Instant Places: Bluetooth presence and naming as enablers for situated interaction and user-generated content in public displays

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Abstract

Instant Places is an investigation into the role of Bluetooth presence and naming as techniques for situated interaction around public displays. Our utilization of Bluetooth naming extends beyond identity representation, introducing the use of a simple instruction mechanism in which the system can recognise parts of the Bluetooth device name as explicit instructions to trigger the generation of pervasive content on situated displays. The study specifically addresses the suitability of these techniques and the type of social practices that emerged from their availability in a real setting. The results of the study, which involved the deployment of a fully functional prototype in a bar for several weeks, suggest that, despite their simplicity, these techniques were effective in their ability to sustain situated interaction around a public display and were easily and creatively appropriated for new forms of social practices.

Keywords: situated interaction, displays, Bluetooth, presence

Introduction

Public digital displays are increasingly pervasive and an important enabling technology for many types of ubiquitous computing scenarios. Not only do they provide a simple and effective way for bringing digital information into our physical world, as their presence may be a catalyst for situated interaction and the emergence of local user-generated content. To successfully play this role of seams between virtual and physical worlds, public displays should become an integral part of the physical and social setting in which they are placed by empowering situated social practices and actions. Rather than relying upon pre-defined models about local activities, their behaviour should depend in essential ways upon their material and physical circumstances [1]. Yet, their behaviour should also be aligned with the always diffuse and highly dynamic understanding of behavioural appropriateness and cultural expectations that are normally associated with place [2].

As a consequence, the design of situated displays is fundamentally affected by a trade-off on control sharing. On the one hand, the need to support a wide range of practices and social settings around the display suggests

approaches that build strongly on active user participation and high levels of appropriation. On the other hand, the need to guarantee the convergence towards a concept of place that matches the wider social expectations and practices of the community as a whole, suggests approaches, such as mediation and explicit user permissions, that define more rigidly the purpose of the system and a pre-defined set of accepted practices. This trade-off is particularly salient in our target scenario: display systems designed for shared and communal use in public and semi-public settings. These scenarios are characterized by a very fluid and heterogeneous social context, where multiple communities with varied motivations, preferences, visions and expectations will continuously emerge.

Our approach to this fundamental trade-off reduces the technical component of the solution and leverages on simple social competences and practices as the most effective path towards situatedness. Presence, and particularly presence as enabled by Bluetooth device discovery, is given the central role as the key driver for the behaviour of the system. In its technical simplicity, this approach may hold a considerable potential as an enabler for new concepts of situated display.

Bluetooth presence and naming

The key concept here is the use of Bluetooth presence and naming as an enabler for situated interaction around public displays. Periodic scanning of Bluetooth devices generates a continuously changing flow of presence information, presence history and presence patterns that can be visualised itself or used as context for situated interaction. Additionally, Bluetooth devices have a user-defined name, created primarily for defining how they present to each other in discovery procedures, but which can be set and changed quickly and enables a simple proximity-based mechanism of self-exposure that according to Kindberg and Jones is leading to a strong culture around the social uses of Bluetooth [3].

Our use of Bluetooth naming extends beyond identity representation and introduces a simple instruction mechanism where the system can recognise parts of the Bluetooth device name as explicit instructions to trigger specific behaviours on the situated displays. We explore these simple techniques as seeds for the pervasive generation of situated content.

Research Design

Within our overall objective of exploring the role of Bluetooth presence as a key enabler for situatedness in public displays, we have conducted a study centred on the following two research questions:

- To what extent can Bluetooth presence and naming be effective techniques for situated interaction around public displays?
- What types of practices, social interactions and forms of appropriation can be enabled by the use of these techniques?

Given our need to study evolving situated interactions, we chose to create a trial where a fully functional prototype of the technology would be available in a semi-public setting, a bar at the campus of University of Minho. This

way, we studied an environment involving a complex set of social phenomena. To understand how and why the above techniques were used and appropriated, we gathered extensive usage logs, and conducted interviews with customers and staff.

The results confirm the potential of Bluetooth as a widely accessible technology for situated interaction and the high level of appropriation that can be reached by the simple techniques explored. They also emphasise the importance of presence as a catalyst for more explicit forms of interaction.

Related Work

Bluetooth scanning has been extensively explored as a mechanism for sensing presence and uncovering all sorts of patterns, e.g. the familiarity of the surrounding environment [4], the social situation [5], and more general large-scale reality mining [6, 7]. Although we also build on the sensing possibilities of Bluetooth discovery, our focus is not on uncovering information about an existing reality, but rather on empowering Bluetooth naming as an enabler for new practices of situated interaction.

The work by Kostakos and O'Neill [8] in cityware is based on the capture of Bluetooth mobility traces and explored several ways of leveraging that information, including a set of in-situ visualizations about current or recent Bluetooth presences. This system also includes support for links between Bluetooth presence and information on the web, but it works in the opposite direction of our own. While we use situated links to the virtual world as a way to generate content for the place, this system uses in-situ presence information as a way to feed a Facebook application with information about physical co-presence within members of a social network. The work by Rudstrom et al. on MobiTip [9] explored the visualisation on mobile devices of Bluetooth-based interactions (tips) advertised by nearby devices. The work included a public display of that visualisation, but does not address its effect on situated interaction.

The work by Karam et al. [10] in the Bluescreen project explores the use of Bluetooth presence to optimise the selection of adverts for display. Content that has already been shown when a particular Bluetooth device was present is avoided if that device is present again, thus reducing the likelihood of the same content being shown again to the same person.

The submission of content to a public display, particularly using Bluetooth [11], can be very attractive in its ability to generate engaging and situationally relevant content. However, previous work has highlighted that enticing people to participate is a major challenge [12, 13], and that there are complex issues related with publication management.

The specific use of presence as a driver for situated interaction around public displays has been explored in the Proactive displays system [14]. The detection of nearby RFID tags was used as a trigger for showing profile information about the owner of the tag, in an attempt to promote occasional encounters

between people around the display. However, this approach requires *a priori* definition of individual profiles and assumes that everyone will be using a particular type of tag. Furthermore, people have a very limited role in the system, which is basically to move around and be detected.

Instant Places

The instant places system was developed as part of this work to serve as an infrastructure for the generation on a public screen of situationally relevant content that is directly and indirectly derived from Bluetooth presence.

The system is composed by one or more Bluetooth enabled computers each connected to a public screen and linked to a central repository. Information about nearby devices is periodically collected by a Bluetooth scanner and consumed by a situation data model that manages data about the place and present devices. The central repository maintains persistent information about previous sessions, and combines information from pervasively distributed data sources, allowing for multiple screens in a large space to share the same presence view. The system does not need any *a priori* information about people, their profiles, permissions or groups, as all the information in the repository is entirely created from the history of presences.

Functionality

The basic form of interaction with instant places is to have a discoverable Bluetooth device, automatically causing the display of its name. This can be classified as an implicit form of interaction in the case of the person who unexpectedly finds his or her name on the display. However, it can quickly turn into an explicit form of interaction when that person changes the device name based on the new meaning created by the visualization on the screen.

This public visualisation of the dynamic patterns of Bluetooth presence provides an element of situation awareness and clearly empowers the use of Bluetooth naming. However, *per se*, it is a limited approach in its ability to produce a continuous flow of enticing content. In instant places, presence information was utilized as a seed for selecting further content from the photo sharing website Flickr, creating a form of situated mashup that facilitated the generation of user-suggested content, while providing a certain level of filtering.

To enable this functionality, we introduced support for the inclusion of simple commands in Bluetooth device names. This is achieved by parsing device names in search for keywords that are recognised as commands and then using them to trigger specific actions. Two types of commands were supported. The first is a tag command, allowing people to associate multiple tags with their identity. This can be done by including in the name the expression "*tag:*" followed by a comma separated list of tags, as in the following example "*my device tag:punk,pop*". The second type is the indication of a Flickr user name, which can be done by including in the Bluetooth name the

expression "*flk:*" followed by the respective Flickr user name, as in the following example "*my device flk:JohnSmith*".

Visualisations

Two different visualisations for instant places were provided. The first is represented in Figure 1 and displays real-time information about currently present identities.

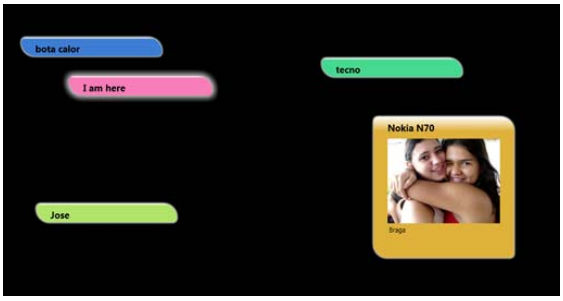

Figure 1 - Visualisation A

Each identity is represented as a multivariate icon. The icon colour is generated when the identity was first created, and is always repeated with all subsequent visits to provide some recognition. As an identity remains present, a glow starts to build around the respective icon providing a sense of which identities have recently arrived and which ones have been here for a while. For those devices with commands in the name, the respective icon expands to create space for the display of the photos obtained using that command as a seed.

The second visualisation of instant places was designed with the specific goal that part of the content should be associated with place rather than individual identities. To accomplish this, we needed something that would characterise the place, but at the same time would emerge from the dynamic flow created by the multiple identities that had been there before. In instant places, we used the concept of a tag cloud associated with the place, both, as a way of creating an aggregate view that characterizes a situation and as a driver for aggregate content generation. The result was the visualisation represented in Figure 2.

Figure 2 - Visualisation B

Presences are still represented as icons, and exactly with the same behaviour as in the previous version. However, their size was reduced, and they were all arranged on a sidebar at the left of the screen. The remainder of the screen is used for representing the tag cloud and for showing with greater emphasis content created using the words in the tag cloud as seeds.

This tag cloud is generated not only from the tags explicitly defined in *tag:* expressions, but also from all the strings used in Bluetooth names, thus providing a combination of implicit and explicit tagging. Each tag has a popularity

attribute that is increased when the tag is found in the names of currently present identities However, the algorithm clearly favours explicit tags, as popularity increments are much stronger (10x) if the tag is explicit.

To achieve a balance between an historical aggregate view of the tags that have "passed here before" and the ability of the tag cloud to dynamically adapt to the ever changing flow of new tags, the popularity of tags is decremented with every new scanning, albeit at a much lower rate than presence-related increments. With every cycle, the system represents the 25 most popular tags listed alphabetically, with their relative popularity being represented by their font size and their current presence being indicated by the yellow colour.

The Campus Bar Study

The deployment of a trial of instant places in a semi-public setting was the key part of this study. A bar at the University of Minho campus matched our targeted environment: informal places where people may go for specific purposes, e.g. eat or drink, but also to spend some time and meet other people. This bar is visited every day by several hundred people that come for coffee or a quick snack, normally in small groups. There are several peak periods, with the busiest moment being at lunch time, when small meals are served. The campus wi-fi service is available, and occasionally some students turn on their portable computers and stay longer. Instant places visualisations were displayed using a 42" LCD screen that was already in the bar and is normally used for watching TV.

The study involved three sequential phases: in a phase 0, running for four weeks we conducted a silent Bluetooth scanning to obtain a neutral perspective of the local Bluetooth environment; in phase 1, the following 3 weeks, instant places became operational with visualisation A (*c.f.* Figure 1); and finally in phase 2, the last 3 weeks, the system run with visualisation B (*c.f.* Figure 2).

When the system first went public, at the beginning of visualisation A, we created a blog with more complete information about the project. Every five minutes, the blog itself was displayed for 15 seconds to raise awareness about the project and promote peoples' comments. Additionally, during the period corresponding to visualisation A, we placed leaflets at the bar with information about the project and basic instructions on how to use tags in Bluetooth names. During the period corresponding to visualisation B, the same set of instructions was periodically and alternatively presented on screen as part of the visualisation. Since one of the objectives of this trial was to uncover how these techniques could be appropriated, we never provided any information or hints to specific uses of the system. This approach of clearly specifying usability while leaving interpretation of use open [15] was purposely made to explore ambiguity as a design goal.

In the last week of the trial, *in-situ* interviews were conducted with the manager and

customers of the bar to gain some insight on people's views and attitudes concerning the way the system was being used and generally perceived. Customers of the bar, normally in small groups, were approached and invited to participate. The interviews were semi-structured and combined initial specific questions with the utilization of probes to familiarize interviewees' with the themes and kick-start their collaboration. The interviews would, normally, proceed with open questions, following the flow of the interviewees' contributions, fostering the uncovering of relevant episodes of use and attitudes towards the system. Five small group interviews were conducted with regular costumers of the bar involving a total of twelve people, all University students aged between 20 and 25 (6 males and 6 females).

Results

The overall results show that the proposed techniques were widely adopted and exhibited a strong potential for appropriation as part of situated interactions.

Table 1 compares key Bluetooth usage parameters between phases 0 (silent scanning) and phase 1. We estimated the total number of visits to the bar based on the number of sales transactions, and we collected from the logs information about how many unique device addresses and unique devices names were seen during these two periods.

Table 1 – Effect on Bluetooth usage patterns

	Phase 0 Silent	**Phase 1** Visualis.
	scanning	A
Avg. estimated visits p/ week	1906	2175
Avg. unique devices p/ week	89	153
Avg. unique device names p/ week	79	228
Names per device	0.9	1.5
% visits w/ bt visible	4.7%	7.0%

Even though no effort was made to recruit users, these numbers show a strong effect of the system on Bluetooth presence and naming patterns. There was a considerable increase in the percentage of visitors that were visible for Bluetooth discovery (from 4.7% to 7.0%), suggesting that many people made their device visible specifically for this purpose. During the silent scanning, there were more devices than device names, which can be justified by the existence of many devices using the same default name. A clear effect on naming practices can be observed when the system became public, with the average number of names per device raising to 1.5.

These numbers can be complemented by an analysis of device name changes. During the 4 weeks of silent scanning, not a single device name change was detected. From a total of 650 unique devices detected during phases 1 and 2, there were 126 that did change their device name (64 of which more than once). Given the absence of any changes during the phase of silent scanning, it is sensible to conclude that all those changes were induced by the system, which may be seen as an explicit usage rate of

19.3%, of which 9.8% were recurrent users (2 or more changes)

To further understand how names were used, we analysed and classified them according to emergent categories. Clearly, the most common type of name was some form of personal name or nickname (55%), followed by device default names (15%). However, the most salient observation from this analysis was the appropriation of the system by changing the device name for the purpose of publishing strongly situated messages, very much like a message board. Some of those messages were directed to or referred to specific persons and were clearly examples of playful and teasing behaviour. Some messages referred to specific interactions happening at the time: "*Shut up X!*", "*Let's go to the Architecture School!*", "*Can you give me a cigarette?*" Other messages played with the sender's knowledge of other people device names trying to pinpoint them within the bar. For example, "*The guy with the black hat!*"

There was also a considerable group of messages that were directed to the service of the bar and strongly situated: "*The fish was cold*", "*The coffee was burnt*", "*The cake was not fresh*" or suggestions "*We want ham sandwiches*". The interview with the bar manager hinted that these messages were mostly playful behaviour taking advantage of the particular friendly relationship between him and his customers.

As expected, some people took advantage of the relative anonymity provided to send satirical or obscene messages to the display. It seems they were testing the limits of the new possibilities created by the system and integrating this functionality into situated in-group practices.

More unexpected was the use of device name changes to facilitate short dialogues through the public display. These exchanges, at least five, seem to be an extension of the first category considered, where messages directed to a specific person were replied by the target person, sometimes provoking a tit for tat. As examples, we could identify: "*Will you marry me*?" "*Yes, I will!*"; "*I got an average mark of 15!*", "*But he gets 10 in accounting*", "*Just to give you a chance*", "*If you can, all can*".

The relation between the number of name changes per device and the types of names used, revealed the emergence of a group of users (with 19 people), each with at least 5 name changes, that made most of the use of the display as a message board. This group was definitely the one where people were more experimental, appropriating the system and tweaking its functionality to serve as an extended communication tool.

Unlike the rest of the names, tags were not displayed on the screen, but used as seeds for the generation of the photo streams. We found a total of 90 well formed tags that were produced by 45 devices. Almost half (45%) of the tags referred to places, particularly to the cities and region where the University is implanted. Another important, but very varied, category (33%) referred to personal interests.

These included 5 tags explicitly naming University degrees, 6 related to football clubs, and 3 trying to re-direct attention to other blogs. The third relevant category (14%) were tags that could be considered obscene or satirical. In most cases these were clear attempts of "winning" over the limitations imposed by the system by causing the display of inappropriate photos. In the interviews, respondents considered that their use of tags was not really part of a thoughtful strategy to combine device names and tags. Most respondents told us that they used tags more a less randomly.

Results from interviews

Eleven of the twelve participants interviewed declared themselves to be familiar with Bluetooth, with the most common usage being file exchange (music, photos or documents). All stated noticing the system before the interview and feeling curious as their first impression.

Some of the interviewees said to be unsure about its purpose, but others easily grasped the basic properties and how to adopted them to enhance their own social relations within the bar: "*I could see the possible use as soon as I saw my colleague´s name on the screen*", "*The system might increase the interaction between people at the bar*". They clearly reported understanding the meaning of what was being displayed and saw the use of the system as a way for people to present themselves, to publicize things, to send playful messages and experiment with a new artefact.

Five interviewees said to have changed their device name in response to their awareness of the system, although none of them on the first encounter. Nevertheless, these same interviewees witnessed colleagues changing their device names on that particular moment. In one of the groups, people said to see the need to personalize their device name when confronted with the viewing of their default device name on the system's screen.

In relation to privacy issues, the interviewees considered that given the characteristics of the technology it is a question of personal choice and they were not concerned about it. Regarding suggestions for system enhancements, the main focus was on more interactivity (described as having the possibility to send and download content and play games). Another suggestion was the deployment of similar screens at different locations within the University, all connected, so that people could use them to communicate and interact. This hints on a notion of place that extends beyond that particular space into all the other bars within the University Campus.

Discussion

We can now re-address our two main research questions and discuss the lessons learned. The first question aimed to investigate "*to what extent can Bluetooth presence and naming be effective techniques for situated interaction around public displays*". The results indicate that, despite their simplicity, the proposed techniques were *effective in their ability to prompt situated interaction*. They were easily

and widely adopted, as shown by the number of name changes during the experiment and by the clear effect on the patterns of Bluetooth naming and usage. Even though there was no specified purpose, 19% of the potential users have engaged in some form of explicit interaction. Considering that Bluetooth is a widespread technology, these results confirm that the proposed approaches can have an extremely low entry barrier and be immediately available to a considerable part of people visiting any place. This large potential user group is important in enabling social practices around the technology and represents a major difference to other sensing and interaction approaches that, albeit more sophisticated, require specific hardware or the installation of specialist software in personal devices.

The second question aimed at investigating "*what types of practices, social interactions and forms of appropriation can be enabled by this use of Bluetooth presence and naming in situated displays*". Given the nature of instant places, this was not something that people could just experiment alone to see how it worked. Albeit at various levels of engagement, all explicit uses of the system corresponded to some form of situated interaction. Even without any instructions or suggestion on what to use it for, many people found their own creative uses, particularly as a board for posting messages about the service or to other people in the room. The existence of an implicit form of interaction was decisive in making people feel that since they were already "using" the system they might as well refine their presence. This ability to easily combine implicit and explicit interaction, blurring the distinction and the transition between them, may have been crucial in promoting user engagement and appropriation by overcoming the problem of the "first step".

Future Work

This study was clearly focused on engagement, and more research is needed to investigate possible differences between active users and passive bystanders (lurkers) in terms of both their characterization and the extent to which the usage by active users affects the notion of the place by bystanders and their social relations. On a different level we are also conducting further research on the usability and syntax issues associated with the use of Bluetooth device names for situated commands.

From the many ideas that surfaced during this work, we can identify three main directions for the evolution of this work: space, identity, and web presence. Exploring space means extending the notion of place supported by the system beyond the local space, allowing multiple spaces, contiguous or not, to integrate a single instant place and thus extending the concept of presence beyond physical presence. Regarding identity, we intend to study how to promote the evolution, differentiation and social relations of the identities created by the system. This may involve exploring the history of presence and interaction, building reputations, supporting social networks between identities, and making all these things

perceptible and in some cases explicitly controllable. Finally, we intend to investigate new models for linking Bluetooth identities with several types of web presence, such as those in social networks.

References

[1] L. A. Suchman, *Plans and situated actions: the problem of human-machine communication*: Cambridge University Press, 1987.

[2] S. R. Harrison and P. Dourish, "Re-place-ing space: the roles of place and space in collaborative systems," presented at Proceedings of the 1996 ACM conference on Computer supported cooperative work (CSCW), Boston, Massachusetts, United States, 1996.

[3] T. Kindberg and T. Jones, "“Merolyn the Phone”: A study of Bluetooth naming practices," presented at UBICOMP 2007 Ninth Inter Conf Ubiquitous Computing, Innsbruck, Austria, 2007.

[4] E. Paulos and E. Goodman, "The familiar stranger: anxiety, comfort, and play in public places," in *Proceedings of the SIGCHI conference on Human factors in computing systems*. Vienna, Austria: ACM, 2004.

[5] T. Nicolai, E. Yoneki, N. Behrens, and H. Kenn, "Exploring Social Context with the Wireless Rope," presented at 1st International Workshop on MObile and NEtworking Technologies for social applications (MONET'06), Montpellier, France, 2006.

[6] N. Eagle and A. Pentland, "Reality Mining: Sensing Complex Social Systems," *Personal and Ubiquitous Computing*, vol. 10, issue 4, 2006.

[7] E. O’Neill, V. Kostakos, T. Kindberg, A. F. g. Schiek, A. Penn, D. Stanton, and T. Jones, "Instrumenting the City: Developing Methods for Observing and Understanding the Digital Cityscape," in *UbiComp 2006: Ubiquitous Computing*, vol. 4206/2006: Springer Berlin / Heidelberg, 2006, pp. 315-332.

[8] V. Kostakos and E. O’Neill, "Capturing and visualising Bluetooth encounters.," presented at CHI 2008, workshop on Social Data Analysis, Florence, Italy., 2008.

[9] A. Rüdstrom, K. Höök, and M. Svensson, "Social Positioning: Designing the Seams between Social, Physical and Digital Space," presented at Human Computer International, Las Vegas, NV, 2005.

[10] M. Karam, T. R. Payne, and E. David, "Evaluating BluScreen: Usability for Intelligent Pervasive Displays," presented at The Second IEEE International Conference on Pervasive Computing and Applications (ICPCA '07), Birmingham, UK., 2007.

[11] K. Cheverst, A. Dix, D. Fitton, C. Kray, M. Rouncefield, C. Sas, G. Saslis-Lagoudakis, and J. G. Sheridan, "Exploring bluetooth based mobile phone interaction with the hermes photo display," presented at Proceedings of the 7th international conference on Human computer interaction with mobile devices & services, Salzburg, Austria, 2005.

[12] H. Brignull, S. Izadi, G. Fitzpatrick, Y. Rogers, and T. Rodden, "The Introduction of a Shared Interactive Surface into a Communal Space," presented at CSCW 2004, Conference

on Computer Supported Cooperative Work, Chicago, USA, 2004.

[13] E. M. Huang, E. D. Mynatt, D. Russel, and A. Sue, "Secrets to Sucess and Fatal Flaws: The Design of Large-Display Groupware," *IEEE Computer Graphics and Applications*, vol. 26, issue 1, pp. 37-45, 2006.

[14] D. W. McDonald, J. F. McCarthy, S. Soroczak, D. H. Nguyen, and A. M. Rashid, "Proactive displays: Supporting awareness in fluid social environments," *ACM Trans. Comput.-Hum. Interact.*, vol. 14, issue 4, pp. 1-31, 2008.

[15] P. Sengers and B. Gaver, "Staying Open to Interpretation:Engaging Multiple Meanings in Design and Evaluation," presented at 6th conference on Designing Interactive systems, 2006.

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