

Socio-technical Factors in the Deployment of Participatory Pervasive Systems in Non-Expert Communities

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ABSTRACT

This chapter discusses the design and development of an interactive mobile tourist guide system according to the principles of Pervasive Computing laid out by Hansmann (2004 pp. 17-22) and presents solutions to the technical issues encountered in the development of a multi-tiered system that encompasses a wide ecology of devices. The chapter further presents the non-technical issues encountered during a live trial of the system and uses the experience gathered from this deployment to present evidence that Hansmann's four principles require the addition of a fifth principle, which is defined and based on hedonic values. In our view, the latter are crucial to the successful adoption of mobile and pervasive systems.

INTRODUCTION

Rural communities face increasing pressure and difficulties that arise from an over-reliance on a declining agricultural sector, ageing populations and poor access to services. Many rural communities are finding that tourism is an increasingly lucrative business and have adapted to provide better accommodation and recreation facilities to attract tourists. Development incentives and funding packages have helped rural communities set up and improve the levels of tourism-related services. However, while Web and Mobile technologies for tourism have become a primary tool for planning and organising tourism in economically developed urban centres, a clear divide between the online presence of rural tourism businesses and service provision (information, booking, enquiries) exists.

In developed countries, the presence of IT equipment and Internet connectivity in rural tourism businesses is at high levels. Findings from previous research (Deakins et al. 2004, Pease et al. 2005, Huggins & Izushi 2002, Buick 2003, Duffy 2006) suggest that while rural businesses understand the potential benefits of adopting ICT and innovation in their operations, particularly the "image" benefits that technology innovation offers to potential customers, there appear to be barriers preventing the integration of innovation. Literature identifies the main barriers to ICT used to be the lack of IT training, cost of relevant hardware and software, security concerns, and dependency on external experts. Major barriers highlighted are also the fear of technology itself and the fear of displaying ignorance of IT especially to peers.

With research in the provision of information on mobile devices (Cheverst et al. 2008, Parikh & Lazowska 2006, Jones et al 2005, Cheverst et al 2000, Dearden & Lo 2005, Dunlop et al 2004, Kenteris et al 2007, Vansteerwegen & Van Oudheusden 2006) feeding increasingly in to mainstream tourism, the barriers of IT training and external expert dependency are increasingly important; at the moment, it is almost impossible for a rural business to integrate and market itself on mobile platforms. In this chapter, we present the design and development of a participatory pervasive computing system based on Bluetooth beacons that transmit up-to-date map-based tourist information to visitors' mobiles. The information is maintained and updated by local businesses through a simple web

interface, with each business responsible for their own content. The system is designed to remove the barrier of IT training by making use of existing skills (web browsing) and also to address the problem of reliance on external experts as the system automatically configures and compiles itself.

We name this system with the initials MiniGIST (Miniature Geographic Information System for Tourism) and introduce the system in a Scottish rural community. This chapter explains the multi-tiered architecture of the system that allows the integration of diverse device ecology and affords the participation of non-expert users into the process of ubiquitous creation and acquisition of information. The chapter discusses lessons learnt in the process of designing, developing and evaluating the MiniGIST system and examines these lessons under the principles of Pervasive Computing proposed by Hansmann (2004 pp.17-22).

TECHNOLOGY AND MOBILITY IN TOURISM

The introduction of technology, particularly the Internet, into tourism, has had a profound effect in the provision of services in the sector. This transformation has come from the facilitation of communication and exchange of information regarding the services offered by businesses and destinations over the web to prospective tourists. The subject of information systems in tourism has been the epicentre of research by numerous scholars and practitioners, although most research seems to pivot around purely business science or computer science points of view, with few studies examining the impact of information systems in tourism by combining the two perspectives.

In order to gain an understanding of the importance of technology and mobility within tourism both the growing use of mobile devices and information software, and the adoption of ICT by businesses must be examined. Whilst some people are still hesitant to adopt mobile devices it has been found that as the mobile market continues to expand, increasing numbers of users will seek out software within the tourism industry as an additional means of information (Dunlop et al 2004, p. 60). Similar studies have also shown that there is an increasing adoption of ICT within small rural businesses (Deakins et al. 2004, p. 148), yet research still supports the suggestions that rural companies are still facing issues regarding their adaption to the “information age”, and are by and large less innovative and slower to adopt new technologies than their industry equivalents in urban environments (Huggins & Izushi 2002 p.113). Although it has been proven that both users and developers are equally interested in the creation and use of mobile software it appears unclear as to what stake business individuals have in the area. Research has highlighted that the barriers that businesses face regarding ICT usage, cost of equipment, IT training, the display of fear or ignorance to their peers and the dependency on experts, all contribute to the reluctance of small businesses to embark on the integration of technology in to their company (Duffy 2006 p.182). It has also been suggested that it is simply due to the lack of understanding of the possible benefits available to local companies if they were to exploit such technology, that they may not recognise the value and potential of such systems (Pease et al. 2005 p. 4).

In order for small rural businesses to benefit from technology it must be recognised by local companies that there is a need to utilize technologies to become more responsive to the market and that the sharing of information would maximise the value of information and knowledge. However in relation to tourist destinations, levels of co-operation and incorporation of the required sharing of information has been low (Pease et al. 2005 p.4). Collaboration by the local business community may assist in the overall promotion of the local area and enhance the tourist industry as a whole.

Another vital point of consideration is the issue of the provision of accurate, localised data (Pease et al. 2005 p.3). This has been noted by several researchers who all agree that “the most important elements of successful tourist information systems are the availability of quality data content” and the attainment of dynamic up to date information is something that cannot be obtained by paper guides/leaflets” (Dunlop et al. 2004, p.59). While development studies have provided city visitors with a hand-held context-aware tourist guide, utilising modern technology solutions, they too identified the need for dynamic, up to date, reliable information (e.g. Cheverst et al. 2008, Vansteerwegen & Van Oudheudsen 2006), as there appears to be a void regarding the creation and control of information (Dearden & Lo 2004 p.112). To ensure the creation of mobile information will not only assist tourists but also be advantageous to the local businesses involved, local companies must overcome the technology barriers they face and take control of the data presentation which intends to improve the local industry. As noted by such researchers as Huggins & Izushi (2002, p. 121) “the key to the

success of any ICT programme is the engagement of local communities in the very early stages so that they facilitate the sense of ‘ownership’ and the development of a self-managed learning process”. The training, content and information management must be controlled by the companies themselves in order to ensure that the companies are not only benefitting substantially in relation to their expended efforts but also to ensure that the tourists are being provided with up to date, reliable information.

THE MINIGIST SYSTEM

Inspired by previous research, but particularly the gap identified from literature in the existence of a system in which the stakeholders (businesses and communities) could be afforded some degree of control of the information presented about them, we designed in 2006 a participatory system called MiniGIST (Miniature Geographic Information System for Tourism). In summary, the MiniGIST system allows the on-site dynamic delivery of map-based tourist information (currently text-based but easily extensible to include multimedia).

The project's primary targets were

- a) To provide dynamically updated, live tourist information to the modern-age tourist by exploiting the mobile devices they carry with them at a nominal cost to the tourist;
- b) To encourage and facilitate the engagement of local communities and local businesses in the tourism industry with modern technologies, such as location based services and mobile advertising;
- c) To stimulate tourism business growth and enhance the visitor experience through the provision of mobile and location-based services that increase awareness of the tourism-related businesses and their services.

Preliminary Research

In order to support the design and development of an appropriate architecture and client interfaces, we carried out some initial research in order to determine firstly, the types of updatable content that tourists would be keen on accessing through the system and secondly, the connectivity methods that would be most appropriate to allow tourists access to the desired content. We interviewed 34 people (tourists currently on holiday and people who indicated a general interest towards tourism) and asked several questions relating to their perception of importance of the most prominent categories of tourist information as identified by literature (Accommodation, Food, Local attractions, Entertainment, Banking services, Healthcare facilities, Transport), as well as the types of devices that they carried with them during holidays and their usage of the mobile internet. Our participants were mostly between 18-30 (74%) and residents in the UK (88%). In terms of looking for information, most of our respondents used the Internet as a source of information (76%). A further 44% indicated that they also used guide books and 34% also depended on other sources of information such as recommendations, newspaper articles, friends etc.

We asked our participants to use a “star rating” to indicate the importance of each category of tourist information, with one star being “least important” and five stars being an absolute must-have. The results are summarised in Table 1.

	*	**	***	****	*****	Total score
Accommodation	1	0	5	11	17	145
Food	1	0	10	10	13	136
Local Attraction	3	6	8	6	11	118
Entertainment	1	8	5	7	13	125
Banking	4	7	10	7	6	106
Healthcare	8	6	7	5	8	101
Transport	2	2	8	12	10	128

Table 1: Participant Ratings.

As it can be seen, the most important category (using a simple scoring system of 1 point per star, multiplied by the frequency of responses) is Accommodation, followed by Food, Transport, Entertainment and Local Attractions. Banking and Healthcare proved to be divisive, with the participant body apparently ambivalent regarding their importance.

With regard to local services such as Accommodation and Food, we also asked the participants what kind of information they felt would be of importance. The results highlighted that costs and special offers were very important, along with contact details and directions to venues (Figure 1).

[FIGURE 1]

Figure 1: Information on Local Services.

We also asked the participants what type of devices they take with them on holiday, and found that 50% carried a web enabled mobile or PDA, 17% a laptop, 35% a non-web enabled mobile or PDA, and 12% indicated nothing as a response. With regard to how often they used the internet on their mobile devices, out of the 17 users who responded that they did use it, two indicated that this was done very rarely (once a month or less), seven did so rarely (4-5 times a month), six used it sometimes (2-3) in the week, one person indicated they used it often (every other day) and one more person indicated that they used it every day. We also queried people on whether they thought that the cost of access limited their use of the mobile internet and found that 35% said cost was not a factor, a further 35% indicated that it was a factor both in their country of residence and abroad, 0% indicated that it was a factor only when abroad while a further 30% indicated this question did not apply to them since they did not use the mobile internet (no suitable device). As such, a significant 65% of the respondents indicated that their main barrier to accessing mobile information was either a lack of suitable equipment, or the cost of access.

MiniGIST High-Level Architecture Overview

While our initial thoughts were to create a web-based architecture to allow tourists mobiles to connect over GPRS or 3G networks to access information, it was decided after these findings, to abandon this mode of connectivity for something more ubiquitously available. We adopted the concept of an “access point” – fixed locations within an area of interest – to deliver data to tourists’ mobiles. These access points consist of a Bluetooth enabled computing device (this can be anything from a PC, laptop, kiosk or dedicated ruggedized miniature computer). Bluetooth is a short-range radio protocol mostly used for the transfer of small amounts of data across mobile devices (such as photos or songs). Bluetooth is, in a sense, the lowest common denominator for communication in mobile devices, as it is found on almost every model of mobile device produced in the last years and incurs no cost to the user.

To receive the tourist information, tourists connect their mobile phone with the access point wirelessly, via a very simple “pairing” process. Once the phone and access point are connected, the access point automatically sends the data (application and content) to the tourist’s phone, at absolutely no cost to the tourist. The access points can alternatively be configured to look for Bluetooth devices in their vicinity and automatically send the data to them (“push” mode), without tourists explicitly

instantiating the connection. Examples of Access Points are shown further in this chapter. The system has a range of approximately 8-10 meters.

[FIGURE 2]

Figure 2: MiniGIST Deployment Architecture.

In this architecture (Figure 2), businesses connect to the MiniGIST central server over their existing internet connections and using a simple website interface, can update their information and details as often as they like. This information is propagated to Access Points at pre-set time intervals through the day (e.g. every hour or twice daily). Access Points are dispersed through a particular geographic location of interest and are connected to our central database server through an internet connection (ADSL, cable, Wi-Fi or 3G/GPRS).

An access point can be a dedicated piece of equipment. However, any business PC can also serve as access point, with the addition of an inexpensive USB Bluetooth device. This way, a business can act as an information generator as well as an information provider. This architecture makes the MiniGIST system extremely low-cost in terms of its maintenance and operation. In a situation where most business PCs also act as access points, there is practically no cost for the system operation as the system utilizes existing Internet connections at business premises. Furthermore, dedicated hardware for the access points can be purchased for as little as £200, making even standalone hardware solutions relatively inexpensive. The system thus provides a high margin for profitability through subscription fees, charges for updates and/or advertisement, depending on the business model agreed upon by its operators.

Development of the Mobile Client User Interface

We chose to build a map-based system to provide the tourist information, as preliminary focus groups indicated that this would be the preferred mode of information delivery, compared to traditional menu-based list interfaces. One finding that became quickly apparent from these initial design consultations was the fact that users were having difficulty with existing Pan-and-Zoom interfaces, such as these encountered in applications like Nokia Maps. Users were becoming frustrated with the continuous pressing of directional buttons (D-pad) for panning and * or # buttons for zooming. We designed thus a novel zoomable interface, in which the map was split in grid-based segments. A user can select a segment (see Figure 3) with the D-pad on their device or stylus, and then press the central “selection” button of the D-pad or tap the screen to “zoom into” that segment. A user can then zoom out to the previous high-level view and select another segment to zoom into. This concept of “jumping” into and out of the map can be infinitely recursive, so that each view can be split into segments and zoomed into further, although for simplicity, our prototype implemented two “levels of detail”, one high level map, plus one level of zoomed in segments. The screenshots in Figure 3 show the mobile client interface from our prototype and illustrate the simplicity and intuitive nature of the application. The application runs on most mobile phone makes and models, including touch-screen based devices (supports stylus tapping).

Evaluation of the Mobile Client User Interface

Since a prototype of our zoomable interface had been built prior to the preliminary research described earlier, we took the opportunity to ask each of the respondents of that survey to undertake a set of three simple information finding tasks using our prototype and asked them for their subjective opinions on the usability of the interface. When questioned if they perceived that the client was quick to learn to use, 32% agreed strongly, 42% agreed, 20% were unsure and 6% disagreed. In questioning their perception of ease of use of the novel zooming system, 35% said they strongly agreed that it was easy, 62% agreed, 3% (one person) was unsure, while nobody disagreed with this statement. The participants were somewhat less sure about the ease of use of the cyclical selection system for the POIs on the map which required them to use the device’s Directional Pad in order to highlight one (12% strongly agreed it was easy, 50% agreed, 18% were unsure, and 20% disagreed). In summary, these results gave us confidence that our design directions were appropriate and we continued with implementing the project’s back end infrastructure and stakeholder interface for updating and maintaining information.

[FIGURE 3]

Figure 3: Mobile Client Interface from the Callander Prototype.

MiniGIST Server Implementation

The MiniGIST Server consists of a MySQL database which is responsible for storing and maintaining business data. Data from the database is distributed to the Access Points in XML format, upon request from the access points. The Server Website is implemented in HTML and PHP5. Data that appears on the website and data elements, such as login usernames and passwords, are obtained directly from the database through appropriate PHP5 code embedded in the web documents.

When a business wishes to register for the MiniGIST system for the first time, they fill in basic contact details on the MiniGIST website (business name, desired password, a contact name and contact details) (Figure 4). Upon registration of these basic details, an email to the MiniGIST system administrators is automatically generated. Once the administrators are satisfied that the request is genuine and that it originates from an authorised representative of the business, the request is approved through the website (administrators can login and manage requests on a special section of the site visible only to them). Upon approval, the business can then log on to the website and change its basic details or its business details (e.g. address, special offers, prices etc.). Subsequently, any data entered by the businesses is exported to the Access Points in XML format. The access points are responsible for packaging this XML and the mobile application code packages and prepare the final application to be pushed towards the mobile devices. This process of “pulling” the XML data from the server and preparing the mobile application for distribution can be scheduled to take place at regular intervals, as deemed appropriate by the deployment scenario. Finally, in order to facilitate updates to the mobile application code, the Server holds a copy of the latest mobile client and AP application code, which the access points pull (if an updated version exists on the server) along with the XML data. Updates overwrite the application code stored locally in each access point.

[FIGURE 4]

Figure 4: New Business Registration Process (above) and MiniGIST Server Data Flows (below).

MiniGIST Server Website

Using a simple login system on our secure server website, businesses can change their information as often as required to provide the latest information to tourists. Updating the information on the web server is also extremely simple, using a web form. The server brings up the information as previously stored and businesses only need to change the parts that need to be updated and then save the update (Figure 5).

[FIGURE 5]

Figure 5: Screenshots highlighting the simplicity of the MiniGIST server business site. Login (left) and MiniGIST server business details input and update screen (right).

MiniGIST Sample access points and mobile clients

Any PC running Windows XP, with the .NET and Java2SE runtime environment installed, with integrated or external USB Bluetooth hardware can serve as an access point. Figure 6 shows a self-contained, dedicated access point hardware device that runs our access point software under Windows CE, although this device was not used during the Callander pilot project). Our access point software starts automatically when the PC boots and runs in the system tray (Figure 7). The access point software has no user interface apart from a right-click pop up menu that allows a user to enter “admin” mode or exit the program. Admin mode is password protected and is not meant for use by access point operators (businesses). This mode allows a technical person to configure an access point by selecting how often it is to receive updates from the central server, and troubleshoot it, by providing manual options for downloading the database info, building the mobile client and sending it to a selected mobile device. Additionally, the pop-up menu allows businesses to explicitly send the mobile app to a device, in the case that the device is not being automatically detected by the access point software (manual mode).

The access points can be configured to distribute data in two modes, Push or Pull. In either mode, a connection to the user's device is established, the mobile client is sent across and then the AP immediately terminates the connection (to prevent misuse of the connection for malicious purposes). The users are prompted that the access point wants to send some data to their device and are given an option to accept or discard the transmitted package. The precise wording of the message depends on the device as each manufacturer implements their own generic message for all incoming Bluetooth transmissions. The messages are typically of the format "*<DeviceName> wants to send some information to your device. Accept?*". By giving a suitable *DeviceName* to the Access Point (e.g. "Tourism Information Point") the message can inspire confidence to users that this is a genuine request, increasing the likelihood of its acceptance. The mobile application is then typically stored as a message on the user's inbox (depending on the manufacturer of the device). Users of some devices are immediately prompted if they want to install the application (e.g. Sony Ericsson devices) but for other devices, they are required to navigate to their message Inbox and manually install the application (e.g. Nokia). Finally it should be mentioned here that the APs log the outcome of the connection and transmission process with the MiniGIST server by first logging the name and MAC address of the Bluetooth device that has attempted a connection with the APs and then whether transmission was successfully completed or not, following each connection. Provision is also made, if required, to log the name of the AP to which a connection is attempted. This allows the close monitoring of a deployment area to potentially scan for problems in transmission and analyse usage statistics such as number of downloads, number of unique devices connected to the system, repeat downloads, frequently discovered APs etc. The distribution modes of the access points in more detail work as follows:

Push Mode: In this configuration, the access point scans continuously for Bluetooth enabled devices in its vicinity. Once a device is discovered, the access point immediately sends the mobile client application across to that device. In order to prevent constant transmission to a device that has already accepted or declined a communication (e.g. in the case that a user remains in the vicinity of the AP for some time), the access point can log recent connection attempts to devices and not make any further attempts to connect for a configurable period of time (e.g. 2 hours). While this function can help reduce the likelihood of "spamming" devices, it has one drawback in the sense that if a connection is inadvertently refused or terminated, the user will not be able to re-establish it until the pre-configured period of time has elapsed. The main advantage of Push Mode is that it keeps interaction with the system to a minimum in the sense that users only have to enable the Bluetooth function of their device and locate themselves in the vicinity of an access point. Additionally, this is a self-advertising mode that means that serendipitous discovery of the service is much more likely than Pull mode, described below, reducing the reliance on clear labelling of the AP's presence and promotional material (leaflets etc).

Pull Mode: In this configuration, the access point remains passive and waits for users to discover and connect to it. Upon attempting to connect, users are required to input a 4-digit passcode (set to 0000 for all access points). Once a connection has been established, the access point immediately sends the mobile client across and terminates the connection once the data has been transmitted. This method requires more input from users and also that they are familiar with the process of discovering and pairing with other Bluetooth devices. Additionally, it requires users to have knowledge of the 4-digit passcode, although this is set to 0000 which is a universal standard for pairing to Bluetooth accessories such as headsets, speakers, keyboards etc. This constraint can also be mitigated through the use of clear labelling on the access point and inclusion of the passcode in marketing and promotional material. The main advantage of this mode is that "spamming" is completely avoided and that users remain in complete control of the frequency and timing of connections, which has the added benefit of allowing for easy repetition of the process in the case an error occurs during transmission. However, this method of distribution is much more reliant on clear labelling, information and promotion of the system, as serendipitous discovery of the AP services is much less likely than Push Mode.

[FIGURE 6]

Figure 6: A miniaturized, screen-less standalone unit that can act as a MiniGIST access point. The unit is ideal for installation at indoor locations and can be secured on walls or fitted inside protective covers.

[FIGURE 7]

Figure 7: The MiniGIST server, running on a standard PC acting as an access point. The server runs discreetly in the background, with only one icon (circled) in the system tray denoting that it is active. The MiniGIST access point icon provides some control options when right-clicked.

DEPLOYMENT AND EVALUATION OF MINIGIST

To test the developed system in a field trial, a suitable location had to be found. In May 2008, we launched the MiniGIST system in the town of Callander in Stirlingshire, Scotland, for a pilot demonstration. The roll-out was conducted in collaboration with Callander Enterprise, a local business association representing a significant proportion of businesses located in Callander. Additionally the roll-out was supported by Stirling Council. The system was rolled out for a period of six months.

Securing Participation

In preparation for the roll-out, it was important to try to form a critical mass of businesses that would be part of the initial data set. If too few businesses participated in the scheme, tourists would be unlikely to find the system of any use, thus would be unlikely to download or make much use of it. Additionally, it was important to find local “champions” for the system, businesses who would be willing to take the first step forward in trialling the system out and hopefully convincing other businesses to join at a later stage.

A presentation of the system during one of the regular Callander Enterprise meetings was carried out to inform local businesses of the system’s functionality and its advantages, where initial interest in the system was judged to be encouraging and the project was given the green light for a roll-out. To facilitate the participation of businesses in the scheme and in order to achieve the required critical mass, we funded the purchase of USB Bluetooth dongles to the first 10 participating businesses. Additionally, we offered to install the Bluetooth dongles and access point software on the computers of those businesses who would be part of the initial scheme.

Even though 10 USB dongles were donated, we found that some businesses had computers that were actually already Bluetooth-enabled. As such, we were successful in recruiting a total number of 16 businesses as a starting point (Table 2 and Figure 8). Two local champions for the system were additionally identified, one of which was the Chairman of Callander Enterprise. To support the launch of the system, Stirling Council provided £1000 towards the design and print costs of promotional material for the launch. The launch material consisted of posters promoting awareness of the system and its existence, leaflets containing more information about the system and instructions for tourists on how to connect to the access points and how to download and use the mobile client and window stickers denoting businesses participating in the pilot project.

Business Type	Number of Businesses
Accommodation	3
Eating & Drinking	7
Shop	5
Attraction	1

Table 2: Type and Number of businesses participating in Callander Launch Scheme.

[FIGURE 8]

Figure 8: Map of Callander showing the geographic distribution of the participating pilot scheme businesses marked with colour-coded stars.

Technical and Promotional Preparation

One of the key decisions that had to be taken during the deployment of the system was whether to use the “Push” or “Pull” mode for the access points. Upon consultation with local businesses and given Stirling Council’s support for the production of promotional material, it was deemed best to use the “Pull” mode for access points and strong emphasis to be placed on the advertisement of the service.

Another issue that was discussed during consultations was the inclusion of information for planned events in Callander. The MiniGIST client supports a time-context aware mechanism that allows the display of events that are happening within a pre-determined timeframe from the time of use, while still allowing users to search for events further in the future or in the past. Events were mostly of three types, some that were organised by local businesses themselves (e.g. live bands), some that were organised by the local authorities (e.g. Jazz festival) and some that were organised by the local Callander Enterprise group. During consultation, it became quickly apparent that entering events and maintaining information about them would be difficult as uncertainty arose on whether events should all be managed centrally by Callander Enterprise or individually by local businesses. While it was decided initially that the former method would be most desirable, the fact that no representative of Callander Enterprise felt they could manage this task individually, coupled with strong opposition from some local businesses led to the decision of excluding this type of information from the pilot phase and that we would continue with the remaining information types identified by the preliminary study.

Given the decision to adopt Pull mode for the access points, a professional designer was hired to design promotional and informational material to help promote awareness of the system. The material consisted of an A3-size poster with basic instructions on how to use the system and 3-fold A4 leaflets containing more detailed descriptions for the use of the system and the information contained therein. Additionally, the designer helped create a logo for the system which consisted of the standard Europe-wide symbol for tourism information (the “i” letter), coupled with the Bluetooth logo (signifying the availability of Tourist Information via Bluetooth). This logo (Figure 9) was used on all promotional material and was additionally printed on stickers that were meant to go on business shop windows to show the availability of the system within the premises of a business.

[FIGURE 9]

Figure 9: The MiniGIST logo as implemented on the mobile client (left) and the promotional material (posters, leaflets, window stickers) (middle). The window sticker is shown on a local business’ window along with the running mobile client (right).

Callander has two main tourist information points, located across from one another on the town’s main square. The Tourist Information Centre (the former “Rob Roy Centre”), is operated by VisitScotland, and provides general tourist information on the area surrounding Callander. Given its central location and establishment inside an attractive former church building, it is generally the first port of call for visitors to the area. The second information point is the National Park Office, operated by the Loch Lomond & Trossachs National Park Authority. It provides information on the conservation area of the Loch Lomond & Trossachs National Park. This office is probably not as visible or attractive to tourists as the Rob Roy Centre although it is located on the main street, just off the square where the Rob Roy Centre is. We held several meetings with VisitScotland and the National Park Authority to allow the installation of an access point in these locations and although both organisations showed interest in the system, ultimately only the National Park Authority allowed us to proceed in time for the pilot launch. Prior to the launch, members of our research group (MUCom) visited the participating businesses and installed the MiniGIST AP software on their computers, to ensure that installation for the pilot scheme went smoothly for all participants. During this process, it was discovered that the diversity in the age and specification of computing hardware available at local businesses posed significant problems in installing and operating the APs. We found that some businesses operated computers that were over 8 years old, running antiquated operating systems (e.g. Windows 98 or ME), making these incompatible with our system. Other computers had so little disk storage space available that the .NET framework required for the AP software to run could not be installed, or due to slow processor speeds and minimal RAM, this took up to 2 hours to install. Additionally, while some business computers were directly connected to the Internet (typically through ADSL), others relied on connectivity through wireless routers, which, depending on the machine configuration, could take quite a while to establish and as such the AP software (configured to automatically run at start-up), would load and attempt to connect prior to the connection being available. While it was impossible to work around the problems of hardware and OS limitations described above, minor changes to the AP software were made so that it would keep attempting to connect every 30 seconds if a connection was not available, until it succeeded. Finally, some problems were encountered with the reach-ability of the AP over Bluetooth, as some businesses’ computers were located in a back office that prevented the AP from covering the

customer area. Some businesses were happy to re-locate their computer but for some businesses where this was not possible, we lent a couple of portable TabletPCs (Ubiquio 701) to act as dedicated APs for the pilot. Eventually, even though some businesses had to be turned down due to hardware incompatibilities, 16 businesses had an AP installed for the pilot launch.

The project was officially launched on the 31st of May 2008 by the Lord Provost of Stirling, the Chairman of Callander Enterprise, *KIT-OUT the Park's*¹ Project Manager and the MUCom group (Figure 10). Following the launch, press releases were issued to local newspapers, university publications and websites, to raise awareness of the system. Additionally, the promotional material (leaflets, posters and window stickers), for which *KIT-OUT the Park* staff had undertaken the responsibility of printing, were given to Callander Enterprise for distribution amongst their members, so these could start to get displayed following the launch. The system was officially supported by KIT-OUT and the MUCom group during the pilot project period which was officially brought to a close on 15th December 2008.

[FIGURE 10]

Figure 10: MiniGIST promotional material & hardware used (left) and MiniGIST demonstrated working in local business (right).

Uptake and Evaluation of MiniGIST in Callander

As mentioned previously, the MiniGIST APs are able to report download and connection data back to the MiniGIST server. In examining this data, we found that during the evaluation period there were a total of 74 attempts to connect and download the application, by a total of 24 distinct devices. Out of these attempts, 10 were unsuccessful. In the first month of the operation of the system (June 08), we found 40 downloads, out of which six (15%) were unsuccessful. Out of these six attempts, four were made repeatedly by the same device in the space of three minutes, indicating that an incompatible device (e.g. Palm or Windows Mobile) was used. These statistics gave us confidence in the robustness of the system but we were disappointed on the seemingly low number of downloads.

In visiting the deployment area at the end of the first month, we were disappointed to discover that while most businesses had the leaflets on display, only two of the posters, which were meant to attract the attention and interest of visitors, were installed in town, and additionally these were in locations that were not easy to spot. Only two of the window stickers that were printed and distributed had actually gone up on business windows.

To potentially increase the visibility of the system, we agreed with Callander Enterprise to switch the access points to a “Push” mode and that more aggressive promotion of the system would be undertaken locally, ensuring that the promotional material was made more visible. In the following two months (July and August 08) and despite the agreed changes, uptake was actually worse (25 connection attempts, one failure in July and nine attempts in August with three consecutive failures from the same device). It was also discovered that despite promises, no additional work had been done to promote the system or enhance the visibility of the material.

In order to analyse the reasons of failure of uptake of the system, we interviewed local businesses as well as the chairman of Callander Enterprise as well as examining the logged updates of information that businesses made in the database. We found that only five out of the sixteen businesses of businesses actually used the system to update their data during the pilot season (Table 3), which shows a low level of interest in businesses for the system. The chairman of Callander Enterprise indicated that while promotional material had been distributed and clear instructions had been given to businesses to take a more proactive role in promoting the system, ultimately it was not possible for him to convince or oblige any of them towards this goal. Businesses themselves indicated that while they understood the potential of the system and its possible contribution in attracting more business, they were caught up in the daily running of their businesses and felt that active participation in the system was not a priority. Additionally, when queried whether they felt any additional business had ensued as a result of the introduction of the system, some businesses indicated that while they did encounter customers actively asking to find out more about the system, they could not be certain of any customers having appeared as a direct result of the system. We asked the chairman of Callander Enterprise whether the fact that participation in the scheme had no financial cost for the businesses influenced the low levels of interest from businesses. His opinion was that given the lack of any financial commitment (the system, support and hardware were all provided to businesses free of

charge) and lack of visibility of the effectiveness of the system probably contributed to the low levels of engagement with the system, which was limited to the most enthusiastic (“champion”) businesses. Finally, on the issue of relatively few downloads of the mobile client, he commented that given the demographics and age range of tourists visiting Callander (typically >35 year olds), familiarity with the technology could have played a role in the low uptake numbers.

Business Type	Number of Businesses	Businesses having updated data
Accommodation	3	2
Eating & Drinking	7	2
Shop	5	1
Attraction	1	0

Table 3: Number of businesses having actively updated their data at least once since the roll out of the system.

As a final step of evaluation, we invited businesses to either fill in an on-line survey or to arrange a meeting with our research team, in order for us to guide them through the system and discuss the questions with them. The questions in the survey aimed to investigate the expectations of local businessmen who were not involved in the pilot phase in terms of business information systems and to gauge their perceived value of the system that we developed.

We received a total of five responses to our request, three were online survey responses and two were through face-to-face meetings. Sadly these numbers do not afford the results of this exercise statistical significance, but some of the findings are worth reporting as they provide valuable insight in the perception of the system. Out of the five respondents, one classed themselves as being in the Accommodation sector, one in the Food & Drink, one in Retail and two respondents classed themselves as “Other”. All businesses had a computer and internet connection for their use and all indicated that this was mostly used for business (managing their web presence, keeping in touch with clients and other businesses, managing other aspects of their business). Three respondents also mentioned that they did use their business computer for personal matters as well. Additionally, all businesses mentioned that they had their own websites as well as listings in other tourism-related sites. Two were in the Yellow Pages and three were also listed in local business catalogues or business groupings.

All respondents indicated that through the media that they advertise their services (web, leaflets, print etc), they offer information such as contact details and prices. Only three of them made a regular effort to update their information with special offers. However, when we asked them what category of information they would like more support with in order to provide better information, two mentioned that they were not happy with their current methods of providing contact details and costs, while four said they would want something to help them publish and advertise special offers more easily. One business said it was rather content with its current set-up: *“We are very small. It all works pretty well at the moment with our own web site and two web ads and I don't really need anything more as I'm getting as much business as I want already - but good luck with it anyway.”*

In terms of ease of use of the system, all businesses either agreed or strongly agreed with the statements that registration and logging into the system was quick and easy, and all apart from one business felt that updating their details was easy. When asked whether they felt the system would do well to promote their business, one business strongly agreed, two agreed, one was unsure and one disagreed. These results are perhaps indicating a positive reflection on the value of MiniGIST. Even more encouragingly, four businesses agreed that they would use the system if it was free, a number which dropped to three when we asked if they would still use it if there was a small yearly fee attached (£20). Finally, we asked if they did use the system, how often they would update their details and special offers. One business responded that they were likely to do this daily, two businesses on a weekly basis, one business on a monthly basis and one on a yearly basis.

Deployment and Evaluation Overview

In summarising the results of our experience in demonstrating the MiniGIST system in the town of Callander, while pleased with the overall technical performance of the system, we were disappointed with the low uptake from visitors and lack of engagement on behalf of the local business community.

We can conclude that first and foremost, for community-driven systems such as this to succeed, marketing and awareness promotion of the existence of the system is critical. Constant effort and participation of all parties involved in ensuring the system is visible to outsiders (visitors) is required.

The fact that we could not gain permission from VisitScotland to use the Tourist Information Centre (TIC) in Callander as an access point was perhaps the most crucial point in the low visibility of the pilot scheme. This is generally the first port of call of visitors to Callander and although posters and information leaflets were available in the TIC, visitors could not access it from there.

Additionally, to make sure that continued support for the promotion of the system is provided by local businesses, it is important to ensure that a sense of ownership and stake into the system is cultivated, as well as clear indication of dividends arising from the participation in the system be provided. To this end, a mechanism to show tangible benefits and uptake feedback to the businesses should be implemented. This mechanism could take the form of agreed discounts or offers made available exclusively through the system (e.g. upon showing the system installed on their device, a customer might receive 10% off their bill). However, such mechanisms would require coordination and agreement through the local enterprise group.

In terms of technical improvements, we felt that while using existing business PCs as access points was a good way to reduce the roll-out costs for the system, in practice the benefits of this approach are outweighed by the significant problems in installation, maintenance and support posed by the diversity of computing hardware and operating systems available on these PCs. Based on our experiences in Callander, we feel that the use of dedicated AP hardware (miniaturised PC as shown in figure 8) could have double benefits. Firstly, it allows for a much more tightly controlled platform that is easier to operate, support and maintain; Secondly, given the hardware cost for this (~£200), it gives businesses that have to invest in its installation a sense of a “buy-in” to the system and should encourage more active participation so that a return on their investment could be achieved.

Reflections on the principles of Pervasive Computing

Hansmann (2004) states four widely acknowledged basic principles that should drive the development of Pervasive Computing systems: Decentralisation, Diversification, Connectivity and Simplicity. The principle of Decentralisation advocates for the advantages of the distribution of tasks across multiple computing platforms in pervasive computing landscapes. We feel that in this respect, our system adheres to the principle, given its distributed nature and the facilitation of the sharing of the effort required to keep an up-to-date information repository of tourism business and services. Our system is designed in order to de-centralise the task of maintaining the repository (each business edits and maintains its own details without the need for central management) and additionally the task of dispersing the information to end users (tourists), through the distributed architecture of access points. The principle of Diversification argues that in Pervasive Computing, a multitude of devices of different types will co-exist, and though they may have overlapping functionality, each device would be designed to perform optimally in single tasks or for single user groups. In this respect, our method of employing diverse hardware types (servers, workstations, dedicated APs, mobile devices and multiple connectivity types) fulfils this criterion, making optimal use of different device types and exploiting overlapping functionality characteristics (e.g. a business PC acting as an AP) where necessary. The third principle of Connectivity discusses the need for standards in communication so that interconnected systems and devices can exchange information to help users accomplish tasks. Although we cannot claim to have made any breakthroughs in this area since the project did not revolve around improving connectivity hardware and protocols, we feel that this principle has been adhered to during our design and development of the project, where we have tried to build bridges between different connection types (Bluetooth, broadband) using industry communication standards, to allow devices that would have otherwise been disconnected from the rest of the world to become part of the pervasive computing landscape. The final principle of Simplicity advocates the need for intuitive and simple interfaces to pervasive computing systems. We feel that this has been demonstrated in the development of our system, with the emphasis on simplicity, learnability and ease of use paying dividends during the evaluation of the system, attracting positive subjective opinions from business and tourist users alike.

When considering the outcomes of the deployment of our system, we cannot ignore the fact that despite our adherence to well accepted guidelines, the integration of our system in the societal fabric of the tourism business community has been less than smooth. We encountered several issues with

adoption and use of the system, perhaps reflecting a mindset of resistance to change, or adherence to traditional methods of work. Additionally, it seems that although in theory, business growth and development is an attractive prospect for many, perhaps “making do and getting by” with current income and business levels is sufficient in societal business and practice. Perhaps also, the prospect of task decentralisation and the affordance of control is not as desirable a proposition as the advocates of user empowerment believe. In attempting to define a design framework for pervasive systems, Kostakos and O’Neill (2004 p. 4) examined the notion of a successful “public space” and believed that they tend to share some common characteristics in affording expectations for uniformity and consistency of services. In this, they perceived that these spaces have a somewhat centralized structure when it comes to delivering such services. This has resulted in the development of notions and ideas such as a “station”, a “centre”, or a “provider”. Kostakos and O’Neill (2004 p. 4) further argue that *“...not one of the above services actively relies on its users for its day to day operation. Users may enjoy the services without much work. It seems that we prefer the stability and consistency of a centralized service provider instead of a flexible decentralized system in which the user has increased responsibilities. This could be the case for pervasive systems as well”*. However, this thesis does not explain the success or popularity of participatory information spaces such as Wikipedia or Facebook, whose content and success is exclusively provided by their users.

In terms of pervasive systems, most research is done in carefully controlled lab environments, or limited field trials with careful monitoring. Despite the theory, it is unfortunate that we still do not seem to have conclusive evidence to support either argument for the integration of pervasive systems in society. Although our work seems to point more towards the analysis by Kostakos and O’Neill (2004), we did uncover some evidence from our post-experiment interviews that users can be encouraged to “buy into” a decentralised pervasive system, given the right rewards (or sight of progress towards a reward). Though our collective understanding of integration and acceptance issues in pervasive systems is (still) limited and we cannot generalise from just a handful of research projects, it seems that a fifth, hedonic principle, could be appropriate in the design of Pervasive Systems. We might thus name this fifth principle as “*Gratification*” and define it as the need for pervasive systems to be designed so as to keep their users and stakeholders in the system constantly gratified, by providing instant tangible or perceptible rewards that arise from active participation in the pervasive computing landscape.

SUMMARY OF CONCLUSIONS AND CONTRIBUTION

In summarising the results of our experience in demonstrating the MiniGIST system in the town of Callander, Scotland, while pleased with the overall technical performance of the system, we were disappointed with the low uptake from visitors and lack of engagement on behalf of the local business community. We can conclude that first and foremost, for community-driven systems such as this to succeed, marketing and awareness promotion of the existence of the system is critical. Constant effort and participation of all parties involved in ensuring the system is visible to outsiders (visitors) is required. The book chapter discussed the major barriers encountered in this respect and suggested how these can be overcome.

The contribution of the chapter is three-fold; first, we discuss the technical solution to a pervasive computing problem and show how introducing a multi-tiered architecture that caters for a diversity of computing devices can help non-expert users integrate with the pervasive landscape, to offer and receive services. Secondly, we discuss the societal, organisational and financial aspects that penetrate the pervasive computing landscape and suggest potential pitfalls and how these can be avoided. Thirdly, we examine the applicability of the pervasive computing principles of Diversification, Decentralisation, Connectivity and Simplicity in our system as defined by Hansmann (2004) and provide evidence in support of this theory for the design of future pervasive computing systems, as well as introduce the concept of reward-based design and the introduction of hedonic values in pervasive computing systems.

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KEY TERMS & DEFINITIONS

Pervasive Computing: A model of Human-Computer Interaction with Distributed Computing Systems in which Information processing does not only take place using dedicated desktop computers, has been integrated into everyday objects and activities.

Mobile Information Access: The process of Information Creation, Retrieval and Access, using mobile (pervasive) computing devices.

Hedonic computing: A discipline in Computer Science concerned as much with the “enjoyment” of use of computer systems as much as formalism in the design and development of such systems

Gratification in Pervasive Computing: A design principle in pervasive systems that aims to keep their users and stakeholders in the system constantly gratified, by providing instant tangible or perceptible rewards that arise from active participation in the pervasive computing landscape.

Participatory Pervasive Systems: Pervasive Computer Systems in which users actively participate not only by requesting and retrieving information, but also by generating information “scraps” or meta-data that other users may retrieve through the same system.

ⁱ Kit-Out (Knowledge, Innovation & Technology Out of University into Tourism) the Park is a project that aims to encourage the uptake of the latest technological developments by small and medium sized businesses within the Loch Lomond and National Park area.