Research of RFID Middleware Model with CEP based on SOA

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ABSTRACT

RFID middleware is regarded as the nerve of RFID systems. Firstly this paper analysis and discuss relatively mature RFID middleware, and propose a RFID middleware which based on service-oriented architecture. Then in this paper we introduce the CEP (complex event processing), and it is a new technology for event and data processing. With the widespread usage of RFID technology, complex event processing becomes a very important part in RFID application. Through introducing its work, we indicate the basis of introducing CEP to RFID middleware. We focus on the complex event processing technology in RFID data processing, and present a based on CEP data processing model, and study cache, Event Filter and Complex Event Builder key technologies. Moreover, a query language for detecting RFID complex events is also introduced.

Keywords:RFID middleware; SOA; Complex Event Processing

1. INTRODUCTION

RFID (Radio Frequency Identification) [1] [2] is a non-contact automatic identification technology, which has features of high-speed moving object recognition, multi-target recognition and identification of non-contact. RFID technology shows great potential for development space, it has been applied to warehousing and logistics management, asset tracking, processing control, authentication, intelligent transportation and other fields. RFID is being developed as an essential elemental technology for realizing sophisticated information technology in ubiquitous environment. A tag containing an identification code is designed to respond to specific frequency, and if it enters the response range of a reader it sends information wirelessly and, receiving the information, middleware converts it and uses as CPU data.

With the development of RFID applications, they are involved in business processes so complicated that lead to more frequent changes of RFID business logic and also higher cost of RFID applications. So this paper introduces an RFID business integration solution that RFID middleware based on SOA and uses complex event processing to extract complex business events from large numbers of simple events submitted by RFID middleware [3][4].

This paper is organized as follows. Section 2 introduces related work. Section 3 introduces related technologies. Section 4 introduces the RFID middleware based on service-oriented architecture and each component of the framework. Section 5 introduces the complex event processing and their components. Section 6 is conclusion and future work.

2. RELATED WORK

References [5] presented for the use of EPC(electronic product code)issues, determined the EPC Network technical framework, including database operations software(Savant), physical markup language(PML), object name service(ONS). However, references [5] don't support the RFID middleware, for example, functional description unclear, not uniform standard event filtering and not support the definition of high-level event. RFID middleware that Sun presents is completely end to end solution. RFID middleware is divided into four levels that presentation layer, business process layer, service layer and the integration layer. The disadvantage is that functions of the middleware are thin, simple filtering rules, the lack of definition and complex event processing. IBM RFID solution presents lightweight middleware framework, the central idea is that through an information bus instead of complex hierarchy. The RFID middleware architecture includes "edge controller" and "promise server". Between "edge controller" and "promise server", whose communications are by the way of publishing the theme/subscribe.

3. RELATED TECHNOLOGIES

3.1 RFID middleware

A typical RFID application system structure is shown in Figure1. RFID reader read RFID tag data at the lower hardware layers. The raw data are read and then sent to middleware processing. In the middleware equipment and data management layer, it reads the RFID tag identification number through the filtering mechanism which is filtering redundant data. After data is filtered, only the upper-related data is sent to the event management. Only the real-time RFID information generated in the event management is handled and then sent to upper application. There are API interfaces or Web Services based on open standard for XML. Besides, there are other services including smart transactions, analysis and event notification in this layer.
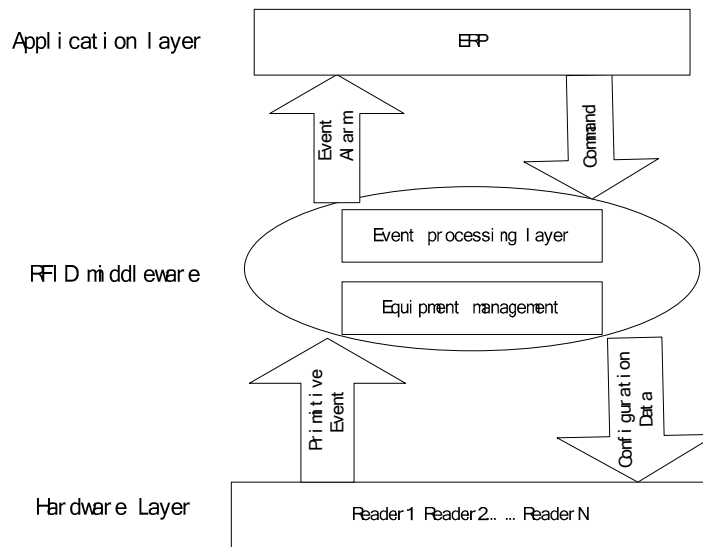

Figure 1. RFID middleware framework

3.2 Service-oriented architecture middleware

Service-oriented architecture is a technical architecture style, which presents an open, agile, scalable and defines between the service providers and consumers loosely coupled relationship. The characteristics of their business agility help enterprises to become more flexible business, and are able to timely respond to changes quickly. The core concept of SOA is that services. W3C [6] defines service as follows: "service is a mission that the ability of abstract resources and a service provider must be specific software entities that can be used to achieve." Web Service is currently the most widely accepted SOA implementations. Its basic structure is shown in figure 2.
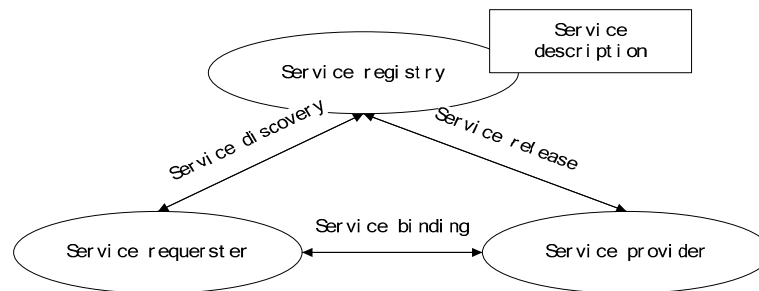

Figure 2. SOA service-oriented architecture

3.3 RFID middleware and SOA integration

As the characteristics of RFID itself, main information sources of RFID application are items for each unit of information objects, however, the large number of article and information on the diversity of goods cause the entire system

to handle the amount of data and data format has greatly increased. As the same time information exchange between systems and management become more complex. Web services map a real world into a set of services above, and RFID data is closely related objects in the physical world in reality and data processing functions are through the form of services provided. System will submit part of the functions to the Web service handle, so that it can greatly reduce the burden of the RFID application system for data management and transmission. It can shield complexity of the system, and just let the system handle some functions, while others related services and technologies provided by the Web service provider. As the same time because of the inherent characteristics of Web service, the combination of RFID applications will can be done with the language-independent, protocol-independent, platform-independent.

4. THE RFID MIDDLEWARE ARCHITECTURE BASED ON SOA

SOA have the features of loosely coupled, business-oriented. Combined with the application of RFID middleware system integration programs can provide a rich interface and help achieve the management of RFID devices and data processing and simplify the application of the underlying device support, avoiding the underlying device handle low-level interface. Using Web Service technology achieves the RFID middleware and enterprise integration, and complete loosely coupled integration among them.

The infrastructure of the RFID middleware architecture based on SOA is divided into device management, event handling layer and the service interface layer, and packaged the appropriate functions of each layer by Web Service technology and the concrete realization. In this paper, we present the RFID middleware architecture infrastructure layer of three functional layers. Three levels have a clear division and the interfaces among layers and are divided into device management, event handing layer and the service interface layer. SOA-based RFID middleware architecture is shown in figure 3.
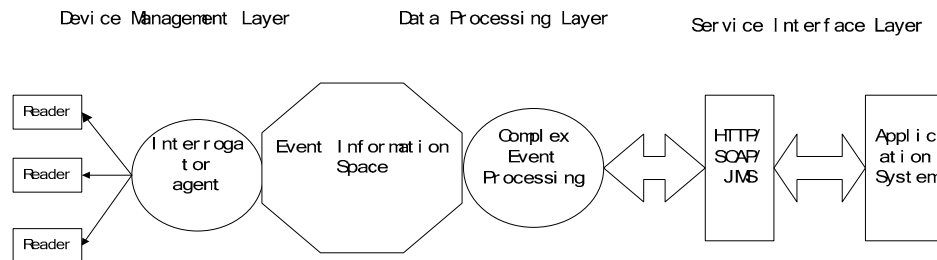

Figure 3. SOA-based RFID middleware framework

4.1 Device Management Layer

Device management layer provides remote device configuration interface, and manage one and more interrogators for readers, other sensors and specified ALE event [7]. Equipment and interrogator are one-to-many relationship. An interrogator is assigned a physical device summary table but not every physical device summary table can have multiple sensors. When a device management initializes oneself, it determines which is responsible for a physical device and its configuration information, then securely downloads and initializes the appropriate interrogator, then register event finally.

4.2 Data Processing Layer

Data processing is the core of RFID middleware functionality that based on the theory of formal method, data mining, neural networks, sensor networks and complex event processing and so on. For solving two issues of the large raw data and original data containing less semantic information, data processing layer reduces data redundancy and compresses event scale for upper commercial applications providing semantic information. Data validation, data filtering, data flow control and data storage are the basic module of data processing layer. The role of the data filtering module is finding useful and important data among the large amounts of data. Data storage module is to deal more effectively with large amounts of data, that reduce data processing operations, store data on the back-end database frequently, and check the data brought forth in the network transmission.

4.3 Service Interface Layer

The data form the event handling layer is the class classification of the final XML file. The same type of data stored as XML files provide to the appropriate use of one or more application. The service interface layer is mainly on filtering these data and storage operations then provide access to the appropriate database service interface. Specific operations are as follows:

a) Bulk storage operations on the stored in XML files on the disk.
b) Before data transplantation should filter out the duplicate data.
c) For internal and external companies access to database and provide Web service interface. Among them, the data filtering processing is in dealing with temporary storage of XML document in the process of completion.

Information server obtain and store information using the EPC and the EPC RFID non-relevant information generated by information technology, EPC-related information, including event manager tag observations and the corresponding EPC data to a higher level of business information. Information server typically has a group of low-level observations into higher level business functions.

Other application through the exchange of XML messages to interact with the information server. Information server supports HTTP and JMS technology information transfer. All data are stored in a relational databases, any support for JDBC-RDBMS can be used as data repository.

5. COMPLEX EVENT PROCESSING

Complex event processing [8] is to build and manage business information system technology. The goal of complex event processing is to extract event formation through the enterprise information system for real-time processing, business management, and provide the basis for business process.

5.1 Complex event processing technology principles

Complex event processing of RFID middleware should have two functions that complex event detection and event information extraction. Shown in Figure4, basic events are processed through three stages that are "event pattern matching", "event stream processing", "event information integration" respectively. Pattern matching includes the filter, combined, control operations that the basic flow detects the high-level event. Event model expression is as follows. Event A (id=16, tag=355) and Event B (id=32, price=55).
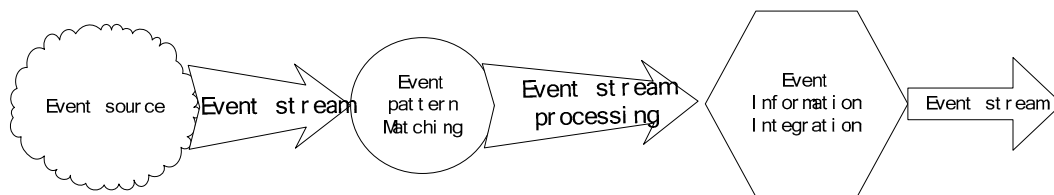

Figure 4. complex event processing

5.2 Definition description language

The mature complex event description language is not much, SASE [9] event description language is a relative mature, open and based on the event stream description language. It can accurately describe the event flow, matching, filtering and conversion that can match the original event stream conditions based on time and the formation of the complex events [10]. Its grammatical structure is as follows.

EVENT <event expression, exp>,
WHERE<conditional expression, p>,
WITHIN<time expression, t>
For example 1
EVENT (SHELF-READING *x*) && (OVER-TEMPERA-TURE *y*)
　WHERE x.id= '*010202*'　　*x.shelf_id =y.shelf_id*
　WITHIN 1 hour

SHELF-READING means the read event of reader on the shelf. OVER-TEMPERA-TRUE means event of temperature sensor. Example 1 expresses if the number '010202' product where the shelf put is too high in 1 hour, then alert.

5.3 CEP-based data-processing model

According to the processing, data processing model based on CEP can be divided into three levels: raw data layer, basic event level and abstract event layer. Raw data layer is responsible for collecting the original data from RFID reader, because there may be different types of readers and standard sign, so that obtained data have a variety of data formats. Basic event layer that use the cache technology process the raw RFID data into common format, information complete, accurate semantic basic RFID event. Abstract event layer using RFID event filter or RFID complex event builder process the basic RFID event into the abstract event that application. In addition, the model rule configuration allows RFID application software to configure the event filter and complex event builder to adapt to changes when the business application software changes. By complex event processing, the business events concerned by enterprise can be collected form a huge mass of primitive RFID events, so as to drive the execution of business processes.
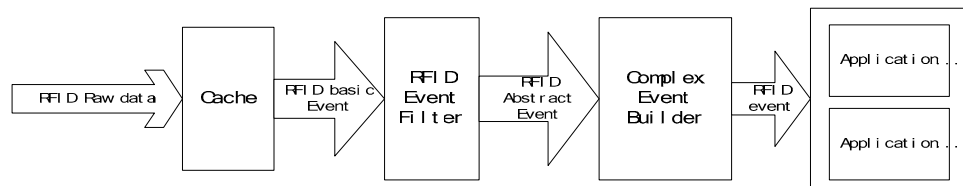

Figure 5. RFID data model for complex event processing

5.3.1 Cache

Cache can store the background information data, manage information on the background by virtual memory management technology, then place various background information pages in the cache. RFID data that use frequency of background information change the stored background information in the cache, so that achieve the RFID data to quickly find the necessary background information.

5.3.2 RFID Event Filter

RFID Event Filter is a series of set of event rules. When a large number of arbitrary simple events are put into event filters, the output is consistent with rules of all RFID events. Event filter function is that it can extract only important or interesting event to reduce the number of dealt incidents. There are two main types of RFID data filtering: the underlying data filtering and system data filtering. The underlying data filtering aims at that raw data filtering- duplication, redundant data filtering. One main cause of producing redundant data is that readers read and write the same label at a long time. More than one reader read a label at the same time in order to increase the reliability reading of item which is bound with many labels. The system data filtering is mainly according to the changes of application layer data to configure the event filters through RFID rule   Configuration, which change and increase or reduce the corresponding rules of RFID events, so that minimize the amount of RFID event and extract the interested event.

5.3.3 RFID complex event builder

There are the complex relationships among the RFID event, for example, time, hierarchical relations, including relations and causal relations. Event builder is a complex event relational mapping library, which predefine the relationship among them. When you enter a number of events that they are consistent certain rules, it will produce a corresponding output event. For example, in the discrete manufacturing production line a part of the manufacturing needs multiple stations, RFID read and write events of each station have a strict time sequence. Equipment management department could easily argue that the useful complex events of a reader misreading occurred, leakage or failure through time relationship. Complex event builder not only tap out the hidden useful information, but also meet the needs of the application.

Based on complex event processing RFID middleware, RFID systems will be most focused event handling to the system of the middle layer, and enhance the middleware functionality. At the same time, complex event processing includes event handling most of the basic logic and basic operations. Therefore, the flexibility of the system will not be affected. Although this platform has some problems of design, it needs to experiment and practice in future tests. Since

the application of RFID in the process exposes the many security risks, so RFID middleware security architecture will be an important consideration in the future development of RFID middle that is a key factor in success.

As one of the focus at home and abroad, complex event processing technology in the financial, physical flow, and military fields have broad application prospects. Based on hierarchical design thinking, combined with the data features of RFID systems, complex event processing technology will be introduced to the RFID middleware system. A RFID middleware model which allows different levels of abstraction in the set filter conditions is interest to the upper application software business information.

6. CONCLUSION

SOA-based RFID middleware platform architecture, the most advantage lies in RFID technology and SOA architecture integration at the enterprise level. In the platform, RFID middleware technology provides data services to enterprises. SOA technology for the RFID middleware and the other application of enterprise provides the underlying security, integration, business process scheduling and other services. Both realize the data exchange and sharing and possess good interoperability and scalability. This paper utilizes the complex event processing for RFID middleware based on SOA. Complex event processing not only helps the user find the interesting events from large number of events, but also contains the ability to analysis data and extract information. The introduction of the complex event processing technology to RFID middleware can improve the ability of data and event processing and enhance the functions of RFID middleware.

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