2006-522: RFID: WHERE DOES IT FIT IN ECET EDUCATION?

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Introduction

Radio Frequency Identification (RFID) is technology that is quickly being embraced by a variety of industries, including retail, pharmaceutical, and defense. Industry experts predict a huge demand for RFID technicians in the next 5 years. Hundreds of thousands of technologists are needed to configure, install, and support equipment being utilized in hundreds of industries and government. Expertise will be needed to adapt off-the-shelf components to unique environments, including warehouses, factories, retail stores, hospitals and libraries. These technicians will need the skills traditionally learned in the ECET curriculum, (such as circuits, power, and computer networking) with the addition of the specifics RFID tags and integrators.

Radio Frequency Identification is a technology where tags containing radio frequency (RF) circuitry are attached to items. These tags are remotely interrogated by readers that use radio waves to activate and collect information from the tags. Since every tag is unique, this technology is being used in a wide variety of applications: keeping inventory in retail operations, keeping electronic pedigrees of drugs to meet Federal Drug Administration requirements, and even taking attendance at schools. The compact size of the readers (the size of a text book), affordability of the tags (less than $1 each), and usability of the reader software makes this an ideal technology for use in the teaching laboratory. Introducing RFID into the ECET curriculum serves two purposes: it teaches modern tools of the industry, and it gives a practical way to teach important radio frequency concepts.

How RFID works

There are four main components in an RFID system: the interrogator or reader, the antenna(s) connected to interrogator, a computer interface, and the tag. (See Figure 1) The interrogator, antenna, and interface will all be part of an installation or a handheld system, while the tag will be attached in the item(s) of interest.

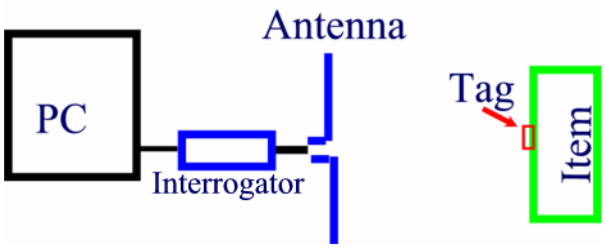

Figure 1: Basic RFID System

The interrogator is the main piece of hardware in an RFID installation. It performs many different functions:

- It creates the "wake up" or query signal to send to the tags.
- It amplifies the signal and sends it to the antenna
- It collects tag responses from the antenna
- It sorts the tag responses
- It determines if and what additional queries are necessary
- It generates the additional queries
- It sends the sorted responses to a computer/microprocessor or network

There can be multiple tags inside the interrogation zone that will answer an initial query. The interrogator will follow a pattern (usually a tree scheme) to address each tag individually and receive only one tag's information at a time. Regulations and standards require RFID systems to

use spread spectrum technology to reduce interference with other systems and limit power at any one frequency.

Each interrogator must be connected to an antenna to radiate and receive the RF signals to and from the tags. Some interrogators may power multiple antennas, thus expanding the zone area from which the interrogator can read tag information. Although directional antennas can be used to increase zone size, circularly polarized antennas are preferred for most installations, since they give more flexibility in the orientation of the tags.

The tags are the most often noticed element of the system. Today, they can found attached to library books, cases of bottled water, jeans, and bottles of pharmaceuticals. Tags are flat, and can be fabricated as an inlay inside of a label. (See Figure 2.) They are about the size of a credit card; in fact, "smart cards" are an extremely common RFID tag application in Asia and Europe. Tags consist of an integrated circuit and an antenna. The most common tags are passive and have no power source: the IC is powered from the RF energy it receives through its antenna from the interrogator. When queried, a tag will respond with the unique number and other data that is stored within it.

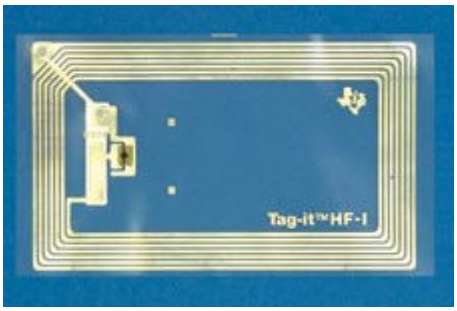

Figure 2: Texas Instrument's Tag-it™ RFID tag[1]

Before the Generation 2 standard was approved and launched by EPC Global (an RFID standards organization) in 2005, tags from one vendor could not communicate with an interrogator from another vendor. Now, tags and interrogators from different vendors that are "Gen 2" compatible can talk to each other.

Required skills of an RFID technologist

There is a great need for more trained technologists in RFID. David Sommer of CompTIA (the organization responsible for the A+ certification) says "We believe the market needs . . . hundreds of thousands of individuals knowledgeable in this technology to meet current and future demand."[2] Industry is looking to colleges to supply some of these technologists. "A February [2005] survey of CompTIA members found that 80 percent of companies do not believe there are sufficient numbers of professionals skilled in RFID to hire from today. In addition, 53 percent of companies said this lack of talent will have a negative impact on the adoption of RFID technology in the next two to three years. Some 60,000 businesses are facing RFID usage mandates from their trading partners in the next 3-5 years, according to industry estimates."[3]

Because of this need, CompTIA has launched an initiative to develop a certification for RFID technologists. The list of competencies required for this certification includes:

- Installation, configuration and maintenance of RFID hardware and device software
- Site surveys
- Tag selection, placement and testing

Site surveys require using a spectrum analyzer to locate and document sources of RF energy to determine if they will interfere with an RFID installation. Tag selection and placement requires

knowledge of RF propagation in various media in order to predict where a tag should be mounted on an item to maximize readability by an interrogator. This wide range of skills means that an RFID technologist must understand not only specifics of RFID equipment and protocols, but also radio frequency fundamentals.

RFID in the ECET curriculum

Many agree that RFID is the "next generation of bar code." Bar code technology, when taught in universities, was usually the purview of industrial or manufacturing engineering technologists. But RFID presents a different skill set that is more in line with what is taught in electrical and computer engineering technology. An RFID technologist interfaces equipment with computers and networks. S/he must predict how radio waves will propagate in a variety of environments, tune antennas, and trouble-shoot both analog and digital components. Some installations require PLC programming, other installations require computer programming. RFID is a field where a comprehensive ECET education can be put to use.

An RFID course is an appropriate capstone for an AS degree program for two reasons. First, it can give students a chance to reach the "synthesis" level of learning. After taking introductory courses in RF, computer networking, and controls, RFID allows students integrate these separate "silos of knowledge" into one system. The second reason for presenting RFID in the AS degree is that the level of knowledge required is appropriate for sophomore ECET students. Because of the RFID manufacturers' desire to make their equipment user friendly, a great depth of knowledge in any one area is in not needed; but a broad technical understanding is required. Sophomores are ready to learn to install and configure RFID systems, even if they lack the detailed knowledge to design the installations. (After taking a course with some theoretical background and laboratory experience, a student might sit for the RFID+™ certification.) If a curriculum lacks specific courses in RF and/or industrial controls, a systems course focusing on RFID would give students an opportunity to become familiar with both topics, which are areas of interest to a variety employers – not just those involved in RFID.

RFID can also be used to enhance BS level electives. One example is to use RFID equipment in the laboratory to teach RF fundamentals in an existing analog communication course. The equipment is safe and easy to set up. This leaves maximum time for investigation of the RF principles and system integration.

Antenna theory can be easily demonstrated using interrogators connected to computers, antennas, and tags. A simple indication of RF field strength is given by the interrogator's read rate: the faster the interrogator can get data from an antenna, the stronger the signal. By moving a tag around the interrogation zone and observing the read rate, the antenna patterns can be mapped. Various antennae (loop or dipole, for example) can be attached to an interrogator and tested for polarity and directivity. Tags also come with different antenna shapes and polarity, and students can examine how different antenna designs perform in different configurations.

Other experiments can demonstrate RF propagation through different mediums. RF transparent materials (such as plastic) can be compared to less RF friendly materials. Students can test the absorptive property of liquids by experimenting with tag placement on a bottle of water. Testing

tag placement on a box of aluminum foil demonstrates the reflective characteristics of metals. Systems are available at high frequencies (13.56MHz) and ultra high frequencies (915MHz) and can demonstrate the effect of frequency on RF propagation.

As discussed above, working with RFID systems allows practical application of the RF theory discussed in the lecture room. Another possible technology course where RFID may be integrated is computer networking. Many interrogators are Ethernet ready and can be assigned an IP address. The high level of data throughput between interrogators and servers is an excellent study in computer network loading. Networking students can study various ways to deal with high traffic volumes. Computer technology students would also benefit from developing software to interface the interrogator with an existing database. This type of software is known as "middleware" in the RFID industry.

In summary, RFID technology can be presented in the ECET curriculum in two basic ways: as an AS capstone systems integration course, or in BS technical electives on RF, computer networking, or industrial controls. If a student took all such courses, s/he would be ready for employment designing RFID installations.

Conclusions

RFID is a quickly emerging technology that will require a huge amount of skilled technicians in the next few years. These technicians will need to have expertise in areas taught in electrical and computer engineering technology programs: computer interfacing, analog and digital systems, and RF communication. The demand for people trained in RFID offers an exciting opportunity for the technology education community to meet a need for society and to increase enrolments. By integrating RFID applications into existing ECET curriculum, educators can engage students in practical and interesting projects, and equip students to work in an industry that has high growth.

References

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