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A Design Scheme of Supply Chain Information System Based on Internet of Things

Bingwu Liu[1], Guangguang Zhao[1*], and Juntao Li[1]
[1] School of Information, Beijing Wuzi University, Beijing, China, 101149.
Liubingwu@bwu.edu.cn; zhaobofan00@126.com; ljtletter@126.com

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Abstract. The development of IOT brings more and more significant impact to the supply chain management. However, the current information system is difficult to meet the conversion between low-level information and operational level so that the enterprise is unable to respond to changes in the supply chain system timely. And at the same time, data extraction method is kind of wasting system resources way, many are repeat extraction, similarly, middleware system for RFID data also functions overlap exists, no maximum efficiency system efficiency. The paper put forward the SOA information services architecture which is based on Internet of Things (IOT). It realizes the transmission of information of the web service application services through defining complex event detection mode, meets the enterprise's requirements for the available information from business level.

Keywords: Internet of Things, Supply Chain, Complex Event Processing

1. Introduction

The increasing development of the IOT technology brings many new ideas to solve the problems existing in the research of supply chain, but it also faces many problems: The huge amount of data generated by RFID systems has been beyond the processing capabilities of existing information systems[1]; In the field of supply chain applications, it lacks the effective management mechanism between the actionable information and enterprise response, which leads to enterprises unable to response timely to the changes occurring in in the supply chain system [2]. In summary, the information gaps need to make up, the

response mechanism to the changes existing in supply chain should be established, and the Complex Event (CEP) [3] provides a new way to solve these problems.

The RFID Middleware brings solutions in information processing for IOT, the raw data filtering, information discovery and extraction based on complex event, the console to manage the whole system. But many middleware are the overlap on the function, at the same time, for the whole architecture, report information service is also a problem, different services require different data supports, because in the supply chain, the participants are all have their own business focus, information sharing and secrecy should find a balance between them. It puts forward high requirements for the overall framework of the flexibility and efficiency[4]. This paper proposes a SOA(service-oriented architecture) framework design, through the application of standard middleware, do not overlap function, and also has safety and normative meet for the web service republication, so that the whole supply chain system can be coordinated, efficient operation between global and local.

2. The Study on System Architecture

The original application system inside enterprises in supply chain and the IOT "perception" system are absolute heterogeneity essentially. In order to establish the implementation of the participation information service in the supply chain, the application architecture based on SOA to establish the information service mechanism, and to meet the different needs of business users through the Web Service. In addition, RFID events and other extracted primitive events are low level and need context to be aggregated into actionable business information, and through the definition of complex event specification detection mode to realize transformation from primitive events to actionable business information. The architecture of system based on Internet of things for supply chain is shown as fig. 1.

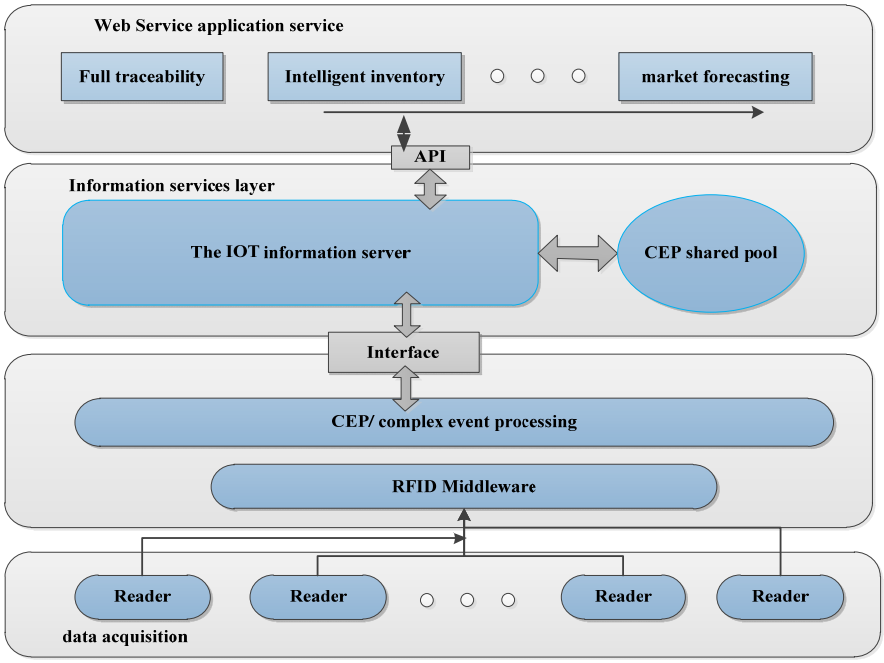

Fig. 1: The architecture of system based on Internet of things for supply chain

The proposed system from bottom to top respectively is: RFID infrastructure layer, The raw data processing and equipment management middleware, Context aware event processing, web service manager, four levels respectively take different tasks. RFID infrastructure layer is the cornerstone of the whole architecture, and the information of acquisition is all from it. The middleware of this system is responsible for the processing of data, and control the system running in a safe and stable environment.

The middleware in the system framework is to complete the following tasks.

Processing the data in the infrastructure architecture

Each device includes RFID infrastructure are required to be registered, configuration, and service monitoring。This level of middleware is responsible for control, automated or semi- automated configuration, monitoring and organize the devices in the infrastructure, to deploy them in the entire network to effectively meet the needs of the application in enterprise。And at the same time, because the identification of RFID is on the instance level, and instantaneously capture product information from RFID data stream, so it must include data filtering and aggregation function. The middleware on this level also need to do is to reduce the complexity of time and space by avoid the temporary read error and smooth data , and optimize business processes as well.

Context aware event processing（CEAP）

It Contains the event processing (EP) and context aware (CA). EP is responsible for the definition, registration of event ,detect the event and processing them base the relationship between the events as well as the context we defined(We talked about the context definition of the next chapter). Context aware include defining the background, context understanding, and trigger the application behavior recognition based on context. Based on the above functional description CAEP is real-time, mining event value, to support the polymerization of RFID information between events and web service application. In this system, the CEP shared pool is a space cached the CEP which is firstly detected. the IOT server will define complex event detection and processing mechanism.

Application program interface (API)

RFID data access supply chain management and enterprise management system, RFID middleware to provide the API function. API is also applied to inter enterprise information service, meet between different enterprise and customer communication.

RFID data sharing between different partners like the melody in the enterprise application system through the inter.

Web service management (WSM)

The nature of Web service is that it can provide interoperability machine to machine interaction in the network, timely response and the event triggered. WSM is responsible for taking care the core part of this system architecture, for example, if CAEP want to accomplish certain design aspects like interoperability, openness, federation via web services, WSM can provide this help. Especially when the RFID middleware solutions deployed in a distributed environment, WSM can reduce the communication cost between staff in different regions.

3 The Key Technologies to Realize the System

3.1. Complex Event Processing

In the supply chain, events can be extracted from the service, database, RFID, and activities and so on. At the same time, the event can be simply divided into the original events and complex events, can also be classified according to their attribute, and they also have a causal relationship between them. Operators combine events together to form complex events or situations. These operators

include logical operators, time operators, causality operators and RFID operators. In this paper, the context used to represent those need to be transformed from a low level to the high level of information. Semantic space is a relatively independent context of events, which is bounded by two events called initiator and terminator. At the same time, characters, locations, role, status and other relatively independent of the context information is contained in the semantic space.

Data structure for complex event detection

The treatment of complex events has many key parts: event extraction, event aggregation, event response etc. For the supply chain information system, detection of complex events is the key to the service implementation. In the distributed system structure, this paper presents a data structure for complex event detection as shown in the following fig. 2.

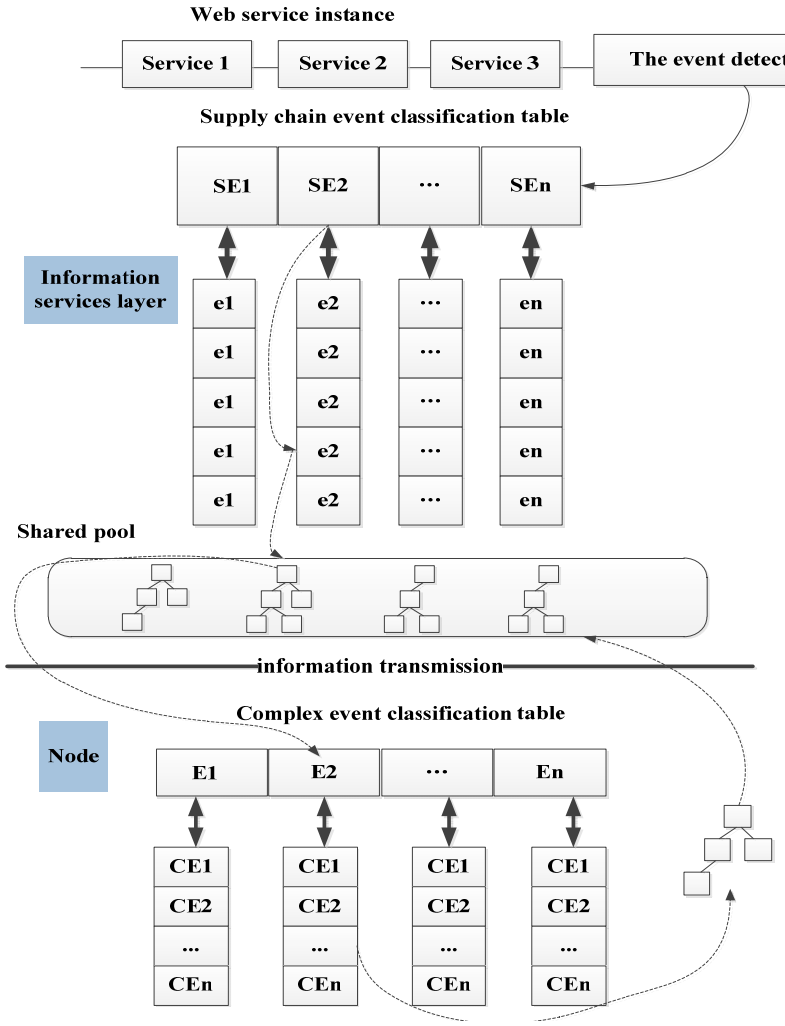

Fig. 2: The data structure for complex event detection

Supply chain event classification table: For the service requests are classified as complex events in supply chain, each instance will have a system resource allocation and every time the user requests are recorded. When the record over a certain period according to the timeout strategy for destruction.

Complex event classification table: Each type of complex event corresponds to a complex event classification in Supply chain node; the table includes each kind of complex event description, and the type of the event as a composite operator. When a complex event expression is compiled and verified to be correct, it will be saved to all its operands' complex event classification table.

Shared pool: the intermediate detection results of each complex event are cached and saved for incremental detection, especially to share the detection results for different complex event expressions which have common sub – expression. The shared pool provides basis for optimization of the complex event detection. For example, if the event of AND(A_1,A_2) is firstly detected. It will be cached in the shared pool as an intermediate result. For the detection of complex events CE_3=OR（AND(A_1,A_2),A_3）, When find the AND(A_1,A_2) in the shared pool, only need to request the A_3event to supply chain node, to avoid a repeat of the detection of AND(A_1,A_2) events.

The user sends a request to the information service level through the web server, the request will be judged the request type through the event detector, and point to the area of the event class; When detected the event processing method, it will check whether the requested information services are saved in the shared pool, if the pool saved the request results before, the results will feedback to client.

3.2. Web Service Design

The use of Web services composition to handle complex affairs has been considered to be a feasible method to realize the cooperation among enterprises. However, participants is vertical in supply chain, not only a large quantity of information source, but not fixed, each supply chain participants need information services are not the same. Inventory managers is more concerned about the inventory is maintained at a high rate of turnover, retail managers more concerned about the effect of sales promotion, how to meet so many needs, I think SOA is a good solution.

The information services of Internet of Things oriented to supply chain applications in the paper revolve around real-time information resources derived from supply chain managers and participants. The information resources include inventory information, distribution information, sales information and a series of other information. The users can get the services they need by entering the query system [5].

In order to ensure that provide high quality web service, we need to meet the requirements of two aspects namely, efficiency and security[6]. We use the web service contract to provide the application for the users in unified syntax and semantics. The underlying data model has been regulated to provide network service application information structure, this measure can ensure that the

information would be applied to the network service for receiving and transmitting. In this way, the service response will be more quickly, and it will be more easy to manage the services. On the another side, the interaction data of web service application must be conducted in a safe and reliable environment, not only have the access control, but also the data interaction between different enterprises will abide by the safety rules.

4. Application example

If we want to find a book, what we most probably to do is that：Pass the door with our ID card, then import the name of the book into the library management system and find the cord of the book. After that we can find the book on the bookshelf by the information of book. But if there more than one library in our school, is it necessary for us to search the book in every library？

The supply chain information system is more complex than the case above, especially in the searching of subject between different systems. The application of tracing an tracking in the whole chain is a good example. But in this paper there have a good solution. If there have two systems namely, Intelligent Transportation system(ITS) and Warehouse Management System(WMS). ITS is responsible for the distribution path planning and update, and the GIS(Geographic Information System) can support the visualization of path; WMS is responsible for the control in inventory, stock-taking, statistical analysis of warehouse usage, etc. The two systems are independent of each other, how to get data from them for tracing an tracking in the whole chain is significant. In this paper we give a plan to solve this problem. The path of product will be planned in the ITS when a new order came in the supply chain system, this planned path contains the way to warehouse, and we can get a preview of the distribution path. If the products of the order arrived at the expected location or warehouse, it needn't to change the plan, otherwise, if there had anything changed in the path just because traffic problem or something else, the path will be planned again by ITS. In this way we can simply the process of searching object in the supply chain, just like someone tell you where the book is if you want to find a book in the library. For the path of product we have a plan in advance, if there something changed in the route, we will remind system to update the path, when we want to search the product, only we need to do is that query the warehouse in the path, so in this we avoid the loss of redundancy query. Furthermore, we put the history query in the shared pool for the other users to search. This procedure not only optimizing the query, but also reducing the query pressure of the system, and it's very useful keep the system efficient.

5. Conclusion

The development of a new technology is not a simple process, just like bring RFID into the field of supply chain. The generation of huge data, at the same time ,with wrong read and leakage phenomenon; what's more Information service demand all participates in the supply chain are also different, so if we in the design of supply chain system, we must ensure the flexibility and the efficiency of the system . SOA is a good antidote, a service-oriented architecture not only can release the required service to different participants, for the different middleware application is also given specification, to insure that the overall architecture of the efficient and safe. For complex event processing, this give a efficiency model to detect and process data, as we all know, repeat query is kind of wasting system resource, so the share pool can improve the efficiency of the system, historical queries can be used effectively. At the end of this paper, is an example of an application, explain it by an example is to go to the library to find the book, extracting data from distributed environment. In the future, we will do further research in specific processing link information, at the same time develop the system to check the design and Implementation of the theory.

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