



# Decentralized, RFID-based Information Management for Facility Management Scenarios

## Abstract

This research was part of the *Network Embedded Systems* (NEMBES) research project, funded by the Higher Education Authority (HEA).

NEMBES was an inter-institutional and multi-disciplinary research programme that investigated a "whole system" approach to the design of networked embedded systems, marrying expertise in hardware, software and networking with the design and management of built environments.

Networked Embedded Systems enable precision sensing, monitoring, control and information gathering/delivery in science, engineering, manufacturing, energy, environment/ecology, daily living, healthcare, agriculture, traffic, security and many other applications.

The application of RFID technology supports improved tracking and tracing of components and tools at an "item level". RFID-technology is more robust and reliable than other tracking and tracing technologies.

Therefore, this research studies the potential of RFID-applications in Facilities Management scenarios. The emphasis of this research is on the usage of RFID-tags for decentralised information management in buildings.

Decentralized Information Management can dramatically improve the efficiency of outsourced inspection and maintenance scenarios, making a positive contribution to new management scenarios in buildings' operations.

## Objectives

This research aimed to develop methods for Decentralised Information Management in FM using RFID-Technology, including:

- (1) The development of a web-based system supporting facility managers.
- (2) The integration of RFID technology with Mobile Technology, such as PDA, to increase the efficiency of facility inspections and maintenance data collection.
- (3) The provision of wireless communication between offices and field locations.

Information/data is stored on active RFID tags, such as:

- o RFID Tag ID: unique ID associated with each RFID tag.
- o Inventory ID: the ID of the relevant item to which the RFID tag is attached. The combination of inventory ID and tag ID provides the link to further information stored in CAFM systems.
- o Inventory Name: the name of the relevant item to which the RFID tag is attached.
- o Type/Specification: specific item specification data.
- o Installation Time: Time item was installed in the bldg.

## Approach

### Stakeholder Scenarios

Three potential user groups have been identified; including:

**Office User:** detects facility failures. Reports are generated (using Java enabled interfaces) to inform facility management departments.

**Facility Manager:** manages the generated tasks/tickets, distributes workload and assigns tasks to work crew members for renovation, repair and inspection.

**Work Crew:** receives task details through mobile devices and uses embedded RFID readers to retrieve information from RFID tags attached to building items.

The information contains relevant facility/item data, and allows a crew member to make timely decisions, and report back to facility management with updates.



Figure 1: typical Scenarios in Facility Management

In the scenario shown in Figure 3, active and passive UHF tags were adopted for different purposes.

**Active UHF tags with integrated temperature sensors** are attached to the radiators to provide technical information. Additionally room temperature is recorded to support local diagnostics.

**Passive UHF tags** are used in all lighting systems. From the unique tag IDs and a central database, a complete set of parametric information can be retrieved.

Approximate Positioning:

- o In addition to the above, while maintenance crews walk through the building RFID-tags from inventory items are identified.
- o Using a set read-range zone, the approximate location of the crew member can be calculated using a digital floor plan.
- o This allows maintenance activities to be monitored in real-time.

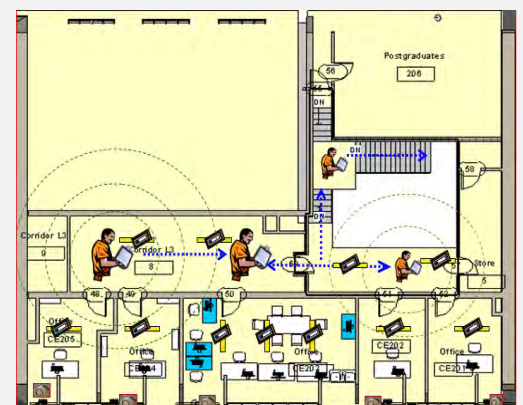


Figure 2: RFID Location Tracking

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# Location Based Sensing In Facility Management Scenarios Using RFID Technology

## Abstract

Technological advancements have made RFID one of the most robust methods for people and inventory identification, localisation, and tracking for indoor environments. This is very crucial in the facility management sector as management of continuous and timely changes is important.

The aim of the research project 'NEMBES' is to address Networked Embedded Systems R&D from an application focus to the whole system viewpoint.

## Objectives

The main objective of our research is to develop a methodology for heterogeneous location-based sensing in FM scenarios for indoor environments. This can only be done by first analysing different location-based technologies currently used and/or researched, as state-of-the-art. Therefore, analysing core techniques, advantages, and loopholes.

## Approach

Facility management of a building includes its operations and maintenance tasks.

Occupant Density, Occupancy Patterns, and Inventory control management are important data inputs for many applications.

These parameters are important for building operations such as fire safety and evacuation procedures, Heating, Ventilation, and Air-Conditioning (HVAC) control, space planning, people/staff management.

**Occupant Density** gives the number of people present in a building space at a particular time. Figure 1 shows a concept of how occupants are counted, to measure density when entering or exiting a building space based on direction of motion. In this project, RFID technology is used to achieve this.

**Occupancy Patterns** represent the use of a building space over a specific period of time. It gives an estimate of the behaviour of occupants towards a building space.

Based on this, energy consumption requirements can be found and efficient use can be assured. This occupancy data is necessary to take out building management decisions based on user comforts.

The HVAC system of a building can be automatically controlled from the BMS, partially based on these parameters. Similarly, other sensor values of temperature, lighting, humidity, and CO2 levels can also be monitored and controlled from these parametric values.

The research, alongside location based sensing, needs to incorporate identification as well as tracking of personnel and inventory items.

Our current research focuses on tracking occupants and inventories within a building facility using RFID.

This research challenges RFID as a more comprehensive alternative to existing positioning techniques in terms of accuracy, cost, and computational complexity.

As part of the research, we are currently working on tracking occupants and inventory items within a building space using RFID. The objective is to find out whether a person or item is within a building space (a predefined read-zone) at a given time and how the space used over a specific period of time, and hence, conclude the behaviour of occupants within a specific zone/building

Therefore, this research analyses occupants' 'usage behaviour' aiming to allow improved specification, determination and complete documentation of usage 'patterns'.

RFID technology can efficiently support localisation and identification methods of components on an 'item level' (including people) with limited overheads. Therefore, this research analyses different RFID-based localisation techniques to identify their potential to accurately locate targets – if required in combination with data fusion.

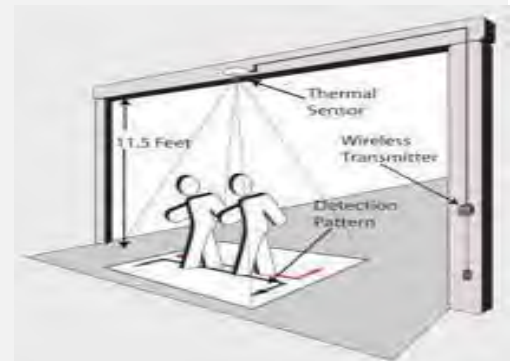


Figure 1: Conceptual Portal Doorway

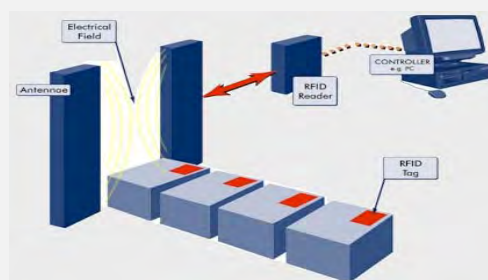


Figure 2: Monitoring of Inventory using RFID

**Inventory Item** control and monitoring is another part of this research project. A facility manager needs to know the location and status of an item, so as to find out about its misplacement, malfunctioning, required replacements, expiry information, inspection, or any other status update.

Figure 2 shows a sequential tag scanning process of inventories using RFID. This type of a process is normally found in production warehouses or in Supply Chain Management (SCM) where each item is tagged with specific information to be read at different stages of the SCM process. Our project focuses on similar and continuous monitoring of items in a fixed read-zone.

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