Ocean: Community-Based, Real-World Ubicomp

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Abstract. The rapid expansion of networked computation into our everyday lives often results in physical environments with an increased potential for Ubicomp support. Often times, however, Ubicomp support is underutilized due to the nature of many real-world networked resources; which are often highly heterogeneous, unsystematically organized, unpredictably available and not inherently interoperable. To overcome these challenges, the ISNM Ambient Ocean project (Ocean) is exploring novel ways of harnessing the collective wisdom of users operating within these complex environments. In Ocean, we assume networked resources will rarely provide a means for deploying heavyweight Ubicomp software components. Rather, we are developing a plug-in-centric, smart-client framework which enables appropriate client components to be installed on-demand; including plug-ins for context detection, resource control, protocol adaptation and collaborative filtering. We hypothesize that plug-in-based extensibility combined with community-based collaborative filtering will help improve and simplify ad-hoc compositions of potentially powerful ambient resources.

Keywords: Ubiquitous computing, Heterogeneous (hybrid) systems, Adaptable software architectures, Service oriented architectures, Distributed programming, Collaborative filtering.

1 Introduction

Continuing advancements in wireless Internet access, mobile computing devices and embedded networked electronics are rapidly extending our computing systems beyond the desktop. Today our homes, cars, offices and public spaces contain an ever-increasing assortment of computer networks, mobile devices, media displays, and embedded sensors and actuators. Increasingly, many of these ambient resources provide some measure of networked computation; often revealing context information or offering remote clients the ability to discover and utilize various functions [7, 11]. Moreover, increasing Internet coverage often provides ubiquitous access to a variety of online data sources; often available programmatically via Web Services. The discovery and synergistic composition of these situated and Internet-based real-world resources is a potentially powerful approach for generating ad-hoc, context-aware software. Several existing Ubicomp projects already demonstrate promising service encapsulation and composition techniques [2, 4, 5, 8], however; these approaches

often require highly instrumented laboratory settings and large-scale deployment of Ubicomp framework components; which may inhibit their widespread adoption. Arguably, unlocking the dormant capabilities of highly heterogeneous real-world environments continues to remain an important challenge for the Ubicomp community [3].

Ocean's Community-Based, Smart-Client Approach

The ISNM Ambient Ocean project (Ocean) is exploring the potential benefits and complex challenges inherent in composing ad-hoc, service-oriented software from an increasing assortment of proximate networked resources and Internet-based Web Services. Specifically, Ocean is being designed to improve and simplify these types of interactions *without the need for specialized instrumentation or large scale software deployment*. In particular, we are interested in enhancing a wide variety of everyday environments with a lightweight, smart-client framework consisting of plug-in support for hierarchical context detection, ambient resource control (e.g. UPnP, Zeroconf), protocol adaptation and community-based filtering mechanisms. Examples of community-based filtering mechanisms include: Automatic resource discovery and publishing ("automatic resource wardriving"); component graph social bookmarking; explicit resource ratings; implicit observations; context histories; and other performance metrics. We hypothesize that plug-in-based extensibility combined with community-based collaborative filtering will help improve and simplify ad-hoc compositions of potentially powerful ambient resources.

In our previous ubiquitous computing framework, Aladin, we demonstrated the utilization of plug-in-based hierarchical context detection as a way of improving context signatures on-the-fly [1]. By analyzing a device's capabilities and dynamically deploying context detection plug-ins at runtime, our Aladin framework is able to continually improve a device's context signature in many types of everyday environments. In addition, Aladin provides pluggable context interpretation capabilities and flexible Web-based service presentation. Using these capabilities, we have successfully developed several context-aware systems, including: A mobile interactive cinema platform [10]; a museum tour-guide system [1]; and a pervasive multiplayer tangible game [6]. Our proposed Ocean framework will include several Aladin results in its design.

Beyond the plug-in mechanisms developed for Aladin, Ocean will provide several additional mechanisms; including the ability to integrate community-based filtering techniques on-the-fly. Using this approach, we will utilize Ocean as a platform for studying how various collaborative filtering models can be used to improve and simplify service discovery and ad-hoc resource composition. For example, Ocean will include a community plug-in which builds on the Intel Placelab wardriving technique; where devices equipped with both WIFI and GPS hardware are used to publish the geo-coordinates of discovered WIFI hotspots [9]. In Ocean, we are extending this technique to include automatic resource wardriving for unlimited types of ambient resources. Ocean clients continually publish discovered ambient resources along with the specific context signature where the resources were discovered (based on the installed plug-ins within a client). Additional filtering models, such as resource

ratings and community-collected performance characteristics, may also be used in parallel to assist future clients (within a specific environment) with ad-hoc service composition.

Similarly, another Ocean community plug-in will provide Ocean applications the ability to discover, compose and "bookmark" the potentially complex component graph of local resources and Web services required for a specific situated application. The results of this composition, along with the related context signature of the environment, can then be used to assist future Ocean users wishing to compose similar applications. In such cases, Ocean may use previously successful (and possibly highly rated) composition bookmarks to help rebuild the component graph required to accommodate similar requests. To facilitate this functionality, we are creating a complimentary set of Web Services providing indexing and search capabilities for automatically discovered and expressly published resource combinations.

For our workshop contribution we are interested in discussing our proposed framework's combination of smart-clients, plug-in-based context detection, resource utilization and community-based filtering. Particularly, we are interested in issues related to security and privacy, peer-to-peer support, heterogeneous service environments and related collaborative filtering techniques.

References

1. Carlson, D.: Aladin - An Extensible Ubiquitous Computing Infrastructure. Master Thesis, ISNM International School of New Media, Lübeck, Germany, 2005
2. Christopoulou E., Kameas A.: "Ontology-driven composition of service-oriented ubiquitous computing applications", Third International Conference on Adaptive Hypermedia and Adaptive Web-Based Systems (AH2004), Eindhoven, the Netherlands, 23-26 August 2004.
3. Davies, N., Gellersen, H.W.: Beyond Prototypes: Challenges in Deploying Ubiquitous Systems, IEEE Pervasive Computing, v.1 n.1, p.26-35, January 2002
4. Dey, A. K., Salber, D., and Abowd, G.D.: A Conceptual Framework and a Toolkit for Supporting the Rapid Prototyping of Context-Aware Applications. Human-Computer Interaction, Vol. 16 (2-4), pp. 97–166, 2001
5. Garlan, D., Siewiorek, D., Smailagic, A., and Steenkiste, P.: Project Aura: Towards Distraction-Free Pervasive Computing, IEEE Pervasive Computing (April-June 2002). 22-31.
6. Heumer, G., Carlson, D., Kaligiri, S.H., Maheshwari, S., Hasan-Waqar-Ul, Jung, B., and Schrader, A.: Paranoia Syndrome – A Location Based Pervasive Multiplayer Game using PDAs, RFID, and Tangible Objects. Third International Workshop on Pervasive Gaming Applications – PerGames 2006, Dublin, Ireland, May 7, 2006
7. IETF Zeroconf Working Group (2006): http://www.zeroconf.org/
8. Kindberg, T., et al.: People, Places, Things: Web Presence for the Real World. 3rd Int'l IEEE Workshop Mobile Computing Systems and Applications, IEEE CS Press, Los Alamitos, Calif., 2000
9. LaMarca, A., Hightower, J., Smith, I., and Consolvo, S.: Self-Mapping in 802.11 Location Systems. In Proceedings of Ubicomp 2005, Tokyo, Japan. September, 2005
10. Schrader, A., Carlson, D., and Busch, D.: Modular Framework Support for Context-aware Mobile Cinema. Journal of Personal & Ubiquitous Computing *(to appear)*
11. UPnP Forum (2006): http://www.upnp.org/