Issues from Deploying and Maintaining a Pervasive Game on Multiple Sites

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Abstract. In this paper we present the lessons learned from the deployment of a collaborative pervasive game on two different sites. We emphasize on the practical aspects of getting a pervasive system deployed without any extra special infrastructure. Based on our experience, we describe the issues providers and administrators must take into consideration to deploy and maintain pervasive environments. In this perspective, we highlight that ubiquitous technologies must be consciously attended, as they are unevenly distributed and unevenly available.

Keywords: ubiquitous computing, field study, seamful design.

1 Introduction

In recent years, the research based on pervasive gaming has demonstrated principles and lessons that can be applied more generally in systems for mobile work in vast work settings [5]. Several studies reveal the diverse ways in which players experience the limitations of positioning and network technologies [3] and how to take advantage of the `seams' and heterogeneity inherent to pervasive systems [2]. Another investigation [4] discusses sketchy and slow mobile Internet access, variations in the quality of speech transmission, loss of connections or ambiguities in positioning as an everyday reality for mobile users.

These studies suggest that designers must understand how to meet the user needs taking into consideration the limitations and availability of network connectivity and sensor data. However, the literature provides only sparse descriptions of the deployment and maintenance issues of providing pervasive games over multiple sites. In this paper, we describe CatchBob!, the pervasive game platform we designed and used on both the university campus of the Swiss Federal Institute of Technology Lausanne in Switzerland and the University of British Columbia in Vancouver, Canada. Then we present the main issues we experienced in deploying and maintaining the system. Finally, we conclude with open questions on the integration of the limitations of technologies as parts of large-scale ubiquitous environments.

2 The Platform: CatchBob!

CatchBob! is a pervasive game running on Tablet PCs in which groups of 3 teammates have to collaboratively find an object on a university campus [8]. Completing the game requires the players to surround Bob with a triangle formed by each participant's position in the real space. When the players are close to the "Bob", the triangle they have to form appears on the display; they then have to adjust it in the proper way. The only mean of communication the players have is by annotating the map display on their mobile device with a stylus. The original game took place on the Swiss Federal Institute of Technology Lausanne campus, whose dimensions are 850x510 meters field mixing both indoors and outdoors [Figure 1]. The second deployment of the game took place outdoors on a large part of the university campus, in an area approximately one kilometer square played outdoors [6].

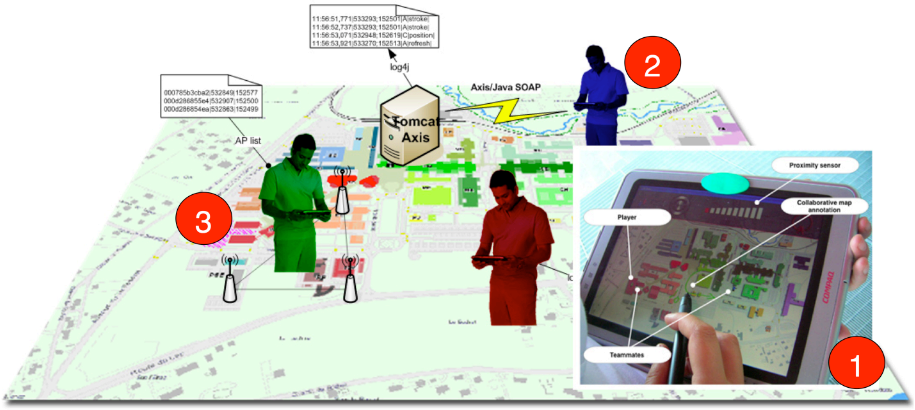

Figure 1: The CatchBob! architecture: (1) Players use TabletPCs to view their and the other players' position. They communicate by annotating the map with a stylus. (2) The data are synchronized over the campus 802.11 network using the SOAP protocol. (3) The positioning algorithm runs on each mobile device. It computes the player's location based on the position of the access points and the signal strength of a radio wave received by the Tablet PCs.

3 Issues from the Real World

Based on our experience of deploying and running CatchBob! in both locations (50 games played in Lausanne, 6 in Vancouver) over different periods, we have been able to identify a set of recurrent issues described in the following subsections.

3.1 Wireless Networks are neither Open nor Pervasive, nor Stable

During the development of the platform, the Lausanne campus network security policies drastically changed in forcing the unique use of the TCP (Transmission Control Protocol) port dedicated to HTTP (Hypertext Transfer Protocol) communications. In consequence, we developed our high-level remote access protocol upon SOAP (Simple Object Access Protocol). In fact, the versatility SOAP facilitated the iterative process of rapid prototyping and user-centered design required for the development of pervasive software in research since we did not need to concern ourselves with lower level protocol and data marshalling issues.

The WiFi network topologies on both campuses were not planned for a pervasive mobile experience, but rather for a nomadic use of mobile device. Indeed, the coverage is limited to places where people work, study or gather. In contrary, alleys, big corridors and parks outdoors frequently proved to be cold spots.

Finally, the transfer of packets to and from access points can show significant asymmetry, and high packet loss can occur despite apparent network access. The latency inherent to wireless networks disturbed some players who questioned if all the messages were actually broadcasted to their teammates.

3.2 The Balance Between Positioning Accuracy and Network Connectivity

The mixed indoor and outdoor settings of the campus in Lausanne prevented us from employing GPS (Global Positioning System) to position the players. Indeed, the campus buildings, corridors and hallways do not offer a sufficient line of sight to the sky to acquire reasonable signals to compute a position. We therefore chose to use another positioning technique based on radio beacons. In this solution, an algorithm computes the position based on the position of the access points and the signal strength of a radio wave received by the Tablet PCs. The mobile clients self-determine their position using the Place Lab [7] native libraries and a simple centroid algorithm. This approach performs a positioning accuracy of 10-40 meters, which consistently decreases when the user is in areas of low network connectivity. It proved to be a viable strategy for the scale of our game as we could take advantage of the approximately 300 WiFi access points deployed on the campus. In Vancouver, while the number of access points is much higher (approximately 3000) due to the predominance of the outdoor settings of the campus, and the extensive changes to the UBC wireless network over the testing period we integrated GPS functionalities. While this improved the accuracy of the positioning, wireless network connectivity was mainly available indoors. This limited the outdoor playground to the areas near buildings with line of sight to satellites.

While many researches aim at improving accuracy and broadening availability of positioning system, our experience suggest that designers might first think of what location information granularity is expected by users of a location-aware system. We are conducting further investigations to understand the level of information accuracy a location-aware system must provide to support its users in certain activities.

3.3 Infrastructures are Inherently Messy

Early in the design process we were surprised that rain, humans, and leaves on trees strongly affect WiFi and GPS performance. The weather had a significant impact on game sessions. For instance we had to cancel several games to keep the rain and humidity from damaging our mobile devices. The outdoor setting used in Vancouver, forced us to improve the high contrast of colors on the screen for better use in sunny days and add audible queues for message and annotation delivery for the noisier outdoor environment.

Likewise, network infrastructures are living creatures regularly mutating into new standards and topologies. In consequence, the positioning system had to be maintained with the constant update of the position of the radio beacons. In that context, we concur with [1] in their general observation that infrastructures are inherently messy; uneven in their operation and their availability.

3.4 The Uniqueness of Devices

While running the experiments, we became aware of the strong “uniqueness of devices” that we were only vaguely aware of ourselves. Similar types of TabletPC, with similar hardware and software, in a similar context had different network or stylus sensitivity. Players became aware—and angry about—the fact that his WiFi antenna had a significantly lower sensitivity than his team–mates’, even though they were using the same device as was found in a similar work [2].

4 Conclusion and Open Questions

Many infrastructures assume an even quality of sensor data and reliable infrastructure. From our experiences of deploying and maintaining a large scale collaborative pervasive game we've found neither is true. Indeed, we suggest that the network and systems issues we present emerge from the current state of unevenly distributed and unevenly available ubiquitous technologies. Furthermore, technological advances will hardly eliminate the constraints we dealt with in the near future. Therefore we question the paradigm of seamlessness in pervasive computing. In consequence, we would like to raise the following high-level questions:

- How can we make the limitations or "quality" of context like location more evident in infrastructures so that they can be used by designers, administrators and end users, either to allow them to compensate for varying quality, or as part of the application?
- How can a general purpose platform for ubiquitous applications make use of the ‘seams’ in infrastructure - is this something that needs to be done on a case by case basis?

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