Instant Places:
Using Bluetooth for Situated Interaction in Public Displays

A study of using Bluetooth to generate pervasive content around public displays over the course of several weeks suggests that simple techniques can effectively sustain situated interaction and easily support new social-practice forms.

Rui José and Nuno Otero
University of Minho

Shahram Izadi and Richard Harper
Microsoft Research

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 of bringing digital information into our physical world, but their presence could also be a catalyst for situated interaction and the emergence of local user-generated content. To successfully bridge the virtual and physical worlds, public displays should become an integral part of the physical and social setting in which they're placed by empowering situated social practices and actions. Rather than relying on predefined models about local activities, their behavior should essentially depend on their material and physical circumstances.[1] Yet, their behavior should also align with the always diffuse and highly dynamic understanding of the behavioral appropriateness and cultural expectations normally associated with place.[2]

Consequently, control sharing fundamentally affects display design. On 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, the need to guarantee convergence toward 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 system's purpose and a predefined 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 semipublic settings. These scenarios are characterized by a very fluid and heterogeneous social context in which multiple communities with varied motivations, preferences, visions, and expectations will continuously emerge.

Our approach to this complex situation-awareness problem is technically simple but leverages on acquired social competences and practices as the most effective path toward new concepts of situated display. More specifically, we explore the role of presence, particularly as enabled by Bluetooth device discovery, as the driver for the system's behavior and its situational awareness.

Research Design

A periodic scanning of Bluetooth devices generates a continuously changing flow of presence patterns that can itself be visualized or used as context for situated interaction (see the "Bluetooth and Situated Awareness" sidebar). Additionally, Bluetooth devices have a user-defined name, created primarily for defining how they present themselves to each other in discovery procedures, but users can easily set and change it; this name enables a simple, proximity-based mechanism of self-exposure that, according to Tim Kindberg and Timothy Jones at HP Laboratories in Bristol, is leading to a

Published by the IEEE CS ■ 1536-1268/08/$25.00 © 2008 IEEE

Bluetooth and Situated Awareness

Researchers have extensively explored Bluetooth scanning as a mechanism for sensing presence and uncovering all sorts of patterns, such as the surrounding environment's familiarity,[1] social situation,[2] and more general large-scale reality mining.[3,4] Although we also build on Bluetooth discovery's sensing possibilities, our focus isn't on uncovering information about an existing reality; rather, it's on empowering Bluetooth naming to enable new methods of situated interaction.

Vassilis Kostakos and Eamonn O'Neill's[5] work is based on capturing Bluetooth mobility traces and exploring several ways to leverage 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 differently than ours: although we use situated links to the virtual world as a way to generate content for the place, their system uses *in situ* presence information as a way to feed a Facebook application with information about physical co-presence among members of a social network. The MobiTip system explored the visualization of Bluetooth-based interactions (or tips) advertised by nearby devices.[6] Their work included a public display of that visualization, but doesn't address its effect on situated interaction.

The BluScreen system uses Bluetooth presence to optimize advertisement selection for display.[7] This approach avoids running previously shown content on a particular Bluetooth device if that device is present again, thus reducing the likelihood of the same content reappearing before the same person.

Submission of content to a public display, particularly via Bluetooth,[8] is very attractive because it generates engaging and situationally relevant information. However, previous work highlights that enticing people to participate is a major challenge[9,10] and that publication management involves many complex issues.

Finally, the Proactive system explores the specific use of presence as a driver for situated interaction around public displays.[11] The system uses detection of nearby RFID tags as a trigger for showing profile information about the tag's owner in an attempt to promote occasional encounters between people near the display. However, this approach requires a priori definition of individual profiles and assumes that everyone uses a particular type of tag. Moreover, people have a very limited role in the system—just moving around and waiting to be detected.

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strong culture around the social uses of Bluetooth.[3]

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

Within our overall objective of exploring Bluetooth's role as a key enabler for situational awareness in public displays, we conducted a study centered on two research questions:

- To what extent can Bluetooth presence and naming effectively prompt interaction around public displays?

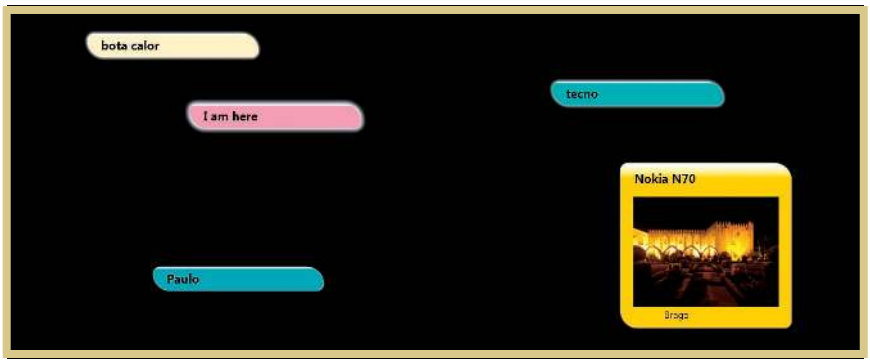


Figure 1. Visualization A. We used this first display in phase 1 of our trial.

- What types of practices, social interactions, and forms of appropriation can the use of these techniques enable?

Given our need to study evolving situated interactions, we created a trial in which a fully functional prototype was available in a semipublic setting: a bar on campus at the University of Minho. To understand how the system was used and appropriated for social interaction, we gathered extensive usage logs and conducted poststudy interviews with customers and staff.

Instant Places

We developed the Instant Places system as part of this work to serve as an infrastructure for generating on a public screen the situationally relevant content directly and indirectly derived from Bluetooth presence.

The system has one or more Bluetooth-enabled computers, each connected to a public screen and linked to a central repository. A Bluetooth scanner periodically collects information about nearby devices, which a situation data model then consumes. The central repository maintains persistent data about previous sessions and combines new information from pervasively distributed sources, allowing for multiple screens in a large space to share the same presence view. The system doesn't need any a priori information about people, their profiles, permissions, or groups—all the information in the repository is entirely created from presence history.

Functionality

The basic form of interacting with Instant Places is to have a discoverable Bluetooth device, the name of which the public display will automatically show. We classify this as an *implicit* form of interaction if someone unexpectedly finds his or her name on the display, but it quickly turns into an *explicit* form when that person changes the device name based on seeing it on the screen.

This public visualization of dynamic Bluetooth presence patterns provides an element of situational awareness, but it's limited in its ability to produce a continuous flow of enticing content. To address this, we used presence information as an enticement to select further content from the photo-sharing Web site Flickr, thereby creating a situated mashup that facilitated the generation of user-suggested content while still providing a certain level of filtering.

To enable this functionality, we parsed Bluetooth device names to find keywords recognized as commands and then used them to trigger specific actions. We supported two types: a tag command that lets people associate multiple tags with their identity (in the Bluetooth name, we looked for "tag:" followed by a comma-separated list of tags, such as "my device tag:punk,pop") and a Flickr username (in the Bluetooth name, we looked for the expression "flk:" followed by a Flickr username, such as "my device flk:JohnSmith").

Visualizations

In the context of our bar trial, we created two different visualizations for Instant Places. Figure 1 shows the first version we used—visualization A—which displays real-time information about currently present identities.

A simple rectangular avatar represents each identity; the system generates its color when it first creates an identity, and this color remains linked with the identity during all subsequent visits to provide recognition. As an identity remains present, a glow starts to build around the respective avatar, giving a sense of who arrived recently and who's been there for a while. When a device name originates a photo stream, the respective avatar expands to display those photos.

Figure 2 shows the visualization that we created for phase 2—visualization B—with the specific goal that part of the content should be associated with place rather than an individual. To accomplish this, we needed something that could characterize place but that would also 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 place, both as a way to create an aggregate view to characterize a situation and to drive content generation.

Here, avatars still represent presences, with exactly the same behavior as in visualization A. However, they're smaller and arranged on the left side of the screen. Instant Places uses the rest of the screen to represent the tag cloud and emphasize the content created by the words in the cloud.

We generated this tag cloud not only from tags explicitly defined in tag: expressions but also from all the words found in Bluetooth names, thereby combining implicit and explicit tagging. Each tag has a popularity attribute that increases when the tag appears in the names of currently present identities. However, the algorithm clearly favors explicit tags

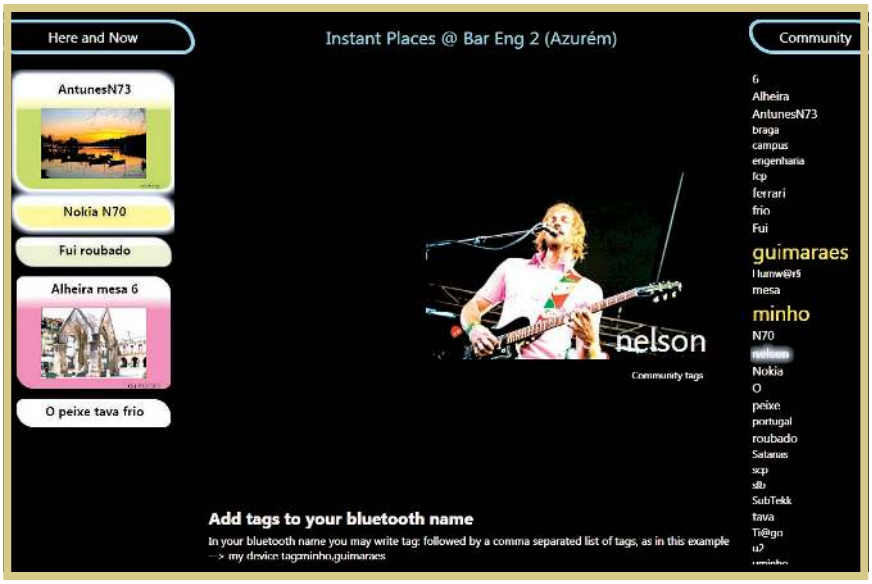


Figure 2. Visualization B. We used this second display in phase 2 of the trial.

because popularity increments are much stronger (10x) if the tag is explicit.

To achieve a balance between a historical aggregate view of the tags that "passed through earlier" and the tag cloud's ability to dynamically adapt to the ever-changing flow of new tags, we decremented tag popularity 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 represented by font size and their current presence indicated by the color yellow.

The Campus Bar Study

A trial run in a semipublic setting was a key part of this study. A bar on campus at the University of Minho matched our targeted environment: an informal place where people go for specific purposes (eat, drink, hang out with friends, or meet new people). Several hundred people visit this bar daily for coffee or a quick snack, normally in small groups. It has several peak periods, but the busiest time is lunch. The campus Wi-Fi service is available here, so some students turn on their laptops and stay for long periods. We displayed Instant Places visualizations on a 42-inch LCD screen that was already in the bar for regular TV viewing.

The study involved three sequential phases: phase 0 ran for four weeks, during which we conducted a silent Bluetooth scan to get a neutral perspective of the local Bluetooth environment; phase 1 ran the following three weeks, during which Instant Places became operational with visualization A (see Figure 1); and phase 2 ran the last three weeks, during which the system displayed visualization B (see Figure 2).

When the system first went public, we created a blog with complete information about the project. Every five minutes, the screen would show for 15 seconds the blog itself to raise awareness about the project and promote discussion. We also left flyers at the bar with information about the project and basic instructions on how to use tags in Bluetooth names. During phase 2, we periodically displayed the same set of instructions as part of visualization B. Because one of the trial's objectives was to uncover any forms of appropriation of the systems' features, we never provided hints about specific uses for the system. We purposely made a point of clearly specifying usability while leaving interpretation of use open, to explore ambiguity as a design goal.[4]

In the last week of the trial, we conducted *in situ* interviews with the bar's manager and customers to gain some insight into people's views and attitudes about the system. The interviews were semistructured and started with some initial, specific questions before digging deeper to uncover relevant episodes of use and attitudes toward the system. We conducted five small-group interviews with regular customers involving a total of 12 people, all university students aged 20 to 25 (six males and six females).

TABLE 1
Campus bar trial's effect on Bluetooth usage patterns.

	Phase 0, silent scanning	Phase 1, Visualization A
Avg. estimated visits per week	1,906	2,175
Avg. unique devices per week	89	153
Avg. unique device names per week	79	228
Names per device	0.9	1.5
Percent visits w/ Bluetooth visible	4.7	7.0

Results

Table 1 compares key Bluetooth usage parameters between phases 0 (silent scanning) and 1 (visualization A). 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 names appeared during those two periods.

Although we didn't recruit users, the numbers show the system's strong effect on Bluetooth presence and naming patterns. We saw a considerable increase in the percentage of visitors who were visible for Bluetooth discovery (from 4.7 to 7.0 percent), suggesting that many

people made their devices visible specifically to participate in the trial. During the silent scan, we found more devices than device names, probably because those devices used the same default name. We saw a clear effect on naming practices when the system became public, with the average number of names per device rising to 1.5.

Remarkably, we didn't detect a single device name change during the four weeks of silent scanning, which is in sharp contrast to the number of changes per device detected when the system went public. From a total of 650 unique devices detected in phases 1 and 2, 126 changed their device names (64 did it more than once). Given the absence of any changes during phase 0, we conclude that the system induced the changes, which might be viewed as an explicit usage rate of 19.3 percent, of which 9.8 percent were recurrent users (two or more changes).

To further understand how customers used the names, we analyzed and classified them according to emergent categories. Clearly, the most common type of name was some form of personal or nickname (55 percent), followed by device default names (15 percent). However, the most salient observation from this analysis was the appropriation of device name changes as a tool for publishing strongly situated messages, very much like a message board. Some of the messages were aimed at specific people and exhibited playful and teasing behavior, whereas some referred to time-specific interactions: "Shut up X!" "Let's go to the Architecture School!" "Can you give me a cigarette?"

A considerable group of messages were aimed at bar service and strongly situated: "The fish was cold," "The coffee was burned," "The cake was not fresh," or suggestions such as, "We want ham sandwiches." An interview with the bar manager hinted that these messages were mostly playful behavior due to the particularly friendly relationship between him and his customers.

As expected, some people took advantage of the relative anonymity to send satirical or obscene messages to the display, seemingly to test the system's limits. Somewhat unexpected was the use of device name changes to facilitate short dialogues through the public display. These exchanges, at least five, seem to be direct to specific persons, sometimes provoking a tit-for-tat response: "Will you marry me?" "Yes, I will!"; "I got an average mark of 15!" "But he gets 10 in accounting"; and "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 a group of roughly 19 people, each with at least five name changes, who made the most use of the display as a message board. This group definitely had the most experimental people, all of whom felt comfortable appropriating the system and tweaking its functionality to serve as an extended communication tool.

We found a total of 90 well-formed tags produced by 45 devices, with almost half of the tags referring to places, particularly to the university's surrounding region. Another important but varied category (33 percent) involved personal interests, including five tags explicitly naming university degrees, six related to football clubs, and three trying to redirect attention to other blogs. The third relevant category (14 percent) included tags that could be considered obscene or satirical. In most cases, they were clear attempts at "beating" system-imposed limitations by displaying inappropriate photos. In the interviews, respondents explained that their use of tags wasn't part of a thoughtful strategy to combine device names and tags—most told us that they used them more or less randomly.

Results from Interviews

Eleven of the 12 participants interviewed declared themselves to be familiar with Bluetooth, with the most common usage being file exchange (music, photos, or documents). Everyone stated that they noticed the system before the interview; some recalled being unsure of its purpose, but others quickly grasped the basics and 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." These participants clearly reported understanding the meaning of what was displayed and saw the potential to use the system as a way to represent themselves, publicize things, send playful messages, and experiment with a new artifact.

Five interviewees said they changed their device names in response to their awareness of the system, although none of them on the first encounter. Nevertheless, these same people witnessed colleagues changing their device names at roughly the same time. In one group, respondents said they saw a need to personalize their device names when confronted with their default device names on the screen.

The interviewees considered that, given the technology's characteristics, privacy was a question of personal choice, and most weren't concerned about it. Regarding suggestions for system enhancements, the main feedback was to increase interactivity (described as having the ability to send and download content and play games). Another suggestion was to deploy similar screens at different locations around the university, all connected, so that people could use them to communicate and interact on a wider scale.

Discussion

Going back to our two main research questions, let's focus on the lessons learned. The first question aimed to investigate "to what extent can Bluetooth presence and naming effectively prompt interaction around public displays?" Our results indicate that, despite their simplicity, our techniques did effectively 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. Although there was no specified purpose, 19 percent of the potential

users engaged in some form of explicit interaction. Considering that Bluetooth is so widespread, these results confirm that this sort of approach has an extremely low entry barrier and could be immediately available to a considerable part of the crowd visiting a particular place. This large potential user group represents a major difference to other sensing and interaction approaches that require specific hardware or the installation of specialized software in personal devices.

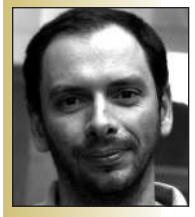
The second question aimed at investigating "what types of practices, social interactions, and forms of appropriation can Bluetooth presence and naming enable in situated displays?" Given the nature of Instant Places, this wasn't something that people could just experiment with alone to see how it worked. All explicit uses of the system corresponded to some form of situated interaction, but even without any hints 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 helped make people feel that because they were already "using" the system, they might as well refine their presence. This ability to easily combine implicit and explicit interaction blurred the distinction and transition among them and might have been crucial in promoting user engagement by overcoming the problem of "taking the first step."

Our study was clearly focused on engagement, so 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 active users affect place versus bystanders and their social relations. On a different level, we're also conducting further research on the usability and syntax issues associated with Bluetooth device names and situated commands.

From the many ideas that surfaced during this work, we can identify three main directions for our research: space, identity, and Web presence. We want to extend the notion of system-supported place beyond the local space, allowing multiple spaces—contiguous or not—to integrate a single instant place and thus extend the concept of presence beyond physical presence. We also intend to study how to promote the evolution, differentiation, and social relations of system-created identities. This could 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. P

the AUTHORS

Rui José is an assistant professor at the University of Minho in Portugal, where he coordinates a research program on situated displays for smart places. José has a PhD in computer science from Lancaster University. Contact him at rui@dsi.uminho.pt.



Nuno Otero is a research fellow at the University of Minho. His research interests include interaction design and human-robot interaction. Otero has a PhD in computer science from the University of Sussex. Contact him at nuno.otero@dsi.uminho.pt.

Shahram Izadi is a researcher at Microsoft Research Cambridge. His research interests include developing novel technologies to enable new forms of human-computer interaction beyond the desktop. Izadi has a PhD in computer science from the University of Nottingham. Contact him at shahrami@microsoft.com.

Richard Harper is a senior researcher at Microsoft Research Cambridge and professor of sociodigital systems at the University of Surrey. He has written 12 books, the most recent of which is *Texture: Communication in the 21st Century* (MIT Press, 2008). Contact him at r.harper@microsoft.com.

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