

# A Study of Infrastructure for Real-Time Location System

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**Abstract-** This paper proposed the infrastructure for real-time location system (RTLS). RTLS determine and track the location of assets and person using active tags which contain a battery and can transmit signals autonomously to a reader. Two or more readers can estimate the tag's range from each reader and determine its location. The data will be send to the data location engine before displayed in the geographical interface server(GIS) which includes mapping software and its application with remote sensing.

**Keyword-** RTLS, active tags, data location engine, GIS

## I. INTRODUCTION

Real-Time Location System is one of the upcoming technologies which will merge with other cutting-edge technologies to make them more versatile and useful. The Real-Time Location system (RTLS) have emerged over the past six years as an alternative and cost effective method for tracking the location and status of assets within local areas, such as yards and remote storage and delivery sites [1]. In order to determine the location of assets and persons, the active Radio Frequency Identification (RFID) tags had been used because it had own internal power source to transmit their ID's and status information at frequent intervals via a low power radio signal to a central processor which computes the location of up to thousands of tagged assets within remote sites. RTLS is a wireless radio frequency solution that continually monitors and reports real-time locations of tracked resources. It utilizes Wi-Fi rather than GPS to accurately pinpoint location and can be developed using different method.

This paper is organized as follows : In section II, discussed about literature review of RTLS. In section III, described about the RTLS infrastructure. In section IV presents the routing protocols. Performance evaluation had been proposed in section V. Discussion remarks are given in Section VI. Finally, in section VII, the acknowledgement are given.

## II. LITERATURE REVIEW

Since 2004, a service utilizing Wi-Fi RFID tags to track children has been available in the theme park Legoland in

Billund, Denmark. The theme park runs a 65 000 m<sup>2</sup> 802.11 wireless network and utilizes 38 proprietary AeroScout location receivers to locate the tags. The location receivers supports Time Difference of Arrival (TDoA) and triangulation. A wristband with an AeroScout T2Wi-Fi RFID tag is available for rent and can be attached to a child's arm. If the child is lost throughout the park, the parents can send a text message to the system, and get the location of their child. The system is capable of providing a positioning accuracy of 2 meters, with the tags transmitting every 8 seconds. The software solution is delivered by AeroScout and Kidspotter [3] [4] [5].

A test pilot similar to the Legoland system was also deployed in Yokohama, Japan in 2006. With participants like Nissan Motor Co. and NTT Communications, the main goal was to provide better safety for children on their way to and from school. In this deployment, the children used Wi-Fi RFID tags to alert parents and security personnel when in danger. Unlike the Legoland deployment, existing Cisco Wi-Fi access points were used instead of proprietary location receivers, together with AeroScout T2 tags and special AeroScout software.

## III. RTLS INFRASTRUCTURE

The RTLS is a wireless system that can locate the position of an object anywhere in a defined space. The RTLS model accurately tracks the location of an object with the RTLS tag in a designated space in which Location Access Point (LAP) are deployed and then provides location information to users. A typical applications system can track a number of tags simultaneously and the average tag battery life can last for four to eight years[6]. Fig. 1 shows the design of the RTLS model.

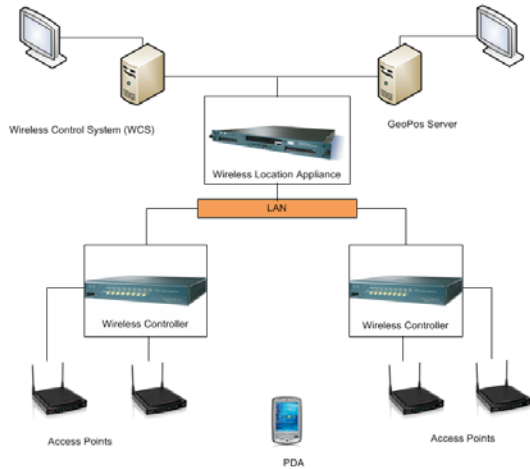


Fig 1. The Wi-Fi RFID tag and the location-based architecture in Wireless Trondheim used in the tests. Based on figures from [7] and [8].

RTLS infrastructure utilizes equipment from RTLS provider such as light-weight access points, access point controllers and a location server. Each access point that receives signals from the RTLS's tag collects Received Signal Strength Indication (RSSI) information about the tag and aggregates this information to the corresponding Wireless Controller using Light Weight Access Point Protocol (LWAPP), a protocol that can control multiple Wi-Fi wireless access points at once. The Wireless Controller had been connected to Wireless Location Appliance using Local Area Network (LAN). The location server, the Wireless Location Appliance, periodically polls all the controllers for location information, using the Simple Network Management Protocol (SNMP) and computes the tag location based on the RSSI information.

The Wireless Control System (WCS) can then be used to get a graphical representation of the tag location. In addition to the WCS interface, the location server has a Simple Object Access Protocol (SOAP)/Extended Markup Language (XML) Application Programming Interface (API) that can be used by third party applications for LBS. The Geographical Positioning Server (GeoPos) Web Service is a brokering service, which utilizes this API to get the tag location coordinates securely from the location server.

The tag location coordinates computed by the location server were collected from the GeoPos Web Service. Both sets of location coordinates were then plotted in the map-authoring software ArcMap. Finally, the error distances between the two coordinate sets were computed in ArcMap and analyzed.

#### IV. ROUTING PROTOCOL

In the proposed RTLS system, tags and readers communicate with each other using a radio frequency. If a number of readers and tags to communicate simultaneously, radio frequency interference happens frequently. This problem

has been solved by using an efficient routing protocol system, Time Division Multiple Access (TDMA). This method illustrated in figure 2 [9].

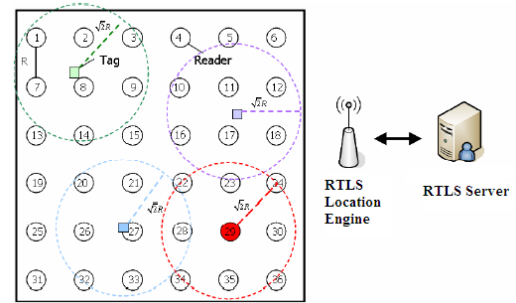


Fig 2. Deployment of readers at regular intervals.

The success of this approach depends on the three following assumptions as below :

- The readers which have unique IDs are deployed in a grid fashion at a regular distance,  $R$ , and synchronized.
- The transmission range of the readers and tags covers the distance defined by  $\sqrt{2}R$ .
- It is possible for a RTLS Location Engine to communicate with one or more readers

All of the readers have been divided into several small groups composed of a set number of readers each using both a local ID and unique ID. For example, if a group is composed of nine readers, the readers have a local ID ranging in order from 1 to 9. We assign a time slot for TDMA communication using the local IDs of the readers. Therefore the readers that communicate at specific time all have the same local IDs in the proposed RTLS system and they can communicate with the next local ID reader within the group without causing radio frequency interference with the readers of the other groups. Hence the reader with last local ID can collect information from the other readers within its group. It then transmits information to nearest reader of the next group in the neighborhood. According to this procedure, the RTLS location engine gathers information from the readers and relays it to the RTLS server.

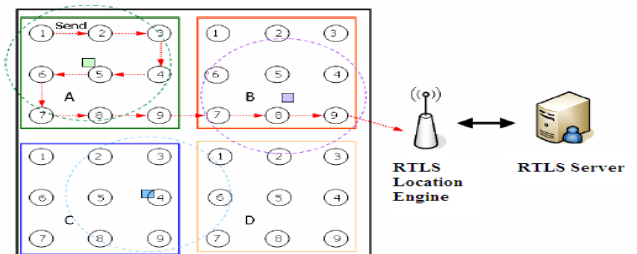


Fig 3. Message routing from the readers using local IDs to the RTLS location engine based on [9]

VI. PERFORMANCE EVALUATION

A. OUTDOOR SIMULATION

From the experiment based on the [9], an evaluation based on the simulation about :-

- changes in signal strength were measured over distance in outdoor,
- the accuracy of the locating system was assessed based on the result of the measurements and
- the performance of the proposed routing protocol.



Fig 4. Experiment environment of RSSI

The figure 4 shows the outdoor environment where the signal strength experiment was held. The readers were arranged in a line, and then the tag emitted the signal. The results are the average of ten repetitions of the experiments. The results of the changes to the signal strength are shown in figure 5.

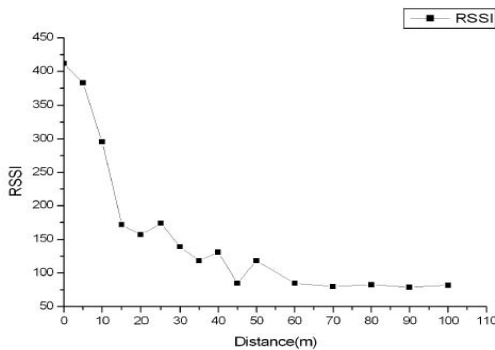


Fig 5. Distance of location error

The tag was located by either four or nine readers depending on the changes in its signal strength. The readers were deployed in a grid over a 30m x 30m flat area and the tag sent a blink message at 3 second intervals. Figure 6 shows the experimental set up.

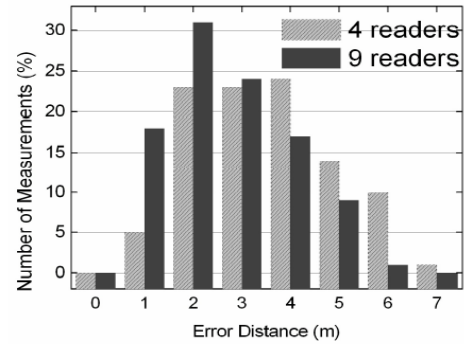


Fig 6. The distance of location error

The results of the field experiment using four readers had an average location error of 3m and using nine readers, 2m as compared with the actual position. The distribution of location error is shown in Figure 6. As can be seen, RTLS having more readers increases the accuracy of the resulting location.

B. SOFTWARE SIMULATION

A simulation using the NESLsim of PARSEC platform in order to evaluate the performance of the routing protocol had been done by [9]. This simulation show the different parameters used in this simulation and each simulation scenario consisted of randomly placing unknown tags in a field.

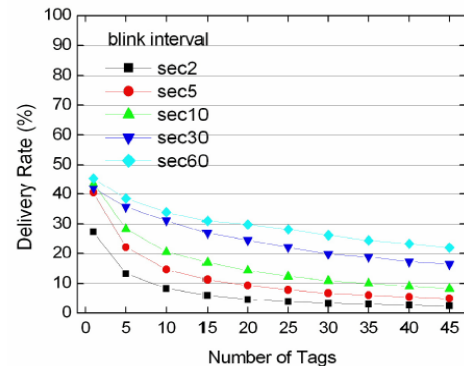


Fig 7. The delivery rate for ungroup APs

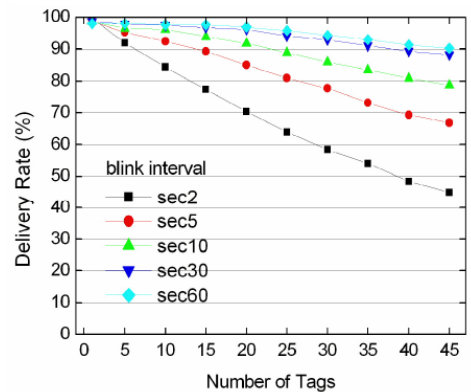


Fig 8. The delivery rate for TDMA

The Figure 7 and 8 showed the comparison between the ungroup access point and TDMA [9]. For ungroup APs, the delivery rate decreased starting from 45% until nearly to zero percent meanwhile for TDMA method, the delivery rate data had been decreased a little bit and it starting from the 100% . As can be seen, TDMA usage had better performance than ungroup APs.

The blink interval also important in this calculation. The low frequent update had better performance than high frequent update because of the collision of the tag signals.

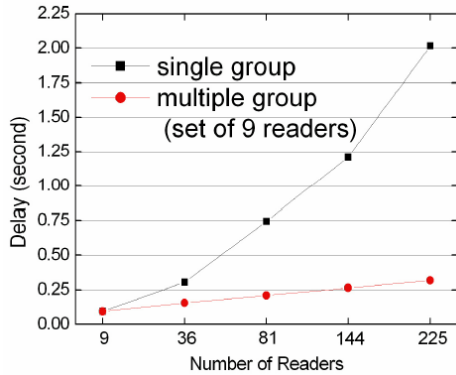


Fig. 9 : Data transmission delay

As can be seen in Figure 9, the single group AP make a long data transmission delay than multiple group.

### C. REAL TIME SIMULATION

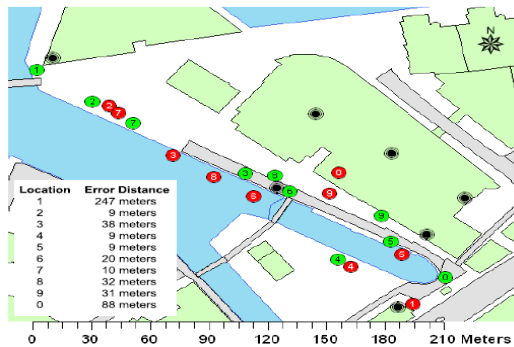


Fig. 10 : The real-time test simulation. The black circle is the access point. The real-life locations are marked with black numbers and the computed locations with white numbers

From the Figure 10, the real-time simulation for ungroup APs for Wireless Trondheim, Norway had been shown. They use the ungroup APs and error distance become wider because of that method. The table 1 also shown that the parameters of error distance.[10]

TABLE 1  
THE ERROR DISTANCE FROM REAL-TIME TEST SIMULATION

Location	Error Distance
1	247 meters
2	9 meters
3	38 meters
4	9 meters
5	9 meters
6	20 meters
7	10 meters
8	32 meters
9	31 meters
10	88 meters

### VI. DISCUSSION

This paper constructed an infrastructure of Real-Time Location System where it can be implemented in hospital, yard or some critical place in order to trace the people and also asset. The TDMA method can be implemented as the best option for positioning method.

### VII. ACKNOWLEDGEMENT

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