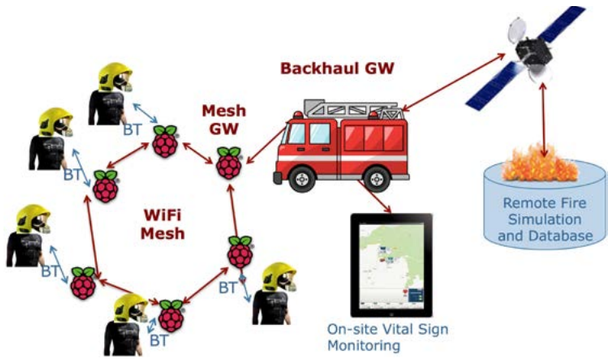
VitalResponder 2.0: Intelligent Management of Critical Events of Stress, Fatigue and Smoke Intoxication in Forest Firefighting

The VR system has been developed to enable on-duty first responders health monitoring and surveillance. We developed WiFi-based wireless mesh solutions, fist based on smartphones and later on RPi. We characterised propagation and battery consumption, evaluate data carrying performance, and built a network coding based data gathering protocol.



Main Project Team

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Funding Agencies

FCT - Fundação para a Ciência e a Tecnologia	**44,220€**
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Indicators

Journal Papers	1
Conference Papers	3

Two Main Publications

P. Santos, T. Abrudan, A. Aguiar, J. Barros, **Impact of Position Errors on Path Loss Model Estimation for Device-to-Device Channels**, IEEE Transactions on Wireless Communications, Vol. 13, No. 5, pp. 2353 - 2361, May, 2014

A. Aguiar, E. S. Soares, P. Brandão, T. M. Magalhães, J. M. F. Fernandes, I. O. Oliveira, **Demo: Wireless IP mesh on Android for fire-fighter monitoring, ACM MobiCom Workshop on Challenged Networks - CHANTS**, Maui, United States, Vol. 1, pp. 1 - 1, September, 2014

PROJECT WEBPAGE URL

https://www.it.pt/Projects/Index/2152

Fig. 1 Prototype developed with RPi.

	WiFi	ZigBee	LoRa	WiMax	Femtocell	Tetra	Satellite	Whitespace
Spectrum	Free	Free	Free	Licensed	Licensed	Free	Licensed	Regulated
Range	Small	Medium	Medium	Large	Small	Large	Large	Medium
Data rate	High	Low	Low	Large	Medium	Low	Low	Medium
Power cempt	Medium	Low	Low	Medium	Medium	Medium	Medium	Medium
Price	Small	Small	Small	High	Medium	Medium	High	Medium
Routing/ network modes	Flexible	Flexible	Star	Star	Star	Star and full mesh	Star	Flexible
Integration effort	Simple	Medium	Medium	Simple	Simple	Hard	Simple	Medium

Fig. 2 Technology re-assessment summary table.

GENERAL MOTIVATION AND OBJECTIVES

The system is composed of wearable monitoring platforms that are used by all members of the first responder team, which then communicate with an aggregator that may then show local parameters (team member location, vital variables etc.), generate alarms, etc.

The goal of IT's task was to provide connectivity to support the data gathering from the sensors to a central collection unit to be installed on the fire truck.

CHALLENGE

This is a challenge because cellular network support cannot be guaranteed in the targeted environments.

WORK DESCRIPTION AND ACHIEVEMENTS

We analyzed the traffic generated by the sensing application (including all sensors), and concluded that it is nearly constant bit rate (CBR) with peak rate of 30kbps per node. Based on the insights, we created a traffic model that enables carrying out network performance evaluation without physically replicating the setup of each fireman.

We opted for using a multihop-enabled mobile ad-hoc network (MANET) built on top of 802.11 technology to support the expected worst case aggregate traffic at the early stage of the project. 802.11 technology is well-established, COTS devices are widely available at affordable prices and decent energy consumption, and integration into a portable system is feasible. As a first prototype, we developed AdHocDroid that enables creating an IP MANET of smartphones, and measured the coverage range of smartphone links in forest environments to be around 70m. The AdHocDroid MANET has been evaluated and compared to other solutions that claim to build smartphone ad-hoc networks, and the software has been made available to the community on GitHub: https://github.com/eSoares/Android-Ad-hoc/. The AdHocDroid MANET was successfully integrated with the monitoring application and deployed on firemen teams during exercises and for 4 weeks in the summer 2015.

AdHocDroid showed some problems on specific hardware due to incomplete or buggy 802.11 driver implementations, so we moved on to a more stable platform, the RaspberryPi B+ (RPi). We evaluated the RPi power consumption, coverage range for various WiFi dongles, and application level throughput on multiple hops within the scope of the MSc thesis of Orangel Azuaje Contreras.

We were able to make a first analysis of GPS traces of a firemen team during a fire exercise. The results show that firemen get as far as 800m away from the fire truck, which supports our decision for a technology that supports multihop to provide connectivity. Additionally, we characterized the disconnection times to any other firemen, and disconnections to the sink. We were able to conclude that over 90% of the disconnection times lie below 10s, but they can sporadically reach 1000s. To cope with these disconnections, we designed the Disconnection-Tolerant Network (DisToNet) network-level buffering and implemented a prototype for RPi. To correctly dimension the buffer, we started developing a network calculus framework, a work that we currently pursue further.

Additional activities include the simulative study of a network coding based probabilistic flooding protocol for data gathering, which we expected to show better resilience to network dynamics caused by node movement. Its evaluation in comparison to the Collection Tree Protocol (CTP) shows that t is more effective only for networks of few nodes which are poorly connected.

At the end of the project, we carried out a technology re-assessment study, considering not only technical performance aspects, but also product availability, stability and integration feasibility.