Research on Addressing Technology of Internet of Things Unique Resources Based on RFID

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Abstract. The global nature of the Internet of things obviously has the problem of cross domain communication, so the Internet of things also needs a set of perfect resource addressing technology to meet its resource addressing needs and promote the interconnection of the Internet of things. Through the analysis of five key elements of resource addressing, such as resource name, resource address, addressing mechanism, update mechanism and security mechanism, this paper summarizes the resource addressing characteristics of Internet of things, which is not only conducive to the design of resource addressing model of Internet of things that meets the demand of resource addressing, but also the necessary premise to solve the key technology of resource addressing of Internet of things. In order to solve the address conflict and addressing problem between different standards of radio frequency identification (RFID), a hierarchical addressing model based on RFID resource name space is proposed. This paper analyzes the characteristics of RFID resource addressing and the existing RFID addressing technology, finds out the defects of addressing technology based on domain name system, introduces the formal expression method of RFID resource namespace, and designs a hierarchical addressing model.

Keywords: Radio frequency identification, Addressing model, Code resolution system

1. Introduction
Internet of things (IoT) is the next generation of intelligent information network, which combines new information technologies such as radio frequency identification (RFID) technology based on inductive devices and wireless sensor network (WSN) with Internet. The research of RFID underlying information resource addressing technology mainly focuses on RFID middleware, location algorithm, discovery service, addressing technology, etc [1]. In the future, the public service granularity of RFID will be oriented to single product level service. Considering the multi system status of item coding, the hierarchical architecture will be more convenient for data management and maintenance [2]. The Internet of things is a new network which combines various information sensing devices with the Internet. It has the same resource addressing requirements as the Internet, so as to ensure that the related information of the Internet items can be efficiently, accurately and safely addressed, located and queried. The particularity of the Internet of things fundamentally determines that its resource addressing is different from that of the Internet. Resource addressing system generally includes five key elements: resource name, resource address, addressing mechanism, update mechanism and...
security mechanism. The resource name refers to the name used to uniquely identify the resource in the resource addressing system, and all the resource names in the resource addressing system constitute the namespace of the resource addressing system; the resource address refers to the location information used to locate the resource in the resource addressing system, and all the resource addresses in the resource addressing system constitute the resource addressing system address space of source addressing system[3]; addressing mechanism refers to the way to find or retrieve the corresponding resource address through resource name, which is the core function of resource addressing system; update mechanism refers to the way to update the corresponding relationship between resource name and resource address in resource addressing system; security mechanism. In this paper, a RFID resource naming and hierarchical addressing model is designed, which can solve the problem of compatibility of multiple item coding standards, and the model is verified by practical application.

2. Characteristic Analysis of Internet of Things Resource Address

Resource name is relative to its corresponding resource addressing system, and it also has a certain hierarchical structure. Its hierarchical structure can be divided into single-level and multi-level, which are called single-level hierarchical structure and multi-level hierarchical structure respectively [4]. Among them, the single level hierarchical structure means that the hierarchical structure of resource name is only divided into one level, and the parts of resource name are parallel; the multi-level hierarchical structure means that the hierarchical structure of resource name is divided into multiple levels, and there can be a certain subordinate relationship between the parts of resource name at all levels. The characteristics of Internet of things resource name, that is, the Internet of things resource name has a multi-level hierarchical structure, but its hierarchical structure has two characteristics different from the Internet resource name, namely, the unknown and decentralized. Among them, the unknownness will lead to the fact that the Internet of things resource names with this feature can not be directly used as the input of the resource addressing system based on hierarchical addressing algorithm, and the decentralization will lead to the fact that the Internet of things resource names with this feature can not be directly used as the input of the resource addressing system of the Internet of things [5]. Therefore, Internet of things resource names can not directly participate in resource addressing as Internet resource names, but need to be converted to remove its possible characteristics. Therefore, the Internet of things resource name is divided into two types: the original Internet of things resource name and the converted Internet of things resource name. The original IoT resource name refers to the IoT resource name without any conversion operation. Its hierarchical structure may be decentralized or unknown, and it may not be able to participate in the normal addressing of IoT resources. The transformation of Internet of things resource name refers to the Internet of things resource name that has removed the decentralized or unknown hierarchical structure after the transformation operation, which can directly participate in the addressing of Internet of things resources.

The resource address refers to the entry address to access the resource. From the perspective of resource addressing technology, resource address refers to the result of a resource addressing operation corresponding to the resource name. Internet of things resource address includes two types: direct resource address and indirect resource address [5]. The direct resource address is the physical address, which can be directly used as the final communication address of resources; the indirect resource address is the relative address of resources, which can not be directly used as the final communication address of resources, but can be directly used as the final communication address of resources. As the resource name of other resource addressing system, it is used to further obtain the relevant address of the resource. However, due to the above characteristics of IoT resource names, the output of IoT resource addressing is not only the IoT resource address, but also the conversion information needed to generate the conversion of IoT resource names. The transformation information includes two types: standard hierarchical structure information and extended hierarchical structure information. The standard hierarchical structure information is the transformation information needed to remove the
unknowns of the hierarchical structure of Internet of things resource names, and the extended hierarchical structure information is the transformation information needed to remove the dispersion of the hierarchical structure of Internet of things resource names. The translated IoT resource name can be used as the input of its corresponding IoT resource addressing system, so it can be regarded as an indirect resource address, and the corresponding translation information can be regarded as the information needed to generate the indirect resource address.

2.1 Characteristic analysis of resource addressing mechanism in Internet of things

Resource addressing mechanism refers to the way that the resource addressing system finds or retrieves the corresponding resource address through the resource name, which is the core function of resource addressing. Accordingly, the resource addressing mechanism of the Internet of things needs to support the conversion of resource names of the Internet of things. Therefore, the resource addressing mechanism of Internet of things includes not only a number of unary resource addressing functions, but also a number of binary resource conversion functions. There are two types of addressing algorithms in IoT resource addressing function: flat and hierarchical. The IoT resource names with decentralized hierarchical structure must be combined with the relevant resource address information output by the resource addressing function and converted into the transformed resource name by the resource conversion function operation before they can be used as the input of other resource addressing functions for further operation until the direct resource address is obtained [6]. The IoT resource names with implicit hierarchical structure must be combined with the relevant resource address information output by the resource addressing function and converted into the resource name by the resource conversion function operation before they can be used as the input of the resource addressing function based on the hierarchical addressing algorithm for further operation until the direct resource address is obtained.

2.2 Defect analysis of mainstream RFID addressing technology

Addressing refers to retrieving the corresponding resource address through the resource name. In radio frequency identification technology, code resolution system (CRS) is the core technology of RFID Public Information Service, which queries the service address of the corresponding item information according to the RFID tag information. The addressing technology of EPCglobal network architecture and uid center ubiquitous network architecture is generally based on the mechanism of domain name system (DNS). There are some problems as follows:

(1) Compatibility issues. There is a set of unified resource naming and addressing standards in the Internet, and the addressing of IP and domain name is a bijective relationship. However, the current situation of the Internet of things is the integration of multiple technologies, the coexistence of multiple sets of competing standards, the existence of explicit and implicit resources of goods, and the addressing conflict between different coding standards of goods in the Internet of things.

(2) Security and efficiency. DNS can't support fine-grained access control for clients, and is vulnerable to DOS attack, so the efficiency of root server is low.

(3) Robustness. The article information is stored in the epc-is or information system server, and the supply chain information is stored in the ons or ucoderp server. The disadvantage is that once there is a problem with the important server, all related dependent services will be affected.

(4) The load is unbalanced. Massive items exchange information on the Internet of things at any time, which inevitably causes the addressing system to suffer a lot of load. DNS load balancing technology is not perfect, and ons and ucoderp with the same DNS mechanism are prone to load imbalance. To sum up, the addressing technology relying on DNS can not meet the requirements of RFID resource naming and addressing.

Therefore, it is necessary to design a new resource naming and addressing model based on the analysis of the characteristics of RFID resources. The transmission model of RFID technology is shown in Figure 1.
RFID tags
RF communication template
Control processing template
Smart unit
Background application system
Ethernet interface
Baseband signal processing unit

**Figure 1.** RFID technology transmission model

1. Tag tag.
   It is composed of antenna and chip. It is usually embedded in the magnetic card. Each tag has a unique electronic identification code. Tag is the information carrier of RFID system, which is mostly composed of coupling elements (coil, microstrip antenna, etc.) and microchip. According to the power supply mode: active tag and passive tag. Working frequency: low frequency tag, high frequency tag, ultra high frequency tag and microwave tag.

2. Reader writer.
   It has the function of reading and writing electronic tags, which are generally set on fixed devices to sense the information of moving objects. Generally, it is equipped with an antenna that can transmit radio frequency signals of a certain frequency. It has a response unit and a memory to play the function of encoding and decoding. The reader can be a read or read / write device according to the structure and technology used. It is the information control and processing center of the radio frequency identification system. The reader is usually composed of a magnetic coupling module, a transceiver module, a control module and an interface unit.

3. Application software database.
   Connected with the reader through the transmission network, verify the tag information, process the collected data, and feed back to the original perception.

3. RFID Resource Naming and Hierarchical Addressing Model

3.1 Characteristic analysis of underlying information resource addressing
   RFID item coding is the carrier of the underlying information resources, with dominant and recessive characteristics. The information of items with explicit characteristics can be simulated and tracked according to the deterministic random number generated by the management mechanism at a certain time. The implicit information contained in the item code with implicit characteristics may have the same attribute code of different items. The resource and code are not bijective, and address conflict may occur. Compared with the resource addressing system, the article coding hierarchies that follow different article coding standards will be decentralized and unknown, and the transformation information needed to eliminate the characteristics of the article coding hierarchies will be different[4]. Therefore, according to the coding system standards of RFID systems, the article coding provides the corresponding conversion information when addressing resources, otherwise it will produce conflict problems. The communication model of RFID system is shown in Figure 2.
3.2 RFID resource namespace

A resource namespace (also called a namespace) is a collection of names for a resource addressing system. Resource name individuals in a namespace are unique in the space. In RFID network, resource namespace is the coding standard of various items. For example, ucode and mrfid codes have 128 bit long codes, and different coding standards may produce the same code. To achieve the global consistency of resource name space, the addressing model should have the mechanism of resource name information recognition and transformation, and support the mechanism of automatically finding matching preprocessing rules[5].

The explicit resource name is \(Y\), and the resource address information is \(X\). Then the namespace of the hidden resource name \(D\), the explicit resource name \(Y\) and the resource address of the n-th level are respectively expressed as:

\[
A(Y_N) = \{Y_1, Y_2, \ldots, Y_i\} \\
A(X_N) = \{X_1, X_2, \ldots, X_i\} \\
A(D_N) = \{D_1, D_2, \ldots, D_i\} 
\]

(1)

The transformation function from recessive resource name to dominant resource name is defined as binary function \(T(x)\), then the transformation function of N-level is expressed as

\[
A(Y_N)A(D_{N-1}) = (T_N(A))^{-1} 
\]

(2)

Meet the following conditions:

\[
T(Y_i, D_{N-1}) = T(Y_i, D_{N-1}) \\
D_{N-1} = T_N(\phi, D_{N-1}) 
\]

(3)

(4)

It can be seen from the above formula that if the resource name does not contain implicit attributes, it does not need to be converted. The addressing function from explicit resource name to resource address information is defined as unary function:

\[
A(D_N) = A(A(X_N)) 
\]

(5)

Among them, \(A(.)\) and \(T(.)\) are general functions, which can be converted into specific functions.
3.3 Hierarchical addressing model

This paper proposes a hierarchical model of RFID resource addressing. The protocol stack can be divided into application layer, resolution service layer, discovery service layer, identification information layer and physical address layer[6]. The RFID resource name represents the tag information collected by the reader, and the physical address of the RFID resource represents the metadata information (location, status or other information) of the item corresponding to the tag. The schematic diagram of hierarchical addressing model is shown in Figure 3.

![Figure 3. Schematic diagram of hierarchical addressing model](image)

The details of Figure 3 are as follows:

1. **Application layer.**
   Connect the RFID resource application software system, and realize the conversion from the standard identification code of the item code to the corresponding item code hierarchical structure information and extended information. The input is the standard identification code corresponding to the item code, which is converted into the lower layer parsing service layer, and the output contains the resource address information corresponding to the item code. In RFID network, it can be applied to middleware between reader and enterprise application, business connection between enterprise application, and information interaction between enterprise application and service registry. Web services can transform tag information from reader to resource in application layer.

2. **Resolve the service layer.**
   Addressing from item coding to corresponding specific resource address information. Taking the item code as the input, it needs to convert the item code into the dominant resource name according to the RFID resource address information provided by the upper layer, and the layer outputs the resource address information [7]. The implementation of this layer can replace the DNS domain name in the original architecture with the index number structure. By segmenting the RFID code, it corresponds to a root node and multiple service nodes in the service system. Each node is identified with a unique index number, and each node has a unique parent node, which is authorized by the parent node to be responsible for a fixed range of code resolution domain. The dependent index numbers between servers constitute a hierarchical structure. The inter tier server supports bidirectional traversal and query through bidirectional linked list and other data structures.

3. **Discover the service layer.**
The addressing of the item code to all its associated resource addresses. It also takes the item code as the input, and needs to convert the item code into the dominant resource name according to the RFID resource address information provided by the upper layer, and then outputs the related resource address set for the next layer through this layer. For EPC network, by opening an extended storage area in RFID tag, and adding fields and relevant information to EPC record table stored in each enterprise, EPC network can be transformed into network and discovery service can be realized.

Identification information layer and physical address layer.

In the RFID network, the structure is different from the Internet, but its underlying resources can be expressed by using the logical address and physical address of the Internet. The future trend of the Internet of things is to assign an IP address to each item in the world, directly connect to the Internet, and realize the Internet of things and the dialogue between people and things on the basis of the unification of the Internet of things and the Internet. In the identification information layer and physical address layer, the output address information generated by the input related resources through the addressing function is relation, and the conversion relation is relatively simple, which can be implemented based on DNS. The identification information layer completes the addressing from the resource address to the logical address. The physical address layer completes the addressing from the logical address to the physical address, and the final output of the model is the physical address of the related resource information.

4. Conclusion

It is one of the most important topics in the research of Internet of things to study the addressing technology of the underlying information resources in the Internet of things, which is accurate, safe and efficient. This paper proposes an addressing model for RFID. Based on the resource name space, the structure is set up to solve the global address conflicts and unaddressed problems caused by different standards in RFID applications, and the model is verified by application. The next stage is to explore a resource addressing model suitable for other types of Internet of things.

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