Chapter 11

XAC Project: Towards a Middleware for Open Wireless Sensor Networks

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ABSTRACT

In pervasive computing environment (Satyanarayanan, 2001), common context management system, that make context of the real world be shared among the context-aware applications, is required to reduce development cost of each context-aware applications. A wireless sensor network (WSN) will be a key infrastructure for the context management system. Towards pervasive computing, a WSN integrated into context management system should be open infrastructure. In an open WSN should (1) handle various kinds of tasks, (2) manage tasks at runtime, (3) save resource consumption, and (4) adapt to changes of environments. To develop such an open WSN, middleware supports are needed, and our XAC project tries to develop a middleware for the open WSN. The XAC project is a research project to develop a middleware for open WSN. In this chapter, the authors show research issues related to open WSN from the viewpoints of task description language, runtime task management, self-adaptability, and security.

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INTRODUCTION

In pervasive computing environments, many context-aware applications controlling various devices embedded in environments, support human activity more proactively and effectively. A context-aware application captures current context of the real world and affects the real world to reach expected context. Common context management system, that makes context of the real world be shared among context-aware applications, is effective to reduce development cost of such context-aware applications.

Context management system should be able to capture various kinds of context required by context-aware applications, and should be able to be deployed easily to various environments. A wireless sensor network (WSN) will be a key infrastructure for the context management system. The WSN is a wireless ad-hoc network consisting of tiny computers equipped with sensors and wireless communication devices. A WSN can produce data about environments, measured by some nodes in WSN using equipped sensors. The WSN can change data to produce according to requirements of applications, since each node can be programmed to use an adequate sensor among equipped sensors. Moreover, the WSN can be deployed easily on environments, since it does not require any communication cables. Nodes in a WSN communicate with each other via wireless links and transmit measured data via multi-hop communications. Therefore, the WSN is useful to develop the context management system.

Towards pervasive computing, a WSN integrated into context management system should be open infrastructure. An open WSN should

- handle various kinds of measuring tasks,
- manage tasks at runtime,
- save resource consumption, and
- adapt to changes of environments.

It is used by many context-aware applications that require different kinds of data to a different level of accuracy, at the same time. Therefore, the WSN should be able to handle various kinds of task, to produce multiple data required by these applications to a required accuracy. Additionally, applications using a WSN appear and disappear dynamically. Therefore, the open WSN should add or remove tasks without stopping itself. Moreover a WSN has severe resource limitations, since each node in a WSN has only poor CPU, memory, bandwidth, and battery. Therefore, the WSN should reduce needless resource consumptions to increase the number of tasks that it can handle, and to prolong its lifetime. Finally, adequate behavior of an open WSN depends on state of environments. Therefore, an open WSN should adapt its behavior to changes of environments without human’s instructions.

To develop such an open WSN, middleware supports are needed, and our XAC project (XAC project, 2009) tries to develop a middleware for the open WSN. The XAC project is tackling research issues related to open WSN, is developing a middleware for WSN integrating these research results, and will publicize the middleware as open source. In this chapter, we show research issues related to the open WSN, and introduce research and development activities of XAC project related to these issues.

BACKGROUND

WSN programming is complicated, since it requires programmers to have deep knowledge about various fields, such as data analysis, distributed programming upon wireless ad-hoc networks, and optimization of embedded system. In this section we will present concrete examples of typical wireless sensor network tasks to identify the issues that need to be tackled when operating open wireless sensor networks.