# Smart Sensors Network to Improve First Responder's Safety

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*The challenge of E-Sponder, an FP-7 European large scale integration project, is to develop a service platform providing information, communication, and decision support to improve the first responder's safety in risky situations they are exposed to during crisis interventions. Among 14 other EU partners, CSEM is responsible for the development of a set of networked sensors and communication devices.*

Crisis management requires—perhaps more than any other situation—taking the right decision at the right time, based on the right information. The European project E-Sponder aims at reducing the accident losses among emergency first responders by providing an innovative support system involving modern communication, information analysis and decision support, with the help of tactile screens and 3-D representations.

An important source of information is the "First responder Unit" (FRU) carried by each first responder, aimed at monitoring his physiological parameters as well as the environmental conditions. A diagram showing all FRU elements is given in Figure 1.

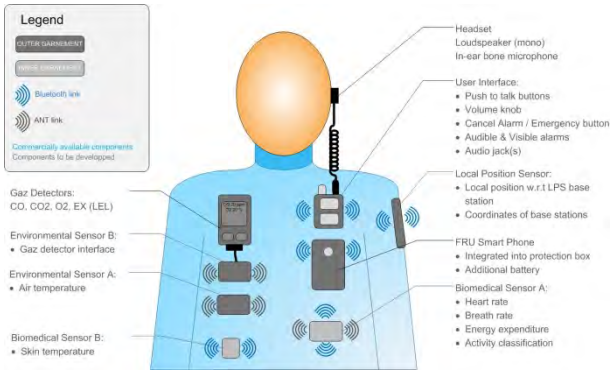


*Figure 1: FRU sensors and devices.*

Heart rate, respiration rate, physical activity and skin temperature are measured by an innovative biomedical sensor set, developed by CSEM and fitted in functional underwear comprising textile electrodes (designed by Smartex, IT). The ambient temperature is also measured on the outside of the firefighter's jacket by a dedicated high temperature sensor (up to 550°C). A special wireless interface for a gas detector has also been designed. All these parameters are sent over a wireless "Body Area Network" (BAN) making use of infrared and radio links (ANT and Bluetooth®) to a smartphone located in the jacket's internal pocket and acting as gateway to the team and team chief, and from there to the Mobile Emergency Operation Center (MEOC). There is also a voice link with acoustic and visual alarm transmission to warn a First responder of an emergency situation. Another module gives positioning information based on locally deployed base stations acting as references where GPS is not available (developed by TUD Dresden, DE). The main components of this BAN and their communication links are shown in Figure 2. These sensors were designed in the line of CSEM previous projects about physiological parameter monitoring, but with a new level of integration in this mixed ANT/Bluetooth®/Infrared network.


*Figure 2: FRU sensors and Body Area Network.*

Less visible but nevertheless essential for the system operation is the large effort made in the signal processing algorithms, which run on the microcontroller sensor unit. The initial information given by the ECG, body impedance variation measurement as well as a 3-D-accelerometer represents a huge amount of data that would overload the available communication bandwidth and also be difficult to handle at a higher level. Therefore the ECG signal is analyzed locally and only the heart rate value is transmitted further, together with a "quality index" giving an estimation of the reliability of heart rate estimates. The same applies to the respiration rate and its quality index extracted from the 4-wire body impedance measurement. The signal processing algorithms also reduce the disturbances due to movement artifacts and improve the signal quality. The 3-D accelerometer data is analyzed and classified in one of several physical "activity" levels, and the energy expenditure is also estimated. Thus only a small amount of data is sent to the operation center, making the decision process faster and easier. For instance, a first responder being in danger because of the environmental conditions or physiological parameters can be identified on the screen and either an alarm can be sent to him to get out of the danger area or help can be quickly organized.

Field tests in realistic conditions will be held during the last phase of the project to validate the concept, involving professional firefighters in their usual training environment.

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