APPLICATION OF RIFD SYSTEMS FOR AUTOMATIC TICKETING SYSETMS

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Abstract

RFID is one of the wireless components which have numerous applications .in a country like India half of the population completely rely on public transport. Increase in efficiency of public transport will certainly increase the people using it, this reduces the individual vehicles in turn reducing the traffic congestion and pollution. This paper focuses on how RFID technology can be used to solve the problems faced by public transport in metropolitan cities of the country and also discusses about the challenges in designing .here we are proposing a method that tracks the buses automatically and to provide useful estimates of arrival times and enhance commuter convenience. We also discuss how the collected data can be used to predict bus movement timing in order to provide better service.

Key word: RFID, public transport, tracking, tag collision, reader collision.

1. Introduction

RFID tags have emerged as a key technology for real time asset tracking .RFID is a non-contact method of using radio frequency electromagnetic waves (with frequencies up to 2.5GHz) for communication between 2 remote entities. Data is stored in devices called RFID tags or transponders, and is retrieved by readers. Each tag stores a unique identification number. RFID tags are widely used in manufacturing, warehousing, retail, logistics, pharmaceuticals, health care and security. RFID systems are foreseen as replacement to the legacy bar code system of identifying an item. One of the major advantages of RFIDs over bar codes is that it is a non-line-of-sight technology. In addition, RFID readers can read tags even when they are hidden.

The primary focus of this paper is the use of RFID technology to solve problems faced by commuters and bus (transport) operators in many metropolitan areas.

Due to urbanization Indian cities are overpopulated. Nearly 75% of the people rely on public transport. Often the buses are overcrowded. The bus arrivals at a particular stop are not regular due to the traffic congestion. As a result commuters usually spend long hours at bus stops waiting. The unpredictability nature of bus system can be partly alleviated by deploying a bus tracking and reporting system. There are couple of ways address this problem, one approach is to use GPS and the other is through the use of RFID technology and present issues related to its deployment.

2. Proposed solution:

2.1 RFID based approach

Each bus could have an RFID tag affixed to it while the readers are conveniently mounted at intersections, lamp posts or bus stops. The crucial information associated with a tag is the specific bus number, the capacity of the bus, the route number currently plying and the termination point (for example, during non-peak hours a bus may terminate at a depot before its usual terminating point). Tag readers continually monitor passing buses and transfer this information in real-time to a central computer.

A commuter with access to a cell phone could subscribe to the following service from the mobile network provider. The subscriber may enter his destination stop, D, (and optionally location of nearest bus stop) on his cell phone in the comfort of his home. The system will inform him of the relevant buses closest to him and expected arrival times of these buses.

The above service can be provided by the mobile network operator. The provider contacts a central computer to obtain the set of buses traveling to D through the closest bus stop to the customer. This list is obtained in sorted order and could possibly be filtered or enhanced in some way depending on the preferences of the customer. For example, if there are several bus stops in proximity to the commuter, information on relevant arrivals at all these bus stops can be provided. The provider can provide customized service to each subscribing commuter for a small fee.

This service can be used for multiple purposes to locate and control bus movement in the metro city. For example, in the event of an accident causing traffic congestion on a particular road, the buses leading to the road can be informed. In some cases, the routes of the bus can be changed temporarily and accordingly bus driver can be informed via wireless network. Or if it is found that a particular bus was stuck in traffic and that has led to a smaller gap with the next bus, the bus driver of the next bus can be informed to slow down to increase the gap. Many such applications can be thought of based on such an RFID application.

3. CHALLENGES in RFID deployment:

3.1 Data Base Management:

3.1.1 Data Management Problem

To explain the problem in database management, we will consider a metro city in India. MTC runs over 783 bus routes in Chennai. The average time between two buses on a route is about 15 minutes. But, due to traffic congestion and peak crowds, the maximum time may exceed 30 minutes. Overall, there are around 3609 buses in MTC which carry around 48,00,000 passengers every day.

MTC buses, on many routes run for -- hours (from 4 AM to 12 AM) a day. So the number of trips along a route will be 80 trips (20 x 60 /15), on an average. Thus, with 80 trips per bus route and an estimated average number of bus stops per route = 17, we could estimate the number of events that will be generated in this scenario as below:
80 trips x 783 routes x 17 stops = 9, 39,600events
Processing and relating so many events to derive a meaningful real-time decision is a challenging task. If we are placing the readers only at bus stops and depot then the management of data obtained from reader is not a problem. But if we are planned to place the readers in the intermediate street lamps to get information between two bus stops the number of events will further increase.

Managing such high volume of events and generated data poses the challenges to applications as well as back-end databases. This data is often redundant and needs to be filtered/cleaned and consolidated in order to occupy less space in database. In doing so, care must be taken that no useful information is lost.

4.1.2 REAL TIME MANAGEMENT:

Real time management can also be done. if two buses are plying in the same route A. the distance between the two buses are lower than threshold level , then by means of wireless communication we can contact the second bus and ask him to increase the bus sped to match the threshold level. It is so useful during disastrous circumstances and long traffic congestion, the buses can be tracked and alternate route can be administered to them..

This type of real type management can be done only when the readers are placed at several intermediates between the stops so that the central monitoring system can find the exact location of the bus and instruct them immediately.

Managing such high volume of events and generated data poses the challenges to applications as well as back-end databases. This data is often redundant and needs to be filtered/cleaned and consolidated in order to occupy less space in database. In doing so, care must be taken that no useful information is lost.

Researchers in the database community have presented techniques and models for warehousing as well as cleaning/filtering RFID data. EPC-IS and PML Core are the RFID system standardization efforts by auto-ID center. Summarizes the data characteristics, models data as events and provides some reference relation to represent data. Dynamic Relationship ER (DRER) presented in is an expressive temporal data model which enables support for basic queries for tracking and monitoring RFID tagged objects. A simple observation that objects move together in initial stages brings a couple of more proposals. Hu et al. used bitmap data type to compress the information corresponding to objects that move together. RFID-Cuboids are a new warehousing model that preserves object transitions while providing significant compression and path-dependent aggregates. Flow Cube is a method to construct a warehouse of commodity flows. Some of these are simple representations of various relationships in the Relational DBMS.

3.2 EPC System Network Architecture

Radio Frequency Identification is a technology used to identify, track and locate assets.
The unique number, called EPC (electronic product code) will be encoded in an inexpensive Radio Frequency Identification (RFID) tag. The EPC Network will also capture and make available (via Internet and for authorized requests) other information that pertains to a given item to authorized requestors.

3.2.1 EPC Network Software Architecture Components

The EPC Network Architecture as in Fig. 4 shows the high-level components of the EPC Network.

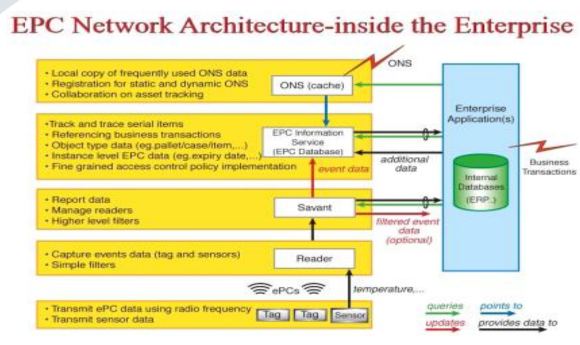

Figure 4: EPC Network Architecture: Components and Layers

These functional components from the figures above are described in the sections below.

3.2.1.1 Readers

Readers are devices responsible for detecting when tags enter their read range. They may also be capable of interrogating other sensors coupled to tags or embedded within tags. The Reader Protocol Specification defines a standard protocol by which Readers communicate with Savants and other hosts. The Savant also has an "adapter" provision to interface to older readers

3.2.1.2 Savant

Savant is "middleware" software designed to process the streams of tag or sensor data (event data) coming from of one or more reader devices. Savant performs filtering, aggregation, and counting of tag data, reducing the volume of data prior to sending to Enterprise Applications.

3.2.1.3 EPC Information Service

The EPC Information Service makes EPC Network related data available in PML format to requesting services. Data available through the EPC Information Service may include tag read data collected from Savant (for example, to assist with object tracking and tracing at serial number granularity); instance-level data such as date of manufacture, expiry date, and so on; and object class-level data such as product catalog information. In responding to requests, the EPC Information Service draws upon a variety of data sources that exist within an enterprise, translating that data into PML format. When the EPC data is distributed across the supply chain, an industry may create an EPC Access Registry that will act as a repository for EPC Information Service interface descriptions.

3.2.1.4 ONS – Object Name Service

The Object Name Service provides a global lookup service to translate an EPC into one or more Internet Uniform Reference Locators (URLs) where further information on the object may be found. These URLs often identify an EPC Information Service, though ONS may also be used to associate EPCs with web sites and other Internet resources relevant to an object.

ONS provides both static and dynamic services. Static ONS typically provides URLs for information maintained by an object's manufacturer. Dynamic ONS services record a sequence of custodians as an object moves through a supply chain. ONS is built using the same technology as DNS, the Domain Name Service of the Internet.

3.2.1.5 ONS local cache

The local ONS cache is used to reduce the need to query the global Object Name Service for each object which is seen, since frequently-asked / recently-asked values can be stored in the local cache, which acts as the first port of call for ONS type queries. The local cache may also manage lookup of private internal EPCs for asset tracking. Coupled with the local cache will be registration functions for registering EPCs with the global ONS system and with a dynamic ONS system for private tracking and collaboration within the supply chain seen by each unique object.

3.2.2 EPC Network Data Standards

The operation of the components of the EPC Network is subject to data standards that specify the syntax and semantics of data exchanged among components.

3.2.2.1 Electronic Product Code (EPC)

The Electronic Product Code is the fundamental identifier for a physical object. The Auto-ID Electronic Product Code Data Specification 1.0 defines the abstract content of the Electronic Product Code, and its concrete realization in the form of RFID tags, Internet URIs, and other representations.

3.2.2.2 Physical Markup Language (PML)

The Physical Mark-Up Language (PML) is a collection of common, standardized XML vocabularies to represent and distribute information related to EPC Network enabled objects. The PML standardizes the content of messages exchanged within the EPC network. The core part of the physical mark-up-language (PML Core) provides a standardized format for the exchange of the data captured by the e.g. RFID readers.

3.2.3 EPC Network Architecture – across Enterprises

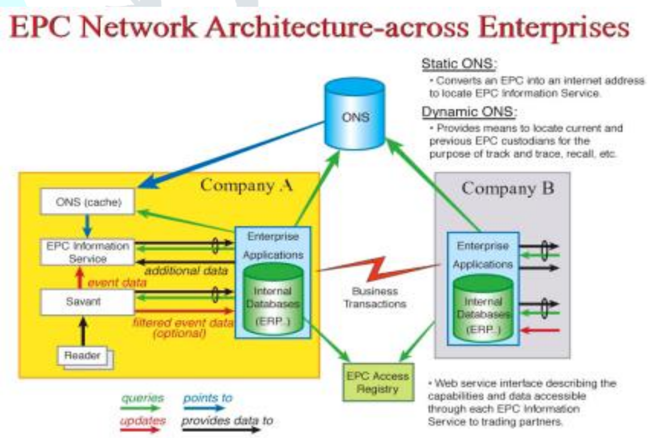

Figure 5: EPC Network Architecture: across Enterprises

5. Reader collision

Reader collision is the major problem. if two reader vicinity is collided the tag present in that intersection will be detected by both the readers. Due to this problem we can'tdetermine the exact location of the tag (bus) and since two tag details are entered, filtering should also be done. in filtering either one of the details is deleted but since we do not know which is the original details (location). We should wait till the neighboring reader detects the same tag

5.1 The placement of the reader:

Based on the requirements the placement of the reader differs. if we just want the location of the bus , we can place the readers at bus stops and depots. If we want a real time location of the bus, arrival display at the stops,real time instruction between central control base to bus. We should track the of the bus for every second. We should place the reads at the lamp posts, traffic interjunctions, bus stops, bus depots. The place meant of the reader in real time is based on the area it should cover and on reader specifications.

Since we plan to place the reader on the lamp post. Each reader should cover both side of the road. Based on the road size the reader specification is varied.

A 2.5 GHz adjustable active RFID reader can be used. Based on the size of the roads the vicinity is varied from 5m to 100m. since it is omnidirectional if we place on the lamp post in the Centre median of the road it will cover both the roads on either side .power supply to the readers will not be a problem because it is placed adjacent to the lamp post from which it can get the power. In a developing country like India the power shortage is a major concern. We can have a battery operated reader..

6. TAG COLLISION:

6.1 Tree based Tag Anti-Collision Protocols

6 .1.1 Binary Tree Working Algorithm

A reader chooses '0' or '1' for the initiative. If the reader makes a choice, the identification process should keep the way of choice order when the tree splits at a node. Then the binary tree working algorithm (BTWA) is operated as follows:

Step 1. The reader transmits k-length prefix.

Step 2. Tags send (k+1)th bit if the first k bits of tag IDs are the same as the prefix.

Step 3. If the received bits collide, the extended prefix attached '0' or '1' to the prefix is retransmitted by the reader. If they do not collide, the received bit is attached to the prefix for the next prefix. If there is no response, the branch is ignored. Also, a collision occurs at the last bit of the tag IDs, the reader assumes there are two tags because of the uniqueness of the tag IDs.

Step 4. The reader repeats the procedure until all branches are searched.

6.1.2 Query Tree Algorithm

The query tree algorithm (QTA) is based on BTWA. The difference between QTA and BTWA is as follows:

Step 2. Tags send from (k+1)th bit to the end bit of tag IDs if the first k bits of tag Ids are the same as the prefix.

Step 3. If there is a collision, the extended prefix attached '0' or '1' to the prefix is retransmitted. Furthermore, if there is no collision, the reader identifies a tag corresponding to the detected ID, which is the connection of the prefix and the response.

6.1.3 Collision Tracking Tree Algorithm

The collision tracking tree algorithm (CTTA) is based on QTA except that this scheme uses collision tracking. The difference between CTTA and QTA is as follows:

Step 2. ***Tag***: the tags send their IDs from (k+1)th bit to the end bit if the prefix is the same as the first k bits of tag IDs. However, the tags stop sending their IDs when an ACK signal is received.

Reader: the reader checks whether a collision occurs or not in each bit on the received sequences, and transmits an ACK signal to stop being sent the tag IDs by the tags if there is a collision.

Step 3. If there is a collision at nth bit in the received sequences, the two new prefixes, 'the former prefix k bits + the received n-1 bits + 0 or 1', are retransmitted sequentially to the tags in the field of the reader. Furthermore, if there is no collision, the reader identifies a tag corresponding to the detected ID, which is the connection of the prefix and the response.

6.2 Slotted ALOHA based Tag Anti-collision Protocols

6.2.1 I-Code

I-Code is similar to the frame slotted ALOHA (FS-ALOHA). In FS-ALOHA, a reader gives the information, which includes read range, clock, and frame size, to tags. Then the tags choose a slot with random backoff time in a frame to send their IDs. If a tag is identified by the reader, the tag changes its state as `inactivated'. Do this procedure during the number of cycles determined by target accuracy in Markov process. How to choose a frame size with the unknown number of tags can be a good research subject.

6.2.2 STAC

STAC is based on FS-ALOHA. The only difference is that STAC reduces the waste of time caused by empty slots in a frame. In the FS-ALOHA algorithm, there is no consideration for empty slots which makes the algorithm inefficient. In the STAC algorithm, a reader sends the 'close slot sequence' to tags when an empty slot occurs. Thus, the empty slot interval is reduced.

6.2.3 Bit-Slot

The bit-slot algorithm is a kind of reservation based algorithm, which assigns the order of transmitting tag IDs by using the reservation sequences. With the reservation sequences, the overhead for assigning slots to transmit the tag IDs is reduced. In the bit-slot algorithm, tags send reservation sequences randomly generated by only one `1' and several `0's, and a reader checks the reservation sequences whether the positions of `1' in the sequences are collided or not. Then, the reader saves the list of the identical reservation sequences to call each tag, and communicates with each tag sequentially.

6.3 PS-ALOHA in EPC Class 1 Gen.2 Protocol

The performance of ALOHA based systems is usually measured by the throughput indicating the efficiency of a system, which can be expressed as the number of success slots over the total number of attempt slots. Typical ALOHA systems with a fixed frame size show good throughput only for the specific number of tags in the field of a reader, but the throughput decreases dramatically as the number of tags increases. To solve this problem, a dynamic frame slotted (DFS)- ALOHA algorithm is devised to maintain the good throughput for any number of tags, where its frame size is flexibly changed according to the number of tags.

EPC Class 1 Gen.2 protocol adopts the probabilistic slotted (PS)-ALOHA algorithm as its anti-collision scheme. Most parts of the PS-ALOHA in EPC Class 1 protocol are similar to the conventional DFS-ALOHA, but the algorithm has its own characteristics as Follows

1. **SLOTS CONTROLLED BY READERS**: Each slot is controlled not by the synchronized clock but by the commands of a reader. Thus, the reader makes a slot finish its duration when the slot is empty, and makes the next slot start for reducing the waste of time caused by the empty slot occurring in the middle of a frame.
2. **TEMPORARY IDs**: Instead of the tag IDs with dozens or hundreds of bits in a slot, the temporary IDs, which consist of 16-bit random numbers (RN16s), are used for the collision detection in a slot, and also used when the reader queries identified tags. The temporary IDs reduce the duration of the slots, and enhance the security of reader-tag communications because the randomly generated temporary ID is used as the key of taking the tag ID.
3. **STATES OF TAGS**: The identified tags change their states from 'arbitrary' to 'acknowledged ', and do not participate in the next inventory rounds (frames). Thus, the number of tags, which attends the next inventory rounds, decreases.

Figure 6 briefly indicates the EPC Class 1 Gen.2 protocol. At first, a reader broadcasts the frame size and notifies the beginning of a frame to all tags with a Query command. After the frame is started, each tag generates a 16-bit random number (RN16) as a temporary ID, and selects a slot in the frame. Next, the reader proceeds to transmit a QueryRep command to the tags for being counted the slot index by the tags. The tags count the slot indexes, and backscatter their RN16s in their own slot time. If a collision occurs, the reader queries the next slot by sending another QueryRep command. If only one tag responds to the slot, the reader transmits an ACK command with the received RN16. Then, the tag replies its tag ID with 16-bit CRC redundancy bits to detect errors. After receiving the tag ID, finally, the reader checks errors, and transmits the QueryRep command if the tag ID is valid. Otherwise, the reader transmits a NAK command.

7. Merits and Demerits

7.1 Merits

- Real time management of buses is very useful both for the transport management and people.
- By using the data available (i.e.) arrival and departure time at the bus stops , total time taken, time taken at stops management can calculate and make sure adequate buses are available in the routes
- Increase and decrease in no: of buses based on the available data will increase the creditability of transport management.

7.2Demerits

- If the adequate calculations are not done before placing the readers it will cause reader collision which causes great problems to the database.
- The tags present in the buses should be unique and not similar to the other tags available in the market. So that the reader will notrecognizeit. If it recognizes the tags filtering modules should be employed to remove those unwanted tag details.

- RFID systems can be easily disrupted
    - Uses electromagnetic spectrum
    - Easy to jam using energy at right frequency
    - Active RFID tags causes problem due to battery down, disrupting the systems.

8. Future works

- Real time management of the public transport can go to next level.
- If all the available data are made available in the website, the user can directly access the website and find where the bus is and plan accordingly.
- The management of buses can be increased to other public transports such as metro trains, monorails and integrating them into a single management will make easy for the commuters.
- Total city traffic can be monitored if this transport management is followed for every vehicles in the city.

9. Conclusion

Currently RFID systems are used in real time tracking and monitoring of events in retail chains. The number of events captures by many RFID systems is very large. clever filtering and aggregation techniques should be employed to avert the problem.

Public transportation is the most important area where modern technology should be used to reduce the commuters' problem. Deploying RFID systems to track the buses and other vehicles in metros could greatly benefit commuters who could plan their trips to avoid long delays at the bus stop. In this paper, we suggested the use of RFIDs for bus tracking using readers placed at strategic locations, such as bus stops, and/or traffic intersections. Events such as arrival of buses can be used to generate useful information such as earliest arrival time of a bus on a given route at a given stop. By informing a commuter about bus arrival times the commuter can save valuable waiting time.

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