

# IBM Research Report

## What Makes Good Application-Led Research in Ubiquitous Personal Workspace?

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## 1. Introduction

*Ubiquitous* or *pervasive computing* covers a broad trend towards increasingly connected computing devices in the environment, which is brought about by a convergence of advanced wireless technologies and the Internet. Pervasive computing devices tend to be tiny, even invisible, either mobile or embedded in almost any type of object imaginable, including toys, cars, tools, appliances, clothing and various consumer goods communicating through increasingly interconnected networks [1]. The field of ubiquitous computing is still very young. The goal of researchers in this emerging field is to create a system that is pervasively and unobtrusively embedded in the environment, completely connected, intuitive, effortlessly portable, and constantly available. With this research goal in mind, what makes good application-led research in ubiquitous computing? In this position paper, we attempt to find an answer to this question.

Because the field of ubiquitous computing is broad, we can address the question more effectively and meaningfully by focusing on specific applications and their required components. Beyond conventional applications such as personal information management, games, Web browsing, and short message service, the emerging application domains expected to prevail in the ubiquitous computing environment of the future include personal workspace, telematics, wearable computing, smart spaces, sensor-driven applications, location/context-aware collaboration applications. In order to support them, a slew of technologies need to be developed. One is physical requirements such as small form factor, low power, often with high speed, wireless technology and a better source of energy. Another is data management technology such as synchronization, semantics-based data integration, and privacy and security. Also, interface technology such as multimodal user interface and sensor and actuator networks would be crucial. In addition, operating technology for attention management, resource management, power management, autonomic computing, collaboration, and policy management is critical to the success of ubiquitous computing.

This paper focuses on the *personal workspace* domain, which is envisioned to provide individuals with a ubiquitous computing-based workspace. [2]. In order to understand interesting research areas for this application, we first identify user needs of the applications; then, we categorize and abstract technical challenges. Finally, an approach for research in meeting the user needs and resolving the technical problems is suggested.

## 2. Identification of User Needs

Often the identification of user needs and scenarios in an application requires objective but imaginative analysis of how people work in today's workspace and how they will use it in the future to organize individual and shared activities in both work and home. Among some common features asked for in the ubiquitous personal workspace are:

- **Ubiquity of access:** Workers need to be able to communicate with others and need to access information and work environment persistently and securely wherever they are.
- **Notification management:** An intelligent system should be able to intercede and prioritize tasks by considering the user's environment. Also, it should be able to recognize urgent information based on the context and should provide proactive alerts on important events and able to forward as necessary.
- **Data Management:** Users need to deal with a multitude of information in heterogeneous data types across multiple devices. The system should enable the users to search and retrieve information for conducting tasks.
- **Coordination and Collaboration:** As computing devices become essential for groups of people to work together on a task, it is critical to coordinate collaboration.
- **Natural Interface:** As ubiquitous devices become small, it is increasingly difficult to interact with them. It is vital for the devices to be equipped with multimodal interface and intelligently interact with the user based on awareness of user, context and location.

## 3. Abstraction and Categorization of Technical Challenges

The next step is to extract technical problems out of the user scenarios, abstract them to an appropriate level and group them into categories to facilitate the solution. Also, it is important to relate the user scenarios with technologies existing or to be developed. Because research on ubiquitous computing involves diverse technology areas of computer science and electronics engineering in a closely connected way, it would require a different structure of technologies from the traditional one. Among useful technology categories for the future ubiquitous computing are:

- **Awareness management:** This category involves a broad set of technical problems for enabling awareness of context, location, and user. It requires various technologies such as GPS, RFID, sensors, etc.
- **Coordinated user interface:** This category addresses user interfaces of the workspace which enable multi-channel user interfaces among heterogeneous devices.
- **Information integration:** This category involves the data integration problem across a multitude of information sources, types, formats, and devices. A promising approach to this problem is a federated integration utilizing a semantic data model.
- **Personalization:** Personalizing the ubiquitous computing environment involves presenting the personal information, providing persistent personal workspace, managing personal data, notification preference as well as privacy and security, etc.

- **Distributed computing:** This category addresses the communication, data sharing, resource sharing, and information exchange among multiple devices without intruding the personal workspace.

#### **4. Open Standard-Based Client Middleware**

For an effective support of various technical solutions in the future ubiquitous computing environment, it is critical to provide open standard-based middleware with standard APIs and communication protocols, which addresses the identified user needs and resolution for the technical challenges. The client middleware for ubiquitous computing will play a similar role as the common multi-tiered middleware into servers does in the enterprise architecture [3]. The success of ubiquitous computing requires an industry-wide effort for building standards for the client middleware which will provide an interoperable platform among a multitude of components.

#### **5. Conclusion**

We discussed several important factors that will make good application-led research in the ubiquitous personal workspace domain. We identified research areas in the context of user needs and their associated technical challenges in the ubiquitous personal workspace domain. We presented a number of technology categories and a research methodology. Then we proposed an approach to building ubiquitous components leveraging an open standard-based client middleware. We argue that the insight from this analysis exercise for the personal workspace will help researchers gain understanding to the broader scope of ubiquitous computing research. Also, we argue that the exercise can be applied to other application domains of ubiquitous computing in understanding the differences and commonalities among other domains.

#### **References**

- [1] Mark Weiser, Ubiquitous Computing, <http://www.ubiq.com/hypertext/weiser/UbiHome.html>.
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- [3] Institute for Enterprise Architecture Developments, <http://www.enterprise-architecture.info/index.htm>.

#### **Acknowledgements**

This position paper is based on a study by an IBM Global Technology Outlook team in the area of the future personal workspace, including Sam Adams, David Bantz, Drew Clark, Chris Codella, Susan Cohen, Jim Colson, Ponani Gopalakrishnan, Dan Gruen, Brent Hailpern, Sebastian Hassinger, Lorraine M Herger, John Karidis, Martin Kienzle, Michelle Kim, Hillel Kolodner, Chalapathy Neti, Modest Oprysko, Michael Rosenfield, Dan Russell, Robert Saccone, Dennis Shea, Jane Snowdon, Jim Spohrer, Kenneth Timmons, Marisa Viveros, John Walicki.