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CIRCUIT CELLAR ONLINE

THE MAGAZINE FOR COMPUTER APPLICATIONS
Circuit Cellar Online offers articles illustrating creative solutions and unique applications through complete projects, practical tutorials, and useful design techniques.

RESOURCE PAGES

RESOURCE LINKS

A Guide to online information about:

Radio Frequency Identification (RFID)

by Bob Paddock

This months Resource Page subject started with a simple question from my wife, "Should we get electronic ID tags for the dogs?"

My answer was "How do they work?" She only knew the application level information, so I set out to learn how these things worked.

You can use Radio Frequency Identification (RFID) for several different applications, such as identifying what tape cartridge was just placed in your tape drive like some of the newer HP equipment does. You can also use them for asset identification.

You can see what one of the "pet implants" looks like in relation to the size of my business card. These are the most common form of RFID in use today by consummers. The one shown below is made by Electronic ID, Inc. The actual ID is the small glass cylinder with the coil of wire under the letters ISO 9001. The other items are the implanter and a protective cap. The implanter amounts to an over sized hypodermic needle. Ouch!

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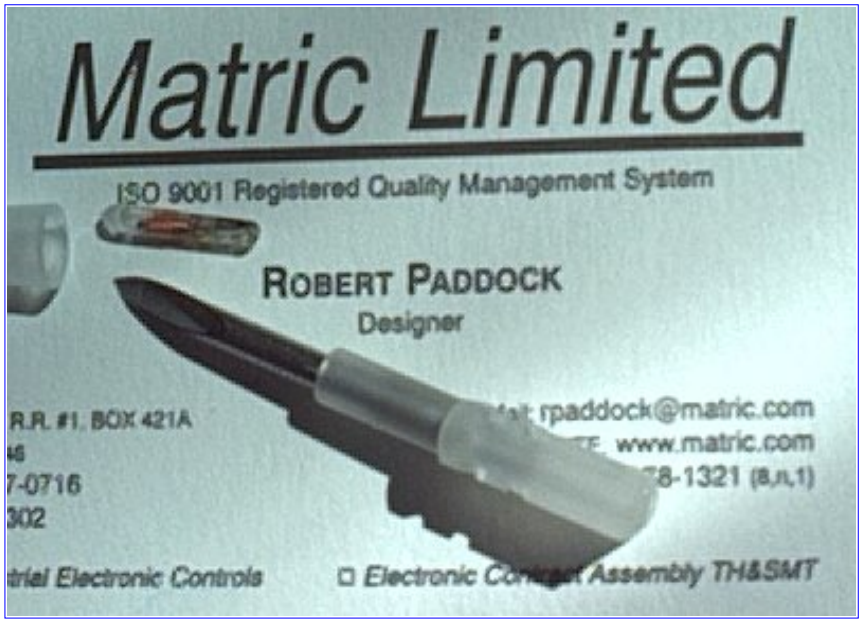

Common frequencies for RFID and contactless smart cards are—low: 125 kHz; medium: 2 to 15 MHz, especially 13.56 MHz; and high: 455 MHz, 900-MHz band, and 2.45 GHz (microwave).

Before embarking on a trip into the world of RFID, you might want to check out a glossary of terms used from Philips Semiconductor or the:

Glossary of Radio Frequency Identification (RFID) Terms
from:

ISO 11784/85 is the animal ID standard defining frequencies, data rate, bit coding, and data structures of the transponders used for animal identification.

As application requirements become increasingly complex, users want to access the animal's data directly from the transponder without having to contact the database. To meet these new requirements, the ISO standardization committee (SC19/WG3) started a program to expand the existing standard with additional functionality, such as read/write authentication. Full compatibility with the existing standard is one of the agreed and important facts, with the new standard incorporating the existing ISO 11784/85 standard. This means the existing installed ISO reader base will not need to be replaced.

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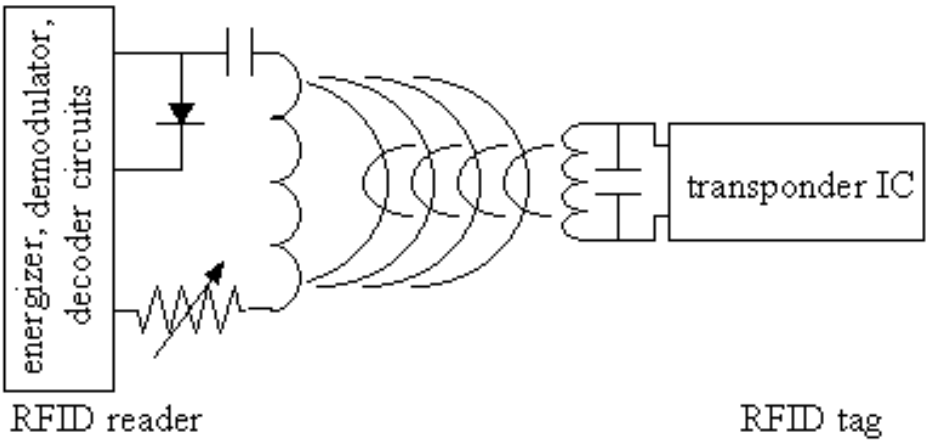
INTERSOFT gives the best "in a nutshell" introduction to RFID that I came across.



INTERSOFT also offers demo kit that lets you "play," to find out if this type of technology might be useful to you.

How RFID systems work: A brief introduction to some of the systems available from *Transponder News* is a good place to start for learning about RFID and related technologies.

Other issues such as the difference between magnetic coupled RFID transponder systems and electric field RFID transponder systems, multiple article scanning, and such are covered also.

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Transponder News

Transponder News is a news service reporting on developments regarding the use of radio-based tagging transponder systems for commerce and scientific applications, covering the RFID technologies, Electronic Article Surveillance (EAS) technologies, and magnetic coupled techniques.

You may have seen the TV commercial by IBM where a person stuffs his coat pockets full of food items in the local food emporium then runs through the checkout area, only to be stopped by the security guard. This makes you feel like there just may be a bit of justice in the world after all. But alas, the security guard hands the fellow his receipt and wishes him a nice day. It turns out, the "checkout line" was automated by IBM technology, something that is yet to come in the future.

I don't know about you, but I hate waiting in checkout lines. My wife says it must be a "male thing." I don't know too many males that like shopping in general or standing in lines in particular. So, it would be great if checkout lines were history, as far as I'm concerned.

Although IBM may be working on such technologies for our future, they're going to be coming after the patents of Trolleyscan from Trolley Scan (Pty) Ltd., from our past.

Trolleyscan can read 100 tags in under 10 s, or up to 1,000 tags in about 130 s.

I often dream of simply scanning my pile of unsorted books and files in a couple of seconds into my computer. Then I can take "Organization = is mostly via piles" out of my e-mail header. :-) This technology might finally let me do that.

Radio Frequency Identification - RFID: A Basic Primer from ETTM gives a good over all introduction to the subject of RFID.

ETTM is a site devoted to providing the most accurate and up-to-date information on electronic toll collection and traffic management.

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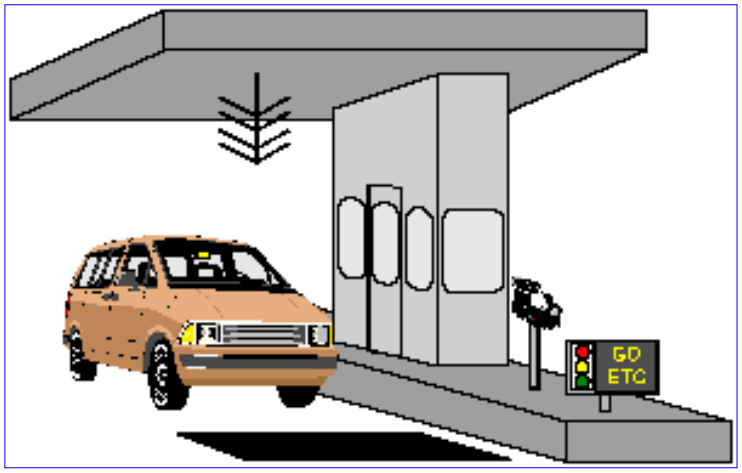

ETTM is a component of Intelligent Transportation Systems (ITS). The ITS effort uses a collection of technologies to improve the movement of people and goods via highways and public transportation. Of the core infrastructure features of ITS, electronic toll collection and traffic management comprise major components that are already in operation.

Automatic Identification and Data Capture (AIDC) is the worldwide industry term that describes the identification and direct collection of data into a computer system, programmable logic controller (PLC), or other microprocessor-controlled device without using a keyboard.

AIM is the global trade association of providers and users of components, networks, systems, and services that manage the collection and integration of data with information management systems. AIM strives to stimulate the understanding, adoption, and use of technology and member company products and services through setting standards, marketing and education, market research, advocacy, and information technology industry relations.

AIM Resources:

- RFID Glossary of Terms
- RFID Basics Primer
- RFID Acronyms
- RFID Standards - a description of standards in the RFID world

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Atmel Corporation announced the availability of the industry's first low-density contactless (RFID) tag chip supporting the ISO 14443 standard AT88RF256-13.

Containing 256 bits of read/write EEPROM memory, this chip is designed for access control systems and other identification applications. It supports the full ISO 14443 A and B, Part 2 standards for contactless smart cards and tags using a carrier frequency of 13.56 MHz. Receive and transmit bit rates have a 100 Kbps peak.

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HYPER X®
MAIN FEATURES
2.45GHz RF band Tags and Readers
This document provides an overview of Hyper-X products. (.pdf).

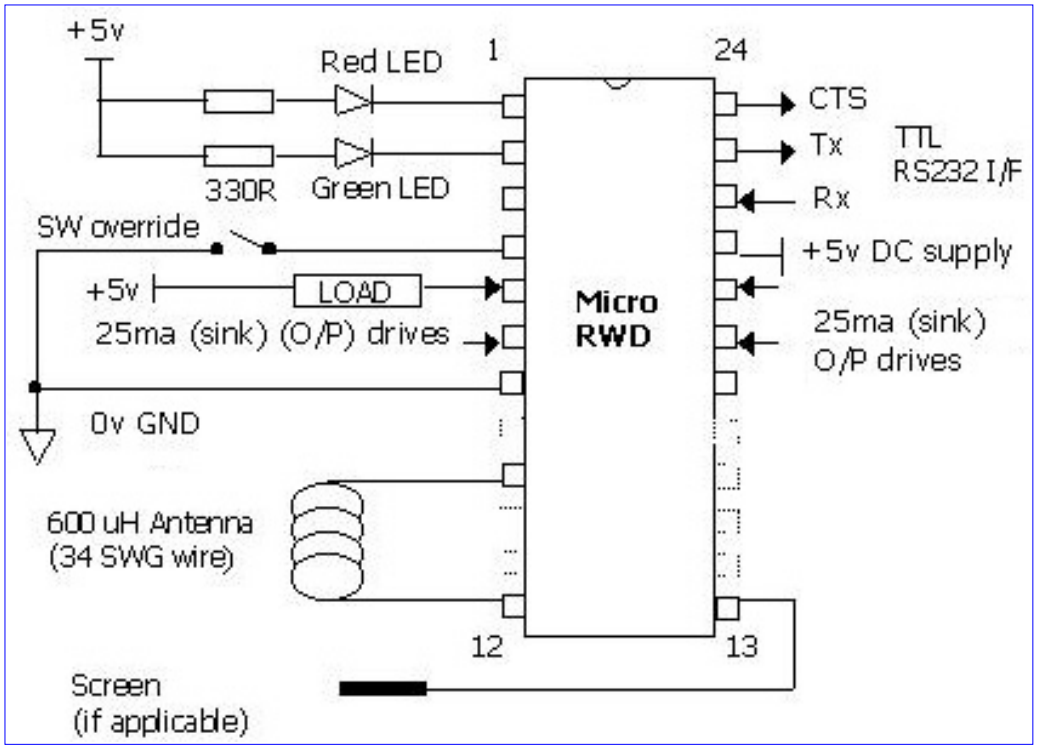
(I found this site extremely frustrating. It took a long time to load applet garbage that made it jump to random places at random times. Whats wrong with simple plain text?)

One of those random jumps took me to Hyper-X Information Center Site Map where some meaningful technical information on their products is located.

IB Technology

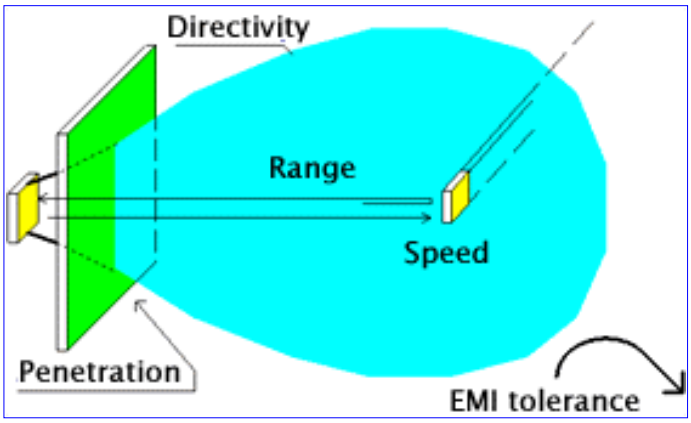
IB Technology offers their Micro RWD chip module, which is a complete RF transponder/ contactless smart card read and write system on a single chip.

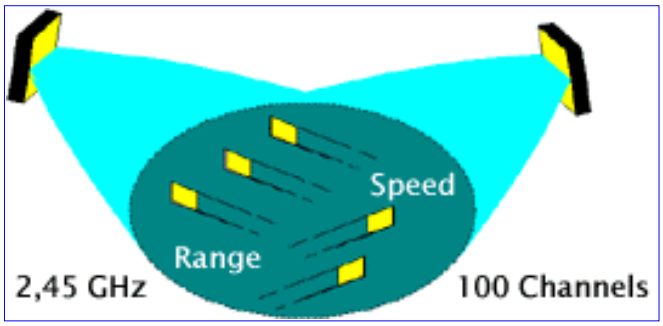
The Micro RWD chip module uses hybrid mixed signal ASIC and RISC processor technology to achieve features and performance for a fraction of the cost of existing systems and is entirely encapsulated within a standard 24 pin DIL package (17 mm × 32mm).



IB Technology also offers:

- Development kits
- PC application software
- Transponders/tags/cards
- PCB antenna





New, state-of-the-art 2.45 GHz RFID systems are certified for use in all industrialized countries—Europe, the Americas, and Asia. They read up to 6 m and at passage speeds up to 400 kmph. They can read several tags simultaneously and use multichannel technology to allow for an unlimited number of readers in each installation area without an interference problem.

RFID—A brief overview of radio frequency identification technology. PDF file (34 kb)

RF Primer

QuickRIC software is a rapid development kit (RDK) developed by IDmicro and used to make development of RF applications fast and painless. QuickRIC is a set of software tools, which allow developers to quickly create their own custom Radio Frequency (RF) applications. Programming RIC and RF applications is

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time consuming and complicated for even the most proficient programmers. Because the technology is so new, developers usually have to create from scratch routines to perform the communications between the readers, tags, and computers. With the QuickRIC tools at hand, all of this low-level programming is taken care of, so developers can focus on building their applications and getting their projects up and running quickly.

How do you select a radio frequency identification system (RFID) system? How do you decide what's right for your business? Not all system are alike, nor does each system fit every need. Start by understanding your requirements and answering the questions below. Afterwards, contact them, and they'll guide you to a system that's right for you.

This table illustrates a comparison of the possibilities with different remote identification technologies. It should be noted that not all manufacturers provide every function.

Microchip offers their microID RFID tags, which cover most of the RFID frequency spectrum. A couple of specific ones are worth highlighting

The MCRF200 and MCRF250 are chameleons—they can emulate almost any low-frequency (100 to 150 KHz) protocol, including many custom ASICs (ASK, PSK, FSK modulation; NRZ, Biphase, Manchester, Inverse Manchester, ISO 11784/11785 FDX-B encoding; and eight different data rates and four different bit widths). Each device has over 300 programmable options in all, so custom configurations for closed-loop systems are also possible.

The MCRF202 can emulate all of the protocols of the MCRF200 and MCRF250, plus it offers a sensor input for detecting a switch closure or logic-level output of a self-powered or tag-powered sensor. Perfect for sensing hidden sensors in industrial application, the MCRF202's V_{CC} output can be used to drive a low-current sensor, the output of which can be detected at the SENSE pad. Logic 1 causes normal tag output, and logic 0 causes inverted tag output. The SENSE input can be used for thermistors, switches, position indicators, leak sensors, overtemperature switches, strain gauges, and other limit sensors. No other RFID device I came across allowed for such sensor input.

Motorola's new RFID innovation (BiStatix) is bringing the RFID price down so low that they can be thought of as a disposable card. The technology allows antennas to be printed on materials including paper, using only silicon and printed ink instead of a costly metal coil and resonant capacitor, drastically reducing card costs.

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White Paper
Download BiStatix white paper

Find out about other Motorola RFID products at the Smartcards Solution Division.

Philips' I-CODE/Smart Label technology—Smart Labels also go by the name of Electronic Article Surveillance (EAS), I've also seen it listed as an asset instead of an article.

"Smart labels are contactless RF identification (RFID) devices, small enough they can be laminated between layers of paper or plastic to produce low-cost, consumable labels. They contain nonvolatile read/write memory to store specific information related to a product, manufacturer or distribution process. They can communicate over a distance of more than one meter and may be operated simultaneously by suitable read/write devices at a rate of over 30 labels per second and, unlike barcodes, do not require a direct line of sight between reader and label."

Texas Instruments Inc (TI), whose TIRIS RFID products are almost unknown, and Philips Semiconductors have reached an agreement to support a common protocol communications standard for RFID smart labels.

Technology by Texas Instruments™

"The two companies submitted a common proposal to the International Standards Organization (ISO) during a recent meeting in Berlin, Germany. It received unanimous support from the technical task force and subsequently was approved by the working group and ISO sub-committee. This emerging standard

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provides the first multi-vendor platform for vicinity-card and smart-label technology, and allows products from both companies to communicate at the same time with suitable reader/writer units."

Philips "Identification Home Page" is at http://www-us.semiconductors.philips.com/identification/indexfl.html

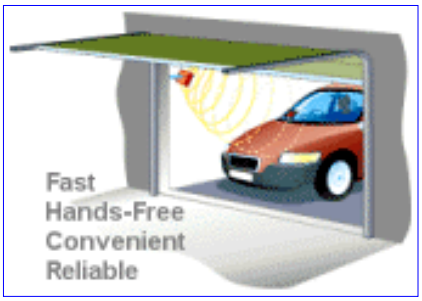
They list applications that cover:

- Banking
- Telecom
- Transport
- Logistics
- Tracking
- Network access
- Vehicle access

RFID, Inc. is focused on the manufacture for resale of its RFID systems in off-the-shelf forms to end users, resellers, integrators, VARS, as well as the development of new RFID systems for OEM's interested in customized systems for incorporation into their own product offerings. A particular new focus was made to develop readers-to-customer specification for users interested in basing their own solutions on the many generic, configurable transponder chips found on the market today by Microchip, Atmel, Philips, Temic, and more.

An understandable yet ugly question often posed is, "Whose chips do you use?" TI? Philips?

RFID's answer: We use our own. Our's is the first RFID technology introduced to many markets in the United States and has been actively supported ever since.



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TagMaster offers long range RFID used for vehicle access, fleet management, tracking, and other applications. Equipped with a TagMaster tag, cars, trucks, buses, trains, or containers are identified on the fly when passing by. Whether it's a parking garage, airport, harbor entry, or gated community, all are benefiting from the fast, convenient, and secure identification and access control provided by TagMaster.

TELSOR Corporation offers their MICROPROX, a patented low-cost single chip RFID reader.

MICROPROX is packaged to fit in a standard 28-pin DIP socket that can be easily integrated into existing equipment or designed in new RFID products. MICROPROX can run on as little as 5 VDC and will use 10 mA of current. All that is needed to complete the circuit outside of the MICROPROX chip is a coil and tuning capacitors.

MICROPROX will read passive low-frequency transponders manufactured by a number of manufacturers. TELSOR can provide custom software services for application specific uses or simply provide the product as a basic building block for reading low-frequency transponders with customers keeping software development private.

Evaluation kits with the Microprox engine mounted on a circuit board with basic output options (LED, RS-232, etc.), a coil, and two different transponder packages are available.

HOW DO YOU PROTECT YOUR CAR?

The Invisible Safeguard from TELSOR is a fully electronic radio frequency starter
interrupt system, more commonly known has an immobilizer.

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http://www.time-domain.com
http://www.golf-domain.com
[Golf-Domain is an application division of Time-Domain]

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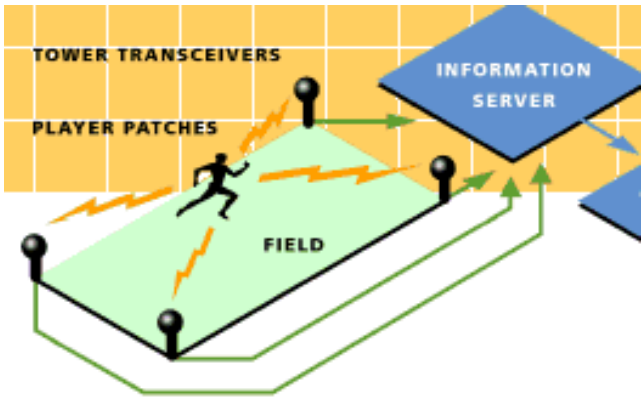
The ultra low power PulsON chip harnesses information that is contained in a radio pulse that has no specific frequency. Huge amounts of data are transmitted without interfering with other radio frequencies, creating amazing new possibilities in low-cost voice and data communications, personal radar, and precise positioning.

Time Domain is a technology company that applies its PulsON chip designs for integration into applications of its commercial and government partners.

Time Domain holds broad domestic and foreign patent coverage on Time Modulated Ultra Wideband (TM-UWB) systems. Such systems transmit a multi-cycle waveform, use the principles of coherent time dither coding and modulation, and receive the signals with a wideband, coherent correlation technique.

High Level block diagram of the TM-UWB system components.



The Trakus system is the next great technology developed for the world of sports, and it will revolutionize the way athletic excellence is measured. The core system calculates the 3-D coordinates of an athlete 30 times per second, creating a dynamic digital model of the action on the field. From this, the system delivers motion characteristics like speed, acceleration, and impact of a collision. The resulting information will form the backbone of a new class of statistics, on-air graphics, and coaching tools. In addition, they have created a new way to record an event, providing a bridge between sports and emerging electronic media like the Internet, digital television, and video games.

How do you you test your RFID? "I'm from the Government, and I'm here to help you."

U.S. ARMY MATERIAL COMMAND
LOGISTICS SUPPORT ACTIVITY
PACKAGING, STORAGE, AND
CONTAINERIZATION CENTER

TESTING OF RADIO FREQUENCY
IDENTIFICATION EQUIPMENT
FOR PM-AIT

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ACTIVE TRANSPONDER

LOGSA PSCC Project Report A0199

The Army Product Manager for Automatic Identification Technologies (PM-AIT), Fort Belvoir, VA, requested that the U.S. Army Materiel Command Logistics Support Activity Packaging, Storage, and Containerization Center (LOGSA PSCC) develop a test plan to evaluate radio frequency identification (RFID) active transponders in a controlled, laboratory environment. They subjected these units to a series of tests designed to evaluate their operability under adverse environmental and handling conditions that may be encountered during military transportation, storage, and field use. It was concluded from the results of the tests conducted that, except for the possibility of some intermittent problems, the active transponders are capable of operating under extreme environmental hazards and conditions and withstanding the hazards of normal manual handling (dropping).

The Navy's Automatic Identification Technology HomePage can be found here.

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Automatic Identification Technology (AIT) is a generic name given to devices used to automate data collection in a variety of applications used by the Air Force.

Axcess Inc. covers a wide variety of RFID related items, but I found of particular interest their Automatic Personnel Identification because it seemed so much like the Star Trek Comm Badge we all came to know over the years.

AXCESS Readers are installed at strategic locations throughout the facility. Readers can be configured to read a specific doorway or portal, or extended to monitor a broad coverage zone. Tagged data is read and forwarded to a host computer. Application software, such as their Secure Monitor, logs the event into a database. Host systems can also be configured to trigger a CCTV camera or sound an alarm to alert security personnel.

Now, can someone tell me what *Marshalling* and *Mustering* in this context means?

[This is the first site I've seen that actually comes up and says "Applet Crashed" right on their home page. At least they told me ahead of time. Most just crash with out being so polite.]

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autoid.org has a ISO Standard Activity watch where you can get a "heads up" on new RFID standards that might impact you.

They offer a primer that covers bar code basics, RFID, symbologies (UPC/EAN, code 39, UCC/EAN 128, interleaved 2 of 5, and PDF417). Did you know the PDF417 symbology can carry a tremendous amount of data, up to 1500

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characters in one symbol? It can be used as a portable database.

Frontline Solutions is a worldwide family of magazines, conferences, exhibitions, directories and other information services, and resources. Frontline Solutions educate operations and IT mangers in the use of technologies that collect and manage information in manufacturing, warehousing, logistics, and field service environments.

All companies listed in the RFID Source Book are first- and second-tier manufacturers of RFID and RTLS products and services.

Frontline Solutions's RFID Source Book is a comprehensive look at RFID and RTLS manufacturers and the systems they offer. With links to dozens of RFID product manufacturers, it makes short work of this Resoruce Page for this month. :-)

Matthew Reynolds at MIT has several interesting papers that get down to the nitty-gritty hardware level:

Microwave RFID: Passive Scattering and Active Transponders.

A Phase Measurement Radio Positioning System for Indoor Use (Adobe PDF) M.Eng Thesis, February 1999.

Web-ready Presentations:

Electromagnetics for Identity, State, and Location (presented at the 10/97 TTT Consortium meeting).

RF and Microwave Tagging Systems (presented at the 8/98 TTT Tags SIG meeting).

Profitable Inventory Control Systems, Inc.

PICS is a full service system integrator and software developer that seems to cover every conceivable aspect of controlling inventory, from RFID to biometric identification. [I thought I had trouble getting parts out of our warehouse to do my job. :-)]

SAMSys Technologies Inc. is the world leader in the design and supply RFID hardware solutions for high volume pallet and reusable container tracking

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applications in global logistics management, materials handling, and supply chain industries.

SAMSys Technologies Inc. announced the completion of the first in a series of Patent Applications in respect of proprietary RFID technology it developed. The filing in question references the "Method and System for Tracking Clustered Objects," and it addresses a novel way of providing a solution to practical operational requirements where accuracy is paramount, but the physical challenges presented by the close proximity, object surfaces which are "unfriendly" to RF, or the sheer number of tagged objects, renders traditional methods impossible. The business method described in the Claims, would have significant relevance to all applications involving large numbers of closely spaced objects (e.g., pallet and tote) and container tracking, baggage handling, and mail/parcel systems.

"The single-most asked question posed by prospective end-users regarding any application involving multiple tagged objects is, 'How can we be certain that all of the objects will be read?' A: The process and method which we have devised provides the reliable solution to that issue, regardless of the specific protocol or frequency of the tag being applied."

RFID-Bulletin Board

The idea of the RFID-Bulletin Board is that everyone who is interested in RFID (for example, RFID-users, engineering, ect.) has the opportunity to exchange information. So, if you have any questions or reports about this subject or maybe you are looking for someone you want to discuss it with, please do not hesitate to contact the RFID-Bulletin Board.

RFID Webring

homepage of RFID-Webring

The RFID-Webring is a selection of RFID web pages that finally came together in a ring. All web sites in a webring are connected with navigational buttons (for example, [previous], [next], [random] or [home]) so you can move from one site to the next one. Finally, you will end up where you started after traveling through the ring. So, every homepage gets more visitors, and everyone who's looking for information gets enough material to sort on their own.

One of the first sites I arrived on the RFID-Webring was *RFID Company Sites on the Web*, put together by Jim Eagleson. Why don't I find these types of sites at the start of working on Resource Pages? At any rate, rather than duplicate over one-hundred links, I'll let you take a look there for yourself.

Radio-**F**requency-**ID**entific@tion is the homepage for the RFID-Handbook.

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ISBN 0-471-98851-0

You can download the schematic and board layout data of the ISO 14443-sample-transponder described in the 2nd German edition.

Consumer Products Manufacturers Association Trade Association is an alliance of global manufacturers. This association provides white papers and other information on anti-theft, product authentication, and product information. Similar sites are listed in Snap Directory International Business Organizations

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IDSystems.com is a magazine/web site that covers RFID and other ID related items in the ID industry. For example, take a look at *What's New in RFID?: The buzz in the ADC [Automatic Data Collection] Air is all over RFID* by Paul Quinn.

The book *Transmitter Hunting: Radio Direction Finding Simplified* by Joseph Moell (K0OV) and Thomas Curlee (W6UZZ) has educational information that's good to have on hand about equipment and techniques for HF and VHF radio direction finding.

After your RFID hardware is working, it would be nice if you could display it on some type of map. The map display section comes down to creating a map of the target area, then using software, place your target on the map at its current, possibly changing, position. It is the easiest section to implement because of all of the work done by the Amateur Radio community, which developed a system known as Automatic Position Reporting System for applications like this, but on a somewhat larger scale.

Keep in mind using the existing APRS infrastructure is not good to use in tracking personal property (such as your pet) or commercial items (such as

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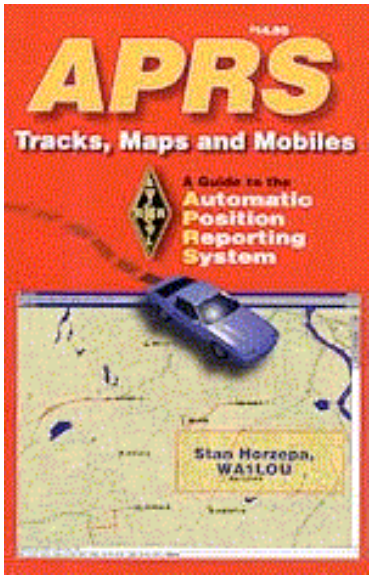
shopping carts). You will have to build the infrastructure suitable to your application. I bring up APRS because it has likely already solved most of the problems you're going to encounter.

APRS Tracks, Maps and Mobiles A Guide to the Automatic Position Reporting System by Stan Horzepa (WA1LOU), author of the original "Getting on Track with APRS," is a book that I recommend. With the help of this hands-on guide, you will learn how to use APRS to track anything that moves, including marathon runners, emergency vehicles, and weather systems. This book covers hardware installation, navigating maps, tracking, sending and receiving messages or bulletins, direction finding, using the Internet for APRS, and more.



A quick summary of APRS is here, and detailed information for the beginner or expert is at NorthwestAutomatic Position Reporting System. To learn more about APRS and the internet system, see http://www.aprs.net or http://www.aprs.org. To learn more about the database and web interface, see http://www.findu.com.

You will frequently see the document *AX.25 Amateur Packet-Radio Link-Layer Protocol* cited in relation to APRS. It is available from Tucson Amateur Packet Radio (TAPR) and covers the underlying protocol of Packet Radio. You don't really need to know it to use APRS. You can find APRS Draft Specification at TAPR, also. TAPR maintains a library of APRS software to get you started using APRS.

One example of APRS is tracking a moving vehicle from street level using Street Atlas 4.0 or 5.0 Maps. This is called APRS+SA.

APRS was developed by Bob Bruninga (WB4APR) to track mobile GPS stations with two-way radio. The Naval Academy uses APRS in a number of applications for data, communications, and telemetry, as shown below. The live displays will show current APRS activity being monitored off the air in Annapolis, MD. (You must have JAVA enabled, and some of these pages will only be active while there are unused PCs in the satellite lab.) Bob has links to many sites that

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allow you to view APRS maps, so you can get a feel of what APRS is about.

The APRS Vision System (AVS) was developed to provide a variable bandwidth vision capability for APRS Robotic applications. The system provides an efficient method for image transmission from a mobile or rover. Because the AVS web page is hosted on a military server for the Navy, it does leave you wondering what they do with AVS.

What you might consider is mounting one of those small video cameras on shopping carts, then you can tell where the customer is and what they are looking at.

There was going to be a free APRS satellite, but bureaucrats don't understand modern technology. Our political system is way off when it comes to this area today.

"Just got word that Boeing was unable to get State Department to accept the NATSweb as a small addition to the Sea Launch Technology Export License without a total re-submission by Boeing for their entire Sea Launch System. Thus, we are bumped by bureaucrats. End of mission."

The sites mobilePositioning and http://www.comm-nav.com/tech.htm cover many of the techniques used to locate a transmitter. Some methods of locating a target within a given area are:

- Angle of Arrival (AOA)
- Time Difference of Arrival (TDOA)
- Signal Strength
- Smart Antennas (Looks for changes in Doppler shift)
- GPS
- Multipath
- Cell of Origin

Each uses multiple receivers to detect a parameter that is different at each receiver site. Multiple receiver sites are linked together, then the location of the transmitter is triangulated to locate its position in space.

The Global Positioning System (GPS), is the most well known system today for determining location. You may find its home site interesting, http://www.navcen.uscg.mil/. Links to related sites can be found on the Time and Frequency Division of the Physics Laboratory of the National Institute of Standards and Technology (NIST) site.

Now that the resolution of GPS has been improved for everyone, see STATEMENT BY THE PRESIDENT REGARDING THE UNITED STATES? DECISION TO STOP DEGRADING GLOBAL POSITIONING SYSTEM ACCURACY.
(I have no clue what that "?" in there means, but that is how it is posted on the whitehouse.gov site). It offers some interesting possibilities.

There are some non-technical areas you need to keep in mind. The laws of the land don't always keep up with technology. Engaging in "person locating" using

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RFID could be illegal under some privacy law in some states. You need to check in your location.

Also, there are many people who have Revelation 13:15 well indoctrinated to their psyche:

"... to receive a mark in their right hand, or in their foreheads: And that no man might buy or sell, save he that had the mark, or the name of the beast, or the number of his name."

Just look at the controversy the IDChip site caused, see *Apocalypse Averted: The Rise and Fall of IDchip.com*. You might end up with no customers because of boycotts, and have no customers to worry about.

Of most concern to me personally is if any of this stuff is actually good for us. Are we damaging our health by the chronic exposure tocell phone energy and other newer transmitters like the type in RFID's? There are a few voices whispering in the crowd that say we are. Time will tell if there is a problem if a number of sports players start to develop brain cancer from wearing helmets with tracking transmitters, or if more people develop brain cancer in the shape of their antennas. See *UK Report on Mobiles Phones and Health,* then check out *Cell Phone Convenience or 21st Century Plague?* compiled by Dr. Nick Begich and James Roderick, also http://www.emfguru.com, as well as the classic book, *"The Body Electric : Electromagnetism and the Foundation of Life".*

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If you would like to add any information on this topic or request a specific topic to be covered, contact Bob Paddock.

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