Development of Consumer RFID Applications and Services

Yong-Woon KIM
ETRI
Republic of KOREA

1. Introduction

Basically RFID is a wireless communication technology within the L1 (Layer 1, the physical layer of the OSI 7-layer Reference Model) and L2 scopes between RFID tag and reader. An RFID tag works as a data storage and transmits stored data to an RFID reader via the wireless technology.

Such a basic communication scope can be extended by inter-networking of a series of networks to support business and consumer applications. Thus RFID has been adopted for enterprise business purposes in the form of Business-to-Business (B2B) RFID applications in retail, logistics, supply chain management, pharmaceutical industries, etc.

Nowadays an RFID reader is being equipped in a cell phone, which enables network-based consumer-purposes RFID applications called B2C (Business-to-Customer). Additionally a business partnership may integrate B2B with B2C applications into B2B2C applications. Consumer applications are provided as services to consumers. Such B2B, B2C and B2B2C applications must be based on network and communication among functional entities distributed in a closed enterprise network or an open, public network like Internet.

When RFID stayed in limited environments with limited purposes, development and standardization issues were not too many. But applying RFID to those new application areas requires consideration of L1 to L7 issues and expands the development and standardization scopes of RFID into higher layer scopes. Each RFID application type may produce new challenges with different characteristics and different requirements.

This chapter identifies a new business opportunity by integration of RFID with mobile telecommunication networks to enable consumer RFID applications and services, describes its development models in terms of communication model, functional configuration, message exchange procedure, and case studies, and then summarizes relevant activities of standardization in ISO/IEC, ITU-T and NFC Forum.

2. Integration with mobile telecommunication networks

This clause identifies a few problem statements about mobile telecommunication services and a new service model of the mobile RFID to mitigate them. Then it describes prospective business impacts of mobile RFID services.

Source: Development and Implementation of RFID Technology, Book edited by: Cristina TURCU,
ISBN 978-3-902613-54-7, pp. 554, February 2009, I-Tech, Vienna, Austria

2.1 Problem statements of mobile telecommunication services

Mobile telecommunication technologies will have a variety of problem statements to be tackled to provide better consumer services. A few of them RFID can mitigate are described.

Media break between off-line and on-line

The media break problem exists between off-line and on-line worlds. In the off-line world, everyone uses his signature to prove his legal actions. Under a seal-based operation system, a seal image shall be registered at a public certification center, for example, the government in Korea, and a seal certificate issued by the public certification center shall be attached to legal documents such as agreements and contracts. But instead digital certificates are used in the on-line world. So people should have two signatures in off-line and on-line, which means such off-line and on-line media cannot interwork each other. This is the media break problem.

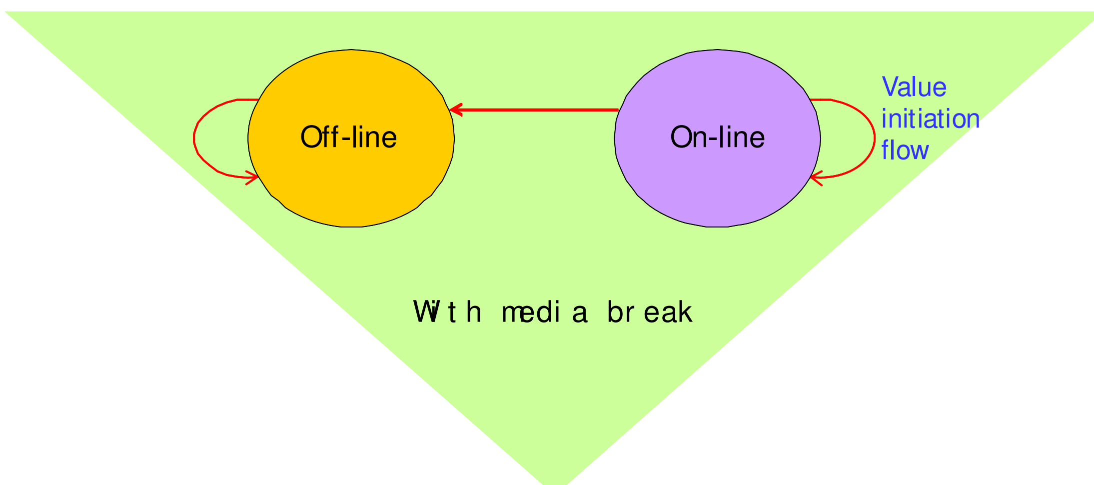

Fig. 1. View of the media break problem

In Figure 1, the off-line world can create values for itself in every off-line business process. For example, physical materials and corresponding products are manufactured; a group of the products are transported to wholesalers and retailers; and consumers buy them at shopping malls. This value chain occurs only in the off-line world. The on-line space also can create values for itself. For example, Google makes money through various on-line advertisement business models. The on-line world can affect the off-line value chain. For example, on-line shopping triggers off-line business processes, but not vice versa. The off-line space cannot initiate any value chain toward the on-line business space due to the media break problem.

Tree-based user interface

It may be said that mobile Internet services of mobile telecommunication service providers are supported via tree-based user interface.

The traditional way of information access was "tree" as shown in Figure 2. The traditional Gopher was based on the tree-based information hierarchy and was the top information access tool until the early 1990's before popularization of the Web.

Figure 3 shows the hyperlink-based information access. Since the Web was released in 1992 by Sir Tim Berners-Lee, its hyperlink-based access interface replaced the tree-based interface eventually.

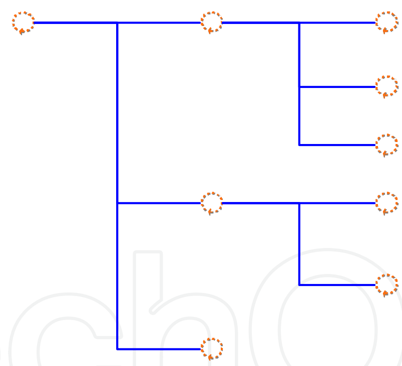

Fig. 2. Tree-based information access

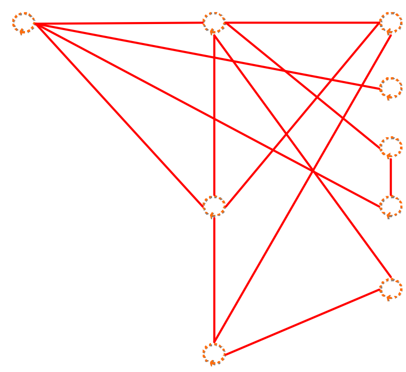

Fig. 3. Hyperlink-based information access

Internet services over mobile telecommunication networks are provided in various ways. The typical example is Wireless Application Protocol (WAP) which is a wireless-profiled Web service platform (WIKIPEDIA, 2008)(OMA, 2008). Other techniques also can provide Web-based information access services.

Even though such mobile Internet services are provided via hyperlink-based user interfaces, they look like working as tree-based user interfaces because cell phones cannot use mouse input interface. Usually consumers should follow links deeper and deeper to reach a final target even in hyperlink interface. They will make decisions to enjoy the target or not. Thus information service providers are struggling to take mobile Internet users to decision points for profitable contents and make them pay money for the contents. The easiest way to do this is to move the decision points up to the top level of the user interface in order to expose them to users more times. But this betterment must be limited due to too small screen size of cell phones.

Monopoly of mobile Internet service providers

Mobile Internet service providers are also called service portals because consumers have to navigate information contents of the service providers from a gate of information access. Consumers are usually locked within a service portal due to user interface problems of cell phone and feel a lot of difficulty in going out to other portals. The tree-based navigation structure limits users' options, that is, users can choose only provided items in the structure and cannot escape from the world made by a tree as illustrated in Figure 4. Theoretically they can go out to other contents and portals by inserting and executing URLs at a user interface of cell phones. But inserting alphabetical URLs in cell phones is difficult actually and almost every user stays within a service portal provided by a mobile telecommunication service provider.

Now the portal appears as power and contents providers must go to the portal to serve their contents to mobile Internet consumers. This kind of monopoly will cause a bad impact that contents providers cannot be revitalized much because such situation causes development of service contents restricted and controlled by service portals.

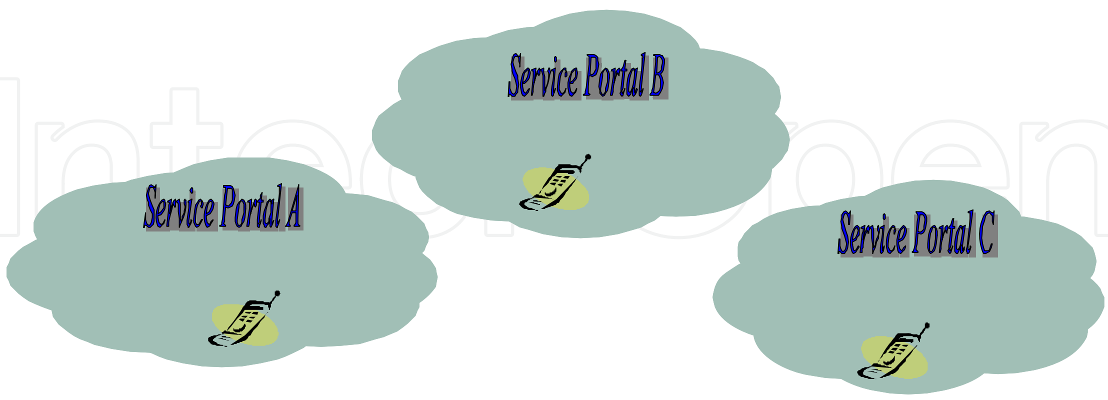

Fig. 4. Consumers locked in a service portal

2.2 Mobile RFID services

For a long time, RFID has stayed in B2B business fields such as transport and logistics, supply chain management, manufacturing and processing, and inventory control due to various problems such as still expensive RFID tag price, lack of 100% reading accuracy, limited operation conditions, etc.

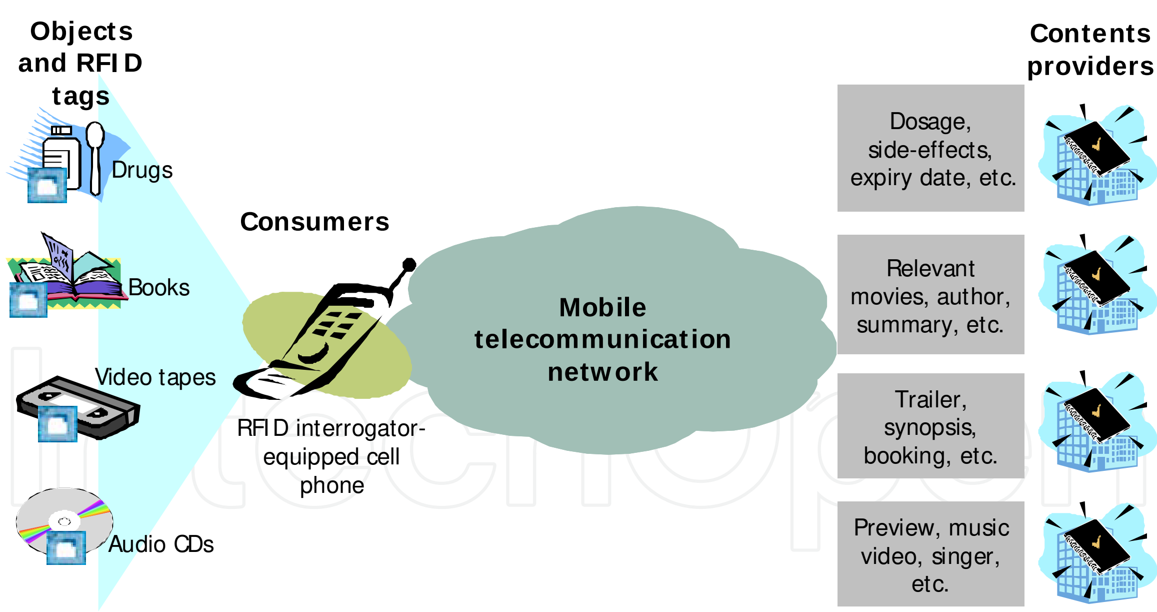

Fig. 5. Use cases of mobile RFID applications and services

RFID can be integrated with consumer applications for which a prominent terminal is cell phone. This type of RFID applications is called mobile RFID applications in a B2C manner where business parts provide information contents and consumers retrieve and enjoy them with their cell phones.

People may confuse the meaning of "mobile RFID." It doesn't mean that RFID is mobile and flowing. But it is a simply combined term of RFID and mobile telecommunication.

ITU-T described mobile RFID telecommunication services from a service point of view as follows: "RFID based mobile telecommunication services can be defined as services that provide information on objects equipped with an RFID tag over a telecommunication network. The RFID reader is installed in a mobile device such as a cell phone. The implementation of RFID in mobile telecommunications services would lead to a scenario where the tags are stationary and readers (that are integrated in the cell-phone) become mobile. There would also be applications where the mobile phone can be both, tag and reader at the same time (Seidler, 2005)." The information provided by an RFID tag on an object doesn't always depend on the object. For example, an RFID tag attached to a wine can give a restaurant name for advertisement purposes.

Figure 5 shows mobile RFID service cases. RFID tags are attached to physical objects; relevant information contents related to the objects are established at backend application systems; and, consumers execute a service operation by triggering an RFID reader-equipped cell phone to read an RFID tag and retrieving the information content associated with the RFID tag, i.e. its corresponding object.

2.3 Business impacts of mobile RFID services

Integration of RFID with mobile telecommunication services can mitigate the problems defined in clause 2.1 with the key feature of off-line hyperlink which can solve the media break problem, realize the hyperlink-base user interface acctually and enable easier navigation within a service portal and to other service portals.

Concept of off-line hyperlink

Merriam-Webster defines "hyperlink" as an electronic link providing direct access from one distinctively marked place in a hypertext document to another in the same or a different document (Merriam-Webster, 2008). It may be seen for easier understanding that a hypertext is an information text with one or more hyperlinks. A hyperlink shall have an address information to take its user to its target information. The Web technology represents the address information as URL (Uniform Resource Locator). Thus the hyperlink has a standardized format to incorporate URL. The following example shows a representation of URL into a corresponding hyperlink:

URL: *http://www.abcd.com/hyperlink*

Hyperlink: <*a href*="*http://www.abcd.com/hyperlink*">*hyperlink*</*a*>

This hyperlink exists logically as digital data and resides in the on-line world. Thus it may be called on-line hyperlink compared with the other case, off-line hyperlink.

An RFID tag is a tiny memory device which embeds some information such as identifier, price, name, manufacture date, shipping date, and manufacturer name of an object. But, the identifier of the object is the mandatory requirement and all the others are optional. ITU-T Y.2091 defines "identifier" as a series of digits, characters and symbols or any other form of data used to identify network element(s), function(s), network entity(ies), subscriber(s), user(s) providing services/applications, or other entities (e.g. physical or logical objects) (ITU-T Y.2091, 2006).

URL also is one of identifiers. An RFID tag may contain a URL for addressing information toward an information content associated with a physical object. That is, RFID tags which exist in the off-line and physical world contain a URL for certain information and then enable hyperlink access at the information. In other words, off-line and physical objects can trigger information users to access on-line information associated with the objects as shown in Figure 6. This is the off-line hyperlink or often called physical hyperlink. Even though, however, an RFID tag can contain a URL, it contains a shorter form of identifier usually in an alpha-numeric form instead of the URL because it has a small memory space and saving memory means saving money. In this case, a resolution from the identifier to the URL has to be provided.

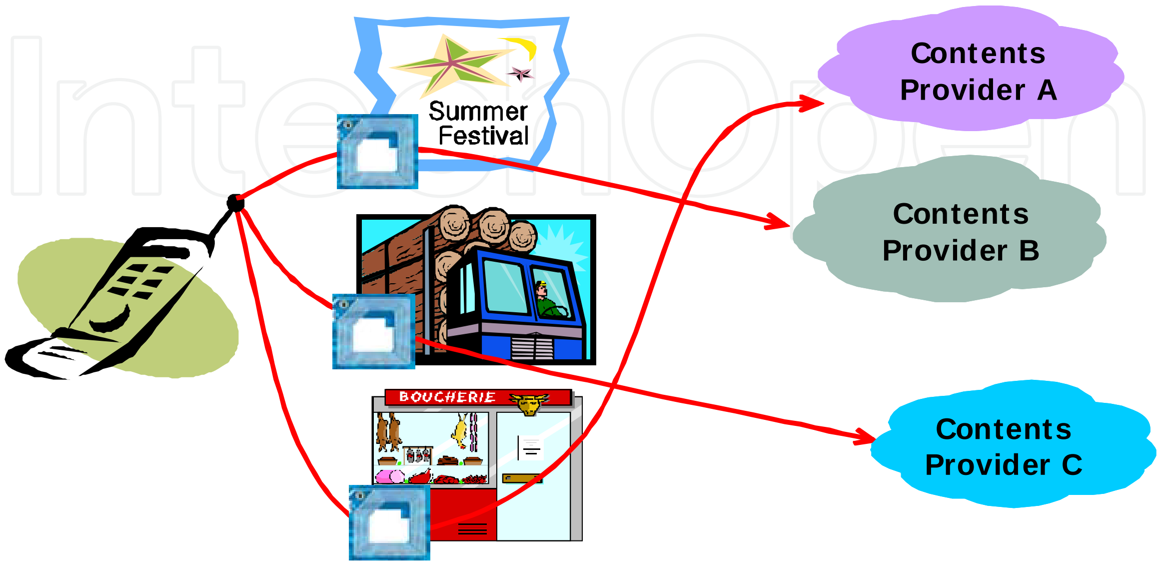

Fig. 6. Off-line hyperlink feature

Solving the media break problem

Clause 2.1 defined the media break problem with Figure 1. That is, there is a broken link between off-line and on-line worlds. The off-line hyperlink feature can solve this problem as depicted in Figure 7.

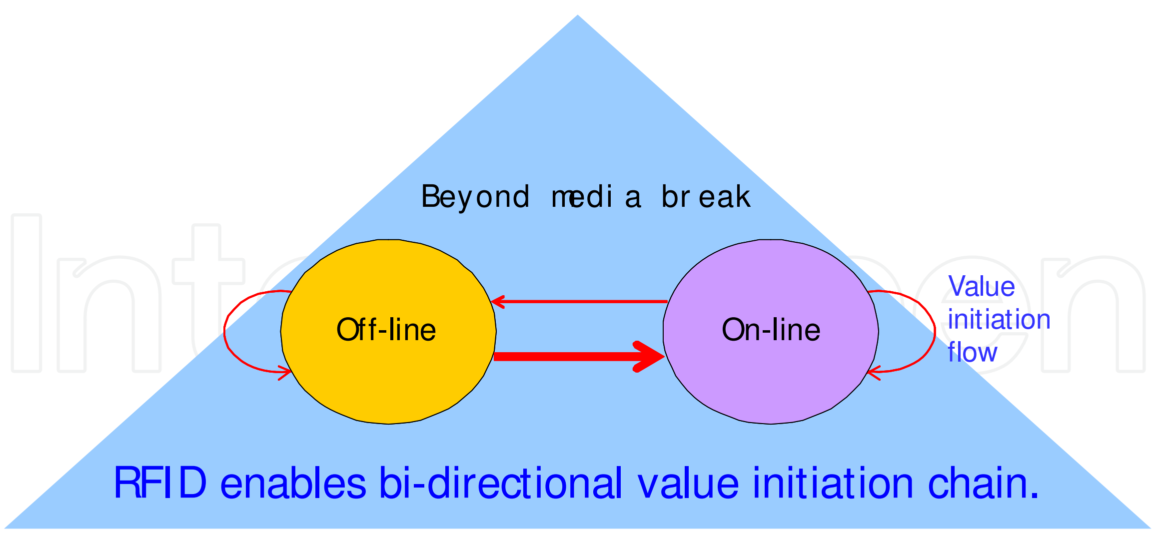

Fig. 7. Solution of the media break problem

An off-line and physical RFID tag contain an information pointer represented as URL or a corresponding alpha-numeric identifier which can take information users to an associated on-line content. That is, off-line objects such as movie posters enable mobile Internet users to access information contents associated with the movie posters and the new initiation line from off-line to on-line is realized as shown in Figure 7. So RFID can realize a bi-directional value initiation chain between on-line and off-line. This benefit makes much bigger business opportunities.

Realizing hyperlink-based user interface

Even though mobile Internet services have been developed in hyperlink-based user interface, their information contents look like being provided in tree-based user interface in which a decision to pay money for certain information occurs at the final step after a few navigation steps. This takes time, makes users feel user interface inconvenient and then causes them to give up their navigation. Thus how to take information users to their decision points to pay money is one of the key problems to be tackled for service providers.
The off-line hyperlink feature of RFID can realize hyperlink-based user interface actually as depicted in Figure 8. RFID can take information users directly to decision points to pay money. That is, cell phone users can enjoy hyperlink-based user interfaces with pressing keypad buttons just once or twice and a tremendous number of off-line objects will take them to on-line contents and services via the bi-directional value initiation flow.

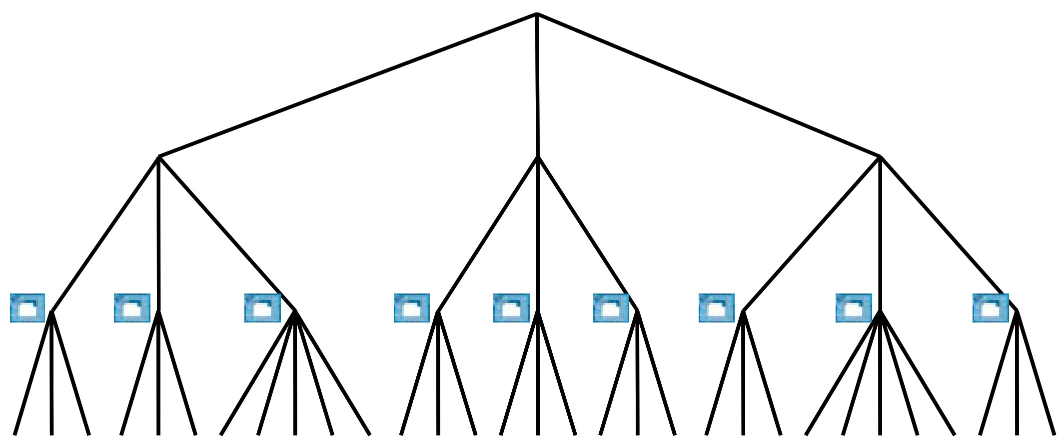

Fig. 8. Off-line hyperlink-based user interface

Enabling easier navigation to other service portals

Difficulty in inserting URL in a user interface of cell phones has caused users to stay within only a service portal. The off-line hyperlink solves this problem and enables information users to go directly to other service portals.

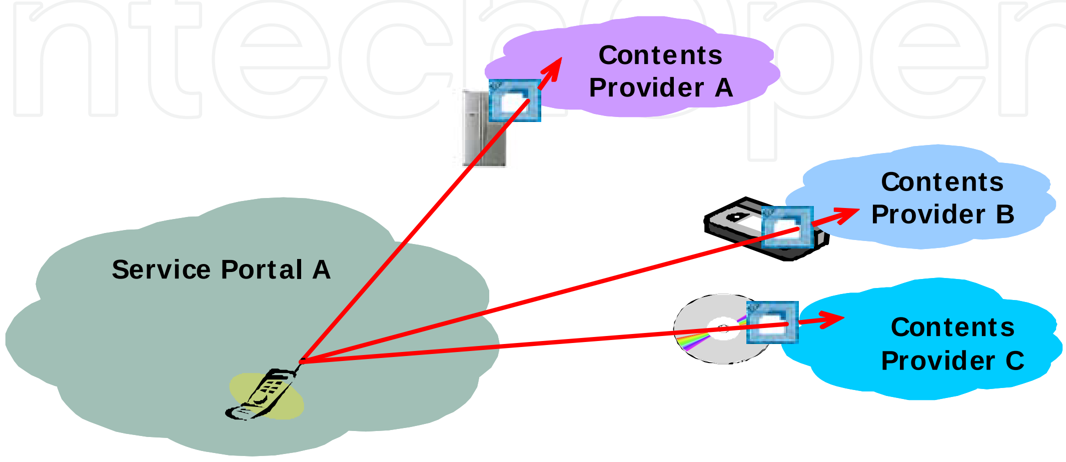

Fig. 9. Easier navigation to other service portals

As shown in Figure 9, anybody can build up an information contents portal at his/her application systems without negotiation or permission of other service portals. Each content provider in Figure 9 can provide its information contents as a service portal because the off-line hyperlink takes users directly to the information contents portal. RFID makes the power shift.

3. Development model of mobile RFID services

Mobile RFID services may be developed in various ways. This clause describes only a basic model and an extended model.

3.1 Basic and extended communication models

Figure 10 shows the case that an RFID tag is attached to a movie poster for a certain movie; an identifier for the movie is embedded in the RFID tag; an RFID reader is built in a cell phone; a contents provider system contains information contents associated with the movie; and, an identifier directory system has a location information for the information contents distinguished by the identifier where the location information may be represented as a URL.

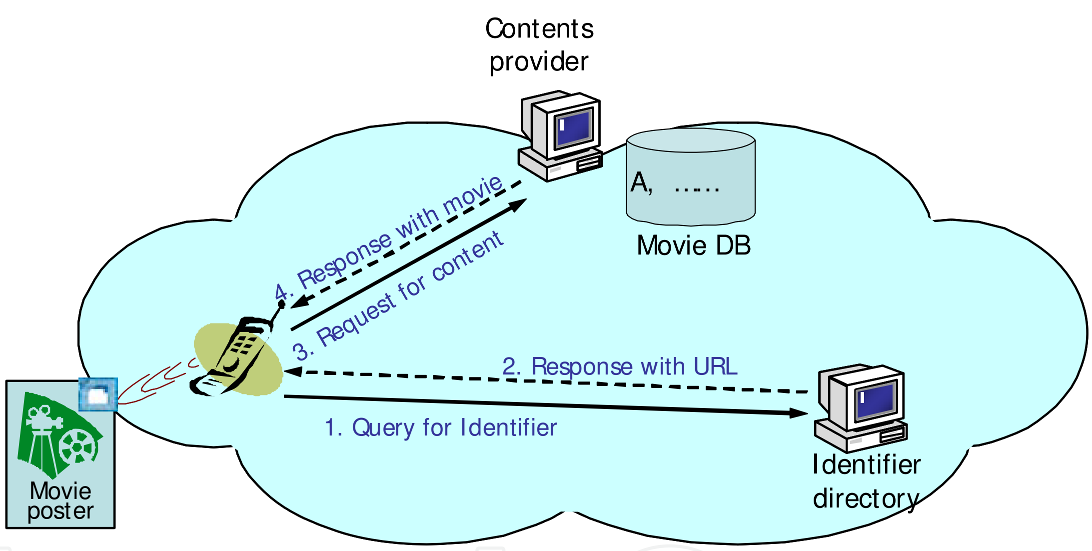

Fig. 10. Basic communication model

Figure 10 illustrates a basic communication model consisting of two end-to-end operations: identifier resolution (step 1 and 2) and content retrieval (step 3 and 4). This basic model is not a new one. Every client/server application works in the similar model: name resolution and content retrieval. For example, when a Web browser accesses a Web page via a URL, it has to get a network address, i.e. IP, resolved from a domain name embedded in a URL by consulting DNS and then it connects with a Web server system addressed by the IP to access the Web page. The former operation is the name resolution and the latter one is the content retrieval.

Mobile RFID has a different resolution target, identifier, not domain name. The identifier resolution is the operation that a client asks the identifier directory of resolving an identifier and receives a corresponding URL to the identifier. DNS is a typical example of protocol solutions for the identifier resolution. The content retrieval works through a generic Web access operation.

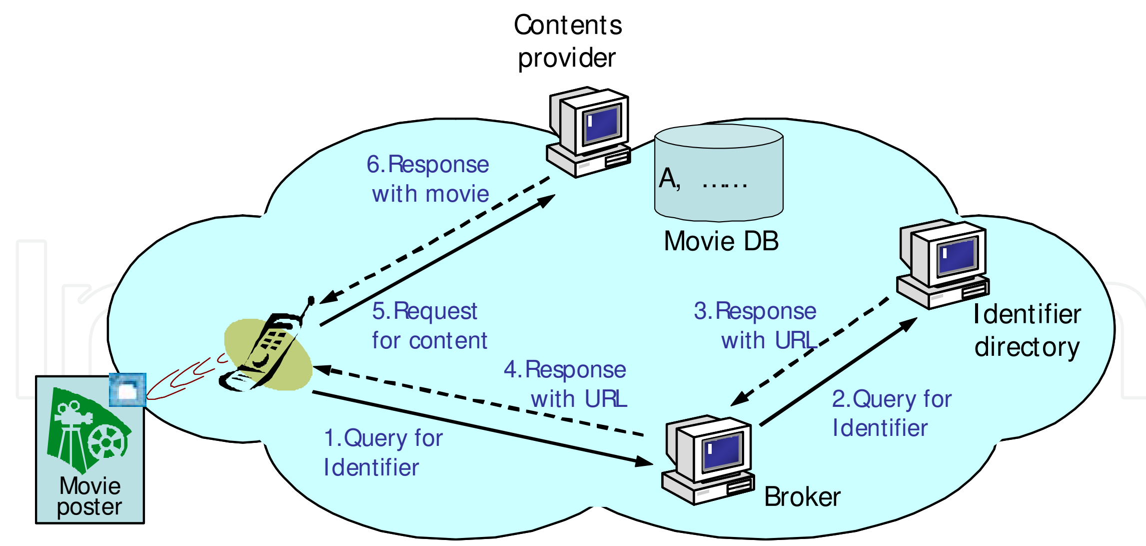

Fig. 11. Broker-based communication model

The basic model may be extended in various ways. One of them is to incorporate an intermediate broker between mobile RFID terminal and identifier directory as shown in Figure 11. It may simply relay identifier resolution messages or do additional functions such as user authentication and filtering for resolution requests.

3.2 Functional configuration of mobile RFID terminal

A mobile RFID terminal may be described in Figure 12 of which WAP browser is one of typical Web browsers in cell phone software environments; bearer service is mobile telecommunication service based on, for example, CDMA, GSM, UMTS, GPRS, etc.; device driver is a functional entity to control the RFID reader; middleware platform is an application execution and running environment like BREW, WIPI and J2ME; and mobile RFID applications run over the platform.

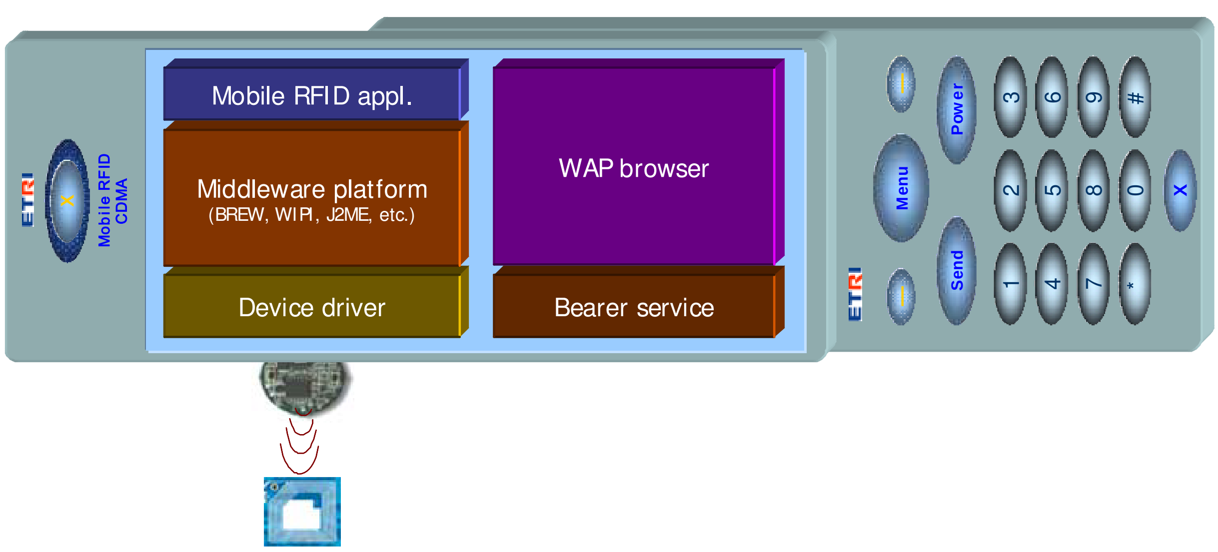

Fig. 12. Functional configuration of mobile RFID terminal

Figure 13 shows a more detailed functional configuration. Various functional entities may be needed to support mobile RFID applications at a mobile RFID terminal. Following functional entities are mandatory: interrogator control, user data processing, identifier processing and identifier resolution. All these functions are provided through proper APIs to mobile RFID applications.

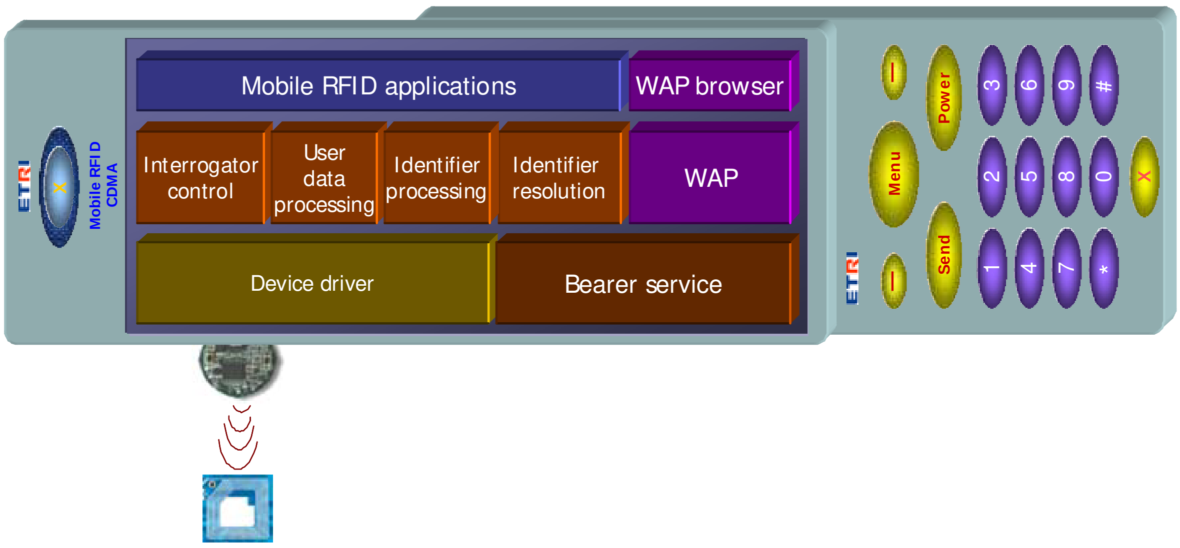

Fig. 13. Key functional entities of mobile RFID service platform

The interrogator control is a set of functions based on the device driver to access and control the RFID interrogator. The user data processing is a functional entity to process user data formatted in a standardized way and contained with an identifier in an RFID tag. For example, an RFID tag shall have an identifier for a product and may have additional information about the product such as name, price, manufacturer and expiry date. Such additional information is handled as the user data.

The identifier processing entity performs a set of functions with an identifier read by the interrogator control as follows:

- It learns what kind of the identifier is by using, for example, OID or EPC header. Learning what kind of the identifier is means getting its structure information. For example, if an identifier is learned as a telephone number assigned by the E.164 standard, the processing entity has to get the E.164 structure information from its local configuration data, internal database or an external directory service.
- It decodes raw binary data of the identifier into a standardized form with structure information of the identifier. For example, if the identifier is learned as an E.164 number, the processing entity coverts raw data of the identifier with the E.164 structure information into something like *1.2.345.6789* in case of using the dot notation for the delimiter of sub-identifier elements.

The identifier resolution is a function to resolve an identifier into associated information which means the information associated with an identifier, which results in maintaining mapping relationship(s) between the identifier and associated information. Example associated information instances are information content like audio, video, text and image, or another identifier like URL, URN, IP address and E.164 number. An identifier may have multiple associations. Example solutions to provide the identifier resolution are DNS, X.500, LDAP, etc.

Those functional entities can be described with an operation scenario as shown in Figure 14. The interrogator control reads tag data from an RFID tag. The tag data may consist of only an identifier or both identifier and additional application-specific data for which the identifier processing function manipulates the identifier and the user data processing function does the application-specific data.

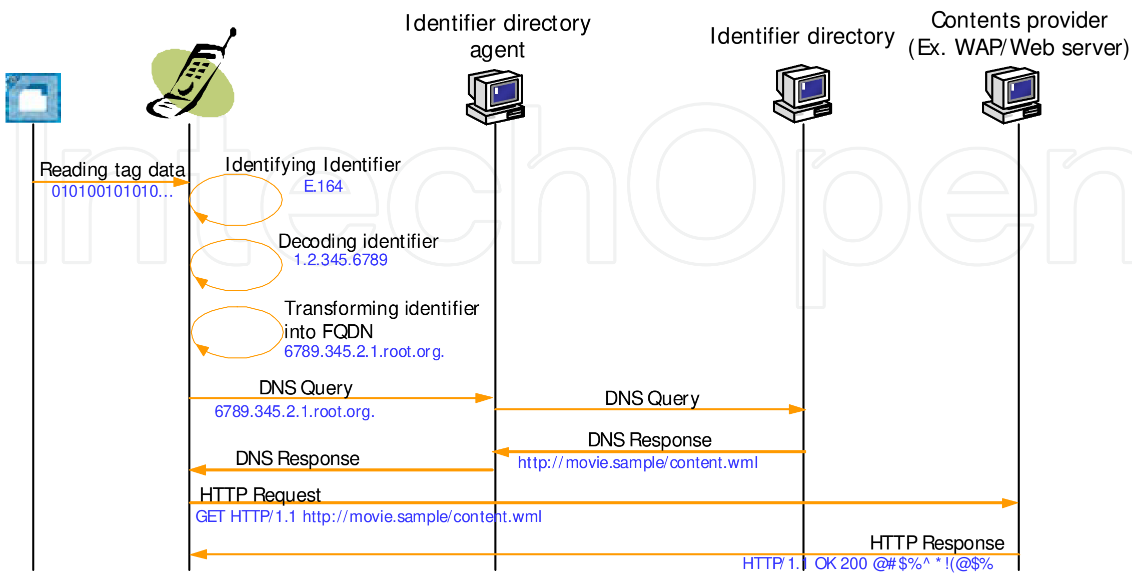

Fig. 14. Example operation scenario

The identifier processing function has to know identity of the identifier. ISO/IEC standards use OID to let users know the identity and EPC standards use EPC header. In the example, the identifier is learned as E.164. The identifier processing function should have E.164 structure information to manipulate the identifier. It converts raw binary data of the identifier into sub-identifier elements, 1, 2, 345 and 6789, which may be represented in various ways by standards. In case of using the dot notation, the identifier is denoted as "*1.2.345.6789*."

Then the identifier resolution process starts. Figure 14 shows the case of using DNS for identifier resolutions. An identifier resolution request is triggered by a DNS Query message which includes an FQDN-formatted identifier like "*6789.345.2.1.root.org*." according to the DNS protocol specification. A corresponding DNS Response message is replied, containing a URL registered with the identifier in the identifier directory.

Finally a Web browser accesses the contents provider through the URL information and fetches relevant information content.

3.3 Internal operation scenario

A service operation may work in a mobile RFID terminal as shown in Figure 15. The step 1 and 2 show that an application invokes the interrogator control function residing in the middleware platform in order to read an identifier from an RFID tag. An internal operation, invoking the identifier processing function, isn't depicted for a simplified presentation but performed actually before the step 3 and 4. Then the identifier represented in a standardized format like URN is returned to the mobile RFID application.

The application should have an address information for the content to access an information content identified by the identifier. It calls the identifier resolution entity to get the address information, URL. The step 3 and 4 shows an identifier resolution operation and a URL is returned to the application.

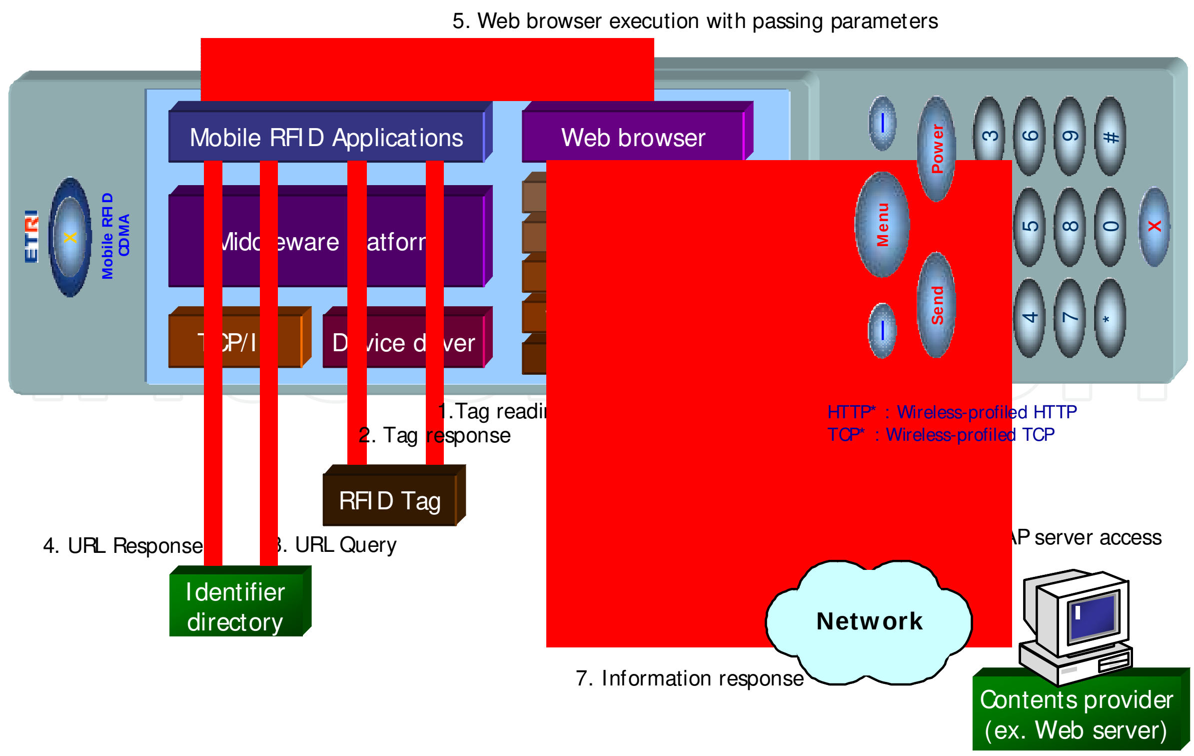

Fig. 15. Internal operation scenario

The mobile RFID application may access the information content directly via the URL or instead a web browser can do that. Since web browsers have rich information content processing features, they are better for information browsing of end-users than dedicated mobile RFID applications. Figure 15 shows the latter case and the mobile RFID application executes a web browser as shown in the step 5 with passing the URL in. Then the web browser takes over all remaining operations.

Figure 15 shows two types of web application platform, WAP 1.0 shown in the left side and WAP 2.0 shown in the right side. The application platform of conventional TCP/IP and web technologies is another alternative. The step 6 and 7 depict an ordinary web access process via the URL.

3.4 Case studies of mobile RFID development

In order to bring RFID to consumers, make RFID and related business opportunities bigger dramatically, and enable B2C RFID applications consequently, end users must have an RFID reader as well as a ubiquitous information terminal. Thus, RFID-equipped cell phones are the perfect candidate device to achieve such purposes.

Table 1 is a summary of mobile RFID development cases. Nokia developed an initial version of the mobile RFID in 2004. Then it developed NFC-based mobile RFID again. KDDI developed two types of mobile RFID with passive and active RFID solutions. Korea has decided to use the UHF band to use following advantages:

- Supporting both short and long read ranges by power control according to user and service requirements; and
- Avoiding duplicate RFID tag installations for both B2B and B2C applications by sharing a single tag. That is, a single RFID tag can be shared by different business domains, B2B and B2C and provide different contents according to applications.

	Frequency	Read range	Standard	Tag/reader features
Nokia's mobile RFID	13.56MHz	2~3cm	ISO/IEC 14443A	Separate
KDDI's mobile RFID with passive type	2.45GHz	~ 5cm		Separate
KDDI's mobile RFID with active type	315MHz	~ 10m		Separate
NFC	13.56MHz	~ 10cm	ISO/IEC 18092	Both
Korea's mobile RFID	908.55~ 913.95MHz	~ 80cm	ISO/IEC 18000-6C	Separate
uID Center's mobile RFID	13.56MHz	~ 5cm		Separate

Table 1. Summary of mobile RFID implementations

[Note] "Both" in the tag/reader features means an RFID device supports reader as well as tag features. Usually an RFID device works as either reader or tag but NFC supports both.

uID center (Kim & Koshizuka, 2006)

The Ubiquitous ID Center developed a network-based ID architecture called "Ubiquitous ID Architecture". The architecture defined "ucode" as an identification scheme to identify things and places. The ucode is stored on several kinds of tags such as RFID, barcode, 2D barcode, and sensor network tag embedded into several things and places in the real world. In the Ubiquitous ID Architecture, these tags that carry ucodes are called as ucode tags.

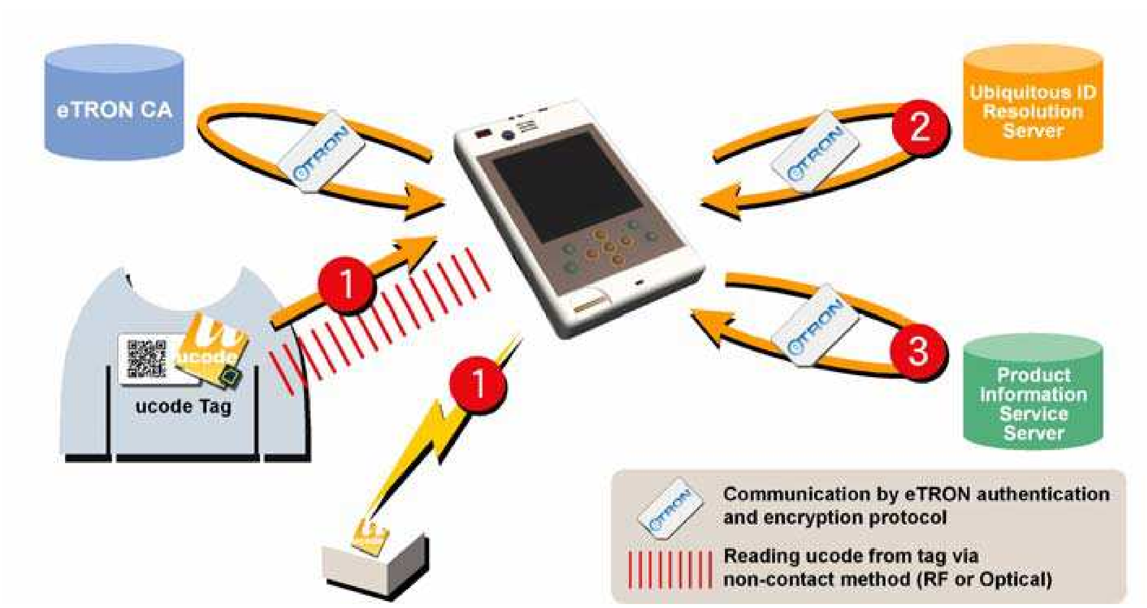

Figure 16. Basic configuration of Ubiquitous ID architecture (Source: uID Center, 2005)

In the basic configuration of the Ubiquitous ID Architecture, the ucode tag contains only a ucode. The information regarding things and places is stored in a database connected to networks and end-user's service browser retrieves the information from the database

through networks. If the ucode tag has enough space of memory, it may contain the information too.
The terminal that reads information from the ucode tag is referred to as "Ubiquitous Communicator (UC)". In Figure 16, the UC reads a ucode from a ucode tag and gains an access privilege to the information service server depending on the obtained ucode (step 1). It gets an address information mapped with the ucode from the ubiquitous ID resolution server which maintains the correspondence between ucode and relevant service information (step 2). Then it retrieves product information from the product information service server via the address information (step 3).
Since the communication by the Ubiquitous ID Architecture is privacy-conscious and secure, it uses a public key cryptography system and requires a certificate authority for the system. In addition, in the case the thing attached with a ucode tag flows out to the public, the identification preventing communication shall be used on the non-contact communication interface of the ucode tag to prevent malicious persons from illegally reading out ucode information stored in the tag.

KDDI

Figure 17 illustrates KDDI's mobile RFID service architecture. A service broker is located. The multi-contact server seems to support both identifier resolution and information contents provisioning. An identifier read by a cell phone from an RFID tag is transmitted to the service broker which finally transmits resulting information back to the cell phone.

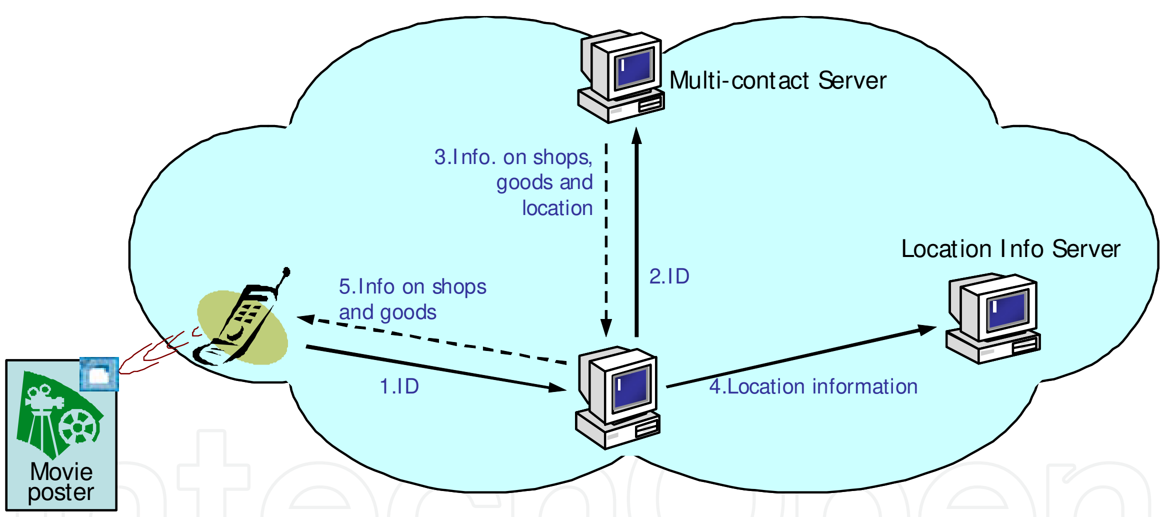

Fig. 17. KDDI's mobile RFID service architecture (Source: KDDI, 2006)

Nokia (Nokia, 2006)

Nokia developed a conceptual model of mobile RFID services based on ISO/IEC 14443A which is a 13.56MHz contactless air interface standard for smartcard applications. Its pilot applications worked successfully.
Then it chose the NFC technology and released the Nokia Field Fource solution in 2005 to support B2C RFID application/service models. Predesigned operations can be performed automatically by touching an RFID tag-equipped object with the NFC reader. Each tag contains a specific serial number which links to the initiation of a service, such as calling, messaging, browsing or recording data. Nokia developed Local Interactions Server (LI Server) which is a Web service that simplifies data capture, reporting, management, and

communication with mobile workforces integrated into back-end application systems. That is, the LI server operates as a service broker as described in clause 3.1.

NFC

The Near Field Communication (NFC) supports three operating modes: Reader/Writer, Peer-to-Peer and Card emulation. The reader/writer mode works as a conventional RFID reader or tag. That is, an NFC device sometimes works as an RFID reader and sometimes works as an RFID tag, but it cannot support both modes simultaneously. Mobile RFID applications and services described in this chapter can be enabled by this operating mode.
The Peer-to-Peer mode enables two NFC devices to exchange data in the communication speed at 106, 212 or 424 kbit/s. When one device runs as a tag, the other device runs as a reader and then vice versa. So two devices exchange some data.
The card emulation mode supports a unified interface for various contactless smartcards to existing smartcard readers. It provides three RF communication modes: NFC FeliCa based on ISO/IEC 18092 and JIS6319-4; NFC Type A based on ISO/IEC 18092 and 14443A; and NFC Type B based on ISO/IEC 14443B, which can support ISO/IEC 14443, 15693 and Mi-Fare also. It is a solution to mitigate two problematic situations: a cell phone is usually equipped with a smartcard for various applicaitons and services and such smartcard cannot support various air interface protocols but do only a single air interface; and existing smartcard readers also have been deployed in such various ways and one smartcard reader cannot support other air interfaces. These situations restrict service coverage because one smartcard reader cannot communicate with other types of smartcards and vice versa. Thus, an NFC device with a smartcard in a cell phone can support a unified interface to almost every existing smartcard readers.

Korea

SKT and KTF of Korea developed mobile RFID service environments of which have been described in the clause 3.1, 3.2 and 3.3.

4. Standardization activities of mobile RFID technologies

Mobile RFID technologies are involved with a set of standardization issues and there are three relevant SDOs (Standards Development Organizations) as illustrated in Figure 18. Relevant bodies are ISO/IEC JTC 1/SC 31/WG 6; ITU-T SG 13, SG 16 and SG 17; and NFC Forum.
ISO/IEC JTC 1/SC 31 has developed AIDC (Automatic Identification and Data Capture) techniques which cover linear and 2-dimensional barcode symbologies as well as RFID. It consists of 6 working groups: WG 1 to WG 6. Among them, WG 6 is working on MIIM (Mobile Item Identification and Management) which covers mobile ORM (Optical Readable Media) as well as mobile RFID and additionally sensor interfaces specified by IEEE 1451. ITU-T is working mainly on network aspects of mobile RFID issues and NFC Forum is dealing with the whole parts of Figure 18. Even though SC 31/WG 6 and NFC Forum have identical work scopes, they have different architectures and technical views.

4.1 ISO/IEC JTC 1/SC 31/WG 6

After 1-year preliminary study of mobile item identification and management issues from March 2007, creation of WG 6 was approved in February 2008 by National Bodies of SC 31 and endorsed at the plenary meeting of SC 31 in June 2008. Its work scopes consist of sensor interfaces as well as RFID and ORM with mobile telephony.

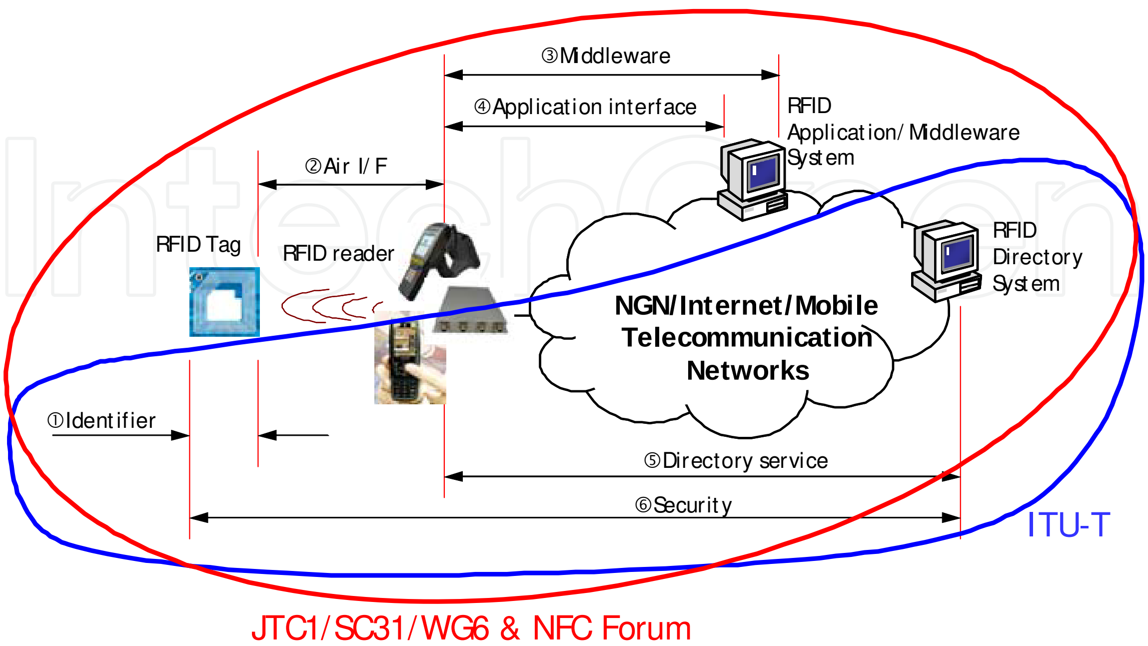

Fig. 18. Standardization scope of relevant SDOs

The mobile ORM is conceptually identical to the mobile RFID but there is the only exception that camera and barcode tag are used instead of RFID reader and tag for a cell phone to read an identifier from the barcode tag through the camera. After the identifier is captured, remaining operations are identical conceptually but technical implementations may be different.

The sensor interfaces have been considered by IEEE 1451 which has already published a few standards and is developing some standards. WG 6 is going to adopt the published standards of IEEE 1451 via the fast track standardization process of ISO/IEC JTC 1.

At its first meeting in April 2008, it made following resolutions to initiate relevant standards developments:

- Regarding mobile ORM,
  - Submission of a new work item proposal for *Implementation guidance for Optically Readable Media (ORM) reader and ORM displayed on Mobile equipment*
- Regarding mobile RFID,
  - Appointment of a project editor for ISO/IEC 29143, *Air Interface specification for Mobile RFID interrogator*
  - Submission of a new work item proposal for *Reference architecture for Mobile AIDC services*
  - Submission of a new work item proposal for *Mobile RFID interrogator device protocol*
  - Submission of a new work item proposal for *UII scheme and encoding format for Mobile AIDC services*
  - Submission of a new work item proposal for *Application data structure and encoding format for Mobile AIDC services*
  - Submission of a new work item proposal for *Consumer privacy-protection protocol for Mobile RFID services*

  - Submission of a new work item proposal for *Object Directory Service for Mobile AIDC services*
  - Submission of a new work item proposal for *Service broker for Mobile AIDC services*
  - Submission of a new work item proposal for *Mobile AIDC application programming interface*

  [Note] "Mobile AIDC" aims at supporting both mobile ORM and RFID.

- Regarding sensor interfaces,
  - Submission of IEEE 1451.0, *Smart Transducer Interface for Sensors and Actuators – Common Functions, Communication Protocols, and Transducer Electronic Data Sheet (TEDS) Formats,* for PSDO (ISO/IEEE Partnership Standards Development Organization) fast-track processing
  - Submission of IEEE 1451.1, *Smart Transducer Interface for Sensors and Actuators – Network Capable Application Processor (NCAP) Information Model,* for PSDO fast-track processing
  - Submission of IEEE 1451.2, *Smart Transducer Interface for Sensors and Actuators – Transducer to Microprocessor Communication Protocols and Transducer Electronic Data Sheet (TEDS) Formats,* for PSDO fast-track processing
  - Submission of IEEE 1451.5, *Smart Transducer Interface for Sensors and Actuators – Wireless Communication Protocols and Transducer Electronic Data Sheet (TEDS) Formats,* for PSDO fast-track processing

It is believed that some of them have been proposed to JTC 1/SC 31 for development of new standards and relevant balloting period for each proposal is being progressed. Standards development activities will be followed according to voting results.

4.2 ITU-T

ITU-T TSAG (Telecummunication Standardization Advisory Group) launched a study group called Correspondence Group to review network aspects of mobile RFID technologies in 2005. After its 1-year study with four deliverables of review of business models and brief service scenarios; relevant standardization issues; proposed ITU-T strategy for relevant standards development; and terms and definitions for the work, ITU-T TSAG recommended ITU-T Study Groups to initiate relevant standards development works in 2006. Then ITU-T SG 13, SG 16 and SG 17 started their works to enable tag-based identification applications and services over telecommunication networks or Internet.

ITU-T SG 13

SG 13 deals with NGN (Next Generation Networks) which is targetting the move from circuit switched to packet based networks and aiming at IP-based convergence networks with public switched telephone network (PSTN), digital subscriber line (DSL), cable television (CATV), wireless local area network (WLAN) and mobile networks (ITU-T SG 13, 2008).

It initiated two work items to provide tag-based identification applications and services over such evolved networks where tag-based identification was defined as the process of specifically identifying a physical or logical object from other physical or logical objects by using identifiers stored on an ID tag such as RFID tag or barcode tag, and tag-based identification applications and services are applications and services which use tag-based identification.

One of the two works was finished in September 2008 and as a result ITU-T Y.2213 was published. It dealt with requirements analysis from NGN points of view because this work is a starting point to develop technical specifications. It covered description and scope of tag-based identification applications and services with some example scenarios; high level service requirements of tag-based identification applications and services; and extended or new NGN capabilities based on the high level service requirements (ITU-T Y.2213, 2008).

The other one is ITU-T Y.idserv-arch. It is scheduled to be finished in 2009. It specifies functional requirements of the NGN architecture based on ITU-T Y.2213 to support tag-based identification applications and services; functional entities of the NGN for extended capabilities; functional architecture of tag-based identification applications and services in NGN; and analysis of ITU-T Y.2213 from architectural viewpoints (ITU-T Y.idserv-arch, 2008).

ITU-T SG 16

SG 16 deals with all aspects of multimedia standardization, including terminals, architecture, protocols, security, mobility, interworking and quality of service. It focuses its studies on conferencing systems, directory services, speech, audio and visual coding, PSTN modems and interfaces, facsimile terminals, ICT accessibility, etc. (ITU-T SG 16, 2008) Since it focuses on multimedia applications, services and systems at higher layers of the OSI Reference Model, its study doesn't depend on specific network technologies.

It has already published two Recommendations: F.771 and H.621. ITU-T F.771 specifies a high level functional model, a service description and requirements for multimedia information access triggered by tag-based identification. Its scope is limited to those applications and services that have both multimedia and tag-based characteristics (ITU-T F.771, 2008).

ITU-T H.621 defines the system architecture for the multimedia information access triggered by tag-based identification based on ITU-T F.771 and serves as a technical introduction to subsequent definition of detailed system components and protocols. The services treated by ITU-T H.621 provide the users with a new method to refer to the multimedia content without typing its address on a keyboard or inputting the name of objects about which relevant information is to be retrieved (ITU-T H.621, 2008).

SG 16 initiated two new work items in April 2008, H.IDscheme and H.IRP. The former one is dealing with identification schemes and incorporating two schemes proposed by Korea and Japan. Korea proposed an extensible code called xCode and Japan proposed its ucode described in the case study of uID center in clause 3.4. The latter one is dealing with resolution protocols from an identifier into an address information like URL and incorporating two solutions proposed by Korea and Japan. Korean solution includes how to incorporate the existing DNS infrastructure for identifier resolution and Japanese solution specifies a unique, dedicated technology for identifier resolution.

ITU-T SG 17

SG 17 deals with telecommunication security, ASN.1 language and X.500 directory matters.

It has developed two items: X.rfpg and X.1171 (a.k.a X.nidsec-1). ITU-T X.rfpg defines guidelines that provide guidance for RFID users and vendors (including service providers and manufacturers) to protect the personally identifiable information for privacy of individuals in the context of RFID technology. The guidelines can be applied to the cases where the RFID system might be used to infringe on individual privacy in such a way that

personally identifiable information is recorded in an RFID tag and then collected, or the object information collected by means of the RFID is linked to a personally identifiable information; provided, however, that it does not be applied to such cases as the object information is collected and used without any risk of invasion of personally identifiable information and privacy (ITU-T X.rfpg, 2008).
ITU-T X.1171 was approved in September 2008 and specifies threats against PII (Personally Identifiable Information) and requirements for PII protection in a B2C-based environment of applications and services using tag-based identification.

4.3 NFC forum

The Near Field Communication (NFC) Forum is a non-profit industry association that promotes the use of NFC short-range wireless interaction in consumer electronics, mobile devices and PCs.
It published a set of standards which are positioned as showin in Figure 19 according to their functional relationships.

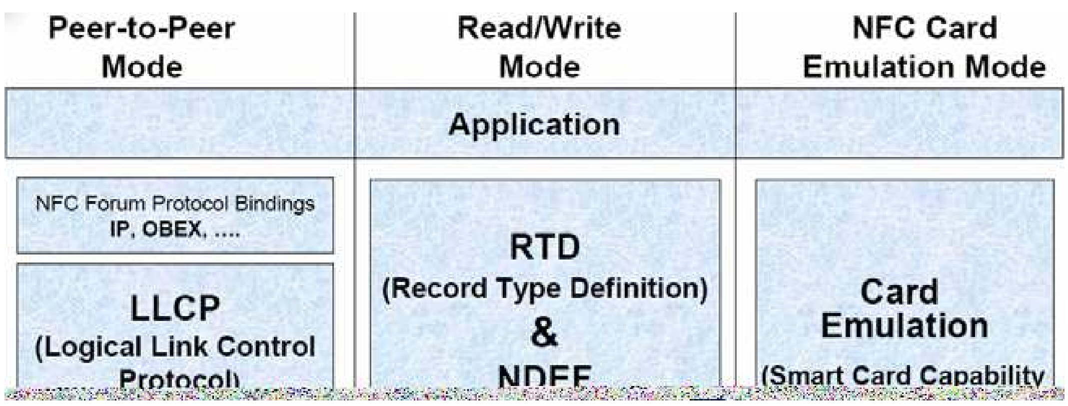

Fig. 19. Structure of NFC standards (Source: NFC Forum, 2007)

The NFC Data Exchange Format (NDEF) specifies a compact, common data format for NFC devices and NFC tags. The NFC Record Type Definition (RTD) specifies standard record types used in messages between NFC devices and between NFC devices and tags, and allows the use of Internet-standard media types. The tag type 1, 2, 3 and 4 specify, with a set of rules and guidelines, NFC device operation and management of a Type 1, 2, 3 or 4 tag. They also define the data mapping and how NFC device detects, reads, and writes NDEF data into the Type 1, 2, 3 or 4 tag platform in order to achieve and maintain interoperability. The Logical Link Control Protocol (LLCP) defines the protocol to manage the logical link between NFC devices (based on ISO/IEC 18092). The mode switch specification defines how to change the communication modes such as data transfer between devices, access at digital content, and creation of contactless transactions like mobile payment. (Romen, 2007)

5. References

ITU-T SG 13 (2008), Study Group 13 at a Glance, ITU-T, *http://www.itu.int/net/ITU-T/info/sg13.aspx*

ITU-T SG 16 (2008), Study Group 1 at a Glance, *ITU-T, http://www.itu.int/net/ITU-T/info/sg16.aspx*

ITU-T F.771 (2008), Service description and requirements for multimedia information access triggered by tag-based identification, *ITU-T Recommendation F.771 (2008)*

ITU-T H.621 (2008), Architecture of a system for multimedia information access triggered by tag-based identification, *ITU-T Recommendation H.621 (2008)*

ITU-T X.1171 (2008), Threats and Requirements for Protection of Personally Identifiable Information in Applications using Tag-based Identification, *ITU-T Recommendation X.1171 (2008)*

ITU-T X.rfpg (2008), Guideline on protection for personally identifiable information in RFID applications, *ITU-T draft Recommendation X.rfpg (2008)*

ITU-T Y.2091 (2006), Terms and Definitions for Next Generation Networks, *ITU-T Recommendation Y.2091 (2006)*

ITU-T Y.2213 (2008), NGN service requirements and capabilities for network aspects of applications and services using tag-based identification, *ITU-T Recommendation Y.2213 (2008)*

ITU-T Y.idserv-arch (2008), functional requirements and architecture of the NGN for applications and services using tag-based identification, *ITU-T draft Recommendation Y.idserv-arch (2008)*

Kim, Yong-Woon & Koshizuka, Noboru (2006), Review report of standardization issues on network aspects of identification including RFID, *ITU-T TSAG TD315, http://www.itu.int/md/T05-TSAG-060703-TD-GEN-0315/en*

Merriam-Webster (2008), hyperlink, *Merriam-Webster Online, http://www.merriam-webster.com/dictionary/hyperlink*

Nokia (2006), Nokia Field Force Solution, *Nokia, http://nfb.online.nokia.com/Page%20Content/Mobilize%20your%20Business/Knowledge%20Center/White%20Papers/WhitePaper_RadioFrequency.pdf | http://www.nearfield.org/2006/08/developing-nfc-applications | http://www.soc-eusai2005.net/documents/presentations/pres_6.pdf*

OMA (2008), Open Mobile Alliance, *http://www.openmobilealliance.org/*

Romen, Gerhard (2007), Near Field Communication Technology and the Road Ahead, *NFC Forum, http://mobile.hkwdc.org/nfc2007/presentations/NFCForum.pdf*

Seidler, Christoph (2005), RFID Opportunities for mobile telecommunication services, *ITU-T Technology Watch, http://www.itu.int/ITU-T/techwatch/docs/rfid.pdf*

WIKIPEDIA (2008), Wireless Application Protocol, *WIKIPEDIA, http://en.wikipedia.org/wiki/Wireless_Application_Protocol*

Development and Implementation of RFID Technology

Edited by Cristina Turcu

ISBN 978-3-902613-54-7

Hard cover, 450 pages

Publisher I-Tech Education and Publishing

Published online 01, January, 2009

Published in print edition January, 2009

The book generously covers a wide range of aspects and issues related to RFID systems, namely the design of RFID antennas, RFID readers and the variety of tags (e.g. UHF tags for sensing applications, surface acoustic wave RFID tags, smart RFID tags), complex RFID systems, security and privacy issues in RFID applications, as well as the selection of encryption algorithms. The book offers new insights, solutions and ideas for the design of efficient RFID architectures and applications. While not pretending to be comprehensive, its wide coverage may be appropriate not only for RFID novices but also for experienced technical professionals and RFID aficionados.