RFID Based Solution for Asset Tracking, Location Awareness and Safety Management

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ABSTRACT

Operations in Chemical plants and Oil and Gas refineries deal with hazardous materials. They use very sophisticated equipment to handle these materials. Working under these conditions requires a high level of training on handling these materials and Equipment. It is very important for the safety of the employees to ensure and audit that only employees with proper training and accreditation are allowed close the equipment, and be able to identify where every employee is physically located, especially to manage disaster recovery, and other hazardous events. In this paper we discuss a solution to implement this safety requirement using RFID technology and advanced location sensing algorithms.
PAPER

Introduction

Starting in the early 1970s, the U.S. government began looking for different ways to track hazardous nuclear material. The Los Alamos National Laboratory developed an Radio frequency identification (RFID) model which put a transponder in each vehicle used in the facility; in turn, this transponder was activated by an antenna at a gate. This model provided a rudimentary ability to track materials that entered or left the facilities.

Today, the application of this model, coupled with modern technology is used throughout the world in transportation payment collection systems. Most commuter toll collection systems use some variation of this model.

Radio Frequency Identification (RFID) has since become an enabling technology with the potential to streamline, automate and transform the way business is done in many different industries.

On March 23, 2005, an explosion at BP's Texas City refinery resulted in the death of 15 contractors. In addition to new safety measures being implemented, this disaster generated renewed interest in using new technology to assist with safety management. In this paper we will examine how this technology can be used by employers in managing safety concerns in organizations.

In this paper we first describe three use cases of safety problems, and then describe sample architecture of how an RFID based solution is being built to resolve these issues. RFID technology combined with business rules and policies will enable companies to exceed safety regulations and provide a framework for expansion to other business enabling opportunities.

Safety problems

There are three kinds of safety problems that we will discuss here. These use cases provide a problem space to explore in the safety domain.
Use case 1: Track assets on a plant floor

Fixed assets, like buildings, machinery, boilers are typically installed and located in a single position. The plant floor models capture location, size, material, and most other details of these assets.

There are also assets, like a fork lifts, cranes, conveyor systems, Automated Guided Vehicle Systems and other equipment movers that handle product material movement throughout the plant. It is important for a business to know exactly what assets and materials exist at specific locations in order to solve supply chain related problems such as identifying WIP inventories, asset turnovers, etc.

The most important asset for any enterprise is its employees. Accounting for the employees in the case of a disaster is of utmost importance. It is important to know where each employee is when a disaster, such as wind storm, earthquake, explosion, fire or structural damage to the building occurs, so that rescue efforts can be focused on parts of the area containing employees. It is important that any technology infrastructure put in place is able to transmit such information to a system outside of the building so that the most accurate information can be used by rescue personnel.

Use Case 2: Track movement of assets and their relationship with other assets

In order to be efficient, fork lift operators and crane operators have to move large amounts of material very quickly, often across large areas of a plant. Often these machines do not have any visibility on whom or what is in their path. It is therefore important for the operator of this machinery to know enough in advance so that he can react and take corrective action before any accidents occur. It is also important that employees are warned visually and by sound when they attempt to enter a zone where the operator cannot stop or avert an accident.

In this example, it is important that we create rules to determine the danger zone for each type of moving asset. This use case requires us to notify information on a console in the equipment used to move the material, and also be able to communicate with different types of audible and visual alarms. Since this scenario deals with moving assets, decisions based on the rules need to be implemented in real time. The rules and algorithms used to calculate the danger zone need to compensate for any machine delays (for networking and calculations) and for delays by an operator to react to an alarm.
Use case 3: Implement complex business rules for asset access

Many newer types of machinery are very sophisticated, and may require significant training for an operator to use them correctly. For safety, liability and perhaps regulatory reasons it is important that unauthorized or untrained users do not operate the machinery. Additionally, there are business rules and policies that restrict who can perform what duty, such as restrictions on who can receive materials into the warehouse. In these cases, we may want only certain operators, or operators that have supervisor approval, to receive this material.

Another important factor can be the materials used in the manufacture of a recipe or other manufacturing processes. In many industries, materials used in the process have to be authenticated, and/or may be time sensitive.

Solution Description

A common factor in the three use cases identified in the previous section is that the primary control mechanism is the management of the relationships between mobile assets (like employees, fork lifts etc.) with fixed assets (like land, machinery, boilers etc.) and the business rules governing them.

The solution proposed to enhance this management will use RFID technology. Mobile assets will have RFID tags that will be read and updated using RFID readers that are attached to the fixed asset, or specific locations in/on the asset. In certain circumstances the reverse will also be true; the mobile asset (people) may use a hand held reader to identify specific assets (equipment or material).

With the RFID infrastructure in place, it is possible to connect to an in-memory decision system, a supervisory control system or an external business rules engine to analyze more complex rules. The resultant decisions will then be communicated to an audio/visual operator alarm, an operator faceplate on an automation/control application or a business application such as a business dashboard. Note that in many manufacturers, a basic RFID infrastructure may already be in place, particularly to mange material inventories.

Every movement of a tag, with respect to a reader becomes an event. As with all event management systems, there is a need to make sure that an event hub message filter is in place to filter the information used by the business rule or event correlation engine.
The following diagram shows a high level logical flow of alerts and events.

It is important that both the event data and process data are persisted throughout the process. This will be used for both audit, and also for disaster recovery.

The physical implementation in a manufacturing facility typically requires the same level of preparation as other IT and/or wireless implementations. Placement of the devices to ensure the readability of tags on movable assets (people) is a prime concern. Passive tags and readers can provide highly accurate positional information, but the reader must be in close proximity to the tag. Active readers provider greater range, often up to 90 meters in industrial environments, but can only provide two dimensional location information. Environmental concerns such as corrosiveness and dust need to be addressed, as does EMI from rotating equipment or other sources. In most of these cases, rugged enclosures for the readers can handle the environment issues, while different frequencies can be used to compensate for EMI. Connections to automation systems (DCS, PLC) require using industrial standards such as Modbus, Profibus, DeviceNet or EtherNet/IP. Many manufacturers of RFID equipment support these requirements today.
Issues arising from RFID safety implementations

As with any new technology, there are a number of issues that need to be addressed prior to the implementation. Some of these issues are discussed below:

Acceptance Issues

The perception of the solution and the ethical usage of the information, particularly with respect to the tracking of personnel is a concern. A system implemented to track personnel movement for safety and disaster management could easily be extended to monitor employee productivity. While most employees would agree with the safety aspect, few in today's environment would accept continuous monitoring of their movements. This is likely to be the biggest challenge to the acceptance of an employee monitoring safety program.

Technical Risk of Failure

While RFID is quickly becoming a mature technology, it is only one component of an overall solution. The combination of choosing the appropriate assets to monitor, the environmental issues of a manufacturing plant and the rules that govern alarm conditions add tremendous complexity. The business and process rules required to cover all possible conditions need rigorous and will require both process and information skill sets to implement. Additionally, the objectives of a safety oriented solution, such as differentiating between a person being in a building or the precise location of a person in a building, add complexity.

 Liability Issues

In no circumstance can the proposed solution be used as a replacement of existing safety measures; technology can only aid, not replace, processes and procedures. Providing coverage slightly in excess of the 'Letter of the Law' may result in less overall liability than a state of the art advanced solution. While using RFID, coupled with process information, to monitor equipment interlocks presents a limited risk of liability, the ability to focus on people in a specific part of a building in the event of a catastrophe has a tremendous benefit, but an immense risk should any part of the solution not function perfectly.

Moving from Safety Requirements to Productivity Measurements

A tremendous benefit to an RFID infrastructure is that it provides a platform to migrate for tracking of assets from a safety perspective to one of monitoring the utilization of the assets. Combined with other asset and process information, improving the utilization of the asset can provide a significant business return. As noted above, monitoring human assets from a productivity perspective may hinder acceptance of a solution.

Summary

This paper has focused on one small aspect of using RFID in manufacturing. The benefits of improving the safety of personnel is an objective of most companies today, and the above solution can be used to facilitate this. Some of the key points in this discussion are:
• RFID can improve safety
  RFID technology can be used to monitor the location of personnel, material and equipment to aid in the location of these should a catastrophic condition arise.

• An RFID based safety solution cannot be decoupled from the process
  The solution described above couples process and physical (RFID) information. Both need to be taken in conjunction with each other with a rules based system to arbitrate any discrepancies.

• An RFID solution is complex
  The solution requires an IT component (rules engine, persistent data stores), a Process component (plant model, equipment) and a Human Resources component (personnel tracking). This results in a complex environment, with a high reward for success, but also a potential for failure.

• The RFID solution provides a framework for additional business improvement
  RFID technology can be easily extended to help improve manufacturing efficiencies in addition to improving safety.