

A Study of Open Middleware for Wireless Sensor Networks

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Abstract. Recently the wireless sensor networks have emerged as an attractive solution in a number of applications. The wireless sensor networks have found many applications in different areas, including environmental surveillance, intelligent building, health monitoring, etc. In this paper we present open sensor middleware model based on SOA (Service Oriented Architecture) in wireless sensor networks. The open sensor middleware model provides flexibility, and reusability based on Web services using open API (Application Programming Interfaces).

Keywords: Open sensor middleware, Service oriented architecture, Wireless sensor networks

1 Introduction

Recently, the wireless sensor networks describe as consisting of spatially distributed autonomous devices using sensors to cooperatively monitor physical or environmental conditions at different locations. The wireless sensor networks consists of large numbers of sensor nodes and a sink node connected through wireless channels, and can be used for building distributed systems for data collection and processing, in-network data aggregation, and self-organized wireless communication. Then, sensor nodes include cooperation small-scale nodes limited in sensing, wireless communication, and computation. The wireless sensor networks have wide range of application such as geophysical monitoring, habitat monitoring, traffic monitoring, military systems, precision agriculture, supply chain management, and etc [1].

Middleware is software and tools that can help hide the complexity and heterogeneity of the underlying hardware and network platforms, ease the management of system resources, and increase the predictability of application executions. The wireless sensor networks middleware is a kind of middleware providing the desired services for sensing-based pervasive computing applications that make use of a wireless sensor network and the related embedded operating

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system or firmware of the sensor nodes [2].

The middleware in wireless sensor networks helps the programmer develop applications in several ways. It provides appropriate system abstractions, so that the application programmer can focus on the application logic without caring too much about the lower level implementation details [3].

Applications that use the wireless sensor networks as the enabling technology set high level requirements on the overall design such as flexibility, reusability and reliability. Middleware based on SOA (Service Oriented Architecture) is a software layer that rests between the operating system and the application software which can help in hiding the operating system variations, underlying hardware constraints and the complexity of sensor network interconnectivity. Middleware provides a potential solution for bridging the gap between the high-level requirements of applications and the hardware constraints of the wireless sensor networks [4].

In this paper, we present is open middleware model based on SOA for the wireless sensor networks in enabling an integrated real-time context data with simplicity, resilience and flexibility. The rest of this paper is organized as follows: In Section 2, related works are introduced. In Section 3, we describe proposed open middleware model in wireless sensor networks.

2 Related Works

The wireless sensor networks have emerged as an attractive solution in a number of applications as they incorporate technologies from three different disciplines: sensing, communication, and computing [5]. A wireless sensor networks itself can consist of merely a handful of nodes or potentially thousands that can spread from a few meters in range or cover extremely vast areas, within or surrounding an area of interest. Due to the nature of the deployment, nodes are intended to be disposable, so unlike traditional wireless devices such as smart phones the power supply unit cannot always be recharged over its operational lifetime. Thus energy efficiency and preservation is a major research issue for both the design of the physical device itself and the software that runs on it [4].

The wireless sensor networks middleware can be seen as a kind of lower layer pervasive computing middleware. Until now, all the exiting work on wireless sensor networks middleware has focused on the sensor networks. The traditional middleware techniques cannot be applied directly to the wireless sensor networks. First, most distributed system middleware techniques aim at providing transparency abstractions by hiding the context information, but the wireless sensor networks based applications should usually be context-aware. Second, although many mobile computing middleware supports context awareness, their major concern is how to continuously satisfy the interests of individual mobile nodes in the presence of mobility. In contrast, systems are data centric, reflecting the whole application's interests. Thus, the locations and mobility of the sensor nodes should be handled by middleware in a different way. For example, a node moving away from a phenomenon may choose to hand of the monitoring responsibility to a nearby node. Also, wireless sensor networks mostly use attribute based addressing rather than relying on network wide unique node addresses. Third, data aggregation in intermediate nodes of the forwarding path is desirable in a WSN, but no such kind of support is provided in traditional distributed system middleware because of the end-to-end paradigm used. Finally, wireless sensor networks require the middleware to be light weight for

implementation in sensor nodes with limited processing and energy resources. WSNs also have new requirements on hardware operating systems and routing protocols, as well as the applications [6].

A lot of work has been done on middleware for the wireless sensor networks, focusing on different aspects and for different purposes. Although several survey papers can be found in literature, each of them addresses only a subset of the issues, e.g., the system architecture, the programming paradigm, and the run time supporting. There is no reference model for classifying and analyzing the middleware functionalities, and no detailed discussion on the implementation techniques [6]. Middleware provides a potential solution for bridging the gap between the high-level requirements of applications and the hardware constraints of the wireless sensor networks.

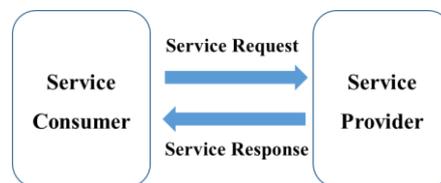


Fig. 1. Basic model of service oriented architecture

A SOA is a set of principles and methodologies for designing and developing software in the form of interoperable services. A service is a function that is self-contained, and does not depend on the context or state of other services. Services are well-defined functionality that are built as software components, possibly reused for different purposes. Fig. 1 shows a basic SOA system where a consumer sends a request message to the provider which returns a response message [7, 8].

3 Proposed Open Sensor Middleware

The proposed open sensor middleware is composed of sensing data collection manager, sensor network interface, interface manager, Configuration Manager, sensing Data Repository (Memory), sensing data distributor, Open API (Application Programming Interfaces), Viewer. The sensing data collection manager is responsible for receiving real-time sensing data using sensor network interface. Sensing data is received from active sensor nodes in sensor network. The manager accesses sensing data sent from sensor node and saves it in memory through sensing data parser. It then parse processing through received sensing data. Interface manager takes a role in monitoring state of the interface connected with middleware.

The configuration manager requests and verify IP address and user access privileges. And the manager takes the format of various sensing data and requests self-configuration information from administrator and configure itself. The user may then request the application to get sensing data for selected sensors, then the sensing data distributor transfer this data to the user application using Open API. Also we may display sensing data using a Viewer.

Proposed open sensor middleware supports programming abstraction, flexibility, and reusability based on Web services using open API. A Web service is a method of

communication between two electronic devices over a network. It is a software function provided at a network address over the web with the service always on as in the concept of utility computing. Now, we use the SOAP (Simple Object Access Protocol) and RESTful for Web services. The SOAP use as a standard protocol for exchanging messages for traditional computer networks and the sensor networks of limited resources. Also, RESTful uses for web services of the feasibility and the performance limits resources based on 6LoWPAN and CoAP.

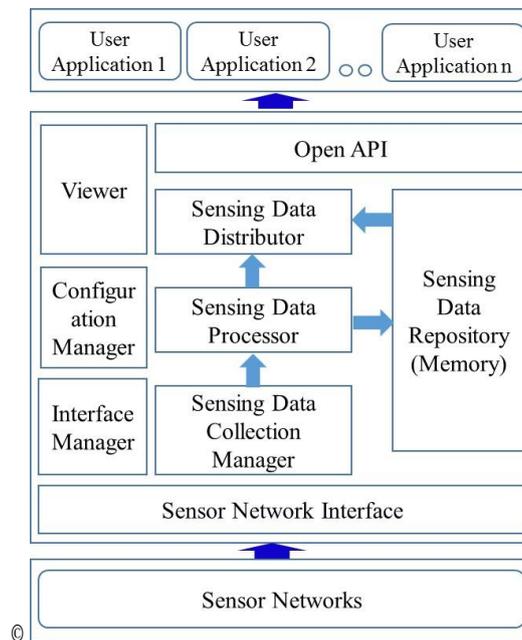


Fig. 2. Sensor web configuration in OGC

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