ISSN 1407-7493

COMPUTER SCIENCE
DATORZINĀTNE

2008-34

APPLIED COMPUTER SYSTEMS
LIETIŠĶĀS DATORSISTĒMAS

VARIOUS ASPECTS OF RFID TECHNOLOGY AND THEIR USE IN MONITORING AND MANAGEMENT OF TRAFFIC

Vadim Zuravlyov, *Riga Technical University,*
Pernavas 1-2, Riga, LV 1012, Latvia, doctoral student,
zuravlov@gmail.com

Eleonora Latisheva, *Riga Technical University,*
Meza iela 1/3, Riga, LV 1048, Latvia, assoc. prof. PhD,
elat@inbox.lv

Radio Frequency Identification, EPCglobal, XML, Physical Markup Language

1. Introduction

Nowadays, one of the leading IT technologies is Radio Frequency Identification (RFID). RFID is an automatic identification method, which relies on storing and retrieving remote data with the use of devices called RFID tags. This technology assumes the embedding of RFID tags in any device. The approach gives a variety of architectural solutions.

This technology presents a great interest for analysis, as for solution of the concrete problem there is an opportunity to change not only the software, but also the hardware. The typical hardware solutions, which are described in literature [1, 2], include smart pallet, sensor, RFID printer, security card, smart weapon, etc.

One of the interesting tasks that authors deal with is monitoring and management of traffic. To solve this problem, several types of architecture framework of RFID solution are discussed in the present document. The most non-typical architecture framework [3] will be chosen among the viewed variants. On its basis, the description of several variants of architectural decisions for the implementation of the required functionality will be presented.

2. About RFID technology

Radio Frequency Identification (RFID) is an automatic identification method relying on storing and remote data retrieving using devices called RFID tags. RFID tag is possible to place in physical object, embedding in physical object or to construct interaction with other

physical objects (for example sensors). Detailed information about RFID technology advantages and limitation are not purpose of this paper. There are possible to see in [1, 2].

RFID technology is based on following basic components:

- Electronic Product Code (EPC) – is an identification scheme that can uniquely identify physical object. In RFID technology context is a 96-bit number which contains the information: header, manager number, object class and serial number [1, 2].
- EPC Middleware – it is services, that realize data exchange between an EPC reader (or network of readers) and RFID based application. The middleware components provide filtering acting events about EPC physical objects, and business application only keeps that which entering or leaving the reader's range.
- Physical Markup Language (PML) – the format modification of XML, is provides a format of saving and exchange data about physical objects and described in [4] as "a simple, general language for describing physical objects for use in monitoring and control of a physical environment - particularly through the Internet. Applications include inventory tracking, automatic transaction, supply chain management, machine control and object-to-object communication."

3. Middleware architectures

Most of all practical application RFID technology influences middleware architecture; therefore further it will be in details considered this theme. For the further description aspects of RFID technology it is necessary to define some terms:

- Architecture framework – is a defined support structure of standards in which base some project can be organized and developed.
- Middleware architecture – a communication layer that allows applications to interact across hardware and network environment. Middleware provides the communications between separate systems.

3.1. Architecture framework

In RFID industry is used EPCglobal Standards as standard de-facto. EPCglobal is a consortium of industry leaders like Wal-Mart, Cisco Hewlett-Packard etc. Architecture framework is shown on Figure 1 [5].

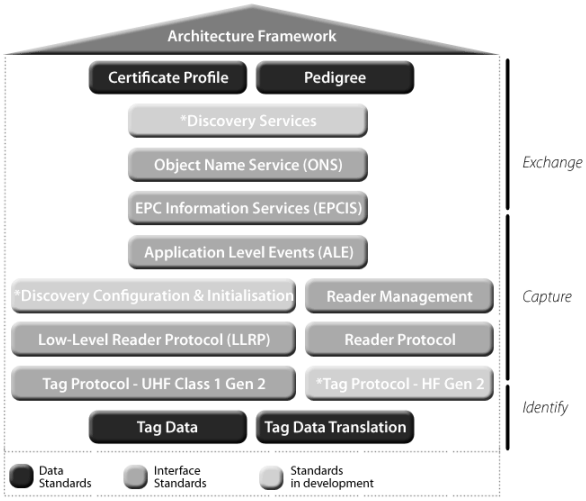

Figure 1. EPCglobal standards

Only part of architecture framework elements is interesting for our discussion. Now we are descripting elements that are used in next characters like separated elements in middleware architecture:

- EPC information Services (EPCIS) [6] – data exchange standard that defines data exchange mechanism that can be used for EPC based applications to exchange EPC data and event information.
- Application Level Events (ALE) [7] – interface definition standard, that define how possible to filtered and consolidate EPC data from a variety of sources. Interface definition that defines how an EPC based application interact with network of RFID readers.
- Object Name Service (ONS) [8] – its service standard that needed, that translates EPC code (96 bits) into web address (URL) of the object data.

3.2. EPCglobal recommended solution

In this chapter is defined EPCglobal middleware architecture. EPCglobal recommended middleware architecture is shown in Figure 2 [9].

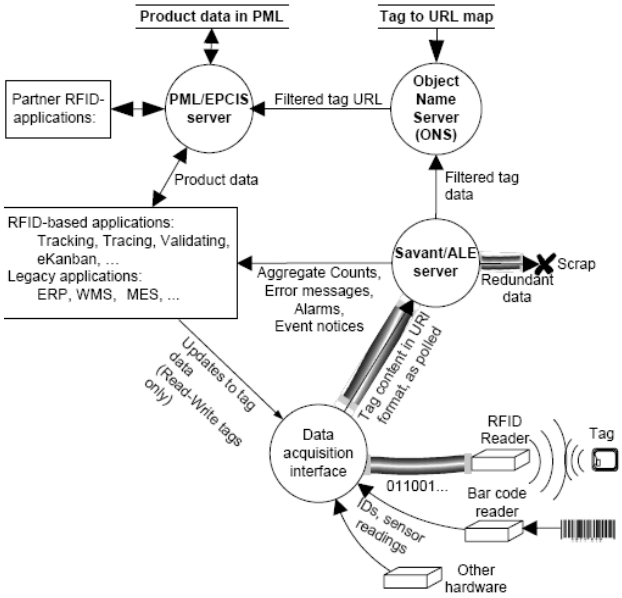

Figure 2. The EPCglobal middleware architecture

In this middleware architecture it is possible to take information from a variety of sources (like RFID tags, bar codes, sensors etc.). The data can be replicated as needed in PML for communications with others applications. Not so important that is use for business application (for example ERP, WMS, MES etc). But more important is sites without data acquisition interface, ALE server, ONS, EPCIS server and RFID based applications.

This middleware architecture is used for big business, if it is necessary to work with a lot of data and various partner RFID based applications.

3.3. Manufacture's solution

How many exists the companies making RFID solutions, it is so much possible different strategies on RFID using. A lot of companies use EPCglobal standards, but sometimes use different terminology and data exchange standards (IBM for example use not only XML but it's own data exchange standard MQ).

For example SAP its own architecture that is build-in SAP application. But for more detailed acquaintance with manufacturing middleware architecture is chosen IBM company "Lightweight RFID bus framework" product for smaller business. The middleware architecture of IBM RFID system is shown in Figure 3 [10].

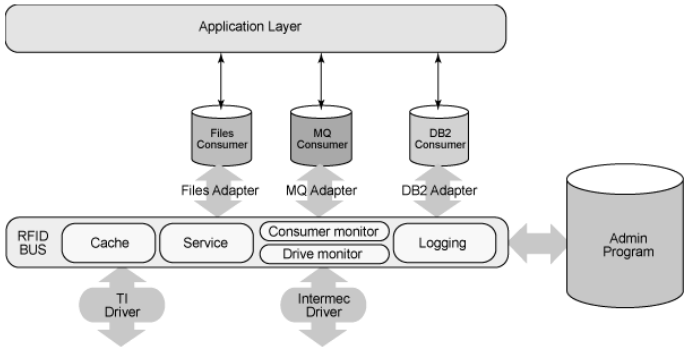

Figure 3. The middleware architecture of "Lightweight RFID bus framework"

In figure is shown RFID bus that contains all components that needed for easy work with RFID readers (like TI, Intermec etc.). RFID readers read tag information, then aggregate and sent it to RFID bus. Drive monitor is build-in core of RFID bus, it receive tag information from RFID readers. The consumer monitor receives the tag information and sent it to customer defined adapter (like Files Adapter, MQ Adapter, DB2 Adapter etc.) or broadcasts it within the RFID bus.

For customer application RFID bus like black box that gives tag information. For customer application is important define data repository (customer defined adapter) and data format for tag information exchange.

3.4. Non-manufacture solution

Except for set forth above middleware architecture exist such which have not received realization in manufacture. One of such middleware architecture, that authors want to present is a "Data-And-Rules-Save-In-Resource" (DARSIR) [3] that can be used with RFID technology.

Main case of this concept is like to achieve universality, flexibility, not necessary to use other sources (such as database) was accepted the decision the information (attributes and rules) save in RFID tag. For maintenance of preservation data and logic in RFID tag is created a new modification of PML, that author calls it RPML [3] (Resource Physical Markup Language).

In RFID reader build-in embedded system, that loads and carries out rules built in RFID tags. For this purpose RFID tags it is necessary to get in the operative range of RFID reader. If RFID readers are connected in network of RFID readers, that RFID readers realize RFID tags information (attributes and rules) exchange.

If necessary the aforesaid allows constructing independent information system. But if necessary, information system can be easily updated with external interface and data exchange with others business applications.

3.5. Choice middleware architecture

To choose one of the three described of middleware architectures for the decision for monitoring and management of traffic it is necessary to detail a problem more.

For example if it is necessary to carry out to apply a problem to city correctly to use middleware architecture the most approached to EPCglobal. As this middleware architecture is calculated on such volume of data and the centralized decision. And those expenses (EPCIS server, ALE server etc.) which will be necessary at realization such solution, will be proved.

At the same time, if it is necessary to solve task in small area it is more flexible to use IBM "Lightweight RFID bus framework" middleware architecture. As then there is no necessity for such components, as EPCIS server, ALE server etc.

In this paper "Data-And-Rules-Save-In-Resource" middleware architecture is chosen, as more interesting architecture decisions for maintenance of performance task, because it didn't have detailed description. "DARSIR" middleware architecture enables to construct

independent information system. But in case of need easily to expand it using interfaces for work with external business applications. One more of reasons why is chosen "DARSIR" middleware architecture, because it is poorly described in other publications and the decision task on its basis is the most interesting to authors.

4. Architecture decisions

In previous chapters three middleware architectures are defined. Next step take one of them and in this middleware architecture define architecture decisions, for monitoring and management of traffic task decision. “DARSIR” middleware architecture is taken because it is chosen in previous chapter.

For the further discussion of the decision of task for monitoring and management of traffic need to define all types of components of traffic:

- Member (Member of traffic) – it can be an alive being (for example human, animal) or mechanical means (for example car, robot);
- Regulator (Regulator of traffic) – it is any sign which adjusts movement. Such signs divide on static (traffic sign, road marking) and dynamic (traffic light).

Architecture decisions of task for monitoring and management of traffic is possible to divide into 3 parts:

- Gathering of the information – this part is named “Monitoring of traffic”.
- Transfer of the information – this part is named “Informing of members of traffic”.
- Data exchange – this part is named “Management of traffic”.

For maintenance of any of architecture decisions it is necessary every component of traffic build-in RFID tag. Because “DARSIR” concept all data and rules save in RFID tag owner. Every RFID tag owner saves data in RPML in own RFID tag. But if RFID tag owner need some rules, it must to be save in own RFID tag.

4.1. Monitoring of traffic

First architecture decision that is shown is the collection of information about members. For this decision not needed rules build-in members because they are only the carriers of information and do not have to perform any actions in our architecture decision. All rules are saved in regulators.

Regulators are situated in the operating zone of RFID reader (or network of RFID readers). When a member gets into the operating zone of RFID reader, the data about the member are checked through the rules of regulators. If even one of the rules have worked, the data of this member are saved in local repository, or broadcasted to the network.

One of the examples of this decision is the monitoring of the traffic rules observation. There is a traffic light on the crossroads, and in this regulator are saved rules. This means that if a member will drive on red light, the information about this member will be broadcasted to some application (service) through the network.

4.2. Informing members of traffic

Second architecture decision that is shown is transfer of information for members. These decisions are return of decision monitoring of traffic. For this decision not needed rules build-in regulators because they are only the carriers of information and do not have to perform any actions in our architecture decision. All rules are saved in members.

Regulators are situated in the operating zone of RFID reader (or network of RFID readers). When member gets into the operative zone of RFID reader it receives data about all regulators which are established in the operative zone of RFID reader.

One of the examples of this decision is informing members about sites of road which are necessary for going round. On most regulators the scheme of a detour is drawn. And if member have some navigation system like GSM with the friendly interface it is automatically possible to lead changes in navigation map.

4.3. Management of traffic

Last one architecture decision that is shown a data exchange between members and regulators. This decision is include informing members, monitoring and management of traffic. All components of traffic must to have build-in rules in RFID tags.

Regulators are situated in the operating zone of RFID reader (or network of RFID readers). When some member gets into the operating zone of RFID reader, then data exchange occurs between members and regulators. After that every member check rules about all regulators, and every regulator check rules about all members. If some rules work, there is a performance corresponding commands. Members can change their movement, but regulators sent commands to members or save information about members in local repository or broadcasting to network.

One of examples of this decision is built-in members advanced devices that can help to members to observe rules, management of regulators and informing about any change in traffic. At non-observance trivial rule of traffic, members informed about infringement. But at gross infringement switching-off of the engine (if this mechanical moved means) or transfer of the information on the infringer to law enforcement agencies is possible. Any changes in traffic, which complicates movement (many machines, accident etc.), can be transferred inside network of RFID readers between regulators. It can by means of dynamic regulators (for example traffic light) to change loading for those or other sites of road (for example "green light" effect). Or if member have any device like GSM system, it is possible to transfer the information about changes of traffic directly to this device.

Conclusion

One of the most quickly developing branches nowadays is RFID technology. Authors of the present paper looked upon various aspects of this technology. For instance, architecture framework of EPCglobal Standards, that is currently the standard de-facto in RFID industry, was mentioned.

In this document, three types of middleware technology, including EPCglobal organization, manufacturing (“Lightweight RFID bus framework” from IBM Company) and non-manufacturing (“DARSIR”) are examined. Choose one of them and in this middleware technology base try to perform the task of the monitoring and management of traffic. For this task the decision depends on three architecture decisions: monitoring of traffic, informing the means of travel and management of traffic. For the performance of any of the architecture

decisions it is necessary that every component of traffic should be build-in RFID tag. Owing to "DARSIR" concept all data and rules save in RFID tag owner. Every RFID tag owner saves the data in RPML in one's own RFID tag. But if RFID tag's owner needs some rules, it should be saved in his own RFID tag.

The architecture decisions, discussed in the paper can be used as a practical guide for the implementation "DARSIR" middleware technology when solving practical tasks. On the basis of this architecture decisions, it is possible to create a real system for the monitoring and management of traffic.

Acknowledgments

This work has been partly supported by the European Social Fund within the National Programme "Support for then carrying out doctoral study programm's and post-doctoral researches" project "Support for the development of doctoral studies at Riga Technical University".

References

1. Sandip Lahiri. "RFID sourcebook" // Upper Saddle River, N.J., IBM, London, 2005.
2. Claus Heinrich. "RFID and Beyond: Growing Your Business Through Real World Awareness" // Wiley, England, Chichester, 2005
3. Vadim Zuravlyov. "Main principles of a new concept of designing data management systems" // Computer Science, Riga, 2006, p.38-46.
4. The Physical Markup Language / Internet. – http://web.mit.edu/mecheng/pml/
5. EPCglobal Standards Overview / Internet. – http://www.epcglobalinc.org/standards/
6. EPCIS Standard v. 1.0 / Internet – http://www.epcglobalinc.org/standards/epcis/epcis_1_0-standard-20070412.pdf
7. ALE Standard v. 1.0 / Internet – http://www.epcglobalinc.org/standards/ale/ale_1_0-standard-20050915.pdf
8. ONS Standard v. 1.0. / Internet – http://www.epcglobalinc.org/standards/ons/ons_1_0-standard-20051004.pdf
9. Michel Baudin, Arun Rao. "RFID applications in manufacturing" // MMTI, USA, Palo Alto 2005, p.1-12.
10. Cren Junwei. "Lightweight RFID framework", IBM, 2004 / Internet – http://www-128.ibm.com/developerworks/wireless/library/wi-rfid/

Vadims Žuravļovs, Eleonora Latiševa. RFID tehnoloģijas dažādi aspekti un to pielietošana monitoringā un ceļu satiksmes regulēšanā

Mūsdienās viena no vadošajām IT tehnoloģijām ir Radio Viļņu Identifikācija (RFID). RFID tas ir automātiskas identifikācijas metode, kas balstās uz datu glabāšanu un datu attālināto saņemšanu, izmantojot ierīces ar nosaukumu RFID tagi. Dotā tehnoloģija ļauj ievietot RFID tagus citās ierīcēs. Dotajā dokumentā tiek izskatītas RFID tehnoloģijas dažādi izmantošanas aspekti monitoringa un ceļu satiksmes regulēšanas piemērā. Tiek parādīti trīs starpprogrammatūras tehnoloģijas veidi, ieskaitot EPC globālo organizāciju, ("Lightweight RFID bus framework" no IBM kompānijas) ražošanu un ("DARSIR"), kas nav ražošanas tehnoloģīja. Autori izvēlējusies vienu no tiem. Tas ir ("DARSIR") neražošanas starpprogrammatūras tehnoloģija. "DARSIR" starpprogrammatūras tehnoloģijas galvenais uzdevums ir sasniegt universālumu, pielāgojamību, neatkarīgi no citiem avotiem (tādas ka datubāze) pieņemt lēmumu ka informācija (atribūti un noteikumi) tika saglabāti RFID tagā. Lai saglabātu datus un loģiku RFID tagā tika izveidota PML jauna modifikācija, autori nosauca to par RPML [3] (Resursu Fiziska Iezīmēšanas Valoda). Starprogrammatūras tehnoloģijas galvenais izpildīšanas uzdevums ir ceļu satiksmes regulēšana un monitorings. Lai izpildītu jebkuru arhitektūras risinājumu nepieciešams, lai katrs ceļu satiksmes komponents būtu iebūvēts RFID tagā. Tiek doti dažādi arhitektūras

risinājumu varianti, lai nodrošinātu ar nepieciešamo funkcionalitāti. Lēmums priekš dota uzdevuma ir atkarīgs no 3 arhitektūras variantiem: ceļu satiksmes monitoringa, informējot par ceļa satiksmes dalībniekiem un ceļu satiksmes regulēšana.

Vadim Zuravlyov, Eleonora Latisheva. Various aspects of RFID technology and their use in monitoring and management of traffic

Nowadays, one of the leading IT technologies is Radio Frequency Identification (RFID). RFID is an automatic identification method, which relies on storing and retrieving remote data with the use of such devices as RFID tags. This technology assumes the embedding RFID tags in any device. In this document some aspects of RFID technology on the example of monitoring and management of traffic are given. Three types of middleware technology, including EPCglobal organization, manufacturing ("Lightweight RFID bus framework" from IBM Company) and non-manufacturing ("DARSIR") are shown. Authors have chosen one of them. It is non-manufacturing ("DARSIR") middleware technology. Main case of "DARSIR" middleware technology is like to achieve universality, flexibility, independence from other sources (such as database) was accepted the decision the information (attributes and rules) save in RFID tag. For maintenance of preservation data and logic in RFID tag is created a new modification of PML, that author calls it RPML [3] (Resource Physical Markup Language). In this middleware technology base perform the task of monitoring and management of traffic. For the performance of any of the architecture decisions it is necessary that every component of traffic should be built-in RFID tag. The description of several variants of architectural decisions for the implementation of required functionality is presented. For this task the decision depends on three architecture decisions: monitoring of traffic, informing the means of travel and management of traffic.

Вадим Журавлев, Элеонора Латышева. Различные аспекты RFID технологии и их применение в мониторинге и управлении дорожным движением

На сегодняшний день одна из ведущих технологий это Радиочастотная Идентификация (RFID). RFID это метод автоматической идентификации, основанный на хранении и дистанционном получении данных, с использованием устройств под названием RFID теги. В данном документе рассматриваются некоторые аспекты применения RFID технологии, на примере мониторинга и управления дорожным движением. Показаны три вида промежуточного программного обеспечения, такие как: EPCglobal организации, производственный ("Lightweight RFID bus framework" от компании IBM) и не производственный ("DARSIR"). Авторы выбрали одну технологию из них. Это не производственная технология промежуточного программного обеспечения ("DARSIR"). Главная задача технологии промежуточного программного обеспечения "DARSIR" добиться универсальности, эластичности в не зависимости от других источников (таких как база данных); принято решение, что информация (атрибуты и правила) хранится в RFID тэгах. Чтобы сохранить данные и логику в RFID тэге была создана новая модификация PML, которую авторы называют RPML [3] (Физический Язык Разметки для Ресурса). Главная задача промежуточного программного обеспечения это обеспечение управления и мониторинга дорожного движения. Чтобы выполнить любое из архитектурных решений необходимо каждый элемент дорожного движения встроить в RFID тэг. Решение этой задачи зависит от трех архитектурных решений: мониторинг, информирование участников дорожного движения и управление дорожным движением.