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# Energy-Efficient Data Forwarding and Query in Mobile Wireless Sensor Networks

Mobile Wireless Sensor Network typically comprise large number of sensors where each can monitor different parameters in the environment such as temperature, magnetometer, accelerometer, pressure, can take images and videos or sounds

These sensor readings are usually sent to aggregating nodes that have high ability to process and store sensor readings. The aggregating nodes then forward the processed and aggraded readings to the sensor sinks e.g. more powerful devices.

This kind of hierarchical sensor archiver suffers from a range of problems that need to be addressed if longer term monitoring and more reliable monitoring is needed such as in case of animal monitoring or remote health care where continuous monitoring is the key.

This project will aim to optimise energy efficiency of such networks by allowing intelligent forwarding and collaboration between sensor nodes. The aim to this collaboration is to avoid local and global energy depletion by utilising statistical analytics of mobility patterns, sensor speed, connectivity patterns and resources predictions. As the connectivity range is limited and usually either 802.11 or Bluetooth, it is important that the intelligent protocol is design that can find the nodes that can at the cheapest cost transfer urgent messages to the sinks. The cost needs to incorporate both the energy cost and the speed of the message delivery we well as reliability of the message. Students are expected to choose either NS3 simulator or ONE simulator. A range of benchmark and state of the art protocols will be provided to the students and are available in the simulators. However, the students will need to extend, modify and add additional logic for intelligent energy modelling and prediction.

As a case study we will use animal movement monitoring scenario based on the real movement gathered in the Diary Centre at the University of Nottingham and uploaded to eh crawdad.org database for researchers to use when they build and test their protocols in realistic scenarios. We will aim to test how quickly the two different forwarding protocols allow a veterinary to respond to urgent events sent from sensors mounted on the animals (e.g., when one animal gets hurt and cannot walk) and how to best issue notifications to the veterinary.. This project requires good Java programming skills (for One simulator) or good C programming skills for NS3 simulator and some understanding of how wireless ad-hoc networks work. You will also have to learnt how to extend fully distributed protocols - but you will not have to build a new model from scratch (you will use the algorithms proposed by the supervisor and her PhD student and published in “Energy Efficiency in the Mobile Ad Hoc Networking Approach to Monitoring Farm Animals”. [ICN 2007](http://dblp.uni-trier.de/db/conf/icn/icn2007.html#WietrzykR07): 1 and “Mobile Ad Hoc Networking Approach to Detecting and Querying Events Related to Farm Animals”. [ICNS 2006](http://dblp.uni-trier.de/db/conf/icns/icns2006.html#RadenkovicW06): 109

# Improving Road Safety for Taxi Drivers through Data Analytics and Complex Vehicle Ad Hoc Network modelling

The project overall aim is to understand and improve road safety for taxi drivers around Rome or San Francisco through data analytics and complex vehicular ad hoc network modelling based on real taxi traces. Over 500 taxi cab traces in San Francisco and over 100 taxi cab traces in Rome have been provided and can identify full mobility pattern and connectivity patterns of each taxi so that information on where and how long congestion has been can be identified . The project should aim to produce real time and historical for busy streets and roundabouts and analyse them to show patterns and trends on congestion and length of tie of congestion. In addition, each taxi contains the information on whether it is free or taken. The project will aim to aggregate and analyse distributed and determine areas and times in Rome or San Francisco of high danger for the drivers. The project will design and build a complex VANET protocol to help the taxis to avoid host spots and congestion and redistribute the traffic in real time in such a way as to keep the delays low and avoid congestions.

# Personal Social Network on a Raspberry Pi

With increased privacy concerns that people have when using current social media, there is a growing interest in avoiding third party companies from capturing, storying and processing the data without individual’s knowledge that may be personal.

The aim of this project is to design and build personal social network prototype that is low cost and consists of a Raspberry Pi that allows the individuals to run their own social network server, store and own their data and allow access only to the individuals they trust. Knowledge of the Rasberry PI architecture and operating system is desirable as well as good understanding of social networks, basic security principles and database design

# Personal Health care Cloud with Raspberry PI

The project will aim to incorporate sensor such as temperature sensor and heart monitor to the Raspberry PI, aggregate and store the sensor readings as well as forward tem to the hub node that allow visualisation of the readings, trends and statistics as well as provide notifications to the individual. Handheld device or a laptop are expected to be used with the Raspberry PI. Knowledge of the Raspberry PI architecture and operating system is desirable as well as good understanding of ANT protocol, basic security principles and foundations of real time multimedia data is highly desirable.

# Building K-anonymity for Mobile Ad Hoc Networks

The aim it to design and build K-ananymity protocol on the top of the routing protocols in Mobile Ad Hoc Disconnection Tolerant Wireless Networks to help improve identity and location privacy of social mobile networks. The simulator NS-3 (or for more challenged scenarios with disconnections simulator ONE) should be used. Real or pseudo real data traces and map based driven experiments should be done with the data sets that will be provided. The students are expected to consider delays and success ratios for different levels of K-anonymity**.**

# Energy Efficient Data Dissemination in Mobile Disconnection Tolerant Networks

The aim is to design, build and evaluate energy efficient DSR or AODV data routing protocols extended with store-carry-and-forward paradigm in NS-3 or ONE simulators as well as identify routing overheads, delays and success ratios for different application scenarios. Students will have access to vehicular and human data traces that may include GPS coordinates, pedometer data or network connectivity data. These traces will serve as an input to the simulator. Basic versions of DSR, AODV, "Epidemic" and Spray and Focus" routing protocols are available together with the NS-3 or ONE simulator.

# Self organised security in Mobile Ad hoc Networks

**The aim is to build simulations of Mobile Ad hoc networks where some of the nodes are compromised or malfunctioning. For example, a node might be dropping all or some of the packets before forwarding. Other nodes should be able to identify such nodes and isolate them from the network. The students are expected to use any of the available mobile ad hoc routing protocols, NS-3 or ONE simulator and will have access to real vehicular and human mobility and connectivity traces available in the public wireless networking repositories.**

# Behavioural Analysis for Reputation Negotiating in P2P systems

**The aim is to build a P2P system where each node is able to claim certain trustworthiness of other nodes. The reputation system is to be modelled where an objective measure of trust should be achieved based on fully distributed trust claims. Nodes should be able to monitor any aspect of behaviour of neighbouring nodes such as: routing queries, answering queries, malfunctioning, storage and network characteristics. When anomalies in observed, actual or reported behavior are detected. nodes resolve and update trust levels based on localised voting.**

# Mobile Bluetooth application for Object Finding

**The aim is to build an Bluetooth application of mobile phones that is capable of locating a lost object (that is also Bluetooth capable) The phones should be able to keep track of recently detected Bluetooth devices and know the blutooth ID of the lost object.**

# Multiuser Poker game over Mobile Phones </h3>

**The aim is to build and test a multiuser Poker game for mobile phones. The users should be able to see their cards but not opponents'. Each hand should be carefully shuffled by the server to avoid predictable card behaviour. User interface should keep history of scores and rankings in addition to the cards views views/ If some nodes get temporarily disconnected other nodes are supposed to continue the game without the disconnected node.**

# Can Imbedded Intelligent Systems Help Chemists?

**The Problem:** Chemist make chemicals – lots and lots of small amounts of different chemicals (often 100s-1000s of <1 g samples stored in small vials – typically 10-15 mm in diameter by 40-50 mm high). When they are done they normally put their sample collections in a box and put them in a cupboard (Some typical examples are shown in Figure 1). It often happens that a year or so later that they decide to do some more chemistry on an old sample – this leads to lots of tedious looking through boxes to try and find the right sample: picking each sample up, checking its chemical structure and sample ID code manually, and keeping going until you find the right one. It’s currently an informatics problem with a 19th century solution! Prof Simon Woodward**[1]** in the School of Chemistry wonders if recent advances in low cost Near Field Communications (NFC ) could offer a better approach to this process.

*Figure 1.* Finding the right sample vial is a nightmare…..

**The Vision:** We perceive that it would be possible to mount small, low cost chemically resistant, NFC tags (such as those used in commercial laundries for garment identification**[2]**) onto the tops of typical 2 g vial (shown on the right of Figure 2a) we would be able to use a standard box to present an array of samples of equal height (schematic in Figure 2).

(a) (b)

*Figure 2.* (a) Various sample vials and the ‘standard’ one we want to use with NFC tags. (b) Schematic of vial array (top view).

***The ‘guts’ of the project:*** Can we develop a small NFC detector wand that (once inputted with the required sample ID code) can ‘pick up’ the correct tagged vial as it passes over that sample? Two actions should be triggered by the NFC ‘correct read event’ – (i) the wand should issue a bleep sound (to indicate sample discovery); (ii) the PC attached to the detector wand should ‘call up’ the sample ID in the associated database and present its structure together with other useful chemical information.**[3]**

NFC tags are currently widely used for single object identification, but their use as ‘locators’ is poorly described in real world applications – in part due to the short range nature of the NFC signals. This is not be an issue in the proposed application here although the presence of many NFC tags in relatively close proximity will issue new research challenges for extracting clear data.

*Figure 3.* Reagent storage can also become a nightmare…..

**Why do this?** Currently only large pharmaceutical companies can afford fully robotic indexed sample storage. An NFC-based sample locating package would be a highly attractive product to chemists for efficient chemical storage. In a second phase of the project one can easily imagine extension of the system to index the chemical reagents used by chemist – an idea of the scope of the problem can be seen through a look at a typical ‘reagents storage cupboard’ (Figure 3) in the School of Chemistry….the bottles are 5 to 500 g…

[1] <http://www.nottingham.ac.uk/~pczsw/SWGroup/>

[2] <http://rapidnfc.com/item/107/nfc_disc_asset_tags_laundry_tag_14mm_ultralight> These have a scan range of approximately 2 cm

[3] Typically we use ChemBioFinder (<http://www.cambridgesoft.com/support/ProductHomePage.aspx?KBCatID=119> ) as our database with a sample ID code that (currently) we just write on the vial. Dynamic linking of sample retrieval to chemical structure and associated data would be so much more useful and a really nice solution to many problems.