Enabling Mobile Sensing through a DTN Framework

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ABSTRACT

Participatory Sensing is the concept of distributed data collection by self-selected participants. By exploiting latest technology's smart devices, a large number of valuable information can be collected through embedded sensors and also be uploaded using provided services. Environmental measurements such as temperature or pollution, while also real-time data considering products information (i.e. prices, availability, offers), can be provided through such a framework. In this paper we present the NITOS mobile framework for data collection, that exploits vehicles moving around in a city. The proposed framework consists of low-sized wireless devices mounted on volunteers vehicles, as well as of static deployed Road Side Units (RSUs) providing the backbone connection for data acquisition. The extracted measurements concern air temperature and humidity plus the available WiFi networks operating in each area.

Categories and Subject Descriptors

C.2.1 [**Computer-Communication Networks**]: Network Architecture and Design - Wireless Communications

Keywords

Delay Tolerant Network, NITOS testbed, Vehicular Network

1. MOBILE SENSING FRAMEWORK

Focusing on a mobile sensing framework at NITOS [1] facility and based on our previous work [2], we developed a sophisticated framework with tolerant delay characteristics. The overall framework consists of two main parts, the NITOS mobile sensing device and the Road Side Units (RSUs). The NITOS mobile devices are mounted on vehicles and collect measurements as the vehicles move around. The acquired data are locally stored at the device, until a vehicle is found into the range of any RSU. RSUs are statically deployed gateways that are connected to a backbone network, aiming to provide wireless connection for data forwarding. When a NITOS mobile device, detects the existence of a RSU, attempts to establish a wireless connection, in order to upload the measurements to a specific Server. The Server stores the transfered data and provides them for further analysis and visualization.

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1.1 NITOS mobile sensing Device

NITOS mobile sensing device (Fig. 2(a)), is comprised of open-source modules and due to its low-size and lightweight characteristics is ideal for mounting on vehicles. The core module utilized, is an Arduino DUE [3] prototyping board. This board features a 32-bit ARM core microcontroller which is interfaced with several sensors and modules through a custom-made shield. In order to sense air temperature and humidity, the Sensirion SHT11 [4] sensor is used, while also a photo-resistor is employed to measure light intensity. Moreover, an Arduino compatible WiFi interface [5] is used, configured to operate in monitor mode, so as to collect available WiFi network's characteristics, such as ssids names, Received Signal Streng (RSS), as well as the encryption supported from each captured network. Exploiting the aforementioned modules, the developed device senses periodically the existing conditions and networks, as the vehicle that is mounted on, moves around. In addition, we also equipped our device with D2523T GPS Receiver [6], which is a small-sized module compatible with Arduino's software. This module provides the coordinates of the vehicle, thus enabling for localization of the acquired measurements. Additionally, it reports the exact time and date they have been obtained.

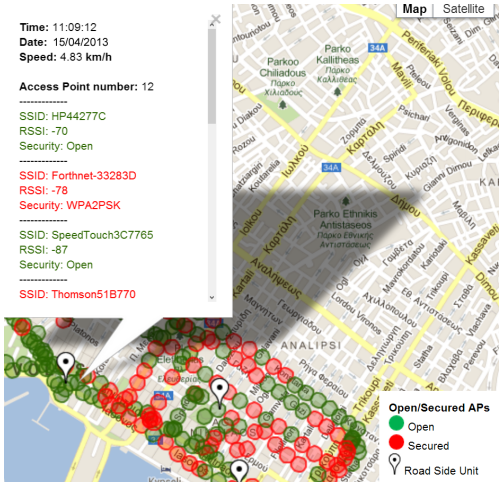
The extracted measurements along with the coordinates and their time-stamp, are locally logged in the available micro SD card. In this way, we can store endless measurements, as well as to keep our measurements safe, while the DUE board is switched off.

A key aspect of mobile devices, is the ability of autonomous operation. The device must be aware of whether the vehicle is moving or not, in order to turn its operation into sleep mode to save energy. To this aim, NITOS sensing device exploits an analog vibration sensor [7] that reports the state of the vehicle. When the vehicle is not moving for a particular period of time, the device stops the monitoring procedure and turns off sensor's operation, for energy saving. Respectively, when the vehicle starts moving, enables the data acquisition.

1.2 NITOS Road Side Unit

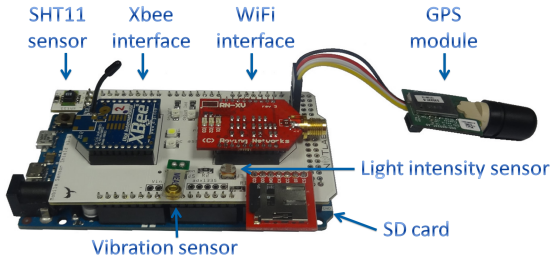
As previously mentioned, RSUs are gateway nodes distributedly deployed, in order to provide connectivity to the NITOS mobile sensing devices. They feature an Ethernet interface as well as a Xbee wireless module [8]. Xbee is

(a) Available WiFi Networks in Volos City.



(b) Secured and Open WiFi Networks in Volos City.

Figure 1: Experimentation Results of the captured WiFi Networks in the City of Volos.



(a) NITOS Mobile Sensing Device.

(b) NITOS Device mounted on Bike.

Figure 2: NITOS Mobile Sensing Framework Components.

a small transceiver implementing IEEE 802.15.4 protocol stack, which defines low-rate wireless communications. In our framework 802.15.4 is used to transfer the captured data from NITOS sensing device to the RSU. NITOS sensing node also features a Xbee module, through which detects potential RSUs. RSUs send periodically beacon frames in order to be visible to the mobile devices. When a mobile device decodes such frames, endeavor to associate and upload its measurements.

2. DEMONSTRATION OF NITOS MOBILE FRAMEWORK

The presented framework has been tested and evaluated in the NITOS facility, which is located in the University of Thessaly, in Volos. In Fig. 2(b), the NITOS sensing device, mounted on a bike is illustrated, while in Fig. 1(a) the number of available WiFi networks in the city of Volos are presented. Moreover, in Fig. 1(b) we show the secured and open WiFi networks operating in each area. Users can observe the available networks characteristics ,by clicking on the depicted pins. Finally, the contacted measurements are publicly available at NITOS site [1]. Google maps API [9] is utilized for the development of the visualization GUI.

3. CONCLUSIONS AND FUTURE WORK

In this paper we presented NITOS mobile sensing framework as part of NITOS facility. We demonstrated results, regarding WiFi availability in Volos city through Google maps tools. As a future work, we seek to integrate a RF IC capable of spectral scanning into the developed sensing device, towards to expand our framework's capabilities, as well as other type of sensors such as air quality modules.

4. ACKNOWLEDGEMENTS

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