A Web based platform for smart spaces

Jilles van Gurp, Sasu Tarkoma, Christian Prehofer, and Cristiano di Flora

Nokia Research Center, Helsinki, Finland
http://research.nokia.com

Abstract. This demo presents our work on middleware for ubiquitous applications in — what we call – smart spaces. Our goal is to show that web technologies can be extended to interact in smart spaces. The middleware reuses various components from the open source world such as web servers; various python frameworks and other components. Key aspects of our platform such as service discovery; use of indoor positioning; use of browser based UI and other features are illustrated using a set of usecases we have developed around the theme of a shopping mall, which we regard as a useful example of a public space where it would be desirable to provision a set of services and applications that can be accessed by users in the smart space in a similar fashion as one would provision a public web site today. Our demo includes examples of both horizontal features that could be of use in other public spaces and vertical features that are more specific to the mall example.

Key words: Smart Places, web services, REST

This demo presents our work on middleware for ubiquitous applications in — what we call – smart spaces. A smart space is a multi-user, multi-device, dynamic interaction environment that enhances a physical space by virtual services [1]. These services enable the participants to interact with each other and other objects in a P2P way in the smart space. The research in the area of ubiquitous and pervasive computing has led to many interesting research demos and usage experiences. Our goal is to show that web technologies can be extended to interact in smart spaces. Building on widely spread wireless devices such as phones, PDAs and other special purpose devices, there is an enormous potential to create new smart space services and applications.

We build our work on several current trends in mobile devices, namely: mobile internet adoption is increasing; more and more phones and other user devices are becoming connected; and the internet is emerging as the glue through which these devices connect. Leveraging this trend of internet in the mobile allows us to avoid some of the pitfalls that have hindered adoption of similar technology in the past. For example, by being web based, our platform can integrate across device, vendor and platform boundaries and be accessible to users with any browser equipped device.

As partially outlined in previous publications [2, 3], our platform comprises the following major components:

- **Service Discovery** In order to allow user devices to discover the smart space, a Zeroconf MDNS based service discovery mechanism is used. Services and applications in our platform are advertised using this mechanism and can find each other when needed.
- **Web Runtime(s)** Since our platform is web based, all applications and services are hosted in a application server. Currently our demo setup consists of a mix of mobile devices with a python based web platform and Java OSGI services as well as regular servers running the same and some additional platforms. A benefit of being web based is that a lot of these components are off the shelf components such as for example blogs and feed aggregators.
- **Smart Space Services** Some important services in our platform include the service discovery that other services and applications integrate through a REST based API; smart space search and indexing; indoor positioning that allows user devices to determine where they are in the smart space; and associated services that allow associating maps; points of interest; etc with these positions. A key feature in our platform is that all these services are accessible through simple web based APIs. Where possible existing APIs are reused rather than reinvented. For example, our platform integrates blog technology using APIs that are commonly used in Blog software such as RSS, Meta weblog Post and Ping APIs, etc.
- **Web Based Security** Users, data, and services make use of common internet security mechanisms such as Openid and Oauth to protect privacy and achieve access control. This security solution will be further discussed in a forthcoming publication.
- **In device Portal** To access the smart space, users use their mobile web browser to either access a in device web portal on their own device or access a centralized portal in the mall. The portal integrates various portal applications that cover aspects of our Mall related usecases such as finding friends in the mall or finding shops near you in the mall as well as more user centric services such as sharing files on the in device portal and searching for files across all devices in the smart space.

The main services in our platform include service discovery, searching and indexing, and indoor positioning. These services are provided as a set of REST APIs, which supports easy integration with 3rd party software. The indoor positioning service allows user devices to determine where they are located in a smart space, and to correlate the location with different kinds of maps and points of interests.

The demo we present shows our platform and web portal running on Nokia N800 internet tablet devices connected to a wireless lan. In Figure 1 a screenshot is presented of the smart space portal running in the browser on an N800. The idea of this portal is that it integrates several smart space applications into one web page. The user can visit other portals in the smart space simply by clicking in the link or chat with users on other devices using our smart space chat application. Additionally, the user can use the smart space search feature to search for media such as photos and music. This search feature works by

Fig. 1. Screenshot of the Smart Space portal running on a Nokia N800

discovering all registered search services in the smart space and collecting the results. The Oulu Mall portal that is listed in the portal list is a server with applications and services specific to the Oulu Mall public smart space. The idea is that when in this mall, users can interact with services such as a mall directory and a what's near feature that make use of the indoor position service available from their own device to provide an experience that is customized to the user and his/her context and location.

We demonstrate the key features of the smart space system by showing several interactions between multiple mobile devices and the mall server. These interactions pertain to finding interesting physical or logical items in the virtual neighbourhood, and communicating with people using blogs and feeds. An overview of the applications integrated into our portal and the components they build on is presented in Figure 2. A full discussion of the technical architecture is beyond the scope of this paper. However, it should be mentioned that the software integrates a large number of open source components and has been designed with portability of both software and concepts to other platforms in mind.

Building on top of many established SW components and technologies, the main novelties of the middleware include

- Indoor positioning, which includes a concept for symbolic or semantic locations.
- Distributed security built on existing technologies like openID and openAuth.
- Modeling a smart space by distribted, REST-based web-services.

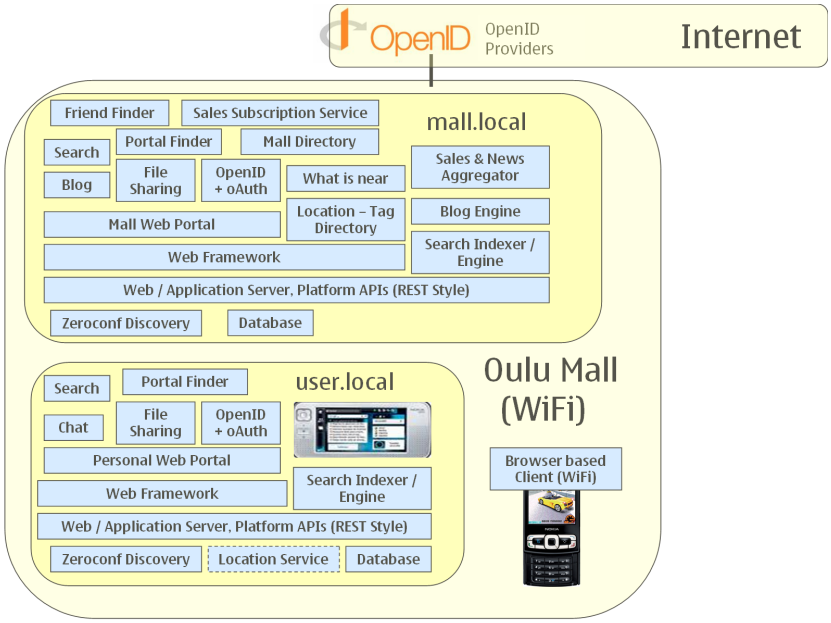

Fig. 2. Overview of usecases and components in the demo

Acknowledgements

The software has been written as part of our ongoing research in the Smart Space Lab in the Nokia Research Center. In addition to the authors, the following individuals have also been involved in developing concepts and software presented in this demo: Jaakko Kyro, Kari Ahvanainen, Pasi Liimatainen, Heikki Mattila, and Vlad Stirbu.

References

1. Wang, X., Dong, J.S., Chin, C.Y., Hettiarachchi, S.R., Zhang, D., Semantic Space: an infrastructure for smart spaces, IEEE Pervasive Computing, 3(3) pp. 32-39, 2004.
2. Jilles van Gurp, Christian Prehofer, Cristiano di Flora, Experiences with realizing Smart Space Web Service Applications, 1st Peer 2 Peer Mobile Handhelds workshop, at CCNC 2008.
3. Christian Prehofer, Jilles van Gurp, Cristiano di Flora, Towards the Web as a Platform for Ubiquitous Applications in Smart Spaces, Second Workshop on Requirements and Solutions for Pervasive Software Infrastructures (RSPSI), at UBICOMB 2007, Innsbruck, 16-19 Sebtember, 2007.