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A Cloud Computing Architecture Framework for Scalable RFID

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Abstract

RFID is a leading edge technology with some bleed points. Some of the issues in RFID are preventing it from gaining everyday acceptance. Such performance issues associated with RFID systems are limited computational capacity, poor resources and inefficient data management. Hence there is a demanding urge to address these issues in the light of some mechanism which can make the technology excel. Cloud computing is a paradigm shift which is gaining momentum with the promise of dynamically scalable and often virtualized resources as a service over the network. Motivated from the innovations offered by cloud computing, the primary focus of this research paper is to propose an architecture framework for the existing RFID systems melded with the Cloud computing paradigm in order to improve the scalability and boost the performance of RFID systems.

Index Terms: *Architecture, Cloud Computing, RFID, Scalability*.

Introduction

RFID (Radio Frequency Identification) is a technology which has been around since early 1900's. It has grown over the years from then. As per the currents scenario, RFID technology is seen heavily influencing our daily lifestyles to an extent that it is woven into our clothes and it has penetrated into our skin. When it comes to tracking objects, RFID has become the prime choice. Fully automated homes are no more a dream. What makes this technology so important would be appreciated by looking at the numerous bonuses it offers over the other existing identification technologies in the market. But even the roses are with thorns and so is the case with this technology. Before actually coming to the issues faced by the technology and the mechanism applied to the issues faced, a brief understanding of the technologies themselves becomes mandatory and the same has been presented in the subsequent paragraphs. An RFID system can be classified mainly according to the physical components it is composed of, frequency and data. The physical components of an RFID system are primarily numerous tags and readers. The RFID tag related factors are power source it has, environment in which it operates, the antenna on the tag for communication with the reader, its standards, memory, logic applied on the chip and application methods of the tag.

The RFID tags depend on power source which may be battery in case of active tags and reader in case of passive tags. An RFID tag is also associated with the environment in which it operates where the temperature range and the humidity range matters. Another component of an RFID tag is the antenna where its shape and material comes into picture. RFID tags have EPC and ISO standards associated with them. RFID tag has its small memory and logic is also associated along with and RFID chip which may be finite state or microprocessor or none. The application methods of an RFID tag are attached, removable, embedded or conveyed. The RFID reader factors include its antenna, polarization, protocol, interface and portability.

The antenna for communication in case of RFID reader may be internal or external and its ports may be single or multiple. Polarization of an RFID reader may be linear or circular. Single or multiple protocols may be used. Ethernet, serial, Wi-Fi, USB or other interfaces are used in an RFID reader. Regarding portability, it may be fixed or handheld. Apart from the physical components inside an RFID system, the RFID system may also be viewed from the frequency perspective. The frequency may further be classified according to the signal distance, signal range, reader to tag, tag to reader, coupling. The signal distance includes the read range and the write range. The signal range here in case of RFID systems points towards the various frequency bands i.e. LF, HF, UHF and Microwave. Reader to tag frequency may be single frequency or multi-frequency. Tag to reader frequency may be sub harmonic, harmonic, corresponding or an-harmonic.

Load modulation, surface acoustic wave or backscatters are coupling used in RFID systems. The data sub classification is in terms of the security associated with RFID systems, multi tag read co-ordination and processing. Public algorithm, proprietary algorithm or none are applied for security in RFID systems. The multi-tag read co-ordination techniques used in the latest RFID systems include SDMA, TDMA, FDMA, and CDMA. The processing part is composed of the middleware which further has its own architecture which may be single-tier or multi-tier and its location may be reader or the server. The cloud computing term refers to computational resources ('computing') made accessible as scalable, on-demand services over a network (the 'cloud'.)

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The concept of cloud computing may be well understood by using an example. Suppose a server room executive of a large academic institute requires installing the right hardware and software on the personal computers of all the faculty of the institute as per the requirements of their respective allocated courses. This would further require the purchasing of various software's or software licenses to give the faculty the tools they require for their respective courses. Whenever there would be a new hire in the institute, more software need to be purchased, it must be made sure that the current software license allows another user and which may not be an easy task for a large organization. If cloud computing is used in such a scenario, instead of installing a suite of software for each computer, the server room executive need to load only one application. That application would allow the faculty to log into a Web-based service which hosts all the programs the user would need for his or her job. Remote machines owned by another organization would run everything from word processing to complex data analysis programs. The cloud computing may be broadly categorized as software-as-a-service, platform-as-a-service and infrastructure-as-a-service.

First, software-as-a-service (SAAS) is also known as application-as-a-service. It includes the process of any application being delivered over the platform of the Web to an end user, typically leveraging the application through a browser. It is based on the more traditional timesharing model where many users shared one application and one computer. Second, Platform-as-a-service is a complete platform, including application development, interface development, database development, storage, and testing, delivered through a remotely hosted platform to subscribers. Based upon the traditional timesharing model, modern platform-as-service providers provide the ability to create enterprise-class applications for use locally or on-demand for a small subscription price or for free. Third, the infrastructure-as-a-service, (IAAS) is what makes the basic computational resources like disk space, storage, and servers available as on-demand services. Instead of using physical machines, IAAS customers get access to virtual servers on which they deploy their own software, generally from the operating system on up. It leads to cost savings and risk reduction since a big amount of capital expenditures are eliminated which were required in the deployment of infrastructure or large-scale applications in-house.

II. Problem Formulation

RFID technology is being adopted widely for various applications worldwide and at the same time the technology has certain issues which are hindering its exponential growth. Worldwide, researches are being carried out to address the issues with this technology like low computational capabilities of RFID, collision in RFID systems and expansion of RFID systems for huge organizations to name a few . The problem is strictly formulated based upon keeping three futuristic scenarios concerns in mind.

A. Limited Computational Capacity of RFID Tags

When it comes to computational capability, the RFID tags start behaving like the main character of movie Ghajni. The main lead of Ghajni tried to solve the mystery of his girlfriend's murder inspire of amnesia and his memory got "rebooted" after every 15 minutes. Similar is the case with RFID passive tags in the computing world . An RFID tag may effectively reboot itself even more than once per second and then lie abeyant indefinitely. RFID tags are dependent for power on occasional, salvaged, electromagnetic energy from an RFID reader waiting for the next RFID reader to come along. Needless to say, RFID tags are less computational capable. In addition to that, the existing RFID systems generate terabytes of data which has to be stored, processed and mined before its usage . This characteristic of the existing RFID systems may even lead to enhanced problems even if the computational and data production capability is improved in futuristic RFID systems. Which means that, even if the computational capabilities in the existing RFID systems is improved in future , then it would lead to fast identification which will directly result in generation of more data the same unit time (compared to the existing systems) which has to be stored, processed and mined . This further directly implies the requirement of more resources, services and of course infrastructure. It strictly depicts a strong urge for more scalable RFID systems to support this innovation of increasing computational capabilities in these systems.

B. Collisions in RFID Systems

Across the globe, extensive research is being carried to minimize the collision in RFID systems The futuristic RFID systems will be the ones with less number of collisions. Reduction of collisions in such systems would be resulting in fast identification. Fast identification means greater number of tags recognized same unit of time (as compared with existing RFID systems). This directly implies more data production capabilities. Hence, this scenario as well creates a stage for the demand of scalable RFID systems to support the ongoing inventions.

C. Adoption of RFID Technology in the industry

RFID is still in its growth phase and is being adopted by a huge number of organizations. Expanded deployments of RFID systems in big organizations are taking place as a result of adoption of the RFID technology. As a result, more infrastructure, cost, services, applications are required. The problem of scalability is even more intense in such a situation.

All the above depicted scenarios point towards one common concern in RFID systems and that is the scalability. For an RFID to perform more computations, efficiently deal with more data or to be widely adopted, it becomes quite important to design ideas leading to the futuristic scalable RFID systems. In the context of RFID technology, when a single reader is able to identify large number of tags and is very well able to communicate with them, it may be referred as a scalable RFID system. But this often does not happen in the real time scenario due to various practical constraints like collisions during the communication that takes place between the tags and the reader, lack of computational power of RFID tags, bulk of data generated by RFID systems. The above discussed scenarios support this view even more strongly keeping in view the futuristic RFID systems. In other words,

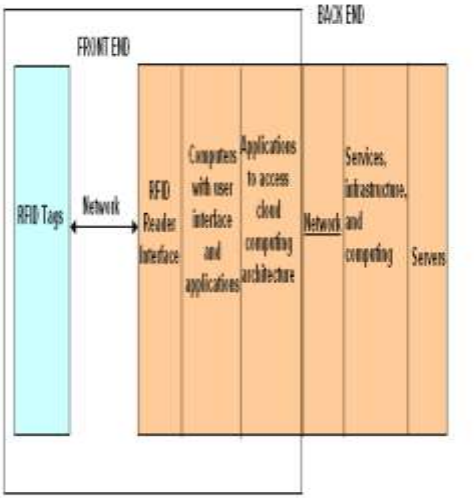

Fig1: A Cloud Computing Architecture for Scalable RFID

there is an alarming need to revive the existing architecture of the existing RFID systems in a way that the new architecture is capable of surviving scalability.

Problem Solution: The Proposed Architecture

The main focus of the paper is to attach a mechanism called cloud computing to the existing RFID technology and thereby to propose a framework of the architecture for the same. This would further show a way to the futuristic scalable RFID systems. Fig 1 represents the proposed cloud computing architecture for scalable RFID.

The Front End:

The front end part of the proposed architecture is composed up of the networked RFID Tags and Readers, computers with RFID data storage and processing capabilities (limited) and lastly applications which provide access to the cloud computing system. The working of the front end starts up with the initial generation of RFID data as a result of communication between the RFID tags and the RFID reader over the network. This data is generated as and when an RFID tag appears in the interrogation zone of the RFID reader. It is assumed here that the RFID system under consideration is the futuristic RFID system which is generating even more data than the existing RFID systems as a result of reduced number of collisions, enhanced computational capabilities and expanded infrastructure with even wider adoption of the technology. The data captured by the RFID reader is now sent to the data processing system composed of user interface and specific application to access the back end of the architecture. Now this huge data generated by this RFID system would be filtered, stored, semantically inferred before its actual usage. Now for all these purposes a cloud computing back end would be used which is connected to the front end via a network. The RFID data would actually be fed as an input to the back end of This proposed cloud computing architecture for scalable RFID in order to enhance the use of RFID data generated for greater purposes.

The Back End:

The back end of the proposed architecture is composed up of infrastructure (computers, data storage systems etc.), applications, services and servers. Here, on the cloud, the RFID data is semantically filtered according to a specific application of need, use its relative platform and infrastructure over the network and then stored on a specific server. Middleware and protocols are used in the cloud computing system here. A server administers the system and traffic. The middleware and protocols allow the networked resources to communicate to each other. Here, in the proposed architecture, the cloud computing systems need a lot of storage space which it requires to keep all its RFID systems clients' information stored. It makes a copy of all the RFID information and stores it. The copies enable the central server to access backup machines to retrieve data that otherwise would be unreachable. Now as a result of using cloud computing, the huge amount of data which was lost earlier at very early stages as a result of lack of storage and because of bearing low priority in the semantic inference may now be preserved and processed on the cloud to draw more intense conclusions. Moreover, it motivates more efficient utilization of the existing resources rather than demanding a need to incorporate new infrastructure and services. Apart from this data being processed according to specific need and scalable according, the back end of the proposed architecture also provides a way to extend the possibility of further extending the framework of infrastructure and scalable computational capabilities for RFID systems.

Conclusions

This paper proposes a cloud computing architecture framework which provides a direction towards the scalable RFID systems. It involves the commitment of the existing cloud computing systems to enhance the computational capabilities and wide adoption of the RFID systems on the cloud. Here, in the proposed architecture framework, virtualized resources as services over the network are melded with the RFID technology with limited resources. It may act as a prototype for the futuristic more scalable RFID systems since it evolves itself under the light of the cloud computing systems.

Limitations

More aspects may be investigated and incorporated before actual system implementation.

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