

# INTERNET-OF-THINGS-BASED ON SMART HOME MOBILE RFID

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**ABSTRACT:** Smart homes can relate new Internet-Of-Things concepts along with Radio Frequency Identification System technologies for creating everywhere services. This paper introduces original read-out method for a hierarchical wireless master slave RFID person who reads architecture of multi standard NFC (Near Field Communication) and UHF (Ultra High Frequency) technologies to construct a smart home service system that benefits in terms of cost, energy consumption and complexity. Various smart home service use cases such as washing programs, cooking are describe as examples that make use of this system.

**KEYWORDS:** Smart Homes, RFID, NFC, UHF, Services.

## I. INTRODUCTION

Internet of Things (IOT) is a concept [1] that visualizes bringing the internet even to model things. In Smart Home spaces is like future home. By bringing the internet to fake things, new services can be created and be used by things, devices and humans. To make the dummy things smart things, IOT report suggest Radio Frequency Identification (RFID) as one of the enabler technologies.

A RFID identification system is built based on a RFID person who read plurality of tags and a back-end system with network connectivity like WLAN [2][3].RFID reader can read the ID information from the tags and replace it with the back-end system for further processing.

There are a small amount of architectural solutions in the market for using identification technologies at Smart home. The first solution is to provide the appliance with a fixed RFID reader to identify the tags around the appliances. But the fixed RFID readers like UHF (Ultra High Frequency) standard are huge and costly for appliance level deployment [4],[5]. The second solution is to use a multi antenna RFID tag reader for several appliances with a dedicated antenna for everyone [6]. This result reduces the cost of individual appliance-level RFID tag. But it is not very stylish and needs quite cost-demanding cable installation and maintenance.

The third result is equipping the home residents with handheld mobile RFID (MRFID) tag readers which can be carried around to different rooms. When a home resident enters a room, the mobile RFID tag reader reads the RFID tag information in its exposure range. The data is shown on the mobile reader show and transfer to the home monitoring system.

At present NFC (Near Field Communication) mobile phones like Nokia 6131 and 6212 are on the market which can be used for one-by-one RFID tag reading. But they work with reading distances up to 5cm [7]. In adding there are RFID UHF mobile readers within the distances up to 2m [5]. But they are currently still very large, heavy and consume extra power compared to the smart mobile devices of today and are not very stylish for home environment and therefore not suitable for resilient long day usage. Another issue is that people would prefer to hold around only one mobile device, which includes phone and RFID reader capabilities.

## II. SMART HOME MASTER-SLAVE RFID SYSTEM ARCHITECTURE

This introduces RFID tag reader system architecture for a home comprise of varies readers in master slave architecture. The communication protocol between the tag readers and tags is based on RFID standard protocols like UHF.

The system consists of following tag reader components.

### A. Master Reader (MR)

The master reader is a predictable powerful fixed reader with a direct fixed or wireless connection to the smart home server. It carries out the reader services demand by the smart home system. It initiates a read method in the slave reader and wakes up any passive tags for power-up or any other service start. In addition, it collects the item-level data and forwards it to the back-end for additional processing.

Any type of MRFID reader entering its range can be linked directly or via slave readers. A Master Reader can converse with other MRs in the smart home. It can also work as a substitute between the MRFID reader and local or remote server systems for information service provisioning.

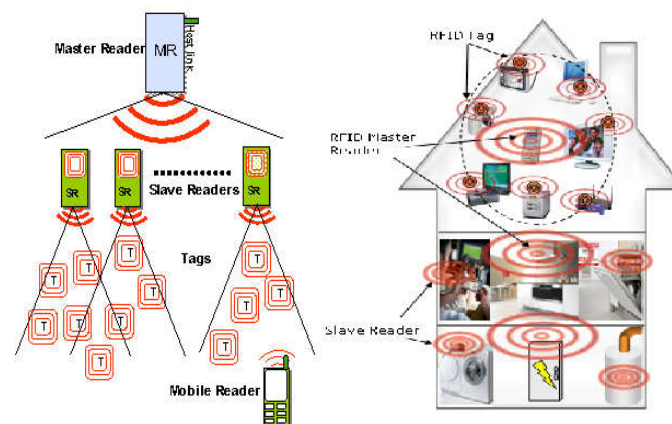


Figure1 a: RFID Master-Slave Architecture;  
b: Room and Appliance level

### B. A number of Slave Readers (SR)

SRs are very simplified readers acting as relay for capturing tag identification information tags which are not available by the direct radio transmission of the master reader. SRs could

be integrated in the home appliances. In addition location of SRs can be used for localization of the tags, when the physical location of the slave reader is known to the system.

### *C. Mobile RFID (MRFID) Reader*

Conventional MRFID readers are believed to have functionalities such as wake up the passive tags, initiating the reading/writing process, RFID tag and reader crash management and announcement with local or remote servers [4]. All these are very power ambitious processes. Depending on human association or reading distance, larger reading window sizes are needed to achieve a 100% recognition of the tags, which implies longer active operation time for the MRFID reader.

In the architecture, the master-slave reader do something as so named “RF Energy Generator” and energizes tags for get up and operation [8]. Therefore the MRFID tag reader forever faces tags which are power-driven up and wakened by the slave or master readers. Thus the MRFID reader acts passive reader and does not need any wake up procedure to start.

## III. RFID READER SERVICE COMMUNICATION

Figure 3 show the high level architecture of the service message between the reader system mechanism and smart home internal and external servers.

The ID process is started by the smart spaces identification service application towards the RFID reader system (step (1) in figure 3). The master reader takes the responsibility and gets up the slave readers and tags in its radio range (step (2)). The slave readers go on in the same way (step (3)) and getup the tags in their range, if those are not yet wake up through the master reader’s first give -up call. The slave readers and the tags throw their identification information to the master reader (step (4)), which collects and removes the redundant information and sends it finally to the smart spaces object server for additional processing (step (5)). The duplicate redundant information from the tags is used afterward for fault tolerance and localization of the tags. The slave reader could in theory take more responsibility in tag data processing. But the brainpower in the slave readers is determined by the charge and complexity limitations. In addition, the system can support RFID services started from mobile devices with and without embedded RFID reader capabilities. There are four possibilities:

### *A. RFID reader services for smart mobile phones*

To some level smart mobile phones can be used to access RFID tag information. The mobile phone needs to use a wireless connectivity like WLAN to converse with the smart spaces RFID master-slave reader system. The mobile phone sends query about e.g. item of interest to the master-slave RFID reader system which provides the required data about the items.

### *B. Conventional method of MRFID reader and tag interaction*

In this method the client is equipped with a mobile RFID reader and wants to know some data (information) about a specific item through shortest touch as is the case today. This method works very well for small operation times, but in complex search services with various tags it can be very instance and power consuming, as mentioned earlier.

C. MRFID reader and tag communication throughout master or slave reader

1) Master or slave reader as a proxy between MRFID reader and tags

In this way the MRFID reader communicates with the tags using master-slave system as a proxy. The MRFID reader sends e.g. investigate profile to the master-slave reader.

The master-slave reader gives up the right tags in the nearness of MRFID reader or navigates to the location of the thing of interest. In the first case the items results and the MRFID reader consume the information in the listen mode. The advantage in this case is the opportunity to avoid power consuming various tag collision processes to be initiated from the mobile reader. Another benefit is the possibility of delegation of the mobile reader wake-up process to the master-slave readers.

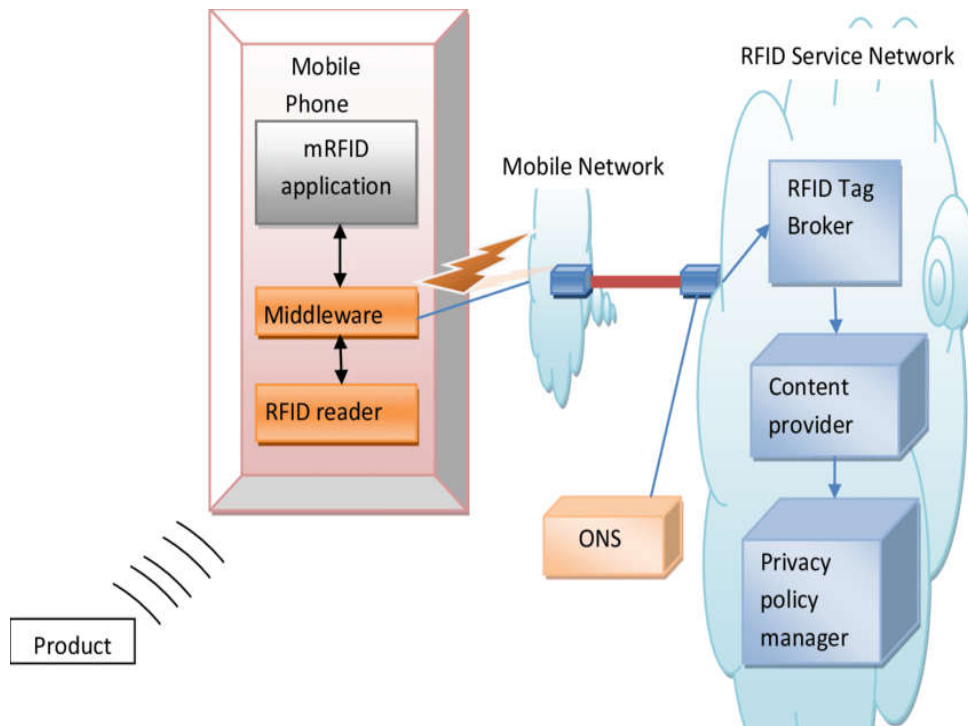


Figure 2.RFID service architecture

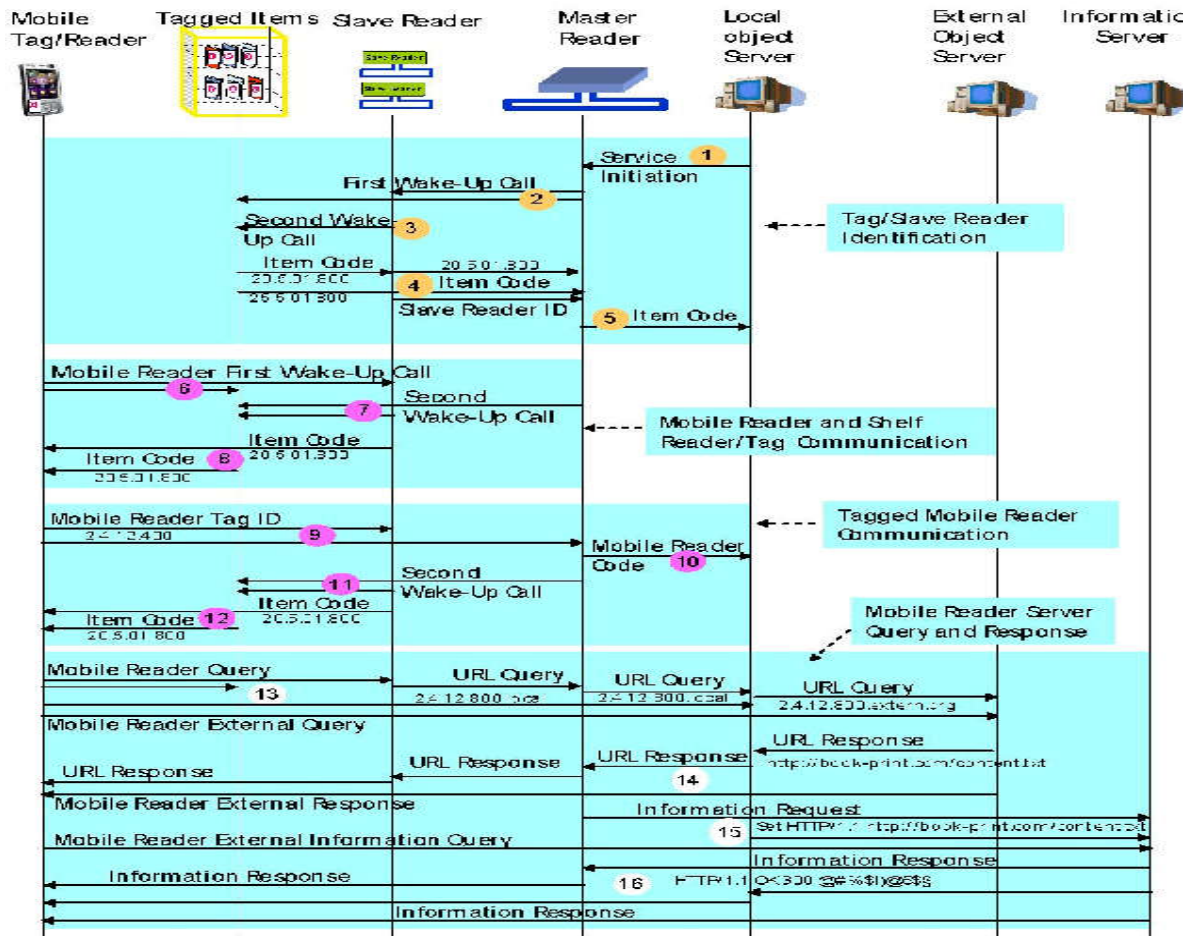


Figure 3.RFID Basic Service Architecture

IV. SMART HOME NFC AND RFID SERVICES

Smart home services can be based on NFC, RFID or both.

Service 1: NFC services

The NFC services can be used for the applications like shopping and be concerned of old people. In shopping the user creates chart for things of interest and plugs them into the home appliances like fridge, shelf etc. The user visits the fridge or shelves and manages the availability of e.g. cooking items. In case of lost items these are loaded from the chart of things attached to the appliance. The charts are an array of NFC tags attach to an A4 paper or plastic cover. On the top of the plastic cover an A4 paper with in print picture of items is fixed (figure 4). The pictures are accurately located above the NFC tags. The client touches one of the pictures with the NFC phone and the shopping application add the item to the shopping list.

Service 2: RFID based services

In this case the control of item stack is much easier, because the UHF readers can read varies tags simultaneously. The user opens the fridge or shelves and read with single touch all

things. The shopping application control the stack list with the cooking recipe and generates without human intervention a shopping list.

*Service 3: RFID and NFC combined services*

In this case the mobile reader has the capability to read RFID and NFC tags at the similar time or indifferent time periods. The various tags read capability of the RFID reader can cause some uncertainty in selecting items of interest at the moment that matters. This result helps to find the possible location of the items. In this case things are connected to their location by an e.g. shelf NFC tag. The mobile NFC reader reads the identification of the shelf before putting Items which is inside the fridge. Every item is understood from the NFC reader while placing it on the shelf. The application associates the shelf and items identifications simultaneously. Later on during the exploration service the RFID reader can read all things at once and the application can contain the read items using the location context from above steps.



Figure 4. Fridge item chart with NFC tags

## V. SMART HOME SERVICE USE CASES

### 5.1 Washing

In this use case dress are attached with RFID tags to represent data about color, material and a fit washing program. The smart home washing system comprise of a master RFID reader and slave readers in sparkling cloth shelves, dirty clothes container boxes and in washing machine. Home washing control application monitor the quantity of clothes in the area of every RFID reader and alarms without human intervention, if the amount of clothes has been reach above a threshold level, it would suggest an energy aware washing program. While the washing machine is loading, the reader checks compatibility of clothes the client puts into the machine. In addition, the control purpose monitors continuously whether some dirty clothes are still left for washing and inform the client. Another opportunity is using the introduced MRFID tag reader with an external 'RF energy generator' as a cost optimized result which is carried by the client from single appliance to the next to collect the required data.

### 5.2 Cooking

The cooking use case uses RFID ID and services. Based on the elastic preferences and other materials like wellness and healthcare it proposes a set of food recipes. The slave readers in



fridge, shelves and in the oven converse with a Master reader in the kitchen. The application client interacts with the server asking for the latest item stack situation to offer a shopping list. Similar to the washing a MRFID reader can be used in this use case too.

## VI. CONCLUSION

This introduced how to apply an advanced power and low cost read-out method for RFID tag reader architecture for smart home applications and services. This system solve the severe power consumption trouble of current mobile RFID tag readers for technologies like RFID/UHF (Ultra High Frequency) Mobile RFID (MRFID) reader policy delegates the most power luxurious service processes like tag energizing to the smart home reader system or to so named “RF Energy Generator”. So the reading Distance is resolute from the home reader system not from the MRFID RF energy source. Therefore this Method increases not directly MRFID readers’ reading Range, which is an additional limit of mobile RFID/UHF readers.

The system has been used for smart home use case services like cooking, washing. This system used several RFID technologies in the similar application. Excellent service of NFC (Near Field Communication) and RFID/UHF combined which increased the act of the system significantly. The introduce system needs the client to select Between the RFID/UHF and NFC communication manually. Further research is needed to join together a multi standard reader and tag supporting together standards. Another research area is tag emulation from reader. Nowadays NFC readers can imitate tag which allows other readers in the space to identify each other. This feature is not supported yet by the RFID/UHF reader.

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