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RFID Deployment in INDIAN RAILWAYS: A case study of E-Transport Initiative in India

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ABSTRACT:

A technology lying largely unused since World War II has suddenly caught the attention of the whole world. The emergence of the industry led global RFID standard has accelerated the adoption of this new technology across sectors. It has helped to fully unlock and open existing opportunities and business applications responsive to today's global needs. Design, Development and implementation of computer-based information systems and associated communication networks have led to the deployment and usage of this wireless technology. According to MCKINSEY & COMPANY, "Railways in India is a sunrise industry! Indian Railways has got the status of super 'JEWEL'. The Indian Railways (IR) is a truly great institution. It is a global giant that operates profitably, effectively and with relatively little government support". The vastness of railways – cars, cargo, track, countries and conditions – presents a massive challenge for management of rolling stock and rail operations. Intellectual Property and Innovation Company's (IPICO's) low cost, passive RF technology enables consistently accurate identification and control of assets in virtually any operating environment. This paper tries to scrutinize the loopholes that exist in the system and examines the modus operandi of RFID technology to address such problems.

INTRODUCTION:

One of the sunrising industry in India as per Mckinsey is that of Indian Railways. Indian Railway is also accorded with the title of “super JEWEL” by Mckinsey. Having the largest network in India, it contributes a lump sum amount of revenue in terms of freight and passengers. In the recent years, Indian Railways has become one of the favourite modes of transport with a share of nearly 22% in the passenger transport market.[4]

The vastness of railways – cars, cargo, track, countries and conditions – presents a massive challenge for management of rolling stock and rail operations. IPICO's low cost, passive RF technology enables consistently accurate identification and control of assets in virtually any operating environment. This largest railway network is on the verge of undertaking a pilot project on “RFID Deployment” for automatic

identification of railway wagons across the whole of India.

As a freight giant, the industry is looking forward to improve the utilization of the wagons and has been on a look out for an online system for tracking wagons on its 62000 km worth of rail network. The pilot is conducted on the Talcher-Paradeep-Vishakhapatnam section of the East Coast Railway where about five hundred wagons will be affixed with RFID tags. This is expected to identify the possible problem areas and come out with strategies to eliminate them.

Under the Information Technology Vision 2012, announced in the Railway Budget for 2008-09 and 2009-10, the railway ministry plans to give the Railways a modern look and feel by implementing Modern Communication systems such as RFID, GPS and GIS. Modernisation of Indian Railways has always been a question in focus for the development of the basic infrastructure of India. Since the railways represent one of the best modes of transport available to the common people, it would be impossible to just keeping increasing the fares to meet the costs incurred due to maintenance, the large workforce and the expansion activities[2]. The Railways should therefore, consider upgrading itself to cutting-edge technologies for better efficiency and cost reduction. One such up gradation is the role of information technology which is achieved with the help of RFID technology. This RFID technology has been extensively used in the identification process with the help of a card and a reader. The idea has evolved from a systematic study of the computerization of railways , Higher demand for Freight and Passenger transport, with planned economic growth, Need for capacity enhancement in the Railway network over the next 10-15 years , Technological upgradation for better maintenance of railway assets and Upgradation of the Railway

Production units for improved efficiency and productivity.

[2] Railway Board has already approved the enclosure of the pilot project for using RFID technology for automatic identification of Railway wagons at an approximate cost of Rs. 2 crores in the existing work of FOIS. The pilot project is implemented on the Waltiar- Kirandul(KK line) of East Coast Railway(ECOR), on a closed circuit. Approximately, 1000 wagons are to be tagged, and trackside readers are to be placed at various locations, alongwith handled readers at major yards and loading/unloading points as part of the pilot.

On successful completion of the pilot project, it is planned to expand the system to tag all the wagons on Indian Railways, and place readers at all the major station yards, and maintenance facility centres. The approximate cost of all the wagons range from Rs. 100 crores to Rs. 250 crores, depending on the chosen features and choice of technology.

[2] The following are planned to be implemented through RFID technology:

RFID:

1. Wagon Number Tracking & Wagon Location.
2. Weight Information

Duplication:

1. Wagon/ Coach Number Tracking is almost common in most of the projects under CRIS.
2. Weightment of Wagon/Rake is also being tapped in most of the projects.

Proposed Solutions:

1. Through RFID technology, a variety of things can be automatically identified, located, tracked, monitored and protected.
2. The things that can be RFID tagged include: personnel, assets, vehicles, inventory,etc as well as their conditions and the environment around them.
3. RFID can operate around the enterprise in a local area, indoors or outdoors. Through RFID, assets can be automatically protected giving the

owner the freedom to come and go from a secured location with the assets.

4. Wagons and coaches can be provided fast, "rolling access" to yards.

5. Wagons/Coach Trailers/Containers and personnel can be automatically identified and coordinated, resulting in dramatic efficiencies in personnel and asset utilization, all of which can enable increased revenue. This provide automatic visibility, improved productivity and dramatically reduces human intervention.

Definition[9,10]

RFID is an ADC technology that uses radio-frequency waves to transfer data between a reader and a movable item to identify, categorize, track the items. It stands for Radio Frequency Identification. It is fast, reliable, and does not require physical line of sight or contact between reader/scanner and the tagged item.

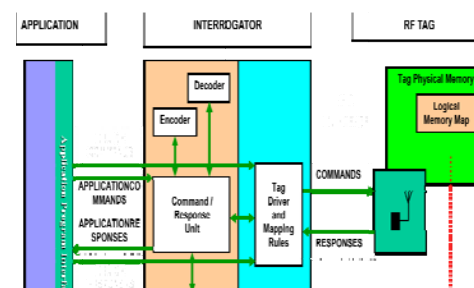
Components of an RFID System:

RFID technology consists of the following three components: Tag, Reader and the Middleware which interacts with backend database. [9,10]

RFID Tag: consists of a microchip with data storage, limited logical functionality and an antenna which is tuned to receive radio frequency waves emitted by a reader or transceiver for allowing wireless transmission of data to the reader. For retail applications, the identifier takes the form of an Electronic Product Code (EPC).

RFID scanner/readers: It usually consists of a radio frequency module, a control unit and a coupling element to interrogate the tags via radio frequency communication. Readers are usually connected through middleware to a back-end database.

RFID Middleware: This refers to specialty software that sits between the reader network and the true application software to help process the significant amount of data generated by the reader network. Middleware is responsible for cleaning the data – eliminating false reads besides performing aggregation and filtering of data. Also, by monitoring multiple readers, middleware can detect the movement of RFID tags as they pass from the read range of one reader to another.



Working of an typical RFID system:[9,10]

- Host Manages Reader(s) and Issues Commands
- Reader and tag communicate via RF signal
- Carrier signal generated by the reader (upon request from the host application)
- Carrier signal sent out through the antennas
- Carrier signal hits tag(s)
- Tag receives and modifies carrier signal
 - “sends back” modulated signal (Passive Backscatter - FCC and ITU refer to as “field disturbance device”)
- Antennas receive the modulated signal and send them to the Reader
- Reader decodes the data
 - Results returned to the host application

BENEFITS OF RFID:

[6]RFID solutions can be used wherever processes are to be simplified and made transparent. It saves time through:

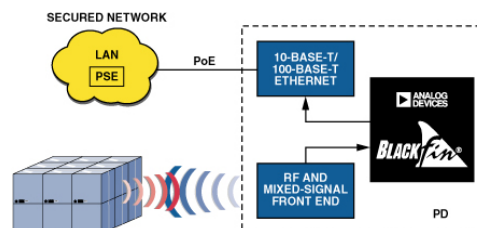
- Remote data exchange
- Parallel identification of multiple objects
- Nearly 100% first reading rate
- No line of sight required for data acquisition
- Flexible label positioning
- Scratch resistance
- Zero maintenance
- Maximum resistance against chemical or mechanical influences
- Data protection
- Reusability

APPLICATIONS OF RFID:[6]

- RFID technology finds its applications in many diverse areas such as Inventory Management, Logistics Management, Surveillance, Toll collection, etc.
- In supermarket food pallets and cases, they can track the assets and allow better management of the pool of assets. In addition, automatic reordering can be implemented to keep shelves properly stocked.
- In libraries they can be used to automate the issuance and return of books that were identified by reading labels individually with a barcode scanner.
- In the pharmaceutical industry they can be used to safeguard against counterfeit supplies.
- In sports competitions, they can accurately track a runner's progress during a long race.

AN EXAMPLE OF ASSET-TRACKING SYSTEMS USING RFID:

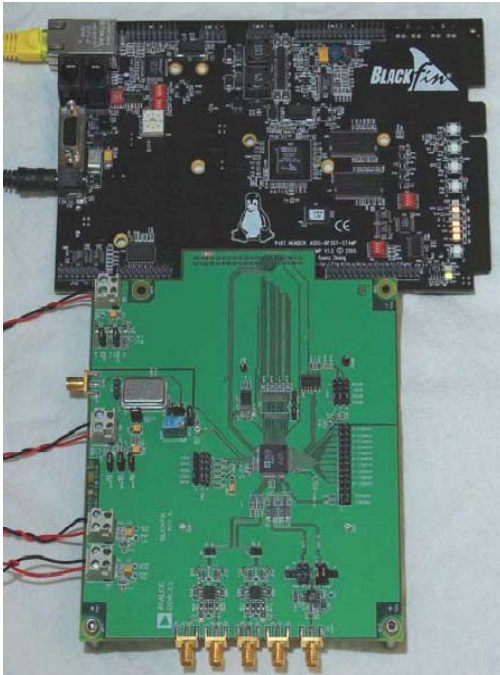
[3]The most common application of RFID is asset management, which benefits by reduction of lost inventory, elimination of incorrect deliveries, improvement in distribution logistics, etc. an RFID system, in a large warehouse, can track a container-laden pallet's movement from the time the pallet enters the warehouse to the time it leaves. Such a system relies on fixed RFID readers placed throughout the warehouse and at points of inbound/outbound shipping.



SOFTWARE OVERVIEW FOR DEPLOYMENT OF RFID:

The RFID reader has embedded software that manages the interrogation, decoding and processing of the received tag information and it communicates with a storage system that houses a tag database and other relevant information. The three elements of the RFID reader software architecture are: the back-end server interface, the middleware, and the front-end tag reader algorithms.

HARDWARE:



A/D and D/A Converters

For communicating with a tag, the *mixed-signal front-end* (MxFE®) IC forms the interface of interest.

MxFE devices are general-purpose, intermediate-frequency subsystems that include A/D and D/A converters, low-noise amplifiers, mixers, AGC circuitry, and programmable filters. Output streams of I&Q data connect directly to processor parallel ports. Analog Devices MxFE2 IC family members constitute the highest performance narrow-band receivers available, well-suited to RFID—and other—applications.

Figure 2 shows a block diagram of a typical MxFE device.

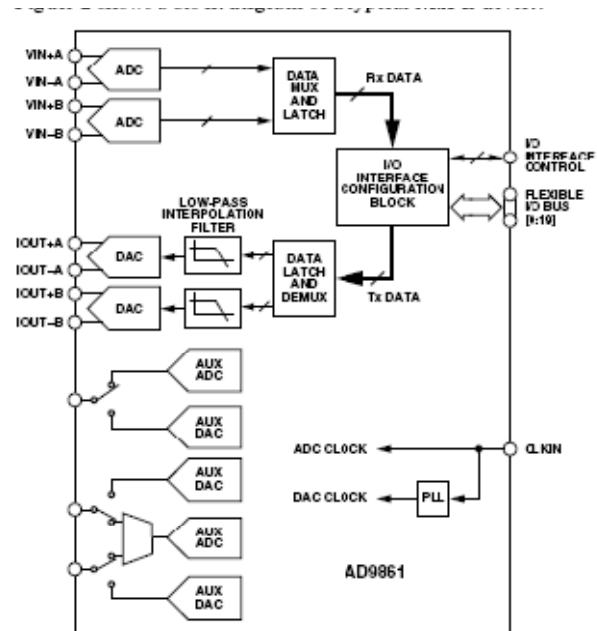


Figure 2. Block diagram of a representative MxFE IC, the AD9861.

Blackfin Processors for RFID Applications[5]:

Blackfin processors provide connectivity to both wired and wireless networks. Some processors, such as the ADSP-BF5363 and ADSP-BF537,4 have a 10-Base-T/100-Base-T Ethernet MAC on chip. On the wireless side, all Blackfin processors can connect directly to both 802.15.4 ZigBee and IEEE 802.11 chipsets via the SPI® and SPORT peripherals. Line-speed transfers can be obtained without consuming the entire processor bandwidth. In addition, Blackfin processors include a *parallel peripheral interface* (PPI), which can connect directly to ADCs and DACs

such as those mentioned above. Some Blackfin processors include two PPIs, which can expand system functionality even further—allowing a camera to be connected to an RFID reader, for instance. Besides RFID applications, these Blackfin features

are also especially attractive for 1D and 2D barcode applications, because of Blackfin's ability to perform system control, networking, and image processing on the same device.

For RFID applications, a single PPI is often sufficient because of the way the RFID reader interrogates tags. First, the PPI is configured in *transmit* mode, and the processor sends a digital sequence to a DAC. The transmitted sequence is converted to an analog signal, which is then upconverted and sent out to excite/

wake up local RFID tags, which then respond. Simultaneously, the PPI is reconfigured as a receiver in a small number of processor system clock pulses (see EE-Note 236),⁵ as shown in Figure 3. In this way, a downconverted RF signal can be sampled by an ADC and brought into the Blackfin directly. In the figure, the time between each *receive* (Rx) and *transmit* (Tx) interval is measured in system clock cycles. The elapsed time allows for the transmitted signal to reach the tag and for the tag to transmit a response.

Figure 3. Illustration of Tx/Rx sequence for RFID reader with a single ADC/DAC interface.

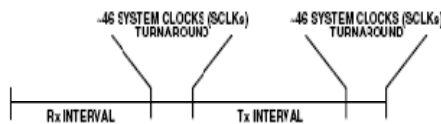


Figure 3. Illustration of Tx/Rx sequence for RFID reader with a single ADC/DAC interface.

In some RFID applications, a Blackfin processor alone can act as the server—for example, when large data stores and database manipulations are not necessary. For instance, imagine an elderly parent wearing a bracelet with a tag that could be monitored within the house. If no signs of activity were noted within a specified time interval, the monitoring agency could alert registered friends or relatives.

The software components that make up the infrastructure of a Blackfin RFID reader includes the drivers necessary to interface to the mixed-signal, front-end IC, as well as a DMA driver that is very useful in moving data through a system. The Clinux-based network stack and SQL database engines are also available. From a system perspective, additional features, such as 802.11 Wi-Fi cards, USB thumb drives, and Compact Flash card interfaces, can very quickly be integrated with Blackfin devices

FUTURE WORK:[1,8]

The system can be extended in future with encoding information other than vehicle identification in a dynamic fashion onto the tag, integration of sensor-based solution and integration with a GIS system. A problem related to collisions arising from reading of multiple tags simultaneously also needs to be addressed. And finally, the issue like interference in case of active tags needs to be tested.

Problems with RFID Standards:

RFID has been implemented in different ways by different manufacturers; global standards are still being worked on. It should be noted that some RFID devices are never meant to leave their network (as in the case of RFID tags used for inventory control within a company). This can cause problems for companies.

Consumers may also have problems with RFID standards.

RFID systems can be easily disrupted:

Since RFID systems make use of the electromagnetic spectrum (like WiFi networks or cellphones), they are relatively easy to jam using energy at the right frequency. Although this would only be an inconvenience for consumers in stores (longer waits at the checkout), it could be disastrous in other environments where RFID is increasingly used, like hospitals or in the military in the field.

Also, active RFID tags (those that use a battery to increase the range of the system) can be repeatedly interrogated to wear the battery down, disrupting the system.

RFID Reader Collision:

Reader collision occurs when the signals from two or more readers overlap. The tag is unable to respond to simultaneous queries. Systems must be carefully set up to avoid this problem; many systems use an **anti-collision protocol** (also called a **singulation protocol**). Anti-collision protocols enable the tags to take turns in transmitting to a reader.

RFID Tag Collision:

Tag collision occurs when many tags are present in a small area; but since the read time is very fast, it is easier for vendors to develop systems that ensure that tags respond one at a time.

Security, privacy and ethics problems with RFID:

The following problems with RFID tags and readers have been reported.

The contents of an RFID tag can be read after the item leaves the supply chain:

An RFID tag cannot tell the difference between one reader and another. RFID scanners are very portable; RFID tags can be read from a distance, from a few inches to a few yards. This allows anyone to see the contents of your purse or pocket as you walk down the street. Some tags can be turned off when the item has left the supply chain.

RFID tags are difficult to remove:

RFID tags are difficult for consumers to remove; some are very small (less than a half-millimeter square, and as thin as a sheet of paper) - others may be hidden or embedded inside a product where consumers cannot see them. New technologies allow RFID tags to be "printed" right on a product and may not be removable at all.

RFID tags can be read without your knowledge:

Since the tags can be read without being swiped or obviously scanned (as is the case with magnetic strips or barcodes), anyone with an RFID tag reader can read the tags embedded in your clothes and other consumer products without your knowledge. For example, you could be scanned *before* you enter the store, just to see what you are carrying. You might then be approached by a clerk who knows what you have in your backpack or purse, and can suggest accessories or other items.

RFID tags can be read from a greater distance with a high-gain antenna:

For various reasons, RFID reader/tag systems are designed so that distance between the tag and the reader is kept to a minimum (see the material on tag collision above). However, a high-gain antenna can be used to read the tags from much further away, leading to privacy problems.

RFID tags with unique serial numbers could be linked to an individual credit card number:

At present, the Universal Product Code (UPC) implemented with barcodes allows each product sold in a store to have a unique number that

identifies that product. Work is proceeding on a global system of product identification that would allow *each individual item* to have its own number. When the item is scanned for purchase and is paid for, the RFID tag number for a particular item can be associated with a credit card number.

CONCLUSION:

Practical RFID systems are involved in real time tracking and monitoring of events. The system performs appropriate actions in response to events based on certain conditions. It is natural to consider the use of the Event, Condition and Action (ECA) framework to address event management issues.. The paper gives an overview of the current state and trends of RFID technology. Even though numerous limitations and unresolved issues still hinder the widespread application of RFID, it can be already seen that especially enterprises in complex supply chains will benefit from RFID, once the application difficulties are overcome.

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