for instance the maximum capacity for discrete resources, or availability/utilization constraints, for instance resource capacity may vary over time.

4.2.9 Remote Management and Configuration

E-SPONDER has been designed to be able to adapt to changing requirements in a crisis event. Both, EOC and MEOC have capabilities to remotely manage and configure First Responder Units. Specific situations may require configuring the First Responder Unit in order to continuously stream specific sensor data instead of frequently pushing it. Another use cases that requires remote management and configuration is when e.g. the FRU of the Chief fails to operate. In this case another First Responder Unit could be updated and configured with the required functionalities for the Chief. This requires no user interaction, so that First Responders can concentrate on their tasks. The remote management and configuration features are based on OSGi specifications.

4.2.10 Collection of field data and data fusion in real time

E-SPONDER has been designed to process collected data at FRU, MEOC and EOC to extract relevant information for each of the entities. The role of the Data Fusion function in E-SPONDER is to mediate between all the information collection elements at the front-end (mainly at the FRUs but also at the MEOC) and the rest of the applications at the back-office located at the EOC (and eventually at the MEOC) in order to implement a central point where all the gathered data are collected from the front-end, combined, analysed and fed into the applications developed for the back-office. This task will also include extraction of inferred information as a result of combining raw data from various sources (FRU sensors, external systems, end-users).

4.2.11 GIS Platform

The GIS services used in E-SPONDER have two main responsibilities: Firstly to process data provided by positioning systems and secondly to provide access to maps used within the system. An important aspect of the GIS services containing supporting services for geocoding and map related delivery-services is that in order to work properly, a common interface with a defined and standardized protocol is needed. Through this interface, the relevant data from positioning systems are provided to GIS Services processing it into visible interfaces for the operator or performing further calculations and transformations e.g. coordinate transformations and geocoding tasks. Coordinate transformations are needed if systems using different coordinate standards than delivered through the common E-SPONDER interface have to communicate whereas geocoding processes are needed to get postal addresses from coordinates and vice versa.

4.2.12 2D / 3D User Interfaces

Ease-of-use is of highest importance, especially when operating such a complex system during a crisis event. E-SPONDER will offer end-users various ways to interact with the system. E-SPONDER focussed on the presentation and visualisation of the available information in efficient and intuitive ways, so as to enhance the perception that back-office users have about the situation in the field. This perception is created from information coming from first responders or external sources (e.g. reports from the public or other systems). On the other hand, apart from presenting information, the UI enables the operators to perform several actions in order to control or react to events and incidents. E-SPONDER users distinguish between three different levels of data representation depending on the level of information needed at each one. These are the *operational*, the *tactical* and the *strategic* levels. All these levels are accommodated by the UI design as well. E-SPONDER developed both 2D and 3D (using special equipment) user interfaces that provide basically the same functionality, with the exception that the 3D view provides the ability to build 3D construction of building in order e.g. navigate first responders.

4.2.13 FR health status supervision

One of the core features of the E-SPONDER project was the ability to supervise the health conditions (e.g. heart and breath rate) from all members of the first responder team. The first responder chief as well as the MEOC commander receives automatic notifications in case of abnormalities. This enables to FR chief to contact team members and avoid that they bring themselves in dangerous situations. The user interfaces for FR chief as well as for the MEOC commander can provide a view on the status of the whole team as well as a detailed view for each team member.

4.2.14 Patents

The innovation impact and exploitation potential of E-SPONDER is supported by the following patterns that the partners have filed:

- Device and method for visual sharing of data (https://register.epo.org/application?number=EP13792403)
- Method for control of controllable high frequency attenuators, involves interconnecting output of amplifier with control input of attenuator, while adjusting common-mode potential of amplifier such that matching condition is satisfied (http://worldwide.espacenet.com/publicationDetails/biblio?FT=D&date=20130829&DB=&locale=en_EP&CC=DE&NR=102012202918A1&KC=A1&ND=4)
- Verfahren zur gleichzeitigen Linearisierung und Anpassung eines steuerbaren Verstärkers (https://register.dpma.de/DPMAregister/pat/PatSchrifteneinsicht?docId=DE102013101388A1)

4.3 Identified innovations

The consortium has identified the following innovations regarding the technologies and solutions developed within E-SPONDER:

- A major innovation of the project is to provide a system comprising not only of voice communication, but also vital signs monitoring of each first responder as well as environmental sensors, all integrated in the "First Responder Unit", with all data available in a simple way at the crisis management level (EOC/MEOC). This innovation is enabled by the high degree of collaboration among the different components (OPTIMIZER, backend and Data Fusion services, OSGi EventAdmin, 3D/2D GIS services utilizing the underlying communication infrastructure and 3D collaborative platform).
- Integration of a local positioning system (LPS) into the E-SPONDER network to allow tracking of all involved personnel in a crisis, even in indoor locations where GPS fails. Development of a robust LPS, which works in many different environments (as dictated by the diverse nature of crises). Therefore our system combines new approaches such as dual-band capability and multiple antennas to provide high accuracy and resilience even in highly reflective environments. Base stations need to be ad-hoc and setup time very short. This usually contradicts to accuracy and coverage range. Therefore E-SPONDER developed a system, which is ad-hoc, but also has good accuracy of less than one meter.
- An innovative software that allows such a rapid 3D prototyping of a building, integrated into a 3D GIS and within which units are displayed (FRs). In addition the necessary hardware has been developed in order to support such a tight collaboration between multiple disciplines thanks to the integration of heterogeneous data. This software has claimed awards (Sections 4.4.2 and 4.4.3) and has a patent awarded (Section 4.2.14).

4.4 Main dissemination events

4.4.1 Organisation of workshops

Two scientific workshops were organized by E-SPONDER, dedicated to the "technicians" of the researchers and industrials. The aim was to share the innovative outcomes of the project. Both workshops allowed publishing results in scientific journals:

- Italian Networking workshop 2014: A session entitled "Emergency networks" was organized and chaired by UNIMORE, during an annual Italian event which gathers researchers working on telecommunication networks, from Italy and from various EU projects. Four joint E-SPONDER publications were presented.
- Emergency Networks for Public Protection and Disaster Relief 2014 (IEEE EN4PPDR): This workshop was organized and chaired by UNIMORE, jointly with another EU FP7 project, PPDR-TC, during the IEEE 10th International Conference on Wireless and Mobile Computing, Networking and Communications (WiMob). One joint E-SPONDER publication was presented.

4.4.2 Participation to fairs and exhibitions

This new channel of dissemination was activated for the last period of the project, prototypes being ready. E-SPONDER was introduced in 5 different fairs and forums:

- Laval Virtual 2014: IMM was invited at this annual conference and exhibition of virtual technologies and uses, to present their innovations, and among them the E-SPONDER collaborative 3D table. IMM won an award thanks to a video and an abstract entitled "Smart devices for smarter collaboration", presenting the collaborative tools developed in E-SPONDER. The video can be found in the following link https://www.youtube.com/watch?v=b2K9isI_aKw
- European Data Forum 2014: EXUS had a booth at this annual meeting about ICT and big data gathering industry, research, policy makers, and community initiatives. E-SPONDER was presented thanks to a running presentation, leaflets, and parts of the system (FRU sensors with FRC application), with representatives being present to answer questions and to demonstrate the equipment's functionality.
- 121st National Congress of French Firefighters: EPLFM had a booth at this major annual event of French rescue forces, which allows debating and defining expectations and future orientations of rescue services. E-SPONDER was presented thanks to a running presentation, a poster, and E-SPONDER package information (brochure, newsletters, pen, folder), with a representative being present to answer questions.
- REAS Salone dell'Emergenza 2014: SMTX had a booth at this leading fair in Italy for the emergency sector, to present the innovative E-SPONDER garment (tee shirt and jacket) equipped with parts of the FRU.
- SMAU Milano 2014: SMTX had a booth at this Italian fair devoted to ICT. Once more, the innovative E-SPONDER garments were presented and also met success with manufacturers of protective clothing for fire fighters. Details for this event can be found in D3.2.
- E-SPONDER has participated in the Civil Protection Forum 2015 (http://ec.europa.eu/echo/partnerships/civil-protection-partners/civil-protection-forum-2015_en), 6-7 May, 2015.

4.4.3 Videos and photos

During the project duration, six videos were designed by some partners, in order to explain the functioning of certain parts of the system, or to present results of the field tests. One video relating the final field test in Marseille will be designed during the last month of the project.

The following videos (available online) show the E-SPONDER in action during the field tests:

1. Activities of the first field are shown in the following video (http://vimeo.com/100315715 password: CrisisplanBV).
2. Aircraft crash landing incident (1st field test) https://www.youtube.com/watch?v=PO6QD4zhXX4
3. E-SPONDER 2nd field test https://www.youtube.com/watch?v=Eo6WcUdgNPA
4. E-SPONDER 3rd field test https://www.youtube.com/watch?v=lb13LXIwBaM
5. Interview of the Vice Admiral Garié of BMPM after the end of the 3rd field testhttps://www.youtube.com/watch?v=gVJtB7uZXUI

The following videos show the functionality of E-SPONDER components:

1. Immersion's innovative emergency center operated with smart devices for smarter collaboration (this is the E-SPONDER's collaborative touch table) is the winner of the LAVAL virtual award 2014 in the category of Smart Devices for Smarter Collaboration. The video can be found in https://www.youtube.com/watch?v=b2K9isI_aKw
2. 3D Crisis view and collaborative touch table (by Immersion) https://www.youtube.com/watch?v=3Zps_nSZSMU
3. FRU user instructions on the garments and sensors (by Smartex) https://www.youtube.com/watch?v=2oNrbgMyuOw

Here are some details concerning the available videos:

- **SMTX** made a video presenting user instructions about garments (tee shirt and jacket) (Figure 29). https://www.youtube.com/watch?v=2oNrbgMyuOw

Figure 29: Video extracts from the SMTX video

- **IMM** made 2 videos (a long one (Figure 30), and a shorter one) presenting their 3D collaborative solutions developed during E-SPONDER project, and 1 video for a contest entitled "Smart devices for smarter collaboration" (**awarded**). https://www.youtube.com/watch?v=3Zps_nSZSMU and https://www.youtube.com/watch?v=pAe5jH9houQ

Figure 30: Video extracts from the IMM longer video (Amsterdam meeting, June 2013)

- **CPLAN** made 1 video following the first field test in Schiphol, Amsterdam (Figure 31). (password: CrisisplanBV) https://vimeo.com/100315715

Figure 31: Video extracts from the 1st field test video (CPLAN)

- **EPLFM** already made 1 video following the second training event and second field test in Villeneuve near Manosque (Figure 32). Another one will be made following the last training event and field test in Marseille.

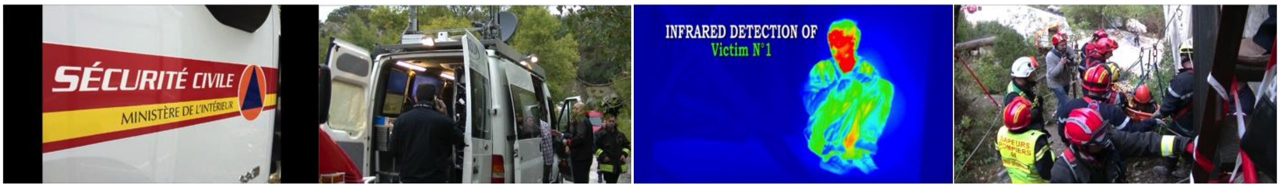

Figure 32: Video extracts from the 2nd field test video (EPLFM)

Photos from the field tests can be found in the following links:

1. Schiphol Airport field test
2. Manosque and Volx field test
3. Marseille field test

Photos from the training events can be found in the following links:

1. From the 1st training event at Schiphol, the Netherlands.
2. From the 2nd training event at Manosque and Volx, France.
3. From the 3rd training event at Marseille, France.

4.4.4 Newspapers and interviews

During the last year a new dissemination channel was used, press and newspapers. This allows increasing public knowledge and acceptance of E-SPONDER products. Thus, press was invited when the E-SPONDER prototype was ready by EPLFM during the 2nd and 3rd field tests.

Local press, radio, and national specific press covered the 2nd field test in France:

1. La Provence, local daily newspaper: 1 article in the journal, 1 web articlehttp://www.laprovence.com/article/edition-ailleurs/3052076/un-vetement-connecte-qui-pourrait-sauver-des-pompiers.html
2. Haute Provence Information, local weekly newspaper: 1 article in the journal, 1 web articlehttp://www.hauteprovenceinfo.com/article-4847-les-sapeurs-pompiers-testent-nouvelles-technologies-europeennes.html
3. Alpes 1, local radio and website: 1 web article http://alpesdusud.alpes1.com/infos/infos-locales?view=info&id_news=30866&start=17920
4. Sapeur Pompier magazine, monthly magazine dedicated to fire fighters: 1 article

During the 3rd field test, local press and television covered the event:

1. La Provence, local daily newspaper: 1 web article (http://www.laprovence.com/actu/leco-en-direct/3165995/une-simulation-dintervention-sur-un-feu-de-navire.html)
2. La Marseillaise, local daily newspaper: 1 article in the journal, 1 web article (http://www.lamarseillaise.fr/marseille/societe/33631-le-secours-d-urgence-en-service-commande)
3. Maritima, local radio and TV channel: 1 web article, 2 interviews (P Pouschat-Pizzo from EPLFM, Vice-Admiral Garié from BMPM), 1 TV coverage for the evening journal

(http://www.maritima.info/actualites/societe/marseille/6230/les-pompiers-du-futur-s-entrainent-a-marseille.html).

4. Ministry of Defence: 1 web article
5. BMPM: 1 web article (http://www.marinspompiersdemarseille.com/communiques-presse/le-bmpm-accueille-un-projet-hitech-sur-la-gestion-de-crise), 1 article in BMPM magazine, “marins du feu”

EPLFM also produced three interviews from end-users invited that day:

1. Lieutenant Albert, BMPM, in charge of the studies
2. Lieutenant-Colonel Terrasse, SDIS 84, director of operations
3. Vice-Admiral Garié, BMPM, commandant https://www.youtube.com/watch?v=gVJtB7uZXUI

Finally, UNIMORE presented E-SPONDER in the main Italian Business journal (Il Sole 24 Ore).
In summary videos and photos form the various events can be found in the following page.

4.4.5 Brochures and posters

In order to introduce E-SPONDER to various stakeholders, a brochure was created during the first year, presenting the project overview, objectives, and foreseen platform, as well as the consortium members. At the beginning of the project, a generic poster was created in order to explain and promote E-SPONDER in a more visual manner. It was created to be displayed in A0 format. Similarly to the brochure, it was updated during the project (Figure 33). Each partner is able to print this poster and use it to visually present E-SPONDER during conferences, fairs or various events. This poster is also used during field tests. Moreover, specific posters were designed and printed for the field tests: they aim at introducing the visitor to what he/she is going to assist, by explaining the scenario synopsis, the main actions performed during the test, the main E-SPONDER features used, and the specific objectives. Photos of the test site and the E-SPONDER tools are also shown.

Figure 33: Updated poster of E-SPONDER project and 3rd field test poster

4.4.6 Presentations and scientific publications

During the project life, consortium members presented their work and the whole platform to various conferences, meetings, workshops. During the first year, 16 presentations were done in international and national events. Nine presentations were made during the 2nd year, and 1 poster was presented. Third and Fourth years were equal in terms of presentations, with 12 each year. In order to share its results with the scientific community, several publications in national and international journals were written by E-SPONDER consortium. During the 1st year, 6 papers were written; among them 2 were joint publications. The total number of publications increased during the 2nd year, with 8 scientific articles and 1 book chapter, as the platform architecture was ready. Once more, the number of publications increased toward the end of the project, and the 3rd and 4th years were equal: 14 scientific publications were written by the consortium members. Among them, there was only 1 joint paper during the 3rd year, but 7 were published during the last year. Collaboration between the different E-SPONDER partners increases as the project goes along and the prototypes are ready, with a maximum of joint papers during the last year of the project.

Figure 34: Updated brochure of E-SPONDER project

4.4.7 Field test package

In order to disseminate E-SPONDER results to end-users participating to the field test and to the invited observers, specific materials were designed for the field tests:

- **Bags:** it allows giving all information about E-SPONDER easily. These bags will be distributed during the last field test.
- **Notebooks, post-it, and pens:** invited persons will use these items during the field test to take notes and fill in the questionnaires.
- **E-SPONDER information:** in a folder specifically designed for E-SPONDER are distributed the project brochure, the 3 available newsletters and some partner information.

Figure 35: E-SPONDER bags

5 Consortium and contact point

The E-SPONDER consortium consists of the following industrial, academic and research partners:

1. EXODUS S.A. (Greece) - Coordinator
2. University of Modena and Reggio Emilia Italy (Italy)
3. CrisisPlan BV (The Netherlands)
4. PROSYST Software GmbH (Germany)
5. Immersion S.A. (France)
6. Rose Vision (Spain)
7. Telcordia Poland Sp. z o.o. (Poland)
8. Centre Suisse d'Electronique et de Microtechnique SA (Switzerland)
9. SMARTEX (Italy)
10. Technische Univesität Dresden (Germany)
11. YellowMap (Germany)
12. PANOU S.A. (Greece)
13. Telcordia Taiwan (Taiwan)
14. Institute for Information Industry (Taiwan)
15. Entente pour la forêt Méditerranéenne (France)
16. Institute of Communication and Computer Systems (Greece)
17. Answare-Tech (Spain)

For more information on the project, please contact Dr. Dimitris Vassiliadis (dvas@exus.co.uk), or visit the project's web site www.e-sponder.eu