

Location Based Context-Aware Services in a Digital Ecosystem with Location Privacy

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EXECUTIVE SUMMARY

This case discusses the architecture and application of privacy and trust issues in the Connected Mobility Digital Ecosystem (CMDE) for the University of Wollongong's main campus community. The authors describe four mobile location-sensitive, context-aware applications (app(s)) that are designed for iPhones: a public transport passenger information app; a route-based private vehicle car-pooling app; an on-campus location-based social networking app; and a virtual art-gallery tour guide app. These apps are location-based and designed to augment user interactions within their physical environments. In addition, location data provided by the apps can be used to create value-added services and optimize overall system performance. The authors characterize this socio-technical system as a digital ecosystem and explain its salient features. Using the University of Wollongong's campus and surrounds as the ecosystem's community for the case studies, the authors present the architectures of these four applications (apps) and address issues concerning privacy, location-identity and uniform standards developed by the Internet Engineering Task Force (IETF).

Keywords: *Context-Aware, Digital Ecosystems, GEOPRIV, Information Systems, Internet Engineering Task Force, Location-Based Services, Mobile Applications, Transportation*

INTRODUCTION AND ORGANIZATIONAL BACKGROUND

The University of Wollongong (UOW) is a public university located in the coastal city of Wollongong, 80 km south of Sydney, Australia. A recent report from the university states a 2009 enrolment of 26624 students and 2127 full-time staff. The University of Wollongong (UOW) is also a significant driver of the local economy providing a direct benefit in excess \$500 million in 2009 and export earnings of over \$90 million (University of Wollongong, 2011).

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The Connected Mobility Digital Ecosystem operates on UOW's main 82-hectare campus, which offers a mix of bushland setting and more than 50 buildings that house modern educational and research facilities. These characteristics describe a unique and vibrant mid-sized Australian regional university that has become central to the identity and planning of the city.

Until recently the city's economy was driven by the manufacturing and mining with infrastructure planning and provision based around their needs. During the past two decades UOW's growth has mirrored the regions economic diversification into services including education, health and financial services. This shift has created a new challenge to the region as infrastructure requirements have changed to cater to the new diversified economic bases (Regional Development Illawarra, 2009).

As the UOW community's population has grown, accessing the physical campus has become more difficult with car parking now a critical issue. To alleviate this, the university has provided free shuttle bus service (UniShuttle) connecting the campus and the local railway station. There is also a free CityShuttle bus service, provided by the State Government of New South Wales, which connects the UOW's main campus, the UOW's Innovation Campus, Wollongong's CBD, hospital precinct and surrounding suburbs. These bus services are well patronised by both the university and general community. Increased utilization of these services are beginning to oversaturate peak capacity which is occurring at certain times of the day, and certain times of the year, in direct correspondence with the university's academic calendar. The free services run at either fixed schedules (UniShuttle) or at ad-hoc 10-minute intervals (CityShuttle). However, the in-session and out-of-session variability as well as daily in-session variability of UOW's commuter community has significant impact on the operation and quality of the service.

The UOWShuttle app case study and its use alleviate the problem of seasonal demand within the bus network. At first it is provided as a location-based convenience app installed on a user's iPhone that links to static timetables. The second iteration will link to dynamic timetables that are based on the actual locations of the buses and their estimated arrival times. Over time, passenger and location data are collected and aggregated so that bus schedules and services can be dynamically planned based on actual usage. The UOWShuttle app is described in more detail within this case.

Despite the sizable patronage of the free bus services, a large number of students do not live close to these routes. Many members of the campus community have no other alternative but to drive in private vehicles. The university provides free parking to those that car-pool to campus, and outsources a car-pooling service to Carpoolworld.com (<http://www.carpoolworld.com>). Car-pooling to the university provides an attractive value proposition: particularly for economic and environmental reasons. However, staggered class times across courses, rigid work hours, and a population being drawn from a wide geographic area effectively limits car-pooling opportunities. A more ad-hoc and route-based means of car-pooling, with consideration towards trust and location privacy, is presented in the UOWRideShare app described within this case.

The infrastructure used to transmit and receive location data for the UOWShuttle and UOWRideShare systems uses hybrid wireless networks when the mobile device is on campus (WiFi and 3G), and 3G networks when the mobile device is off campus. The same infrastructure can also be used to provide useful services to students and staff members at the university. Based on student feedback, it is common for first year students to feel lost within the large campus grounds and many also worry about making new friends at university—particularly for those adjusting from a high school environment. The UOWCampusGuide app is a location-aware application that uses a student's timetable to direct them to classes and to track the locations of their nominated 'friends' (other app users such as classmates) as they move about the campus. Like the UOWRideShare app, UOWCampusGuide presents a less formalised, more spontaneous means of user interaction

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