
Wireless value-added services in exhibition shows

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Abstract: This paper discusses the development and trial of a Wireless Exhibition Guide that employs mobile, wireless, and indoor positioning technologies to introduce sophisticated information, communication, and navigation exhibition services, thus, leveraging the value proposition of exhibition stakeholders. Results indicate user acceptance of the system and provide guidance towards the future of portable location-sensitive systems.

Keywords: wireless networks; indoor positioning; location-based services; exhibition shows.

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1 Introduction

Despite the emergence of various electronic business communication and promotion methods over the past years, exhibition fairs continue to rank as the most dynamic and effective sales and marketing tools in existence (UFI, 2004). In the context of the modern economy, fairs continue to bring together market participants, providing a unique opportunity for personal contact and information exchange. Moreover, fairs and exhibitions are 'shop windows' offering insights into the latest industrial products and services to business and individual visitors.

As exhibition organisers compete to generate value for their shows, their attention and promotional activities have been concentrating more and more on visitors rather than on exhibitors (Munuera and Ruiz, 1999). Visitor satisfaction has become of strategic importance and has led trade fair organisers into pursuing a new strategy described by the term 'visitor orientation'. Towards implementing this strategic goal, one of the things exhibitors bear in mind while designing and setting up their show is the need to accomplish the 'extended-stay visit' (Spaeth, 2001). Exhibitors are naturally interested in making visitors stay at their corporate booths for as long as possible. To this end, traffic flow engineering is typically employed. Self-guided tours based on various technological means (ranging from CD-ROMs to portable computing devices) are used to direct visitors at a desired pace throughout the show. In addition, firms try to notify visitors about presentations taking place at different times of the day so as to extend their stay in the exhibition place. At the same time, exhibitors must provide something to be remembered; this trend is referred to as 'experiential exhibiting' (Konopacki, 2002). Technology can assist in making a sophisticated and impressive presentation of the offering's core functionalities and unique selling points.

2 Background

The above analysis suggests that guidance, interaction, effective communication, and attractive demonstrations are vital elements of a successful exhibition. By contributing to one or more of the above essential elements, the utilisation of technology in the exhibition industry has been a major force for providing value to all parties involved (organisers, exhibitors, visitors).

Within the last five years, several mobile and wireless applications have been introduced to the exhibition industry with the main purpose of automating and facilitating the conduct of certain business processes. In the London Fashion Week 2002, an

important exhibition of the fashion industry, selected guests were able to view live coverage of the catwalk shows through handheld and palm sized Pocket PCs while moving freely throughout the exhibition tent. Guests were also able to view archived footage of previous shows. A similar case of an electronic personal assistant used in exhibitions is the eGuide (Bieber and Giersich, 2001), a PDA-based application that was introduced at CeBIT 2000. Visitors owning a PDA could download the software-based eGuide either via the internet or at infrared data beaming stations at the show entrances. Tasks supported by the system before and during the exhibition included finding the way to the show, getting information on exhibits, acquiring plans of personal tours, organising appointments, navigating inside the building, attending the right lectures or sessions, obtaining lists of exhibitors under various topics or user specific criteria, and locating an exhibitor's position (drawn hall/location info). However, the eGuide did not cater for communication and information exchange between exhibitors and visitors.

At CeBIT 2001, an evolution of the eGuide, the LocalNavigator solution, was introduced to answer for the inefficiencies of the original guiding application. The LocalNavigator offered its services through Pocket PC/PDA devices and Bluetooth-based networks (Kraemer, 2001). Visitors enjoyed guiding services for finding the shortest path to particular exhibitors and information 'push' services based on the selected user profile. Moreover, users could obtain additional information concerning products or exhibitors either displayed on their PDA or sent to a user-defined e-mail account. Advantages of the Bluetooth technology over the previously applied infrared technology include low power consumption needs and the elimination of direct line sight requirements. However, there were certain important operational problems. The limited capacity of the base stations had an impact on the granularity of the location service, while the employment of a timed-out-based protocol resulted in high user waiting times. Finally, software faults caused some system crashes.

In addition to the above solutions for exhibition shows, a number of wireless applications targeted to similar environments such as conferences, art festivals, and museums have appeared. IntelliBadge, an academic experimental technology of the National Center for Supercomputing Applications (NCSA), uses smart technology to track participants at major public events (Cox *et al.*, 2003). It was first publicly showcased at SC2002, the world's premier supercomputing conference in the Baltimore Convention Center last 16 to 21 November 2002. This was the first time that radio frequency tracking technology, database management/mining, real-time information visualisations and interactive web/kiosk application technologies fused into operational integrated system and production at a major public conference.

Table 1 Wireless navigation and tracking solutions in exhibitions and information-rich environments

	Motivation	Services	Technology	Advantages	Disadvantages
eGuide	Assisting the visitors of big exhibitions (e.g. CeBIT, EXPO) to navigate and find their orientation in spacious exhibition centres.	Finding the way to a stand Plans of personal tours Organising appointments Search functions under various topics or user specific criteria Displays of exhibitor position	Infrared beam stations, PDAs	The first exhibition guide with a graphic visualisation of exhibitor location. Use of situation-aware info; user's basic need for communication and information exchange computer system. Available in a couple of implementation forms (download via Internet or on site by infrared beam stations).	Provides services only to visitors Did not manage to cover the basic need for communication and information exchange between exhibitors and visitors.
Local navigator	Eliminating the deficiencies of eGuide and providing services not only for visitors but also for exhibitors and organisers.	Creating a personal profile Additional exhibitor and product info on request Navigation through the exhibition Info 'push' services based on user's profile Statistical information Broadcasting and advertising tools	Bluetooth, Pocket PCs/PDAs	Compared to eGuide Low power consumption needs Elimination of requirement for direct line sight	Reconnect time after handover was far too long. Limited capacity of the base stations has an impact on the granularity of the location service. Software faults caused some system crashes.
IntelliBadge	Providing a general tracking to people events (conferences, museums, art shows).	Visualisation of visitors' flow patterns within the event Creation of user profile Delivery of personalised info based on user's interests and positioning behaviour Identifying location of another user at the conference, finding other users with similar or specified interests, etc.	RFID technology, Info-kiosks	General solution that can apply to a number of events (exhibitions, museums, conferences, etc.). Specialised to tracking other people wearing an IntelliBadge tag and being at the event at the same time.	No mobile device is used and you have to check at the kiosks when you need to access the information. It is still an academic experiment under development.
HIPS	Serving the visitors of a museum before, during and after their visit.	Planning the visit (opening hours, tickets) Defining a personal profile (preferences) Orientation and navigation in the museum Taking notes on exhibits Sharing experience of different visitors Revision of art pieces that capture interest	Pocket PC (with pen-based interface, sound playing facilities), Infrared technology, Electronic Compass	The system is easy to maintain and upgrade. Intelligent interaction between tourists and the pieces of art. Multimedia presentations.	Need for more accurate positioning technologies such as indoor GPS

Finally, the Hyper Interaction within Physical Space (HIPS) project, carried out by a joint European team and led by the Multimedia Laboratory at the University of Siena, has developed a wireless application for museum visitors (Bianchi and Zancanaro, 1999). The HIPS application tries to enhance museum visitors' experience by providing them with the opportunity to plan their visit, get personalised information according to their declared preferences, and review the pieces of art that capture their interest after a visit. The deployment and trial of the system took place in Civico museum in Siena, Italy.

Table 1 presents a comparison of the aforementioned wireless navigation and tracking solutions.

3 The wireless exhibition guide

Drawing on the experiences of systems like the ones discussed above, and having identified a set of technological solutions allowing for efficient peer-to-peer wireless communication and positioning of increased accuracy, a European-wide development and research team (with the participation of a number of ICT providers like Intracom Hellenic Telecommunications and Electronics Industry S, L.M. Ericsson A/S, Elisa Communications Corporation, Pouliadis Associates Corporation, Space Systems Finland Ltd.; research institutes like Research Center of Athens University of Economics and Business and Helsinki University of Technology; and exhibition venue owners like The Finnish Fair Corporation and ROTA Ltd.) initiated a research project partially funded by the European Commission to design and develop a Wireless Exhibition Guide (WEG). The WEG aimed to exploit the technological opportunities arising from evolution in the areas of wireless networks and indoor positioning technologies (Giaglis *et al.*, 2002) so as to provide value-added services supporting the professionals and customers in the exhibition industry in a context-aware manner (Mathes *et al.*, 2002).

The following sections discuss several aspects of the Wireless Exhibition Guide development, such as the technology applied (sub-systems and infrastructure), the services provided for the three stakeholders of the exhibition sector; exhibition organisers, exhibitors, visitors, and the results from the trial testing and user evaluation of the system in a real exhibition event.

3.1 The service solution

The WEG prototype was developed to serve the information, communication, and navigation needs and requirements of the three stakeholders (visitors, exhibitors, organisers) in an exhibition environment. Specifically, the WEG service portfolio includes the following service categories:

- *Information services*

They include delivery of information to visitors regarding the exhibition show, its organisers, parallel events, exhibitors' profile and product/service catalogue as well as detailed information on specific exhibits that they bookmark. Moreover, organisers are provided with information on visitors as well as statistics regarding the visitors' volume, traffic and behaviour within the exhibition centre (for example, which stands they visited, how much time they spent there, and so on). Under the organisers' consent, exhibitors may also be given restricted access to such information.

- *Navigation services*

They include real-time delivery of a navigation map depicting the visitor's location on a digital exhibition map and a provision of routing advice for reaching a user-defined point within the exhibition centre (e.g., restaurant, presentation room, exit or a stand).

- *Communication services*

They include delivery of real-time messages between visitors (belonging to a group) as well as targeted messages sent by organisers and exhibitors to clusters of visitors.

Table 2 lists in more detail the services offered by the WEG to each targeted user group, as they were defined through a user requirement capturing and analysis process (Fouskas *et al.*, 2002). Complying with users' stated requirements, the proposed services have been divided into two groups: basic services and value-added services. This distinction allows WEG provider to make versions of its product offering. Four screenshots of indicative WEG services are presented in Figures 1–4.

Table 2 Basic and value-added services of the wireless exhibition guide

<i>Number</i>	<i>Service</i>	<i>Visitor</i>	<i>Exhibitor</i>	<i>Organiser</i>
<i>Basic Services:</i> Constitutes the 'entry level' commercial offering of the Wireless Exhibition Guide. This service package focuses on making the visit efficient and enjoyable and the marketing activities of exhibitors effective, while the organiser has a powerful tool for organising the event.				
1	Event organising			√
2	Registration	√	√	√
3	Questionnaire	√		√
4	Virtual communities	√		
5	Catalogue	√	√	√
6	Bookmarking	√		
7	Exhibition information	√	√	√
8	Real-time messages	√	√	√
9	Notice message board	√	√	√
10	Statistical analysis			√
11	Routing advice	√		
12	Navigation and positioning	√		
<i>Value-Added Services:</i> Constitutes the 'advanced level' commercial offering of the Wireless Exhibition Guide. This service package increases communication facilities for visitors and exhibitors, and provides exhibitors with key information (statistics and questionnaire feedback) for assessing their participation effectiveness in the exhibition. Visitors are also provided with value-added information concerning their visit history.				
13	Questionnaire		√	
14	Virtual business cards	√	√	
15	Target messages	√	√	√
16	Statistical analysis		√	
17	Virtual trail	√		

Figure 1 The PDA visitor menu



Figure 2 Real-time navigation

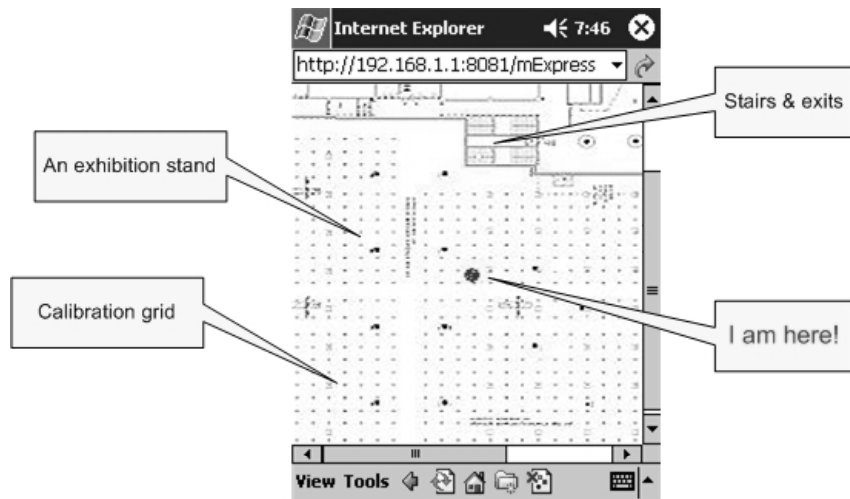
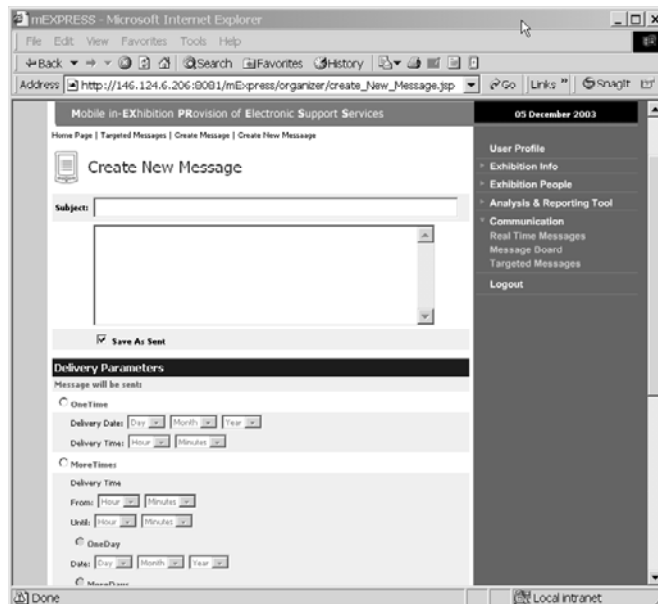


Figure 3 Products' bookmarking action



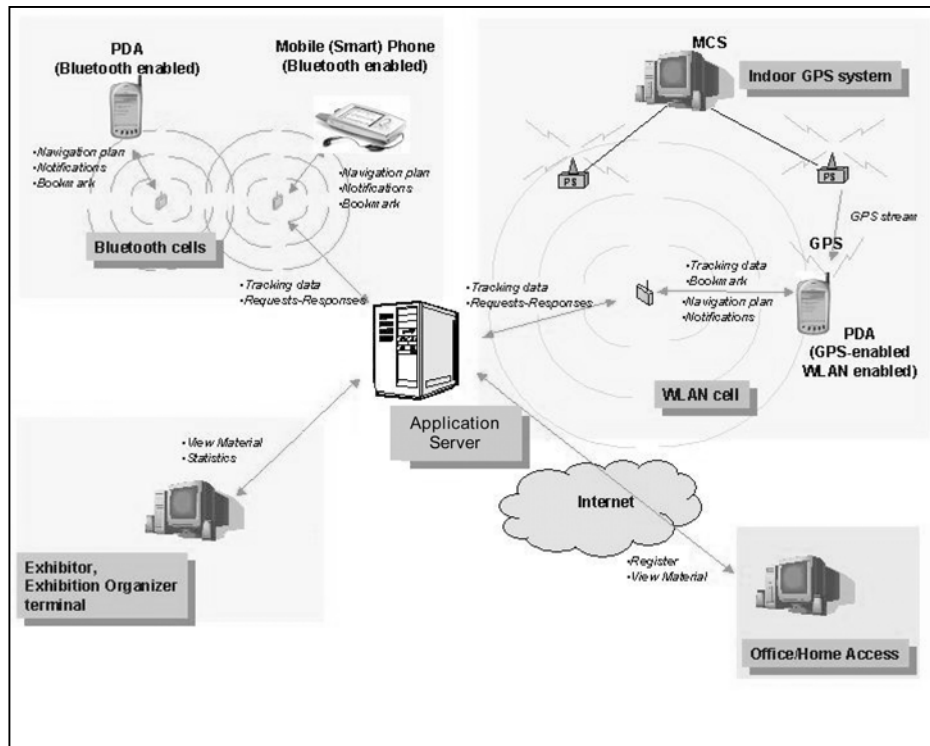
Figure 4 Targeted messenger



3.2 The technology solution

A number of hardware and software components must be deployed and inter-operated for the provision of the aforementioned services, as illustrated in Figure 5.

Figure 5 Technical architecture of the wireless exhibition guide



3.2.1 The application server

The application server is responsible for handling user requests and realising the relevant application logic. Its main functionality includes:

- a front end-to-user requests
- authenticating the users and imposing access control to subsequent user requests, thus providing a privilege-based access system
- providing a set of user applications including navigation assistance, personalised recommendations, 'bookmarking' capability, business cards exchange, and virtual communities application
- continuous monitoring of mobile terminal locations, collaborating with location tracking modules
- analysis of user behaviour and provision of useful information and statistical reports to exhibition organisers and exhibitors
- provision of management tools for content submission and service management (such as definition of user roles and access rights).

3.2.2 Wireless access systems

Two wireless technologies (802.11b WLAN and Bluetooth) were employed and tested to provide wireless access to visitors, exhibitors and exhibitor organisers within the exhibition boundaries. The two alternative technologies are used to provide interaction between the users and the WEG system, thus enabling 'bookmarking' requests, business card exchanges and the reception of location-based multimedia content.

3.2.3 Location identification mechanisms

A number of positioning technologies are currently available. While mature outdoor positioning technologies have been available for several years, indoor positioning technologies are currently an evolving technology (Zeimpekis *et al.*, 2003). In the WEG case, two different technologies were tested for the tracking of visitors within the exhibition area:

1 WLAN-based location positioning

This technique is based on the WLAN infrastructure, which is also used for transferring data to and from the users.

2 Indoor GPS

Taking into consideration the limited visibility (or none at all) of GPS satellites in indoor environments, an innovative indoor GPS solution has been employed. The solution includes:

- A number of ground transmitters called *pseudolites* (pseudosatellites) that emulate the signal of GPS satellites and replace GPS in the exhibition environment.
- A set of reference receivers that are used for signal integrity provision and synchronisation of the pseudolites' signals.
- The Master Control Station (MCS) running the control software for providing monitoring, configuration and control of the whole system.

The receivers used are standard GPS-receivers; the difference from GPS navigation is that an external software module is used to calculate the user position based on the raw data from the receiver.

3.2.4 Wireless terminals

Several types of terminal devices have been used to provide access to wireless exhibition services, including:

- PDAs

Visitors use PDAs to make bookmark requests and to receive multimedia content, notifications and routing information relative to their location. PDAs are also used by the exhibition organisers to receive notifications. During the trial operation of the system, a specific PDA (iPAQ 3870) has been chosen to test visitors' services. The chosen device provides an efficient platform for developing prototype services, being able to support the necessary infrastructure (WLAN via PCMCIA and Indoor GPS)

and having appropriate portability, input, and screen capabilities. Nevertheless, other PDA devices can also be used provided they are WLAN-enabled and have a free PCMCIA socket for a GPS receiver.

- *PCs/Laptops*

Visitors can also use PCs and laptops for preparing their visit before the exhibition and for reviewing their visit after it. Exhibitors and exhibition organisers use these devices to receive statistics and notifications and to submit content.

3.3 A WEG use scenario

The following paragraphs discuss a future scenario involving Philip (a visitor in the 'Mobile Expo' organised by Finnish Fair Corporation (FFC) in Finland), who uses a set of value-added services provided by the WEG application.

Philip enters the exhibition centre and passes through the reception. The registration staff of FFC asks for his invitation and the visitor informs them about his online pre-registration. The secretariat asks the visitor if he wishes to use the WEG. After getting all the required information, Philip agrees to download the WEG software to his device under the guidance of the FFC technical staff. While he is about to enter the exhibition hall, he meets a colleague, Charles, who is about to register onsite. Philip, who is a leader and moderator of a group comprising of the company's employees, invites Charles to become member of the group. After that, Charles gets his device as well, and they go on their different ways. Before going separate ways, they both ask to view a personalised and location-aware navigation plan on their devices.

Since Philip wishes to locate specific products, he uses his device to locate stands with the specific products on the map. After locating those stands on the navigation plan, he takes the routing advice of his device to get there. As he approaches the stand of interest, he receives alerts for offerings based on his profile as well as on targeted promotional spots of certain exhibits from the exhibitors. While wandering through the stands, Philip gets recommendations for specific events as well as common announcements (for example, that the exhibition is about to close). He is visiting three or four other stands that are in his list, and he followed the exact same procedure with the previous ones.

After being in the exhibition for three hours, Philip decides to take a break for a snack or coffee so he moves towards the closest restaurant or rest area by using his navigation plan and routing advice on his device. On his way to the restaurant, he decides to meet with Charles, so he uses the system to track him since they both belong to the same user group. When he manages to locate Charles, he sends a real-time message asking him to meet in five minutes in the restaurant area. Before sitting in the restaurant, they connect to the nearest kiosk to get information on their visit trail and movements up to that particular moment. Before leaving the exhibition centre, Philip asks to get information on nearby means of transportation.

While at home or in the office, Philip gets connected to the internet, gets access to the WEG software, and downloads the material that he requested through bookmarks as well as additional promotion materials sent either by organisers or exhibitors. Furthermore, replying to the organisers' request, he uses the system to send feedback by giving his response to an online questionnaire.

4 Trial results and business implications

4.1 Trial design

Most benefits have been identified based on the results of a trial operation of the WEG prototype that took place during the ViiniExpo (The Wine Exhibition) in the FFC Exhibition Centre, Helsinki, Finland on 18 to 19 March 2004. The trial was evaluated through user tests. All user groups were tested (visitors, organisers and exhibitors), aiming to explore the overall user experience. A total of 17 persons were involved in the evaluation process of the WEG prototype: 12 visitors, three exhibitors, and two organisers. They were all interviewed and then given an evaluation form to fill in.

The trial, which lasted two days, gave emphasis on visitors' experience of the system with the use of PDAs. In addition, the trial focused on testing the delivery of position services, which had been considered as the most important feature of the Wireless Exhibition Guide in the business requirements phase. Table 3 indicates which validation methods were applied in each user group.

Table 3 Evaluation methods applied per test-group

<i>Test group</i>	<i>Evaluation methods</i>	<i>Visitors</i>	<i>Exhibitors</i>	<i>Organisers</i>
Test tsks		X	X	
Interview		X	X	X
Observation		X		
Evaluation frm		X	X	X
Demonstration				X

In practice, visitors performed a set of test tasks. While they conducted the tasks, they were placed under observation. The evaluation expert went through all tests with users playing the role of moderators. Visitors were asked to perform eight tasks in total, and after every single task, the moderator asked relevant questions concerned to each task. Visitors were also asked to think aloud while interacting with the system. When all test tasks were completed, the moderator asked the visitors some general questions and then gave the visitors some free time to fill in an evaluation form.

Exhibitors performed about ten test tasks in total. Before any task, they were shortly introduced to the WEG system from the visitor's side in order to imagine how their customers interact with the system. Also, exhibitors were told to think aloud, and after every single task, the moderator asked relevant questions as to the performance, obstacles and suggestions for improvement of tested features. Exhibitors also filled in an evaluation form tailored to their interaction with the system.

For organisers, there were no test tasks available. Instead, the whole functionality of the WEG system was introduced and demonstrated to them so that they were able to evaluate it from the viewpoint of a candidate software buyer. In practice, all working parts of the system were demonstrated to the organisers, and then they were asked relevant questions for evaluating the system from every user group's perspective. Like the rest of the test groups, they were also asked to fill in the evaluation form based only on the organisers' point of view.

4.2 Trial results

Test users who played the role of visitors were very keen about the features of the WEG. Some of them rated the system very high, despite the usability problems and the relative instability of the system during the trial. Others were not so happy with their visiting experience. This was naturally reflected in their comments (interviews and forms) and can be explained by their high expectations from the system. Conversely, for those whose expectations were not so high, technical problems that were presented were not insurmountable. Regarding the positioning services that were provided, these were seen as key drivers for the use of the software. In addition to positioning features, communication features were also found interesting and useful. The message service was especially considered to be an advantageous feature. However, users were not happy with the way in which these services were delivered, since communication features suffered from usability problems. Below are some suggestions of visitors for improvement.

- The real added value concretises in bigger exhibitions (CEBIT, COMDEX, *etc.*).
- There should also be some features that show users' location and their direction when they move.
- If users can choose the most interesting stands before, those stands should be seen in different colour on map when entering to exhibition hall.
- As, in the next two or three years, almost everyone will have a smart phone (or a similar mobile device), it would be useful to be able to use the Wireless Exhibition Guide through smart phones as well.

Visitors were keen to use position-based services in the future, and they were also 'happy to see the glimpse of WLAN in action' for the very first time. The positive attitude towards the system can be analysed in the user needs context as they were set there in the first place. In the case of visitors, it can be said that apart from some existing needs raised from the exhibition visiting experience, there were also needs which emerged only during the WEG use experience. General requirements like knowing where you are, locating companies and stands as easily as possible, and sharing your experiences with others can be considered 'universal needs'. The WEG fulfilled this kind of needs in a satisfactory level, and this is why majority of the visitors involved in the test appreciated these features. On the contrary, needs like 'avoid[ing] the information overload' and 'get[ting] just the information [the] user wants at particular time/place' were clearly born by the usage of the WEG system. The system's ability to offer limited or regulated information based on user's location in order to avoid unnecessary actions (like scrolling long lists of exhibitors) is a feature which visitors found surprisingly useful. This is the result of the technology's ability to create new needs, not just to satisfy the existing ones.

Test users in the role of exhibitors were first introduced to the features that visitors used through a PDA. After this short demonstration, exhibitors were asked to conduct ten test tasks designed only for them. The expectations of exhibitors were quite neutral. This is perhaps one reason why they were considerably happy with the elements of the WEG, as they identified a number of very useful and value-added tools provided by the system. Their specific comments are quoted as follows:

- The Analysing and Reporting Tool was found ‘Useful tool to know what kind of individuals or groups of individuals have been visiting the exhibition or stands’ and ‘Very valuable tool for after-sales service’.
- The Virtual Business Cards facility was considered a value-added service because ‘It can consist of more important information of a company and its products than traditional business cards or brochures’.
- The Communication tool was characterised as ‘a very handy tool for sending messages to certain individuals characterised by some attributes vital to exhibitor’s own interests’.

Overall, exhibitors were also quite satisfied with the elements and features of the WEG. In more specific terms, the ability to use tools for analysing and reporting visitors was found as a useful and quite valuable new service. The identified usability shortcomings somehow affected the overall experience, but exhibitors still saw the whole service as a good tool that could generate added value in their exhibition experience.

There were two exhibition industry organisations involved in the trial: Finnexpo and ROTA. Representatives of these companies were first shown the visitor’s part of the system (with PDA in the exhibition hall). After this short demonstration, the organisations were asked to use the system via PC at the same place where the exhibitors did their tasks (the office setup). Some of the WEG services such as the online exhibitor catalogue and the pre-registration facility were already offered by the exhibition organisers through one or more web-based information systems. However, the very added value of the WEG is the fact that organisers did not use just one system that would incorporate all valuable features. Thus, the system could even, in principle, somehow replace or supplement their current business practices and systems. This is the main reason why organisers also like the WEG. However, they were skeptical about the ability of the system to integrate with their legacy systems. Yet despite this skepticism, several very useful and precious features were found. Specifically, tools for creating and viewing questionnaires as well as for extracting statistical reports were seen very handy in replacing their existing practice of getting feedback from visitors. However, ‘if the system could generate real-time information such as how many visitors are online at a particular time [and] which stands are the most popular ones, then it would offer even more positive feedback to organisers’.

Organisers were the most significant test group. Their high requirements and expectations from the use of the WEG system were due to having already taken part of the WEG services placed through their legacy systems. However, organisers lacked an integrated system that incorporates all essential features. This was considered as the core value that the WEG system generated for exhibition organisers. Moreover, navigation and positioning services were also seen as critical source of value, since the organisers currently do not offer such services in their exhibition events.

5 Conclusion and further research

The evaluation trials have indicated that the WEG has achieved a high degree of overall acceptance. Despite some minor technical problems (which regards mainly to the stability of the system in the case of multiple PDA users interacting with the system in parallel sessions), all user groups were satisfied with the overall experience of having a personal exhibition guide, which provided them with navigation services and location-based information. User feedback has been recorded in as much detail as possible to support future redesigning and redevelopment of the WEG technology and service solution.

Since user acceptance is increasingly regarded as a critical success factor for mobile services, future research could be directed towards evaluating the Wireless Exhibition Guide system with the aid of a mobile-oriented acceptance model. Such model is the Compass Acceptance Model (CAM) proposed by Amberg *et al.* (2004), which is especially designed for analysis and evaluation of mobile services from the user acceptance perspective.

From the involvement in both the design and implementation phases of the WEG technology solution, a set of challenges towards improving the technology solution of the WEG has been raised. As for the design of the WEG system, future work includes redesigning the application or testing the existing design model against several published frameworks (*e.g.*, Olla and Patel, 2003), providing guidelines on the design of Context-Aware Mobile Information Systems (CAMIS). As for the WEG future implementation, the primary research challenge concerns the use of handheld devices with advanced combined functionality such as smart-phones (for combining voice and data communication). Using smart phones instead of PDAs can improve the usability of the WEG solution from the visitors' perspective, since more people are familiar with mobile phones than PDAs. Moreover, one of the primary innovative features of the WEG is the use of a GPS system that is able to locate users with quite great accuracy, compared with the positioning abilities of WLANs. The described indoor GPS solution has been implemented with the integration of a rather large module into the PDA device. However, adding the GPS module has rendered the PDA device unacceptably large and has also significantly decreased its battery life. Future versions of the WEG should handle this problem by using either 'chipless' GPS technology, which several device manufacturers are currently investigating, or a single chip that will handle all GPS functions (Kumar and Stokeland, 2003). Both GPS technology solutions will greatly contribute to minimising both the power consumption and the size of the device to be used for accessing the WEG services.

As for the convergence of voice and data services, the implementation of the same technology solution based on interconnection of wireless and mobile networks is proposed. The challenge concerns the provision of roaming services from mobile to wireless network and vice versa. To cover future inter-network roaming for users of wireless location-based services, an integrated location management architecture, much like the one proposed by Varshney (2003), should be developed. Such architecture supports location tracking in other wireless networks (WLANs, PANs) as well as in cellular networks (GSM, GPRS) and satellites (Varshney, 2003). The proposed solution would allow the WEG users to access multiple networks while in the exhibition show, thus increasing the value of the WEG solution.

The current analysis of the WEG business solution has triggered interest in analysing the successful conditions under which commercialisation of the WEG could be achieved. Based on alternative patterns of alliance formation, with the purpose of the WEG commercialisation among actors of the mobile and exhibition industry, a wide range of alternative business models can be identified and designed (Maitland *et al.*, 2003). In practice, we expect that more than one business model for the exploitation of the WEG can apply given differences in the organisational and market conditions. We contend that the final selection/decision on what business model to apply in a given situation will be based on a number of factors of both the internal and external environment of the candidate service providers, such as size, competitive position and corporate strategy (internal factors) as well as competition degree, technology uncertainty, and market maturity (external factors).

Qualitative research to capture Critical Success Factors (CSFs) for applying such a wireless solution in the exhibition market, or another market of similar characteristics such as conferences, festivals and entertainment shows, can shed light on the design of a theoretically sound business model selection mechanism. Such research would include both final users as well as providers of the services. The final description of one or more alternative business models should include:

- definition of main players involved
- description of their alliance pattern
- specification of the CSFs that contribute to the business model's adoption (Vassilopoulou *et al.*, 2003).

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