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Technology in Tourism:

Handheld Guide Systems and Museum Technologies

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ABSTRACT

This report examines current trends in the use of technology within tourism and provides an overview of current technologies and the variety of use scenarios these engender. The first section outlines a number of key innovations within museum technology. A specific focus is laid on mobile digital travel guides. Section two focuses on location based services used world-wide and describes technologies for location detection as well as types of devices commonly used. Overall, issues are highlighted that should be taken into consideration before embarking on a specific system type and during design and implementation to assure success in terms of user experience, acceptance, troughput, and market value.

Keywords: tourism, museums, edutainment, mobile guides, installations, handheld devices, location-based services, context-sensitive information delivery, user experience, souvenirs, treasure hunt, maintenance of content, tagging, virtual graffiti, augmented reality, GPS, WiFi.

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Introduction

This report examines current trends in the use of technology within tourism and provides an overview of current technologies and the variety of use scenarios these engender.

The first section outlines a number of key innovations within museum technology. A specific focus is laid on mobile digital travel guides, as this is an area that the tourism industry is expecting to expand rapidly.

A goal of this report is to provide tourism experts with ideas and insights for new services. Therefore we highlight issues that should be taken into consideration either before embarking on a specific system type or during design and implementation to assure their success in terms of user experience, acceptance and market value as well as throughput.

Section two focuses on location based services used world-wide. Technologies for location detection are described as well as devices that can be employed. It is important to be aware of the limitations of these technologies along with their abilities. Thus issues of these technologies that need to be taken into account when deciding on how to implement and realize a specific application are described here.

Section One: Technology in Tourism

Travel or museum guides

Travel and museum guides are the most common and long-standing approach to augmenting the experience of site visits. One can argue that digital guide systems are the natural next step after guide books and audio guides on cassette. While they provide the same basic functionality, they can enhance the experience and provide more or different information. It has been found that visitors remember more from an audioguide than from reading labels (Schwarzer 2001) and that they benefit people with disabilities. Digital audio guides that allow visitors to branch into more specific content and select topics (or the language) allow for more personalized and varied tours from different perspectives. Audioguides can enhance the experience of art museums e.g. by hearing the artist talk about his work, or hearing an interview with his friend about the artist's life (oral history).

Schwarzer (2001) in her summary on digital augmentation of arts museums tells us that most museum experts agree on one thing – the devices are not money-makers. The expense of production and maintenance needs to be carefully considered. What e.g. audioguides can offer is providing context on an exhibit, and often visitors will ask for audioguides. There is also evidence that visitors that use digital guide systems spend more time.

An example of a city wide electronic tourist information system is GUIDE setup for Lancaster in the UK (Cheverst, Davies et al. 2000). This is designed to be an alternative to group-based tours which are inherently inflexible with fixed start times, and fixed durations. The system is configurable and able to offer the user custom tours depending on their interests. While it is acknowledged that electronic guides may not be as personal or memorable as human guides, there may be a place for them in supporting tourists who are not able to fit in with pre-arranged schedules.

Stratford-upon-Avon, Shakespeare's birthplace town, in 2005 started hiring PDAs to tourists for 8 pound a day, providing internet access, an interactive map, and a guide to tourist hotspots. The Stratford Unplugged project is set to run for initially one year. Wireless Hotspots are installed in hotels, shops and tourist attractions to give complete connectivity in the town (report in the BBC News UK, 29 June 2005). Projects based in dense cities often make use of Wireless LAN (especially in Europe, where these services are now commonplace) in combination with GPS localisation (cp. Cena, Modeo and Annese 2005).

Many of these devices integrate recommendation systems for tourists, that e.g. give information about the nearest restaurants, price classes, types of food, or that give directions to the next parking house or supermarket. Provision of information can either implicitly be specified through location and context-sensing or the user may be required to formulate an explicit search which is queried from the web or the yellow pages (c.p. Karlson et al. 2006). How to enable complex searches and efficient navigation through multiple-criteria menus is only one of many usability issues related to handheld and mobile devices.

A variety of context-sensitive systems and electronic guides have been developed within the last decade (Cyberguide (Abowd et al 1997), Guidebook (Semper, Spasojevic 2002), Sotto Voce (Grinter et al 2002). These by now almost belong to the normal experience for visitors of museums and historic sites. Other than the stereotypical wands that require visitors to punch in the number of an exhibit that they want information on, context-sensitive guides make use of location information and of previously delivered content in combination with the visitor's personal preferences to select the next bit of presented content. "The Electronic Guidebook" (Semper, Spasojevic 2002) uses different sensors such as infra-red and barcodes in combination with RFID to identify a user and an exhibit and employs WLAN to transmit the required data onto the visitors PDA.

One of the big problems of these museum systems is their upkeep. Often museums engage in a one-time effort to develop an electronic guide. Discussions with museum professionals and museum study researchers indicate that these systems grow out of date quickly, as exhibitions evolve or change. Many projects result in highly stylized content that is difficult and costly to extend and change (often requiring actors for doing voice-overs and graphic designers for visual design). One approach that can alleviate these problems is to depart from stylized, high-end content design and instead aim for a more informal, 'reality TV' aesthetics that allows for on the spot authoring by docents and curators (Weal et al 2006). Besides of the expenses of creating and keeping up content there is another issue to consider – the role of human docents who often feel that they're being replaced by guide systems or come to feel unappreciated. The ecology of docents and guide systems should be carefully considered, as human docents cannot be replaced. While docents offer a human face, hand-helds tend to reinforce a societal trend toward isolated, individualized experiences (Schwarzer 2001).

Visits to museums or historic sites are usually social events and are shaped by social interaction (Ciolfi 2004, Aoki et al 2002, Kelly 2000, 2002). It has been found that visitors that can eavesdrop into each other's guide systems tend to integrate the audio snippets into their own conversation. Open audio, while providing the simplest solution to the problem of individualizing visitors (through headphones), unfortunately is problematic in crowded museum settings. Aoki et al (2002) therefore developed Soto Voce, allowing visitors to define their devices as belonging to a group. This allowed them to eavesdrop at any point into each others headphones, so that group members could check where someone was, or could decide to listen to pieces together.

Issues to consider:

Weight and ease of carrying: Handheld devices often suffer from being too heavy and cumbersome to carry around.

Network availability: Depending on the location and size of the area covered by the device, network availablility cannot always be ensured. Enabling the system to work autonomously without a network connection minimizes network costs, prolongs battery life, and allows the system to work in regions with no or bad mobile phone coverage. Whenever network coverage is available, the system could e.g. update and share content. Based on the last location recorded, rough guesses on the current region can be taken which may be corrected by users.

Focus on the device or on the exhibit/environment: It has been noted as a drawback of digital guides that visitors tend to look down at the computer screen, rather than up at the exhibits or the site (c.p. Schwarzer 2001).

Ease of use (content navigation + physically) and added value: Navigating the complex hierarchies of content on such devices can become an issue in terms of usability. Visitors also can run into problems juggling with a hand-held device, a stylus, and potential other objects (guide book, camera, etc).

For such a system to be successful it is important that user enjoy a good experience with the device, encouraging others to use it, and will re-use it themselves on subsequent visits. To ensure this the device must be well tested, reliable, cost effective, have a good user interface, and offer something additional to current market alternatives

Support of social interaction: Visitors tend to come in small groups and want to experience something together. Hand-helds tend to lead to isolated, individualized experiences. Audio guides with headphones cut off visitors from each other. Listening to the same content and knowing this can be a social experience in itself.

Visual content can provide issues for groups using a system. If many users share a single system (eg. family in a car) it may be difficult for them all to view the content simultaneously. However audio can easily be heard by multiple users of a single device.

Upkeep of content: Is a one-time effort of development sufficient or is ongoing evolvement of content wanted? How can evolving content be authored and added to the system in a simple and efficient way?

Context-based, intelligent information delivery: Users can quickly become overwhelmed with too much information that does not correspond with their interests or with their current goals. Users need simple means of editing a personal profile of interests or of indicating their current goal (sightseeing, getting quickly somewhere, needing navigation help).

Information may sometimes need to be sequenced in manageble chunks (attention span) which then creates the danger of single items not being understandable in themselves. It may get necessary to indicate that certain items of content should only be delivered to users if these have previously received certain other items that provide the necessary background.

Other strategies might involve the careful design of items of content so as to be independent, and the creation of short summary overviews which precede further items. Furthermore users will not want to hear the same piece of information several times, when e.g. driving on the same road out of town (courtyard problem). The system thus needs to keep account of the history of interaction. A system offering vast amounts of information requires an ordering algorithm and filtering algorithm to control the content delivery.

Grain, amount and precision of information: The user can quickly loose faith in a device if it gives inaccurate guidance, and can become frustrated if it does not react often enough or quickly enough. Also there must be enough content for the user to be happy with their financial outlay. If the system offers information on departure from a town, then 3 hours later on arrival in a town they may consider it a poor investment. However the converse is also true that if the device wishes to notify them of items constantly for 3 hours, it may become tiring and annoying.

Design and Maintenance of content: For a travel guide system which is to encompass a larger area and to provide more general information (e.g. restaurants, motels, current events) care needs to be invested into designing the structure and uptake mechanisms for the data base. Some types of content have a long life span, others will be highly temporal. Some content might be sourced through users (e.g. comments, user recommendations), others from other companies and instittutions interested in advocating their services (e.g. city events, special rates in hotels). Using a tiered layer data structure allows for easier update and maintenance and provides flexibility.

Hardware costs, replacement, supporting costs: Investments to initiate and maintain such a system in relation to the income it can create for the provider and the market size. This includes costs for replacing broken or stolen devices and needing to have a surplus storage to replace broken devices. While these costs need to be accounted for in setting the price e.g. for visitors renting the device, it also needs to be inquired how much visitors would be willing to pay for which type of service.

Battery life and recharging options: relevant for a guide system that tourists keep for a longer term of travel (not just for a single site)

Augmented Museum exhibits

Novel types of exhibits can make objects accessible in a tangible way that is not possible with the original object. For example Schwarzer (2001) reports of a device that allows visitors to virtually handle a fragile 17th century, 27-feet scroll and a Japanese tea bowl fro the Philadelphia Museum of Arts. A blank paper scroll sits underneath a sheet of glass, which functions as display screen for images projected on top of it. As visitors roll the dowels on the sides of the glass, the projected part of the scroll changes, and synchronized chanting of the poetry is played. The tea bowl was CAT-scanned and duplicated so as to imitate the texture. The tethered bowl could be manipulated by visitors while a 3D image of the real bowl was displayed accordingly. Ciolfi (2004) developed an exhibition design for the Hunt museum in Limerick, which essentially hosts a collectors' cabinet of curiosities. Some of the objects have not been identified by curators and Ciolfi's ideas focused on turning these into objects of inquiry. Visitors can handle replicas and record their hypothesis. One of the larger rooms is set-up as a bourgeois living space. Besides of other interactive objects, there is an old fashioned radio. Turning the dials, visitors can listen in to other visitors' hypotheses about the mysterious objects.

The evaluation of an exhibition entailing a variety of different types of augmented exhibits (Hornecker and Stifter 2006) showed that most visitors were attracted by hands-on exhibits that combined a physical set-up or input devices with computer augmentation. In particular elderly people seemingly did not want to interact with the terminals. Stand-alone computer terminals (information kiosks) were only used by the few that wanted to read more about the background of the exhibition. Gammon (1999) suggests that it is not simply fear of technology that might underlie this, but sometimes rather technology-fatigue. Ciolfi and Bannon (2002) give a rather harsh verdict on information terminals: "These kiosk installations tended to separate the person from the actual artefacts, and called attention to the computer interface itself as the object of interest, rather than the actual artefact. Far from augmenting the artefacts, they served to distance visitors from the items in the collection. People are not happy about moving away from the exhibitions to consult a kiosk, they would prefer to focus on the displayed objects" (c.f. Kelly 2000). In addition these kiosks would offer an essentially individualized experience, although museum visitors usually come as small groups.

It is well known that visitors on average engage with single devices and art objects in museums for a very short time period only (12 to 27 seconds, typically below one minute), while there are huge variances – some visitors may engage up to half an hour with an exhibit that attracts their attention (Berkovich et al 2003, Harrison, Minneman and Balsamo 2001). Visitors decide very quickly where they spend their time, as there is a multitude of objects and the visit has fixed duration. Thus an exhibit needs to attract the visitors interest within the first few seconds – otherwise it will be deserted. Several museum study researchers recommend layered activities respectively providing different levels of engagement. E.g. during first contact and for a short period of engagement (which tends to be below 30 seconds in most museums per exhibit) the visitor is quickly rewarded with a success experience and provided with simple and short amounts of information. With extended engagement the complexity of information provided or of the problem domain tackled increases (c.p. Ciolfi and Bannon, 2002; Gammon, 1999)

Issues to consider:

Quick success experience and layered activities: Allowing for different levels of engagement in order to satisfy both the quick user and the deeply interested (respectively allow for the user to be sucked into interaction). Provide value within the first few seconds, and increase complexity and depth over time.

Techno-fear and fatigue – should not look like a computer if it need not be: Research indicates that people often want an interaction experience that is different from their normal interaction with computers. Hands-on input devices have proven to be inviting and to encourage a sense of playfulness, while lowering the interaction threshold for all ages. Integrating computer augmentation with actual objects furthermore allows to contextualize information and allow people better to focus on the object, and it can support group interaction better.

Keeping installations running: Computer-augmented exhibits need to be kept running – visitors are disappointed if they don't work (or think they are too stupid to use them). This requires good hardware and additional staff that checks and restarts computers.

Virtual Graffiti and Tagging – annotated locations

An approach that is growing in popularity and has been adopted by community activists as well as artists is the notion of virtual graffiti. The basic idea is that users annotate physical locations either with text or voice messages and other users can then retrieve these messages. The aim can be to increase community knowledge, to trigger communication between strangers, or to allow for playful interaction. Many existing systems are based on a very simple set-up of unique identifiers pointing to audio or text content and a call-and-answer routine to pick the content from a server using a standard mobile phone.

Physical notice boards act as information hubs for people to find and share information. They are designed for a mass audience, and are often placed in entrances, corridors or other places where people have to pass through. However they can only be placed on physical structures, and are therefore limited. GeoNotes (Espinoza, Peterson et al. 2001) is a location based system allowing users to leave and access virtual *Post-It* notes. The device is aware of its current location, and allows a user to leave a note which can be viewed by other users at a later date. This encourages sharing of information, tips, advertisements, anecdotes, and reminders. Over time an area may become densely occupied with virtual notes, and filtering systems based on language, content, date, or the note author may be necessary to prevent information overload and disturbance for the user.

Tagging usually involves visual codes, such as barcodes which translate into phone numbers or web addresses or optical markers. Visual tags are cheap, but visible, while RFID tags are more expensive, but can be hidden inside an object. Many research groups in the late 90s experimented with the notion of associating physical objects with web page, using the object as hyperlink into virtual space. With the advance of small mobile and connected devices with cameras and displays, mobile tagging has come into everyday life. In Japan Electronic Tagging has recently moved into the commercial sector. A system called QR Codes provides visual tags readable with mobile phone cameras which are interpreted as web addresses. QR codes turn up in magazines, advertising sings, on business cards, in bus timetables, and even get printed into passboards after immigration (Holmquist 2006).

The Swedish [vislek] project picks up on the Chinese whispers game (Lindström and Ståhl, 2005). The basic structure of this game is that people sit in a circle and a sentence is passed on in whispered voice until it gets to the last person. [vislek] moves this game into the public sphere to invite people to communicate and have fun, creating a shared social space for strangers to meet and interact. As initial content several young people were recorded that tell a personal story connected to a place in Växjö, Sweden. Posters at this location tell other people to call a phone number on the poster. People then hear a standard message on how to play the game. The message is played out, memorized, repeated and recorded. The next person hears the latest version of the message. After four iterations, the game starts all over again. The researchers found that the messages evolved in varied ways and people often broke the rules of the game creatively.

[murmur] is an interventionist public art project by Shawn Micallef, Gabe Sawhney and James Roussel, recognized at DigiFest with the 2003 New Voices People's Choice Award. [murmur] connects people with their city by allowing them to listen to stories about particular locations told by Torontonians themselves, while standing in those places. At each of these locations, a [murmur] sign with a telephone number and location code marks where stories are available. By using a mobile phone, users are able to listen to the story of that place while engaging in the physical experience of being there. The details will come alive as they walk through, around, and into the narrative. Some stories suggest that the listener walk around, following a certain path through a place, while others allow a person to wander with both their feet and their gaze. The smallest, greyest or most nondescript building can be transformed by the stories that live in it. Using audio instead of text, the user is free to wander throughout the space, touching the objects and structures described in the story. [murmur] is very much a flâneur experience, updated and augmented with modern

technology. The project relates to political practices of local community building and to the art practice of psycho-geography. It focuses on the very international and politically activist neighbourhood the ‘Annex’.

Similar projects are running in other cities (Perlman 2005). Yellow Arrow is based in New York City, but claims to have over 2.000 yellow arrows registered worldwide. People can place yellow stickers in shape of arrows around the city, stating they have something to say about this location. Each arrow has a unique code that can be sent to a mobile phone via text messaging, allowing others to read the message that was left. *Grafedia.net* is a website which provides a similar service for images. Grafedia is blue, underlined text that can be written anywhere. The word is sent to @grafedia.net via cellphone and an image is sent back to the phone.

Issues to consider:

Costs of mobile phone calls: Axup (2006) reports of interviews with backpackers (which tend to be 20-35 year old and travel on a limited budget) that use only pre-pay SIM cards which can be purchased in a country, thereby avoiding international roaming charges. Most phones support voice calls and SMS.

Legal issues: it might need to be clarified who is legally responsible for visitor annotations that are available through a providers services. How are annotations dealt with that present a city, a person, or a place in a bad light and could harm its reputation. An art or community project will be judged differently than a commercial project on these respects.

Souveniring and re-experiencing a visit

A rather novel approach is to piggyback on people’s motivation to take home some souvenirs to remember a holiday or special event.

The San Francisco Exploratorium was one of the first museums to experiment with technologies that allow visitors to take home personal souvenirs (Schwarzer 2001, Fleck et al 2002). The vision is that visitors will borrow a PDA and as they go through the museum, infrared beacons will open web pages on the PDA that visitors can either read in the museum or bookmark for later lecture. Upon leaving the museum, visitors can download everything onto a ‘my visit page’ on the museums web site, which they can read from home. The Exploratorium tested using a bar-coded wrist band that swipes and stores information, and communicates with web cams within the exhibition to capture images of the visit. The design rationale for the wrist band had been to allow for hands-free and social interaction.

One issue of this wrist band, that we have been told about verbally, is that visitors tend to loose or forget about it, because it looks too cheap.

Most experiments in this domain are still limited to providing access to fixed and given content. Only few allow visitors to generate individual objects that they can take home in digital form. “Discovery Point” (Berkovich et al 2003) can be explained as a bookmarking functionality. The authors developed a prototype of an audio device that is carried around the neck. It tells up to five short stories on images in an art museum. If the user pushes the ‘Mail Home’ button of the device, a picture of the painting is placed onto a website that has been generated for the visitor.

The Technical Museum Vienna so far has implemented one of the most complex systems for souveniring which has been running since mid 2004 by now (see Hornecker and Stifter 2006). As part of an exhibition on the history of media, visitors can buy a Smartcard. Using the card, visitors can store collected or self-created data in a ‘digital backpack’. Via the museum homepage, they can later-on access their digital backpack and send e-mails to other visitors. Card owners interact with the information system of the exhibition that is accessible at diverse installations and terminals. Comparing the visitor path with previous visitors allows giving recommendations of what to visit next. Digital objects created by the visitor and given data (e.g. content from an information terminal, TV and radio archive clips) are saved in his/her digital backpack along with objects from other exhibits the visitor interacted with. Visitors for example can use a bluescreen studio and take the role of a TV News speaker. The video is augmented with the Austrian TV newsflash and can be stored in the digital backpack. Visitors can also record sound samples and take images of themselves. Here self-created personal content has proved to be among the most appreciated features of the system. Interestingly visitors often appropriated the media offered to their own purposes, such as a birthday greeting with the TV News background. Evaluation (Hornecker and Stifter 2006) furthermore indicates that visitors were less interested in reading a lot of background information while in the exhibition, but would like to save or bookmark it for follow-up activity at home. Research by Opperman and Specht (1999) showed that two thirds of museum visitors wanted to engage in follow-up study on their museum visit and currently primarily use catalogs and printed guide books fort his purpose.

Evaluation of log files from the Technical Museum Vienna project revealed a surprisingly low number of visitors that actually accessed their digital backpack (below 50%) although almost all interviewed visitors expressed the intent to do so. It was unclear whether this was due to technical problems with accessing the backpack or whether the saved content was perceived as not interesting enough with some hindsight (Hornecker and Stifter 2006). The evaluation also showed that significant effort has to be put into marketing such a system if visitors need to buy it extra to the visit itself. This means visibility of the service as being on offer, demonstration of its value for visitors, and carefully targeting visitor groups with specific aspects of the services offered. Helpful has been the development of a demo profile that visitors can explore in advance that provides an idea of what one take out of this.

Issues to consider:

Targeting, Marketing, demonstrating value: It is essential to provide high visibility of the service on offer, to demonstrate its value for visitors, and to carefully target visitor groups with specific aspects of the services offered, in order to sell services or devices on top of the 'normal' experience and expenses.

Personalized content as souvenir AND supporting follow-up study: Research results indicate that visitors find the creation of personal content attractive and like to appropriate the given opportunities for their own purposes. It is further notable that visitors when on site are less interested in reading text, but are interested in selecting topics they want to do follow-up study on at a later point. For NZ visitors this might refer to content that could be read or listened to in the evenings or during travel periods.

Form and Appearance of the device: A device should be easy to handle, not get lost too easily, allow for hands-free interaction, and be easy to share and to integrate in social interaction

Novel Types of Activities

Several newer projects augment the museum visit with new activities such as treasure hunts and puzzle games, or aim to make the hidden visible via Virtual Reality technologies. Visitors, for example, can engage in 'virtual archaeology' using a carry-around monitor which is augmented with GPS (kind of a wheelbarrow) to look under the ground and search for objects (Hall et al 2001). The History Hunt enhances a child's visit to an English castle. On electronically tagged paper visitors collect drawings or rubbing pictures (Fraser et al 2003). Coming to the 'Storytent' they can put he papers on a table and see images on the castle's history projected to the tent walls. In a pit of sand they can dig for further images, which are pre-selected through the papers from a larger selection of content.

Brown et al. (2003) experimented with a system fostering conversations between online museum visitors (VR or web) and conventional physical visitors. The system allows visitors to share location and orientation, communicate over a voice channel, and jointly navigate a shared (digital) information space. The design aim had been to support sharing of context and supporting conversational resources found to be important in museum visits (voice, knowledge about location and orientation, access to the same objects). Visitors were able to navigate together, collaborate and discuss exhibits. Physical visitors were carrying a PDA with ultrasonic tracking.

A recent project in the UK explored the augmentation of historic sites for school fieldtrips aimed at supporting creative writing and literacy education (Halloran et al. 2006). Year 5 children explored the grounds of a historic English country house, Chawton House, carrying a PDA that was providing them with location-based information in the form of audio clips and text instructions. These were designed to encourage children to interact with this environment for the specific purpose of gathering data, ideas and inspiration for a piece of creative writing: a story. The children were free to go wherever they wanted on the estate. Arriving on a location, the device would play an introductory audio clip about the location, followed by a series of carefully sequenced instructions. These for example asked to engage in a roleplay and to record this using the device, or to describe the location in own words, or to speculate about how it was used in historic times. In a second phase the children focused on only two locations where they were starting to write descriptions of these, and to imagine situations where the main characters chosen for their stories would come there. The participation of school teachers in the design of the activity and the instructions was found to be essential for the success of the event, as it had e.g. to be considered what kind of information children of this age could deal with, what would stimulate their imagination, how much time they would need for the different activities etc.

Blogging

Backpackers have been using email to provide travel updates to friends at home and to connect with other backpackers they met. Backpackers are usually young people (20-35) who travel on small budgets for long periods of time). Travel blogs allow for the integration of photos with text. Comments and Links to other blogs can produce a kind of community between bloggers, but usually these are small circles of cross-pointing. Mobile Blogging started gaining popularity in 2002 and refers to updating blogs from a mobile device. Travel blogs focus on documenting trips and often link to sites of other travel bloggers. Travel blogging sites such as TravelPod (www.travelpod.com) provide travel services and support community interaction via recommendation systems and popularity ratings. Increasingly these sites integrate maps which show the routes taken, and include search engines for finding blogs on a specific theme. Blogging does not really connect traveller while they are in location – they primarily are a way of documenting a trip and updating other people about oneself. A review of travel blogs indicates large gaps in what is captured and that the need to remember an experience and later-on type it up at an internet-café produces lapses in reporting and errors in recall. (summarized from (Axup 2006).

Issues to consider:

Careful Design of Activities: If novel activities are to be successful, they need to be well designed, so as to be engaging and fun. This may require the participation of people specialised e.g. in creating games or in working with children during the design phase. A good knowledge of the site(s) that the activity relates to and takes place at was found to be helpful for designing the details of these actitivies.

Number of Participants: Often activities get more engaging with more participants, but too many participants may make things confusing and create information overload – there may be threshold or a ‘sweet spot' for the number of participants.

Supporting visitors in blogging or collecting souvenirs: the difficulties found of travelers to recall details if not able to note them down directly suggests that some travelers might be interested in lightweight options for note-taking which could be used to later-on jog their memory. Tagging photos with GPS locations and showing these on a map could be one useful mechanism.

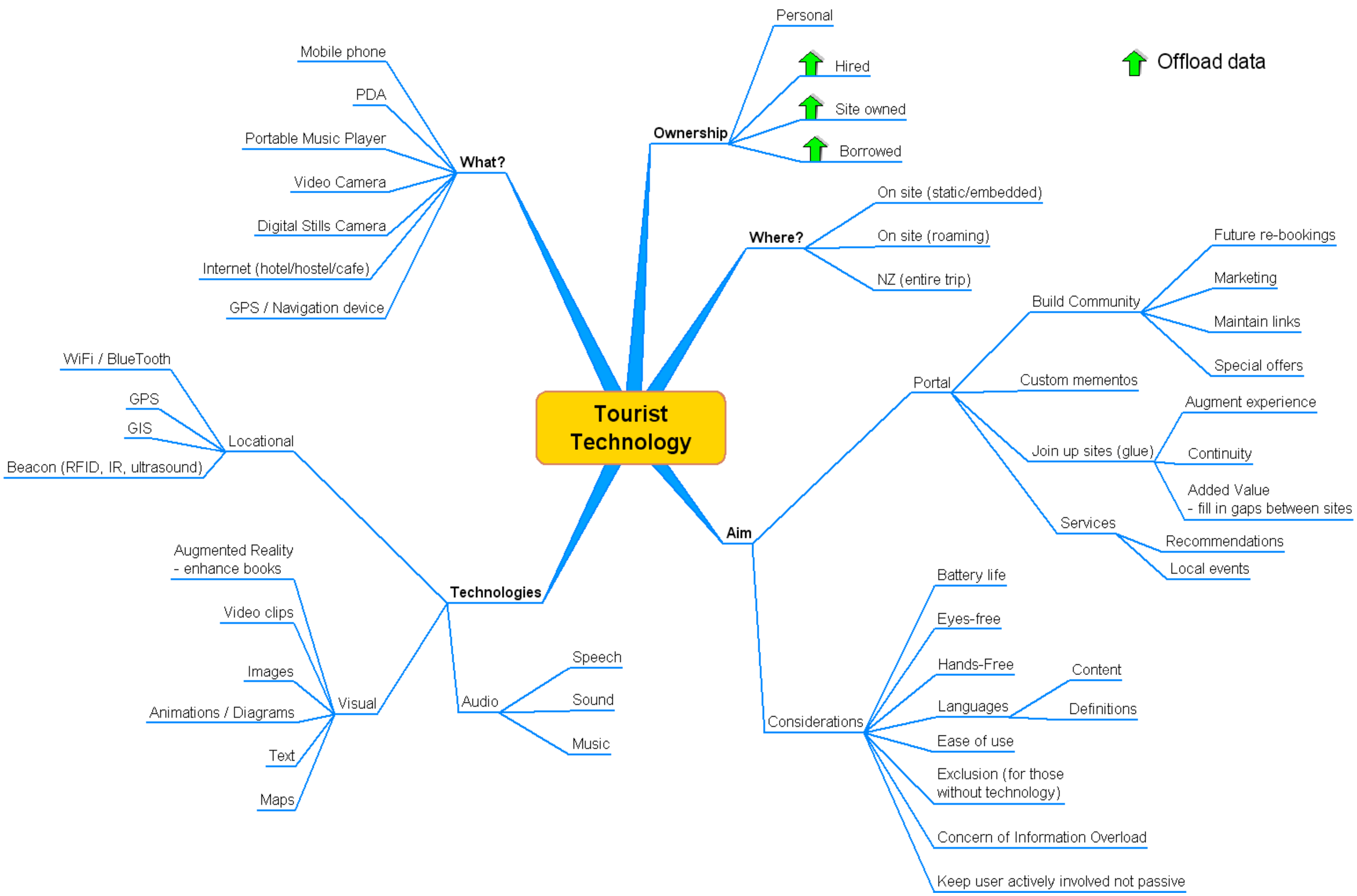

Figure 1: Technology Options

Section Two: Location Based Services

Location-based services (LBS) provide information and services depending on the location of the user or mobile object. As these devices are mobile they need to be small, light weight, have a self contained power supply, be robust, and have the facility to automatically find their location in geographic space.

Typical platforms for LBSs include laptop and tablet computers, PDAs, and smart mobile cell-phones. Each platform has a number of advantages and disadvantages. The larger platforms such as tablet PCs are the easiest to program and offer the largest screen display area, but tend to be fragile and the most expensive.

An emerging technology is the e-ink reader which is both light, it offers a very high screen resolution similar to paper, requires minimal battery power, and many include WiFi receivers.

The next section reviews a number of methods for locating a user in geographical space.

Location Detection Technologies

GPS

The Global Positioning System is able to calculate a user's location based on timing information gathered from a network of satellites in space. GPS is maintained by the US government, and made freely available to anyone in the world. The handheld GPS unit range in functionality and price from the most basic products able to locate a user to the nearest 10m, to those used by surveyors and engineers which are able to work to the sub-centimetre.

The main advantages of GPS are that the service is available for free, and offers global coverage. However direct line of sight to the satellites is required for GPS devices to work and system performance is adversely affected the fewer satellites available. This means that use in dense forest or inside of buildings is not possible.

In urban scenarios the view of the sky can be obscured by tall buildings, scaffolding, shop awnings, sun shades, which block the number of concurrently available satellites. Flat surfaces also act as reflectors for the signals and can confuse the handheld GPS unit, leading to inaccurate location results. It is more difficult to track pedestrians than car users as they operate in a less restricted frame of reference

(Fritsch et al, 2001), and walk next to buildings reducing their field of view of the sky compared to cyclists or car users in the middle of the street.

System latency is often encountered when a GPS device is exposed to the satellite network for the first time. During this time the unit scans for available satellites, and calculates the user's location. Therefore if a user is moving in and out of buildings frequently the GPS unit is unlikely to be able to accurately track their path. For this reason GPS units are most suited to use in open areas such as motorways, fields, deserts, at sea, and in low rise built up areas. Furthermore it is known that GPS signals drift up to several meters according to time of day and weather conditions.

GPS devices output location details in latitude and longitude, the current user's speed, bearing, and elevation. Devices can normally be connected to computers via either a cable connected to a COM or USB port, or wirelessly using BlueTooth.

GPS is used in navigational devices found in newer cars to direct users around foreign countries and cities. It is also becoming available more in some top of the range mobile phones and PDAs. For example the Garmin iQue is a PDA with inbuilt GPS. The main consumer products are made by Garmin, Trimble, Magellan, and Navman. Navman originate from NZ, and provide a full range of navigation, running, and handheld GPS units.

A tourism company that, for example, offers boat trips along New Zealand rivers, lakes, and bays could equip their boats with GPS. Then the actual track of each trip could be recorded and be made available for users to view or download later. It would be possible to display not only the path taken, but also the speeds reached, and the rest points which could be tagged to any photographs the customer's had taken at that point. The route data could be made available as an image displayed on the internet, or for mapping software such as Google Earth, which is available for free from the Google website.

Markers

Unique image markers, typically bar codes or symbols, are placed on key points, sometimes called fiducial points, so that on approach the system may identify the location. This technique requires each POI to be prepared in advance, and for the system to be in sight of the marker, preventing its use on large complex structures where the user may approach from any angle. The open source ARToolkit aids developers who wish to use this technique. The main disadvantages of this technique are that the markers need the permission of the building owner before they may be placed, maintenance to ensure they are not vandalised, and only provide locational information when a marker is in sight. They would therefore not be suitable for a device which is designed to announce distant points of interest. Marker-based identification is most effective when identification is done explicitly by the user, as is common in mobile tagging (Holmquist, 2006), exemplified with the printable QR Codes common in Japan that are readable by mobile phone cameras and translate into a web address.

Image matching

This technique allows a live image to be compared to an existing image databank of known street addresses, or locations. Once the live image has been geometrically corrected to match that of the image in the databank, a street address may be found (Randerson, 2004). This technology is in its infancy and not able to provide sufficiently fast updates for real time use. Researchers are currently looking to reduce the required image storage space and search times by adding radio beacons at key locations to assist in the location process (Knight, 2001).

Infrared or Bluetooth beacons

Beacons can be used to triangulate a user's location very accurately. Infrared requires direct line of sight from the user to the beacon, therefore any object which gets in between, such as another pedestrian, could interrupt the location calculations. Bluetooth is based on radio waves and able to penetrate objects between the user and beacon. Both of these techniques have a short range, typically of about 10m and are therefore more suitable for indoor use.

Costs associated to these technologies include the handheld units as well as the setup and maintenance of the beacon network. The beacons require housing, and an electricity supply. If placed in the outdoors, water- and weatherproof housing becomes an issue (see Harris et al. 2004). In built environments, electricity might be provided via cabling, but in other instances batteries might be required. In this case replacement of batteries requires regular manual maintenance.

Whilst many devices contain Bluetooth and Infrared (eg PDAs, Phones, Laptops) they are only readily used for data sharing. Any use of Bluetooth for location would require that custom software is written restricting their use on

RFID tags

Radio Frequency Identification (RFID) tags are small devices which can be attached to an item, person or animal. They are recognisable electronically from a distance using an RFID reader. A common example of their use is in clothes shops which tag their garments so an alarm would sound if a customer should leave the shop with an RFID tag still on their item.

RFID tags are seen as a replacement to barcodes, as the offer the ability for automatic recognition without the scanning device needing to be in direct line of sight. The passive tags do not require any battery power and can be made very small, typically only a few centimetres across. Depending on the size and thickness of tags these can be detected within a range of only a few centimeters or up to a few metres. Smaller (and cheaper) tags therefore usually require explicit interaction (e.g. swiping a card or putting it on a reader) while larger (and more expensive) tags can be used for implicit interaction and detection. RFID tag detection is sensitive to the electro-magnetic environment and can be effected in performance e.g. by power lines and motors, data lines, large metalic surfaces, or by water respectively humidity (cp. Harris et al. 2004). During installation of an augmented museum exhibition it was for example found that mid-range RFID-tag readers did not work in the vicinity of large touchscreen installations (Hornecker and Stifter, 2006).

In tourist applications RFID tags could be used to locate a tourist as they wander around a site, creating zones which are recognisable to a device equipped with an RFID reader.

WiFi Positioning

Recent research has shown that knowledge of the location of existing Wi-Fi (802.11) base stations can be used to calculate user location (Frauenfelder, 2004; Cena, Modeo and Annese 2005). The most simple localization technique is based on the users' access point (cell)-based), which has a certain coverage area. The accuracy of this technique is limited by the size of the coverage area, but it is simple to implement and execute. Triangulation techniques require radio coverage of multiple access points and are thus more likely to work in dense cities. WiFi base stations are typically found in airports, internet cafes, coffee shops and libraries and allow a mobile computer user the ability to log on to the internet from their own device without the need to connect any wires. The range of each base station is typically 90m (802.11g standard), and each transmits a unique identifier code (Future Publishing, 2004). By allowing the community to add their base station identifier (MAC address) along with its position into a public database it is hoped that coverage will become very dense allowing rapid and accurate triangulation of user location from Wi-Fi Positioning System (WPS) devices (Intel, 2003). As Wi-Fi transmission power and range is far greater than Bluetooth this radio wave based triangulation technique offers a solution for both indoor and outdoor usage. It is possible that this technique may be supplemented by GPS so that a user's location can be calculated in low density Wi-Fi regions (Biever, 2004). An advantage of Wi-Fi over GPS is that it does not require direct line of sight to the base station, and therefore a WPS device would be able to function while hidden in a bag, or pocket. It would also offer locational data inside buildings where GPS is not available, and in urban corridors where the sky view may be highly restricted and therefore GPS may perform badly. At the current time this technology is not able to provide location better than 50m, and therefore is not suited to this research, however it is hoped that in the near future a denser Wi-Fi network would improve accuracy.

Radio Triangulation for Calculating Location

There are a number of methods available to locate a user by means of triangulating radio wave signals. These have the advantage over GPS that they can operate indoors, through walls, and under dense forest canopy. They however do not tend to be freely available, and often require the user to setup their own network structure.

Mobile Phone Triangulation

The base transmitters used to carry mobile phone communications can be used to locate a user. However this requires the permission of the mobile phone companies, and the location accuracy is poor, being between 50m to 100m (Randerson, 2004). As the new G3 mobile phone protocol becomes more widely available so the infrastructure to support it will rely on a denser network of mobile phone transmitters, allowing for greater speed and accuracy of location using this technique. The main advantage of this technique is that it works both indoors and outdoors, and the infrastructure is already in place.

Devices

Mobile Phones

Mobile phones are becoming more powerful, and opening up possibilities for custom applications to be written. They are very portable and normally offer good battery life. They do however only offer limited screen real estate and restricted interface for user input. The design of appropriate input mechanisms and strategies for presenting and sequencing information is therefore a high concern (Karlson et al 2006).

The most popular operating system for mobile phones is Symbian (eg Nokia S60 range) which can be programmed using Java, C, Python, or Flash Lite. There is also a Microsoft Mobile phone operating system, which is more easily programmed but not so popular in the market place.

Programming mobile phones can be time consuming and tricky with many limitations and restrictions. Many mobile phones do not permit any custom programming, those that do can differ widely and supporting many applications to serve the need of all phone platform options can be costly.

Phone2GEarth is an example of a custom mobile application for Nokia Series 60 phones, which allows users to record their route on a GPS enabled mobile phone, then send the data in a format which can be displayed by Google Earth (RealTrackMobile 2006).

Standard features of modern mobile phones include the ability to make voice calls, and SMS text messaging. These can be used in tourist applications to supply a user with additional content, perhaps narratives in alternative languages, or to allow them to ask questions without having to be brave enough to raise their hand in a crowd. Otago University is trialling the use of SMS messaging as a way for students to ask questions of a lecturer during class. A public mobile number is used which collects the questions, and the lecturer reviews them at the end of the lecturer answering each in turn. This is particularly suitable for shy people, those with a stutter, not good at public speaking, or who prefer to take a little time to compose their question.

PDAs

Modern PDAs are fairly powerful mobile computers able to perform sophisticated operations in the mobile arena. They are reasonably robust, have a useable screen size, and offer an easy to use touch screen interface.

PDAs are available with two different operating systems. These are Palm OS, and Microsoft Windows Mobile. Both offer input via a stylus (a pen like input device used on touch sensitive screen).

These devices can be programmed and enhanced with additional functionality such as GPS, or image capture devices.

A concern over the use of PDAs is their battery life which under heavy processing loads could be a matter of hours.

Crossover Devices

There are a number of devices which give both PDA and mobile phone functionality on a single unit. These tend to be more costly however they do offer convenience for the user who only requires one item, charger, set of accessories. An example of a unit offering PDA, GPS, mobile phone, digital camera is the MIO A701. Information can be found of these links.

Company website: http://www.mio-tech.be/products/GPS_PDA_Phone/a701/a701.html
Unofficial forum: http://www.fourpages.co.uk/mioA701/

Alternative Technologies

An alternative technology available today is the 'gumstix' pocket Linux PC. These tiny devices, about the size of a packet of chewing gum, provide basic functionality for a few hundred dollars. They can be expanded using additional daughterboards, for example to provide support for GPS, audio input and output, WiFi or BlueTooth networking. They do not have any graphical display but could provide menu choice options by utilising other technology.

Company website: http://gumstix.com/products.html

One example scenario would be that a 'gumstix' device with GPS daughterboard is fitted to a hire car, providing audio commentary while the user is driving. Any setup changes, or imagery would be viewed on a separate networked graphical display unit. This might be in the form of the user's mobile phone (if equipped with Bluetooth), or perhaps an eInk reader.

eInk readers are a new technology offering paper quality displays which are clearly viewable in bright sunlight, and with minimal power requirements.
Company website: http://www.irextechnologies.com/shop/products/iliad.htm

Google Earth

Maps are used by people to locate themselves, find resources, or just browse for items of interest. Tourists use maps before they depart their home country to study where they are going. Once they arrive they use them to work out how to reach places of interest. When they return home again they might use them to show friends and relatives the places they visited, or to add an environmental context to a conversation. For example showing a friend a photograph of a mountain and the accompanying place on a map.

Mapping on computers has existed for many years as a specialised area of IT, known as Geographic Information Science (GIS). Traditionally GIS required very expensive software running on high end computer workstations.

Whilst high end simulation modelling remains a speciality of GIS, the more simple tasks such as browsing maps, and locating places has become available to main stream computer users through a variety of free software. In recent years Google have bought a company providing a mapping solution, and re-badged it as Google Earth. This software is available for free download from the internet, and gives GIS specialists the opportunity to distribute datasets to a wide audience. Google also host and provide a community layer where any user can add and share points of interest, annotated with their own comments, images and links to website addresses.

In terms of the tourist industry this software offers the potential to share route data with a wide audience for free. A trek into the mountains could be recorded by a guide using GPS, and be made available later to all those on the trip in the form of a KML file for loading into Google Earth on their return home.

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Appendix 1: Useful Links:

http://www.rmaguides.com/ - audio city guide – MP3 download

http://www.beyondguide.com/ - use your mobile phone as a guide

www.soundwalk.com - downloadable audio tours

www.qrcode.com mobile tagging with visual markers from Japan

http://www.year01.com/forum/issue12/caitlin.html www.murmurtoronto.ca