Sensor Event Processing on Grid

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Abstract. *Wireless sensor networks are increasingly being deployed in many important applications. For sharing huge amount of sensor data efficiently with diverse users, an information dissemination mechanism is very necessary and important component. In this paper, we have proposed an efficient architecture integrated with sensor network and Grid technology. To disseminate the sensed data to users geographically distributed, an experimental method using Data Grid on pub/sub (publish/subscription) is designed for a u-Healthcare application and its performance is evaluated for various predicate cases.*

Keywords. Wireless Sensor Networks, Grid, event processing, dissemination

1. Introduction

With rapid advances in sensor technology, wireless sensor networks (WSNs) have begun to collect large quantities of information about the physical world. WSNs are characterized as an interconnection of many resource-constrained sensor devices with sensing capability, data processing, and wireless communication capabilities [1]. Sensor nodes sense their environments, including such things as temperature, humidity, and pressure variations.

Wireless sensor networks are increasingly being deployed in many important applications such as healthcare monitoring for patients, weather or disaster monitoring and forecasting, tracking of goods and manufacturing processes, safety monitoring of physical structures, and smart homes and offices.

In WSN environments, a large number of sensor devices are deployed and aggregated over a wide area for data acquisition and processing. However, WSNs have limited sensing capability, processing power, and communication bandwidth. Because of these limitations, processing and storing a huge variety of sensor data are necessary and are usually done with shared geographically distributed computing resources.

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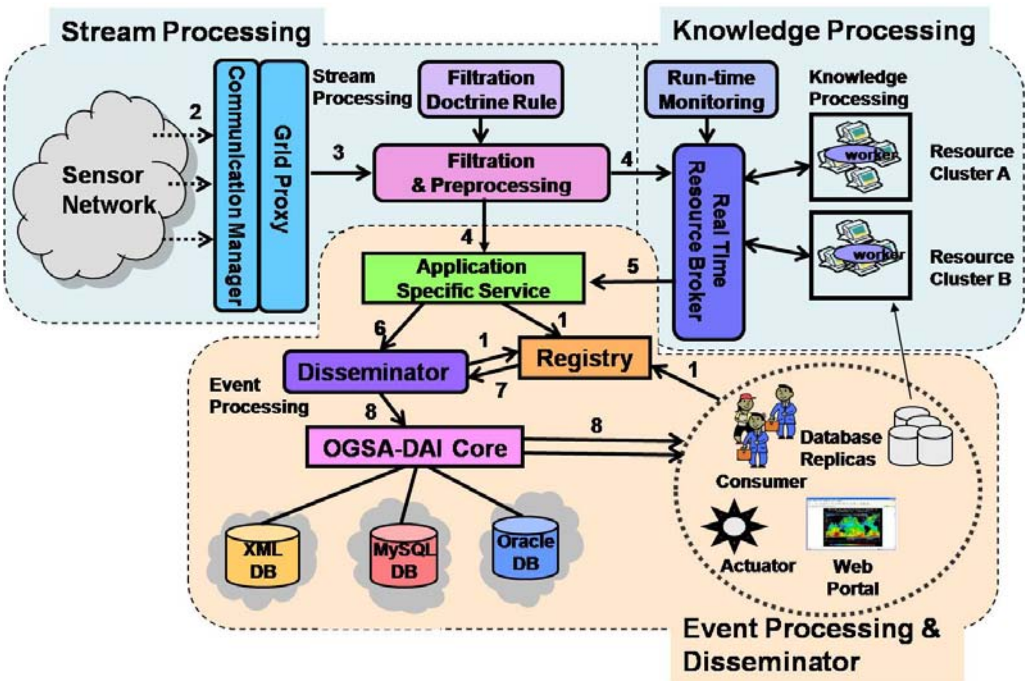
In recent years, Grid computing has evolved to coordinate sharing of distributed and heterogeneous resources and to support a very powerful method of managing, processing and storing huge amounts of data. Grid (which is a combination of a computational Grid and a data Grid) provides distributed computational resources to solve large-scale problems as well as seamless access to storage resources and efficient management and transmission of large amounts of distributed data.

By integrating sensor networks into Grid, large amounts of sensor data can be stored, processed, and accessed more efficiently. For sharing large amounts of sensor data efficiently, an information dissemination mechanism is necessary and important. Little research integrates Sensor network into Grid and Information Dissemination mechanisms [4].

2. Event Management Architecture on Grid

In this section, simply our architecture is introduced. The architecture has two parts- Stream Processing & Knowledge Processing part and a disseminating part. We propose an overall system called ARROW (Adaptive and Reconfigurable ResOurce Management for Wireless sensors using Grid technology) which consists of “Stream Processing”, Knowledge Processing” and ”Event Processing & Disseminator” as shown in Figure 1.



(Figure 1) The ARROW architecture

2.1 “Stream Processing & Knowledge Processing”

“Stream Processing & Knowledge Processing” is designed for collaboration with the sensor network and Grid. The raw data can be filtered and processed using Grid resources in “Stream Preprocessing & Knowledge Processing” architecture. “Stream Processing & Knowledge Processing” has three components. The definition of each component of “Stream Processing & Knowledge Processing” is explained as follows:

- **“Communication Manager& Grid Proxy”** – “CM & Grid Proxy” communicates to the wireless sensor devices or wireless sensor gateway. It works as a bridge between wireless entities and mitigates the effect of frequent network disconnection, security, and fault recovery. “CM & Grid Proxy” also employs an important algorithm to retrieve data from wireless sensor devices. After collecting the data from the sensor devices, “CM & Grid Proxy” sends it to the “Filtration & Preprocessing”.
- **“Filtration & Preprocessing”** – “Filtration & Preprocessing” collects the sensor data and sends requests for resources to the “Real time Resource Manager” to aggregate the sensor data and to filter the data using an administrator defined event doctrine file.
- **“Real time Resource Manager”**– “Real time Resource Manager” seamlessly serves dispersed Grid resources to the “Filtration & Preprocessing” for knowledge processing sensor data. The “Real time Resource Manager” monitors the resource workload to adapt to the variations in resource performance and application requirements.

The system flow steps for “Stream & Knowledge Processing” are explained as follows;

Step 1: Sensors sense data from the environment.

Step 2: “CM & Grid Proxy” gathers the data and propagates to “Filtration & Preprocessing” for sensor data filtration.

Step 3: After filter the sensor data, “Filtration & Preprocessing” sends the data to Application Specific Service. If the data should be processed, “Filtration & Preprocessing” sends to the “Real Time Resource Broker” for knowledge processing using Grid resources. “Real time Resource Manager” monitors computational resources and allocates the resources for Knowledge Processing the filtered sensor data using the filtration doctrine. “Real time Resource Manager” can reconfigure resource allocation dynamically.

Step 4: After knowledge processing, “Real time Resource Manager” sends to Application Specific Service to disseminate the data to users using Information Disseminator.

2.2 “Event Processing & Disseminator” Architecture

As we mentioned in section 1, the Info-D standard is well explained in [2] by illustrating use cases such as the NextGRID graphical animations use case, the car dealer use case, and the sensor networks use case. Our implementation for Grid environments needs to plug the data Grid technology. OGSA-DAI, a widely used tool, is employed and discussed in the following subsection.

2.2.1 OGSA-DAI

OGSA-DAI [3] handles data resources, such as flat file, relational or XML-databases, to be accessed via state machine web services. It also allows data to be queried, updated, transformed, and delivered. More detailed advantages of OGSA-DAI include the following.

- We do not need additional code to connect to a data base or query data. OGSA-DAI supports an interface integrating various databases such as XML and relational databases.
- The OGSA-DAI provides three basic activities which are querying data, transforming data and delivering the results in sequence. The OGSA-DAI can support not only querying and transforming but also delivery using ftp, e-mail, and push services.
- OGSA-DAI allows users to make new activities. This function is very scalable and powerful so the data resource can be used in various ways.

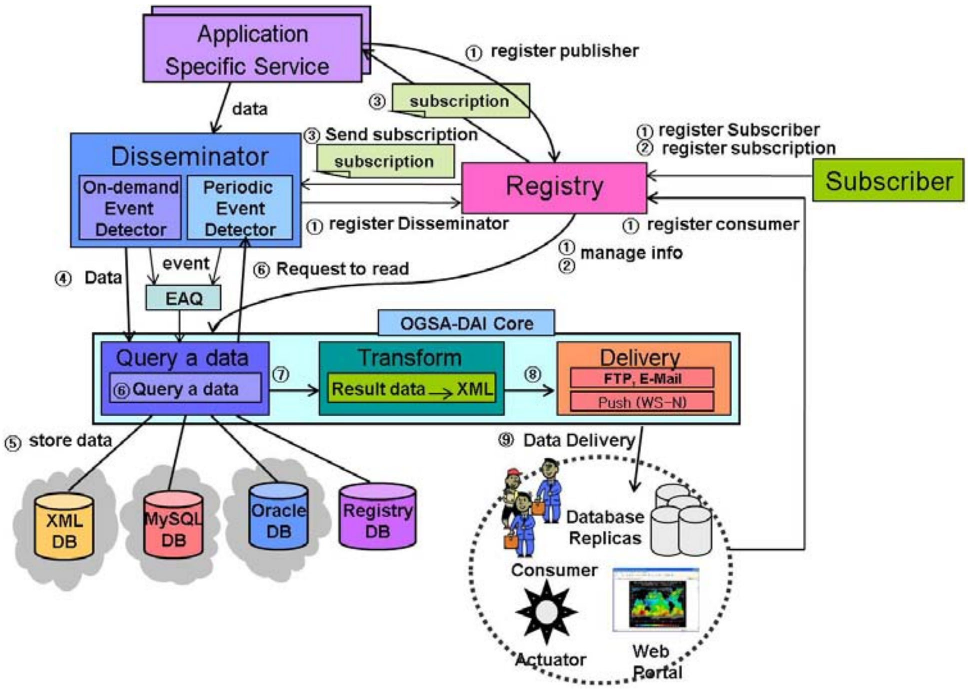
General steps for ”Event Processing & Disseminator” as shown in Figure 1’s bottom part is illustrated as below.

Step 1: Each entity should register its information to the registry.

Step 2: An application specific service sends the processed data to the disseminator.

Step 3: The registry can manage, store the subscription of each entity and distribute the information to disseminator(s). The disseminator can distribute sensor data to users efficiently using the information.

Step 4: The disseminator detects event data for immediate delivery and schedules time-based data for regular delivery according to the consumer’s subscriptions. It also stores sensor data to heterogeneous and distributed resources with uniform access using OGSA-DAI.



(Figure 2) Detail “Event Processing & Disseminator” system flow

“Event Processing & Disseminator” system flow is shown in detail as follows in Figure2

① The components of “Event Processing & Disseminator” (such as Application Specific Service, consumers, disseminator) register their information to the registry.

② Consumer send the subscriptions which include consumer’s interests to the registry using subscribers. Registry stores the information to the OGSA-DAI.

③ Registry sends subscriptions to disseminator.

④ When sensor data reaches to the “Event Processing & Disseminator” system from Application Specific Service, disseminator detects whether the sensor data is an event data or not. Predicates include single condition or multiple conditions. If the predicates include single condition “Event Processing & Disseminator” processes step ⑤ and step ⑦ directly If the predicates include multiple conditions, the event data is sent to the EAQ(Event Aggregation Queue).

⑤ Before disseminate sensor data to consumers, disseminator stores sensor data to the OGSA-DAI.

⑥ When predicate include single condition, Periodic Event Detector schedules dissemination using subscriptions and requests queries to the OGSA-DAI. When predicate include multiple conditions, if enough events are stored in EAQ, disseminator disseminates the data with, ⑤,⑦ steps.

⑦ Disseminator request to transfer the data to XML format using perform document.

⑧ OGSA-DAI delivers the data to various consumers using FTP, E-mail or Web services.

3. Conclusion

In this document we have proposed the ARROW architecture, which integrates a sensor network and Grid for information dissemination. The ARROW supports a gateway between the sensor network and Grid to process, manage huge amounts of data, provide interfaces for consumers, and employ the pub/sub system. In the future, detecting and matching event for subscriptions should be studied in an efficient manner.

References

[1] Hock Beng Lim, et. al. "Sensor Grid: Integration of Wireless Sensor Networks and the Grid", Proceedings of the IEEE Conference on Local Computer Networks 30th Anniversary (LCN'05)

[2] "INFOD Patterns", http://www.ogf.org.

[3] "OGSA-DAI", http://www.ogsadai.org

[4] Gero Mühl, Andreas Ulbrich, Klaus Herrmann, and Torben Weis, " Disseminating Information to Mobile Clients Using Publish–Subscribe", 2004, ISSN:1089-7801,IEEE Internet Computing