Using Peer-to-Peer Ad Hoc Networks for Play and Leisure

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The bandwidth of commonly available broadband connections is growing less quickly than the capacity of commonly available storage devices. UK broadband speeds for the home are commonly 512kbps for downloading and 256kbps for uploading, while the Apple iPod can hold 40 GB of data and the home PC often has a 120 GB hard drive. Downloading a 1GB file to a domestic PC may take a day. In contrast, short–range wireless networking technologies are improving dramatically. In the last year or so we have seen 802.11 speeds increase from 11mbits/s to 54mbits/s, and access points are appearing that can transfer at 108mbit/s. Transferring a 1GB file over wireless takes as little as 3 minutes in such conditions. These figures point towards a near future in which high bandwidth peer–to–peer short–range wireless connections are just as commonly used as the Internet. In addition, P2P ad hoc networks may alleviate some of the real world deployment issues of communications systems. The publicity about 'wi–fi hotspots' tends to distract attention from the large and cold expanses between such hotspots, i.e. the large areas with little network coverage. Even less is said of the way that the cost of commercial 802.11 access is a significant constraint on the use of hotspots. Since many everyday applications are built on the assumption of constant network access, they tend to perform poorly, or not at all, on mobile devices that are actually mobile. Ad hoc networks present difficulties in terms of transience and security, but they do support many interesting research avenues in the areas of mobile systems and ubiquitous computing. Applications that have no reliance on central servers, or only intermittent or indirect reliance on such servers, are capable of running at any location without requiring an active Internet connection, a connection to a particular access point or having a specific, static IP address.

As part of the Equator interdisciplinary research collaboration (www.equator.ac.uk), we are exploring the use of P2P ad hoc networks to support a number of interactive applications for leisure and entertainment, such as mobile multiplayer games and—in collaboration with the Kelvin Institute—a guide and recommender for visitors to the Edinburgh International Festival. This builds on our earlier work on collaborative ubicomp, such as our system for the Lighthouse in Glasgow [1]. Our earlier systems were often constrained to operation within a building—effectively, to within a hotspot—and so we have changed our direction so as to concentrate on new techniques in three areas. Firstly, we are exploring new ways, involving P2P ad hoc networks, to share and disseminate information amongst a community of use. Secondly, we are using these information subsystems in developing new ways to personalise and contextualise the information available, using histories of system use and movement, and personal profiles. Thirdly, we are developing new tools for evaluating such systems in use, combining system logs from multiple devices and digital video from evaluators' cameras in composable and tailorable visualisation tools.

Many of our systems rely on the same infrastructure for discovering mobile devices and spreading information among them: *FarCry*. This is, in essence, a file sharing and mobile

web-server system that runs on a PDA using 802.11. It will attempt to connect to any networks in range or set up its own ad hoc network in the search for other systems. There are two basic modes of operation: one allows a user or a program to interactively select files from other FarCry clients, while the other "leech mode" downloads all the presented files automatically.

We have developed several prototype systems on this basis. The first, *Samara,* is a P2P ad hoc recommender system, offering personalised recommendations of locations in the city to visit and for web pages to read. The second, *Domino,* is a testbed for experiments in recommending, sharing and dynamically integrating software modules into the user's running system. Both Samara and Domino are now entering initial user trials, and system components from them are feeding into a system being built in collaboration with Intel Research and the Edinburgh Festival: *EdFest*. This system is a guide for visitors to the Edinburgh Festival, and will offer recommendations based on previous ticket purchases, ticket availability, current visitor location, and the schedules and locations of events.

We have also built a number of mobile games on this infrastructure, including *Monopoly,* which is based on the popular board game but uses wireless access points as 'properties' to discover, rent and trade; and *Tigger*, which is based on the playground game of 'Tig' but involves pointing in a particular direction and using gestural interaction to send a 'missile' in that direction via a mesh network, so as to catch or touch an opponent. Tigger was developed along with the University of Bristol. These games are early prototypes, used to explore and demonstrate the technology. We are taking forward Monopoly to user trials but, as a result of our early experience, we are combining elements of these games in a new system called *Yoshi Feeding*. This game is being built in collaboration with the University of Nottingham and UCL, and uses P2P ad hoc networks as well as fixed access points to explore the notion of *seamful design* discussed in [2] and [3].

In the course of our experience with testing and evaluating mobile systems, we have found that the collection and analysis of system log data in combination with the video data often used in user studies is a difficult task. Drawing from our experience with our first 'seamful game', we developed a tool called *Replayer* to collect, synchronise and play back systems logs from multiple devices including PDAs, game servers and observers' video cameras. The visualisations that Replayer provides have been useful in our user trials of seamful games, and we are now using it in developing and evaluating our newer systems such as *Domino, Yoshi Feeding* and *EdFest*.

References

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