RelateGateways: Using Spatial Context to Identify and Interact with Pervasive Services

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Abstract. Our everyday life is surrounded by pervasive services. While on the run we should be able to use the mobile devices we carry to interact with these services. Yet, a number of studies have shown that it is difficult for users to *identify available services in an unknown context.* RelateGateways extends the desktop of a mobile device with a new kind of widget: the gateways, arranged around the edge of the screen, pointing towards the co-located services. Identified services can be consumed in a consistent manner by dragging-and-dropping an object on the gateway.

1 Introduction

One goal of ubiquitous computing is to let mobile users make spontaneous use of services embedded in the environment. Ad hoc networking technologies already facilitate spontaneous connection of a user's device to encountered services. However it remains difficult for a user to match network-discovered services with a physically present device, and initiating an interaction can involve a complex configuration phase. This is illustrated by the following example.

Imagine Bob visiting a new research lab. He brings his laptop, cellphone and PDA along to finish editing some slides. Printing them out may be trivial for the local researcher, but Bob will have to go through various steps: 1. Physically locate the printer. 2. Find out its features. 3. Install and configure it on his personal laptop. 4. Print the document. As a result it is likely Bob will give up, frustrated by the clumsiness of (mobile) interaction with pervasive services.

From this use case, two basic challenges can be extracted: 1. The need for the user to identify (or discover in a physical sense) the device. 2. The need to provide natural and seamless interaction mechanisms.

2 Spatial Discovery with RelateGateways

We have developed a user interface concept to access the pervasive services. Our system assumes a sensing technology that provides relative positioning information such that the spatial relationships between a mobile user's device and devices

in their environment are established and tracked in real-time. The RelateGateways interface uses the positioning information to dynamically and contextually display the services the user can interact with in their immediate environment. The devices providing these services appear as gateways in the interface (Fig. 1), taking the form of small widgets at the periphery of the user's screen as they move through an environment. The gateways are spatially arranged around the screen based on a compass metaphor (Fig. 2). They serve as "access points" to interact with services, and are integrated with a mobile desktop interface to support direct manipulations such as "drag-and-drop" of documents to a service.

In our use case, Bob sees a printer gateway *on the right* of his PDA screen. Then he drags-and-drops his file onto the gateway and the printer *to his right* immediately prints it. Then he enters the conference room, sees a projector icon *at the top* of his screen, drags his presentation onto it and it starts fullscreen on the big display *in front* of him.

Fig. 1. OQO handheld computer displaying three gateways (left). Each gateway displays a descriptive icon and the distance between the user and the service (right).

We have implemented a printing service, a public display service for presentations, a keyboard service where a mobile device can "borrow" the keyboard of a larger computer. Each service defines a set of spatial conditions which must be fulfilled before a gateway is displayed. For instance the public display service gateway is only visible when the user is facing the display, and the keyboard gateway is only visible when the user is a short distance away.

3 Features

Interface The gateway interface is a seamless extension of the desktop, integrating the gateways in an unobtrusive manner at the perimeter of the screen but allowing direct interaction with the desktop or with other applications. To achieve this, the user interface was implemented as a portable Java application where the gateways are small borderless windows which may be used as drag-and-drop targets for files or clicked for more options.

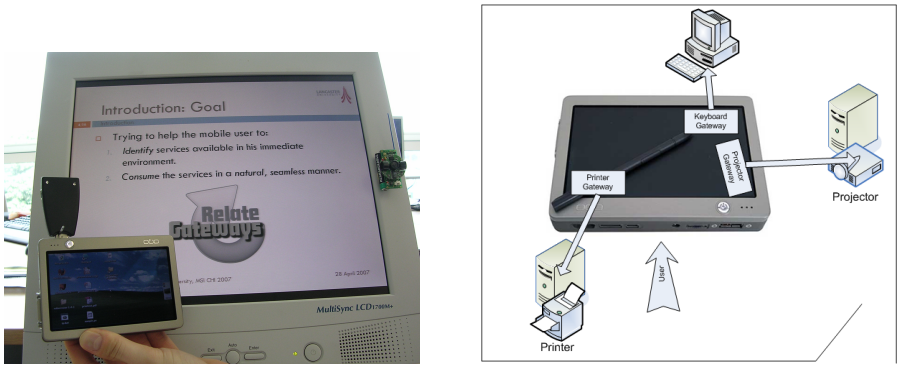

Fig. 2. OQO handheld computer with a Relate USB dongle in front of a public screen equipped with a Relate sensor node (left). Compass metaphor (right).

Service Discovery A user-study [1] conducted to evaluate the user interface and interaction techniques of this work emphasized the importance of auto-configuration and installation. For our users the fact that the system was taking care of all the technical details for them was the most significant step towards spontaneity. RelateGateways addresses discovery in the physical sense but also network discovery.

Mobile Code Everything the client needs to know to use a service is included in a MobileCode package. Once the mobile user has identified a service and their mobile device has been connected to the service provider, the MobileCode is transparently downloaded. This makes services truly "plug-and-play".

Sensor Integration The application can operate with any suitably accurate positioning system but since only relative location information is needed it is being developed in tandem with Relate [2] sensing technology. Relate sensors directly capture the spatial arrangement between co-located devices and dynamically update the positions of the gateways as shown in 2.

References

1. D. Guinard, S. Streng, and H. Gellersen. Extending Mobile Devices with Spatially Arranged Gateways to Pervasive Services. In *International Workshop on Pervasive Mobile Interaction Devices (PERMID 2007) at PERVASIVE 2007*, May 2007.
2. M. Hazas, C. Kray, H. Gellersen, H. Agbota, G. Kortuem, and A. Krohn. A relative positioning system for co-located mobile devices. In *MobiSys '05*, pages 177–190, New York, NY, USA, 2005. ACM Press.