Capturing and visualising Bluetooth encounters

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Abstract
In this paper we describe the development of a platform that enables us to systematically study online social networks alongside their real-world counterparts. Our system, entitled Cityware, merges users' online social data, made available through Facebook, with mobility traces captured via Bluetooth scanning. Furthermore, we present three prototype visualisations we have developed for representing the captured data. Finally we discuss the comments we have received from users who engaged with our systems.

Keywords
Social networks, bluetooth, Facebook, mobile phones.

ACM Classification Keywords
H5.m. Information interfaces and presentation: Miscellaneous.

Introduction
In this paper we describe the development of the Cityware platform, which enables users to submit data about their urban social networks. The online component of our system enables users to explore and annotate a common corpus of data representing an amalgamation of their online and physical social networks. Additionally, we present three in-situ visualisations which enable users to actively engage with their data.

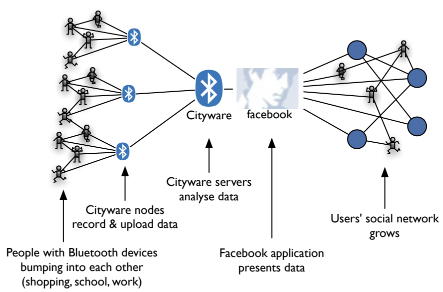

figure 1. Overview of the Cityware platform.

Cityware

Our platform is a massively distributed system, spanning both the online and physical worlds. Its main components are: people's Bluetooth-enabled devices, Cityware nodes, Cityware servers, Facebook servers, Facebook application. An overview of this architecture is shown in Figure 1.

Infrastructure

In many ways the most vital element of our platform is people's Bluetooth enabled mobile devices, such as mobile phones, PDAs or laptops. For any data to be colllected, users must have switched on their Bluetooth devices, and set them to "discoverable" mode. From empirical observations, we know that, at least in certain cities in the UK, about 7.5% of observed pedestrians had Bluetooth switched on and set to discoverable [2]. More crucially, however, Bluetooth matches very closely to people's movement, as it typically has a short range (10 or 100 meters).

The presence of discoverable Bluetooth devices is captured via the deployment of Cityware nodes. These nodes are computers that carry out constant Bluetooth scanning, thus recording details about the Bluetooth devices in the immediate vicinity. Initially, we deployed a small number of nodes as part of a pilot study. However, we also released open-source software that allows users to turn their Windows, Linux, and OS X computers into nodes. Additionally, we modified the open-source application WirelessRope [1] to make it compatible with our platform, thus enabling mobile phones themselves to become Cityware nodes. So far, our platform has attracted hundreds of individuals worldwide who have set up their own nodes and are uploading data to our servers.

The Cityware servers are responsible for analysing the data arriving from the nodes. Our servers record instances when pairs of devices have been copresent (i.e. captured by the same node at the same time), and establishes a social link between these devices.

User interface

Our platform relies on the Facebook system (http://www.facebok.com) in order to present data to users. Our user interface has been deeply integrated with the Facebook system itself, matching its look and feel and using a number of Facebook's capabilities. A screenshot of our UI is shown in Figure 2.

Users are able to explore who they met most recently, who the spend most time with, and who they meet most frequently. For each encounter, our system displays the Bluetooth name of the device (as recorded by the Cityware nodes). If a user recognises a device as belonging to someone they know, they are able to "tag" that device, thus linking it to a Facebook account and to that account's owner. If this happens, the owner of the newly tagged device is notified via the built-it Facebook mechanisms.

In-situ visualisations

To gain an understanding of people's views on urban and digital encounters we developed a series of prototypes intended to visualise such encounters. All prototypes utilised the same underlying mechanisms for sensing, capturing and storing digital encounters. The only difference between our prototypes was how they visualised the sensed information.

Our first prototype (Figure 3 top) was a public display installation that featured a fish-tank with various fish

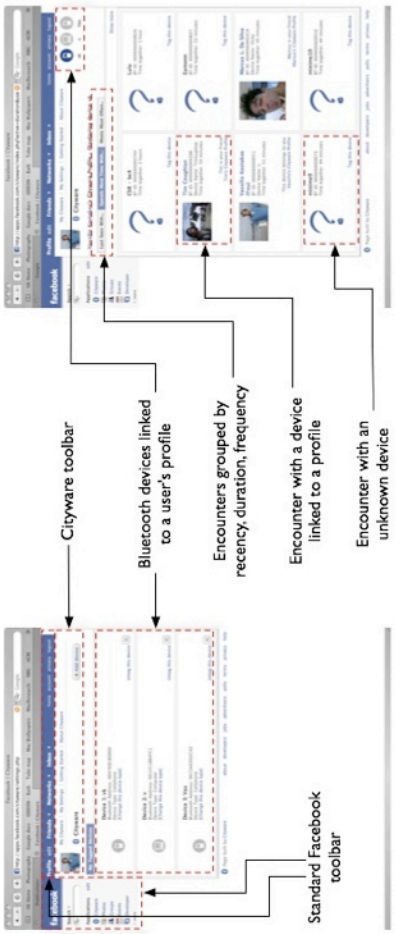

figure 2. Screenshots of the Cityware user interface.

swimming left and right. The screen was augmented with the sensing mechanisms described above. Thus, when a Bluetooth device was detected nearby, a new fish was created in the fish-tank. Each fish had the Bluetooth name of the associated Bluetooth device. The fish remained in the fish-tank as long as the associated devices was being picked up by our scanner. If a device was not detected for a period of one minute, the fish promptly disappeared by hiding in the bottom of the fish-tank.

Our second prototype (Figure 3 middle) featured a timeline of people's visits and encounters near the installation. This prototype featured a conceptual timeline for each device it had discovered. On this timeline, which indicated real time, our prototype highlighted the instances when devices where picked up by our scanner (bright green cells). On the top, the prototype indicated the hour of day (0 - 23).

Our third prototype (Figure 3 bottom) used Bluetooth proximity data to progressively build sociographs of people's encounters in real time. This prototype created a new node for each unique discovered device, and linked together devices that at some point encountered each other. Devices that were currently being detected were highlighted with Blue, while non-present devices faded to a light red (top of Figure 4). This transition was triggered when an active device had not been detected for one minute.

User reactions

Privacy is a much-debated topic amongst online users of Cityware. While some users are being critical of Cityware's privacy implications, many are supportive. Certain users have expressed concern about people being tracked about a city, and having their preferences and routines being inferred by a malicious party. In response, other users commented that anyone can at any time opt-out of Cityware by switching Bluetooth to "invisible". Additionally, it was highlighted that authorities can track people who simply own a mobile phone, regardless of Cityware. Furthermore, users commented that location is not being made available by our system, but nevertheless could be inferred. Another user noted that people are already disclosing information about themselves via their Facebook profile, and that Cityware can expose only that information. A good synopsis was offered by a user who wrote: "There are two groups of people here - one group that willingly submits to this, and the other group, that are totally opposed to any tracking/ recording."

We also collected comments on our prototypes, by deploying them on our campus for a period of three months. The Fish-tank prototype was quite well received, and very few negative comments were made about it. The screen, in addition to showing who is standing here also reflected who was here recently (up to a minute ago). Thus, our prototype in many cases acted as an object of discussion, and prompted people to talk to each other about it. Most of the user comments focused on the interactivity and responsiveness of the display. A common reaction to the system was for users, especially children, to change the name of their phone in order to observe the change on the displayed names. This is a prime example a digital encounter, where the users having been made aware of the screen intentionally initiate an interaction (change of name) in order to perceive the effect on the screen.

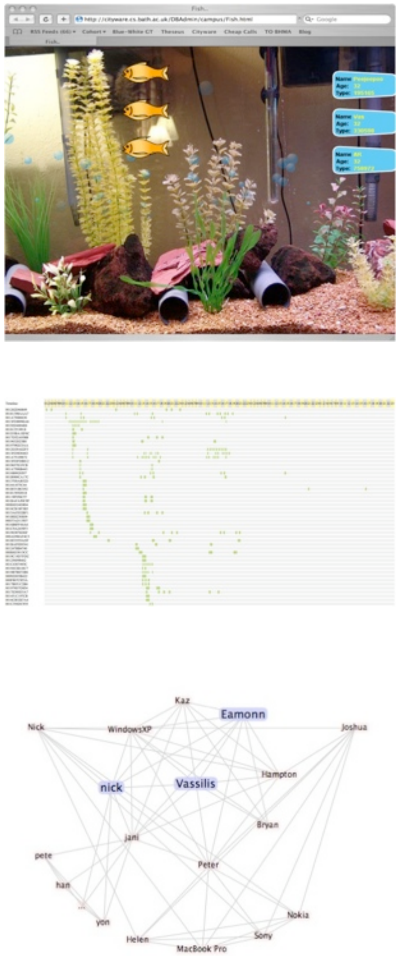

figure 3. Screenshots of our in-situ visualisations (Top:fishtank, middle: timeline, bottom:sociograph).

The timeline prototype received the largest numbers of negative comments from our users. Most comments and worries about our timeline prototype focused on the potential privacy implications and violations of our systems. While objectively this prototype had the least amount of graphic design and realtime responsiveness, for many users it resembled a punch clock. Thus, most people felt that this prototype generated, and revealed, a record of people's work habits. In addition to inferring people's work habits (e.g. when they come to work, when they leave), one could look for further patterns, such as when someone goes to lunch, has a break, or with who they walk. A well-received property of our prototype was that it gave an overview of "how busy" the space was, and when does most of this activity take place.

The sociograph prototype ranked second in people's preferences. While it received a number of positive comments, we found despite the dynamic animation it offered it still failed to capture users or engage them. Some of the positive comments had to do with the fact that over time, especially in a closed environment like a lab, well-defined clusters started to emerge visually. It was also interesting, according to users, to be able to see how these clusters relate to each individual. A major drawback however, was the fact that users could not relate or understand the clusters that emerged, perhaps because not everyone in the lab had a Bluetooth device. Similarly, some desktop computers where constantly present in the environment, thus skewing the sociograph.

Conclusion and Ongoing work

In this paper we have described the Cityware platform, how users have reacted to it and three prototype visualisations we have built. As part of our ongoing work we are developing visualisations that both end users and researchers can utilise for better understanding the various patterns and properties of our dataset. We are also considering the development of software that will allow users to automatically geo-tag their data if they have a compatible GPS receiver. Furthermore, we are in the process of correlating aggregate encounter patterns with user-specified properties of those encounters. Finally we are examining the potential viral spread through users' encounters, and relating viral spread to user-specified qualitative data.

References

[1] Nicolai T., Yoneki E., Behrens N., Kenn H., (2005). Exploring Social Context with the Wireless Rope. LNCS, 4277:874-883.

[2] O'Neill, E., Kostakos, V., Kindberg, T., Fatah gen. Schiek, A., Penn, A., Stanton Fraser, D. and Jones, T. (2006). Instrumenting the city: developing methods for observing and understanding the digital cityscape. Proc. Ubicomp 2006, 315-332.