Collaborative knowledge, data and control generation for real time information and control system

Evtim Peytchev

Abstract: *This invited lecture presents the experience that Nottingham Trent University has gathered in the area of pervasive computing where collaborative knowledge generation is a requirement and the possibility of collaborative control exists. In this respect the participants in a real-life process (e.g. traffic movements) not only provide measurements based on their own experiences, but together with the other participants generate new knowledge which in turn is solid base for generating the actual demand responsive control.*

INTRODUCTION

The real time wireless communication test bed in Nottingham.

From March 2002 until October 2005 I have been involved in a British Department of Trade and Industry (DTI) funded project called "Traffimatics". The aim of this project was to show how off-the-shelf wireless components can be used for car-to-car and car-to-roadside communication. Nottingham was chosen to be the place to deploy the research test bed required for the project. It has been decided to deploy 6 different wireless nodes across the Nottingham City Center, so that a car can be driven in a closed loop and be always in the range of one or more access points for car-to-roadside infrastructure communication. Figure 1 below gives the locations of these 6 access points superimposed on the map of Nottingham. The minimum distance between the points is 250 m. and the maximum distance between the points is 650 m. The overall distance of the closed loop is 4.5 km. The type of devices used in the test bed is 802.11b, which limits the speed to 10mb/s. The devices used are found to be most prone to interferences which in Nottingham City Centre proved to be major obstacle for deploying wireless devices. Only one of the 6 points is directly connected to the Internet, while all others must rely on multi-hopping service to get Internet data. Each nod combines two separate devices – Access Point and Wireless Bridge. The access point accepts all local requests for connection and through the bridge gets access to the previous access point in the chain. Some of the location where there is a node infrastructure deployed are shown on the Figure 2 (in a traffic lights) and Figure 3 (street lights pole). The deployment proved that a variety of hosting devices can be used providing

Figure 1

Figure 2

Figure 3

there is main power supply for the units which are enclosed in a tightly closed white box containing all necessary details and only the aerials attached externally for the bodywork of the hosting unit.

SIMULATION TOOLS PREPARED FOR THE "TRAFFIMATICS" PROJECT

- Wireless connectivity simulator superimposed onto a traffic movements simulator

- Simulation of all currently available wireless links – Figure 4

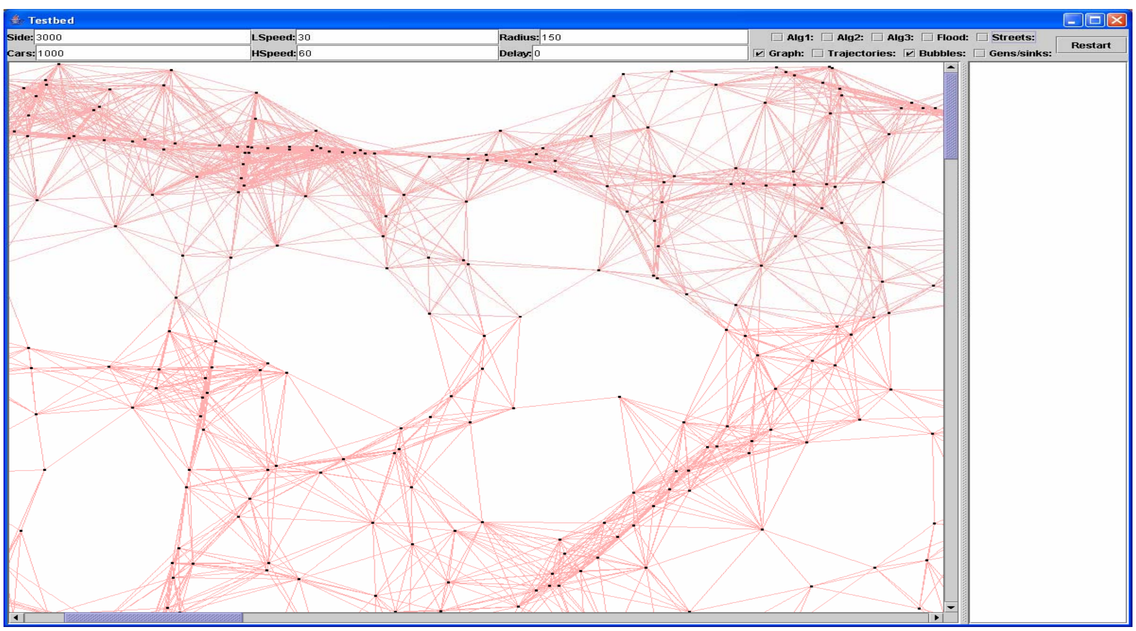

Figure 4

- Simulation of different routing protocols – max. Time To Live, min number of hops etc. (Figure 5)

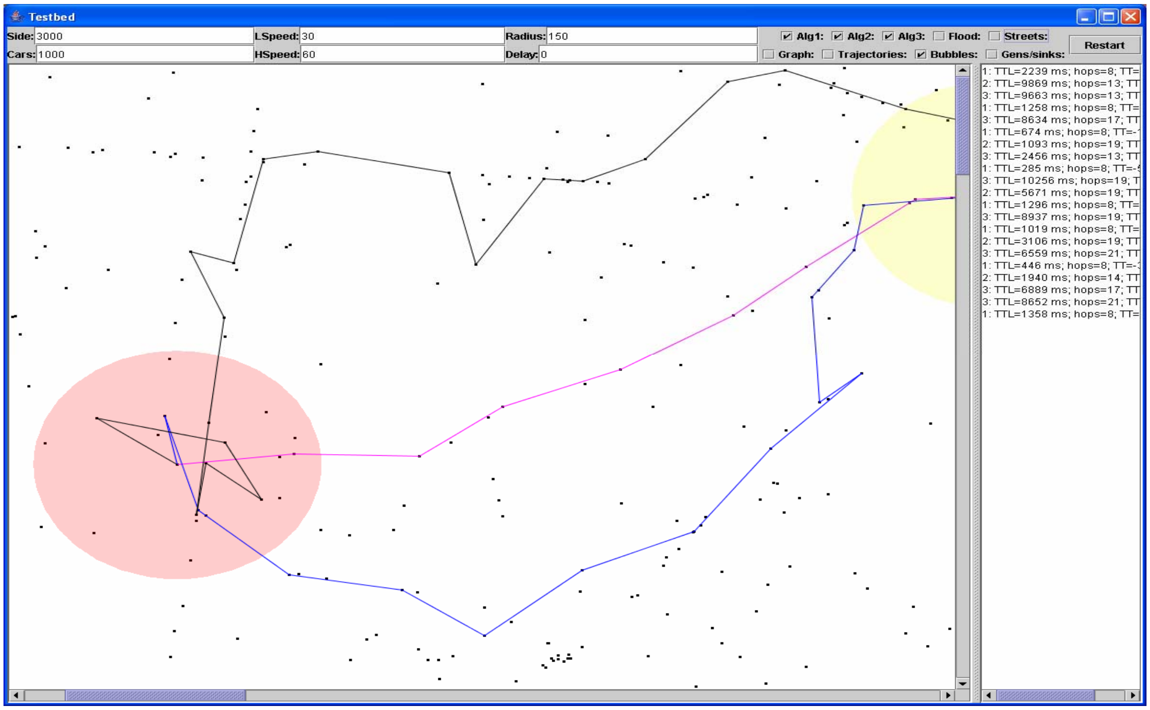

Figure 5

The screen shot shows several routes caring different meaning: minimum hops route (magenta), maximum time to live route (black) and a balanced between the two route (cyan).

- Operator Screen Display Simulation tool

    - Showing collaborative traffic information generation – snowing, raining, dark regions, slippery spots etc

Several screen shots are given:

On Figure 6 you can see raining regions detected collaboratively in the city (raw data – all cars report that their windscreen wipers are working).

On Figure 7 you can see slippery regions detected collaboratively in the city (raw data – all cars report that their ABS systems are working).

On Figure 8 you can see dark regions detected collaboratively in the city (raw data – all cars report that their head lights are on).

CURRENTLY DEVELOPED APPLICATIONS WHICH WILL BE OPEN FOR ACCESS AS WEB SERVICES IN THE TRAFFIMATICS PROJECT

- Traffic queues real-time information
- Traffic lights real-time countdown

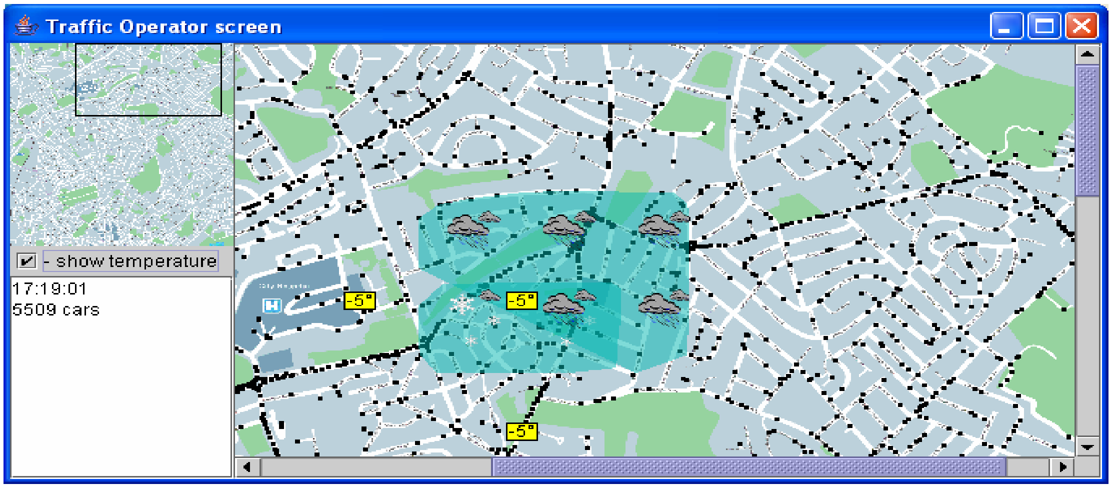

Figure 6

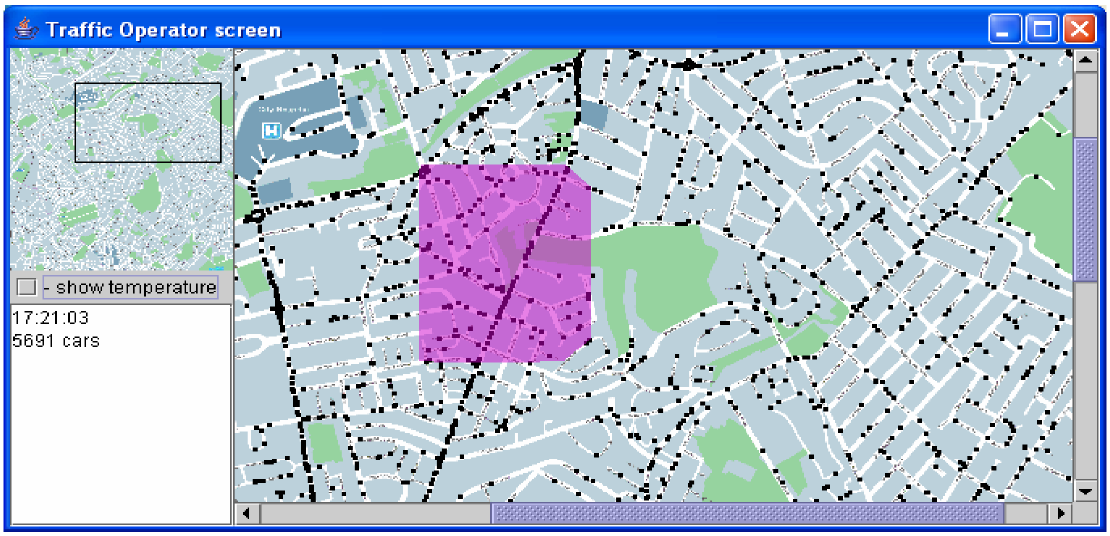

Figure 7

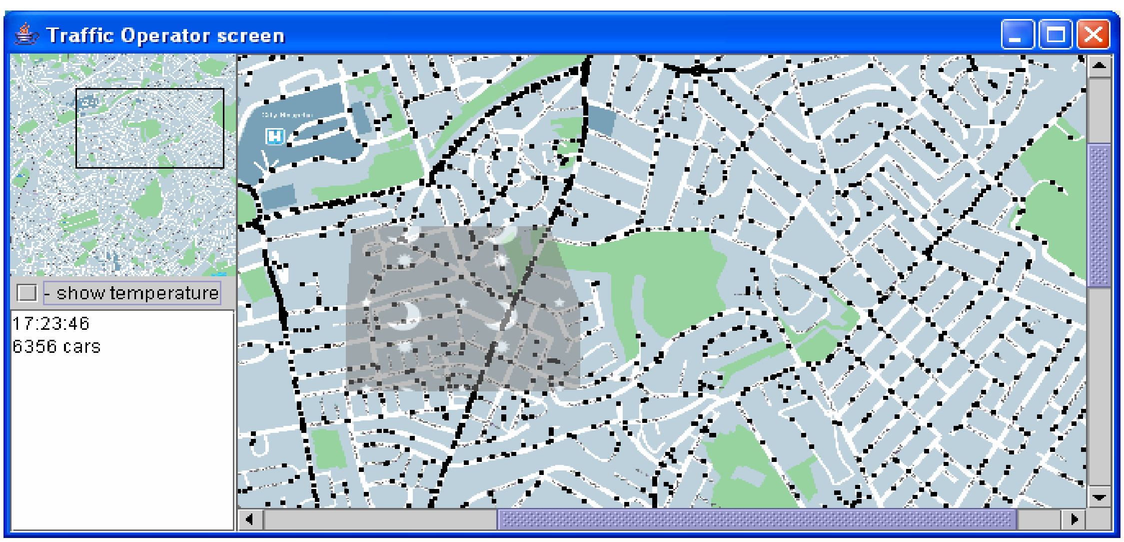

Figure 8

- Real time traffic streaming images from operator-selected vehicles
- Route finding
- Parking information

CONCLUSIONS

- The creation of open telematics platform will deliver important economic and commercial benefits
- The cost of operating real-time traffic information collection and delivery can be substantially reduced
- New applications are emerging as a direct consequence of the research:

  - cooperative traffic information generation
  - cooperative traffic information distribution
  - cooperative traffic control generation

REFERENCES

[1] J. Freebersyser, B. Leiner, "A DoD Perspective on Mobile Ad Hoc Networks", In "Ad Hoc Networking", edited by Charles E. Perkins, chapter 2, pp. 29-51, Addison-Wesley, 2001.

[2] G. Pottie and W. Kaiser, "Wireless Integrated Network Sensors", *ACM Communications, vol. 43 no. 5, pp. 51-58, 2000*

[3] H. Hartenstein, B. Bochow, A. Ebner, M. Lott, M. Radimirisch and D. Vollmer, "Position-aware ad hoc wireless networks for inter-vehicle communications: the FleetNet project.", *In Proc. 2nd ACM Int'l symposium on mobile and ad hoc networking and computing, 2001.*

[4] FleetNet website, "www.fleetnet.de"

[5] C. Lochert, H. Fussler, H. Hartenstein, D. Hermann, J. Tian, M. Mauve, "A Routing Strategy for Vehicular Ad Hoc Networks in City Environments", *In Proc. IEEE Intelligent Vehicls Symposium. 2003.*

[6] L. Wischhof, A. Ebner, H. Rohling, "SOTIS – A Self-Organizing Traffic Information System", *In Proc. 57th IEEE Semiannual Vehicular Technology Conference, Jeju, Korea, April 2003*

[7] W.H. Liao, Y.C. Tseng, J.P. Sheu, "GRID: A fully location-aware routing protocols for mobile ad hoc networks", *Proc. IEEE HICSS, January 2000; Telecommunication Systems, to appear*.

[8] R. Morris, J. Jannotti, F. Kaashoek, J. Li, D. Decouto, "CarNet: A Scalable Ad Hoc Wireless Network System", *ACM SIGPOS European Workshop, Kolding, Denmark, September 2000.*

[9] J. Liu, P. Cheung, L. Guibas and F. Zhao, "A Dual-Space Approach to Tracking and Sensor Management in Wireless Sensor Networks", *In Proc.1st ACM Int'l Workshop on Wireless Sensor Networks and Applications, pp 131-139, Atlanta, April 2002*

[10] C. Intanagonwiwat, R. Govindan and D. Estrin, "Directed Diffusion: A Scalable and Robust Communication Paradigm for Sensor Networks", *In ACM/IEEE Int'l Conf. On Mobile Computing and Networking, 2000.*

[11] M. Thomas, E. Peytchev, D. Al-Dabass, "Auto-Sensing And Distribution Of Traffic Information In Vehicular Ad-Hoc Networks", UKSIM 2004, Conf. Proceedings of the

UK Simulation Society, St. Katherine's College, Oxford, 29-31 March 2004, pp124-128, ISBN: 1-84233-099-3.

ABOUT THE AUTHOR

Dr. Evtim Peytchev, School of Computing and Informatics, Nottingham Trent University, Clifton Lane, Nottingham NG11 8NS, UK, Tel.:++44 (0) 115 8488371, email: evtim.peytchev@ntu.ac.uk