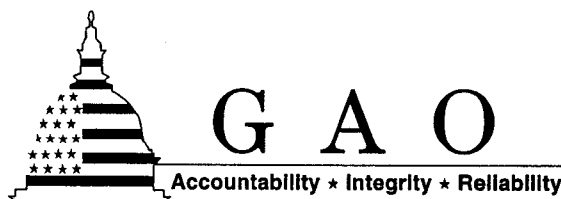


May 2005

INFORMATON
SECURITY

Radio Frequency
Identification
Technology in the
Federal Government



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Washington, D.C. 20548

May 27, 2005

The Honorable Christopher Cox
Chairman
Committee on Homeland Security
House of Representatives

The Honorable Bennie G. Thompson
Ranking Member
Committee on Homeland Security
House of Representatives

The Honorable Zoe Lofgren
Committee on Homeland Security
House of Representatives

The Honorable Mac Thornberry
House of Representatives

Radio frequency identification (RFID) is an automated data-capture technology that can be used to electronically identify, track, and store information contained on a tag. The tag can be attached to or embedded in the object to be identified, such as a product, case, or pallet. RFID provides identification and tracking capabilities by using wireless communication to transmit data.

The technology can provide a more efficient method for federal agencies, manufacturers, retailers, and suppliers to collect, manage, disseminate, store, and analyze information on inventory, business processes, and security controls, among other functions, by providing real-time access to information. The use of this technology also has the potential to assist agencies in tracking their assets, thereby maintaining more accurate inventory records.

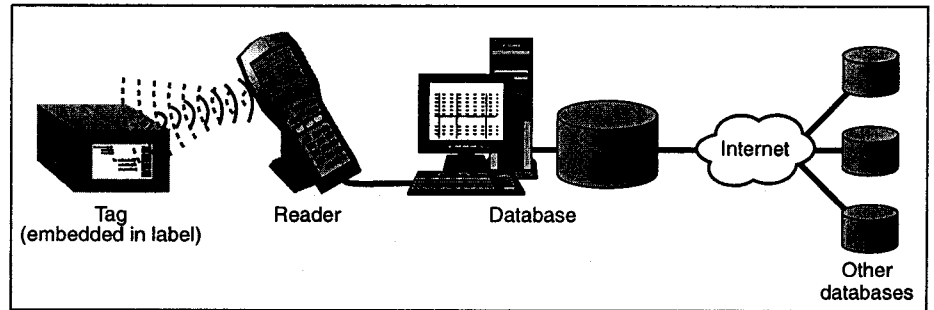
In response to your request, our report discusses considerations surrounding RFID technology implementation in the federal government. Specifically, our objectives were to (1) provide an overview of the technology, with an emphasis on passive technology; (2) identify the major initiatives at federal agencies that use or propose to use the technology; (3) discuss the current standards, including those for interoperability, that exist; (4) discuss potential legal issues that the 24 Chief Financial Officer

Illustrative List of Standards-Setting Organizations for RFID Systems

Type of standards body	Organization	Description
International	International Organization for Standardization (ISO)	A network of national standards institutes from 148 countries that works in partnership with international organizations, governments, industry, and business and consumer representatives to develop technical standards.
International	International Electrotechnical Commission (IEC)	Produces international standards for electrical, electronic, and related technologies. Its members include manufacturers, providers, distributors, vendors, consumers, users, all levels of governmental agencies, professional societies, trade associations, and standards developers from over 60 countries.
International	International Civil Aviation Organization (ICAO)	Chartered by the United Nations to regulate international aviation and includes the United States and 188 other nations.
International—professional	Institute of Electrical and Electronics Engineers (IEEE)	With more than 360,000 members in approximately 175 countries, the organization, through its members, works in the technical areas ranging from aerospace, computers, and telecommunications to biomedicine, electric power, and consumer electronics.
Regional	Comité Européen de Normalisation (CEN)	Contributing to the objectives of the European Union and European Economic Area with voluntary technical standards.
Regional	European Telecommunications Standards Institute (ETSI)	Produces standards for telecommunications, broadcasting, and related areas, such as intelligent transportation and medical electronics.
National	American National Standards Institute (ANSI)	Promotes and facilitates voluntary consensus standards and conformity assessment systems and safeguards their integrity.
National	British Standards Institute (BSI)	Works with government, businesses, and consumers to represent the United Kingdom's interests and facilitate the production of British, European, and international standards.
National	Japanese Industrial Standards Committee (JISC)	Consists of many national committees and plays a central role in standardization activities in Japan.
National	Standardization Administration of China (SAC)	Authorized to exercise the administrative functions and carry out centralized administration for standardization in China.
Private sector	AIM Global	Working with its members, AIM Global develops standards and practices for automatic identification and data collection technologies.
Private sector	EPCglobal, Inc.	A joint venture between EAN International and the Uniform Code Council. Its subscribers include manufacturers, retailers, wholesalers, carriers, government, hardware and software companies, consultants, systems integrators, and training companies. EPCglobal has developed a series of specifications for use in the supply chain.
Industry	Automotive Industry Action Group (AIAG)	With more than 1,600 member companies which include North American, European and Asia-Pacific OEMs and suppliers to the automotive industry, the organization developed standards for use in the automotive industry and its goals include reducing cost and complexity within the automotive supply chain.
Industry	International Air Transport Association (IATA)	It is an inter-airline cooperation in promoting safe, reliable, secure, and economical air services - for the benefit of the world's consumers. It has over 270 members from more than 140 nations.

The main technology components of an RFID system are the tag, reader, and database. (See fig. 1.)

Figure 1: Main Components of an RFID System



Source: GAO.

The Tag

An RFID tag, or transponder, consists of a chip and an antenna (see fig. 2). A chip can store a unique serial number or other information based on the tag's type of memory, which can be read-only, read-write, or write-once read-many. The antenna, which is attached to the microchip, transmits information from the chip to the reader. Typically, a larger antenna indicates a longer read range. The tag is attached to or embedded in an object to be identified, such as a product, case, or pallet, and can be scanned by mobile or stationary readers using radio waves. Figure 2 illustrates the back of an RFID tag that is used in libraries to track books.

Objectives, Scope, and Methodology

Our objectives were to (1) provide an overview of the technology, with an emphasis on passive technology; (2) identify the major initiatives at federal agencies that use or propose to use the technology; (3) discuss the current standards, including those for interoperability, that exist; (4) discuss potential legal issues that the 24 Chief Financial Officer (CFO) Act agencies have identified in their planning for technology implementation; and (5) discuss security and privacy considerations surrounding the technology and the tools and practices available to mitigate them.

To provide an overview of the technology, we analyzed research studies and reports discussing the technology and its application. We also conducted an extensive Internet search of professional information security literature produced by information security experts, practitioners, and news organizations. To identify the major initiatives that federal agencies use or propose to use RFID technology for and their concerns, we sent a questionnaire to 23 of the 24 executive branch agencies covered by the CFO Act of 1990. The Department of Defense was not issued a survey because relevant data were collected through other ongoing work we are performing. All 23 agencies responded to our survey. We did not verify the accuracy of the agencies' responses; however, we reviewed supporting documents that agencies provided to help verify their responses. We contacted agency officials when necessary to clarify their responses or to obtain additional information about their use or proposed use of RFID technology. We then analyzed agency responses to determine the extent to which agencies are using or proposing to use RFID technology. In addition, we analyzed their responses concerning security, privacy, legal, and other issues related to RFID. We also reviewed prior reports and testimonies on information security that discussed privacy and security issues.

To discuss the current standards, we met with leading standards-setting organizations, the National Academy of Sciences, and the National Institute of Standards and Technology to discuss the standards used, the various standards-setting organizations, and the current state of standards. We also reviewed relevant literature, research studies, and reports.

To discuss the potential legal issues agencies identified in planning for technology implementation, we analyzed agencies' survey responses and reviewed relevant reports. We also assessed relevant legal issues associated with the implementation of new information technology such as RFID.

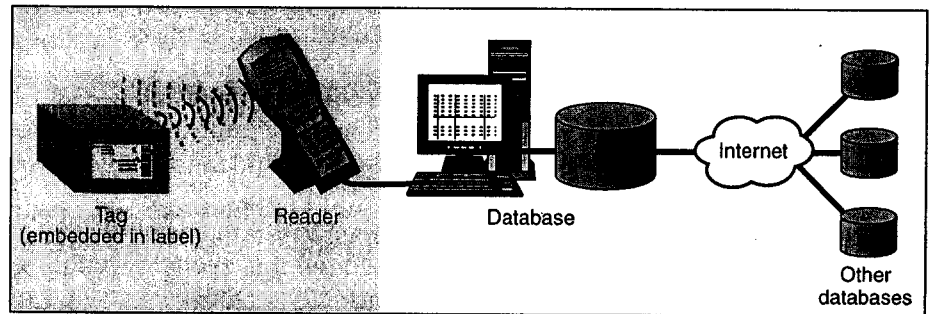
communicate with the tag without a direct line of sight, depending on the radio frequency and the type of tag (active, passive, or semipassive) used.

Readers can process multiple items at once, allowing for increased read processing times. They can be mobile, such as handheld devices that scan objects like pallets and cases, or stationary, such as point-of-sale devices used in supermarkets. Readers are differentiated by their storage capacity, processing capability, and the frequencies they can read.

The Database

The database is a back-end logistic information system that tracks and contains information about the tagged item. (See fig. 4.)

Figure 4: The Database



Source: GAO.

Information stored in the database can include item identifier, description, manufacturer, movement of the item, and location. The type of information housed in the database will vary by application. For instance, the data stored for a toll payment system will be different than the data stored for a supply chain. Databases can also be linked into other networks, such as the local area network, which can connect the database to the Internet. This connectivity can allow for data sharing beyond the local database from which the information was originally collected.

RFID Systems Operate on Radio Frequencies

Choice of radio frequency is a key operating characteristic of RFID systems. The frequency largely determines the speed of communication and the distance from which the tag can be read. Generally, higher frequencies indicate a longer read range. Certain applications are more suitable for one type of frequency than other types, because radio waves

or tag interferes with the radio waves, read-rate accuracy decreases. For instance, defective tags created by the manufacturer can be unreadable or tags may be damaged during the supply chain process. Additionally, readers can produce false negatives (a reader does not read a valid tag that passes within the prescribed range) or false positives (a tag not intended to be read inadvertently passes within range of a reader), which typically occur with closely packed items where multiple tags are near each other. Further, environmental conditions, such as temperature and humidity, can make tags unreadable. Experts have indicated that tags read at high speeds have a significant decrease in read rate. As the technology continues to mature, these limitations may eventually be addressed, but currently they remain a challenge to organizations. One agency official reported not implementing the technology because its reliability was not at an acceptable level.

Placement. The placement and orientation of the tag contributes to how effectively the reader can scan it. Factors to consider in tag placement are read and nonread points on objects such as items, cases, or pallets; locations that minimize the risk of damage to the tag and have the highest potential for a successful passive tag reading; and read points in specific environments, such as an item running through a conveyor belt at various speeds.

Some organizations, such as DOD, have documented procedures for tag placement to help ensure placement precision, consistency, and efficiency. Determining optimal tag placement may require software or an automated application to improve this otherwise manual process.

Costs and Benefits. Best practices for information technology investment dictate that prior to making any significant project investment, the costs and benefits of the system should be analyzed and assessed in detail.³⁰ The cost of the tags generally falls on the supplier, as it is the supplier who tags the items. Retailers see benefits from RFID tags such as improved product visibility during the supply chain process. Suppliers can also see such benefits when they go beyond the “slap and ship”³¹ model and find new

³⁰GAO, *Aviation Security: Challenges in Using Biometric Technologies*, GAO-04-785T (Washington, D.C.: May 19, 2004).

³¹“Slap and ship” is when a supplier tags the products with an RFID tag right before shipping them to the retailer. Suppliers who slap and ship generally will not benefit from the technology because they do not make use of it for their own benefit.

Table 3: Federal Agencies' Reported Use or Planned Use of RFID Technology

Agency	Application
Department of Defense	Logistics support Tracking shipments
Department of Energy	Detection of prohibited articles Tracking the movement of materials
Department of Health and Human Services	Physical access control
Department of Homeland Security	Border control, immigration and customs (U.S. Visitor and Immigrant Status Indicator Technology (US-VISIT)) Location system Smart containers Tracking and identification of assets Tracking and identification for use in monitoring weapons Tracking and identification of baggage on flights
Department of Labor	Tracking and locating case files
Department of State	Electronic passport
Department of Transportation	Electronic screening
Department of the Treasury	Physical and logical access control Records management (tracking documents)
Department of Veterans Affairs	Audible prescription reading Tracking and routing carriers along conveyor lines
Environmental Protection Agency	Tracking radioactive materials
General Services Administration	Distribution process Identification of contents of shipments Tracking assets Tracking of evidence and artifacts
National Aeronautics and Space Administration	Hazardous material management
Social Security Administration	Warehouse management

Source: GAO analysis of agencies' survey responses.

Note: The Departments of Agriculture, Commerce, Education, Housing and Urban Development, Interior, and Justice; the U.S. Agency for International Development; the Nuclear Regulatory Commission; the National Science Foundation; the Office of Personnel Management; and the Small Business Administration reported no current use or specific plan to use RFID technology in either a pilot or an operational environment.

In addition to the initiatives reported by the 24 CFO Act agencies, other related federal initiatives are under way. While the U.S. Department of Agriculture reported that it is not using the technology and takes a technology-neutral stance, it noted that private-sector participants in its animal identification program have the option to use the technology to

issues associated with RFID implementation include notifying individuals of the existence or use of the technology; tracking an individual's movements; profiling an individual's habits, tastes, or predilections; and allowing for secondary uses of information.

- **Notification.** Individuals may not be aware that the technology is being used unless they are informed that the devices are in use. Therefore, unless they are notified, consumers may not be aware that the RFID tags are attached to or embedded in items they are browsing or purchasing or that the items purchased are being scanned.
- **Tracking.** Tracking is real-time, or near-real-time, surveillance in which a person's movements are followed through RFID scanning. Media reports have described concerns about ways in which anonymity is likely to be undermined by surveillance. As previously reported, many civil liberties groups are concerned about the application of this technology to track individuals' movements, such as in a public school setting, and the resulting loss of anonymity in public places. Additionally, periodic public surveys have revealed a distinct unease with the potential ability of the federal government to monitor individuals' movements and transactions.²³ Three agencies also indicated that employing the technology would allow for the tracking of employees' movements.
- **Profiling.** Profiling is the reconstruction of a person's movements or transactions over a specific period of time, usually to ascertain something about the individual's habits, tastes, or predilections. Because tags can contain unique identifiers, once a tagged item is associated with a particular individual, personally identifiable information can be obtained and then aggregated to develop a profile of the individual. As previously reported,²⁴ profiling for race, ethnicity, or national origin has caused public debate in recent years. Both tracking and profiling can compromise an individual's privacy and anonymity.
- **Secondary uses.** In addition to issues about the planned uses of such information, there is also concern surrounding the possibility that

²³GAO, *Technology Assessment: Using Biometrics for Border Security*, GAO-03-174 (Washington, D.C.: Nov. 15, 2002).

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common international standard. As previously mentioned, the U.S. Department of State has reported plans to use RFID technology in its electronic passports.¹⁸ The United States and other countries are anticipating using the International Civil Aviation Organization¹⁹ (ICAO) Document 9303 standard, which prescribes an international format for passports, visas, and other official machine-readable travel documents.

To maximize the global interoperability of supply chains using RFID technology, it is important to ensure that the standards chosen can be used in all relevant markets. Interoperability of global supply chains using RFID technology means that tags used in one country can be read easily by readers in other countries. ISO's item management standard for frequency interoperability includes its ISO 18000 series. This series addresses issues such as generic air interface parameters for globally accepted frequencies and air interface communications parameters at different operating frequencies. To complement ISO's standard, EPCglobal has proposed its Generation 2 standard. EPCglobal claims that this standard will allow for global interoperability of systems built to it for supply chain management because frequency and power level used within this standard comply with most relevant markets.²⁰ As previously mentioned, DOD and various private-sector organizations are currently using EPCglobal's specifications in their supply chains; the specifications cover issues such as placement of the tag, structure of the coding for the tag, specifications for tag data, and parameters for interaction between a tag and a reader.

Federal Agencies Raise Few Legal Issues

Of the 16 agencies that responded to the question on legal issues associated with RFID implementation in our survey, only one identified what it considered to be legal issues. These issues relate to protecting an individual's right to privacy and tracking sensitive documents and

¹⁸The proposed U.S. electronic passport will resemble a regular passport with the addition of a small RFID chip embedded in the back cover. The chip will securely store the same data visually displayed on the photo page of the passport and will also include a digital photograph.

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	Location system
	Smart containers
	Tracking and identification of assets
	Tracking and identification for use in monitoring weapons
	Tracking and identification of baggage on flights
Department of Labor	Tracking and locating case files
Department of State	Electronic passport
Department of Transportation	Electronic screening
Department of the Treasury	Physical and logical access control
	Records management (tracking documents)
Department of Veterans Affairs	Audible prescription reading
	Tracking and routing carriers along conveyor lines
Environmental Protection Agency	Tracking radioactive materials
General Services Administration	Distribution process
	Identification of contents of shipments
	Tracking assets
	Tracking of evidence and artifacts
National Aeronautics and Space Administration	Hazardous material management
Social Security Administration	Warehouse management

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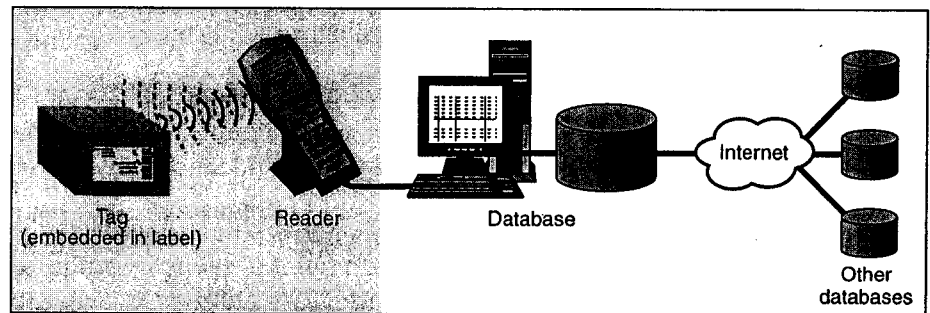
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The Database

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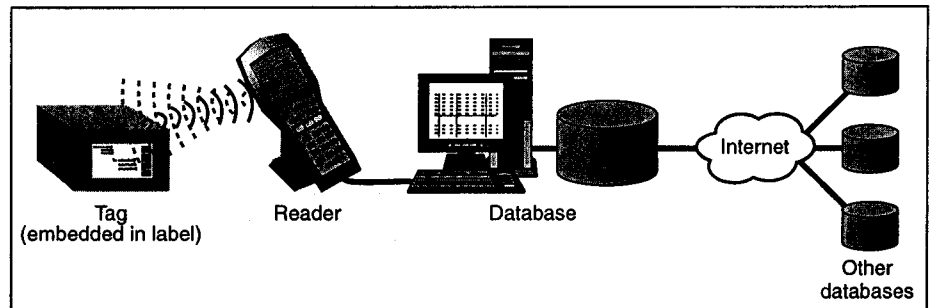
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Illustrative List of Standards-Setting Organizations for RFID Systems

Type of standards body	Organization	Description
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International	International Civil Aviation Organization (ICAO)	Chartered by the United Nations to regulate international aviation and includes the United States and 188 other nations.
International—professional	Institute of Electrical and Electronics Engineers (IEEE)	With more than 360,000 members in approximately 175 countries, the organization, through its members, works in the technical areas ranging from aerospace, computers, and telecommunications to biomedicine, electric power, and consumer electronics.
Regional	Comité Européen de Normalisation (CEN)	Contributing to the objectives of the European Union and European Economic Area with voluntary technical standards.
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National	American National Standards Institute (ANSI)	Promotes and facilitates voluntary consensus standards and conformity assessment systems and safeguards their integrity.
National	British Standards Institute (BSI)	Works with government, businesses, and consumers to represent the United Kingdom's interests and facilitate the production of British, European, and international standards.
National	Japanese Industrial Standards Committee (JISC)	Consists of many national committees and plays a central role in standardization activities in Japan.
National	Standardization Administration of China (SAC)	Authorized to exercise the administrative functions and carry out centralized administration for standardization in China.
Private sector	AIM Global	Working with its members, AIM Global develops standards and practices for automatic identification and data collection technologies.
Private sector	EPCglobal, Inc.	A joint venture between EAN International and the Uniform Code Council. Its subscribers include manufacturers, retailers, wholesalers, carriers, government, hardware and software companies, consultants, systems integrators, and training companies. EPCglobal has developed a series of specifications for use in the supply chain.
Industry	Automotive Industry Action Group (AIAG)	With more than 1,600 member companies which include North American, European and Asia-Pacific OEMs and suppliers to the automotive industry, the organization developed standards for use in the automotive industry and its goals include reducing cost and complexity within the automotive supply chain.
Industry	International Air Transport Association (IATA)	It is an inter-airline cooperation in promoting safe, reliable, secure, and economical air services - for the benefit of the world's consumers. It has over 270 members from more than 140 nations.



United States Government Accountability Office
Washington, D.C. 20548

May 27, 2005

The Honorable Christopher Cox
Chairman
Committee on Homeland Security
House of Representatives

The Honorable Bennie G. Thompson
Ranking Member
Committee on Homeland Security
House of Representatives

The Honorable Zoe Lofgren
Committee on Homeland Security
House of Representatives

The Honorable Mac Thornberry
House of Representatives

Radio frequency identification (RFID) is an automated data-capture technology that can be used to electronically identify, track, and store information contained on a tag. The tag can be attached to or embedded in the object to be identified, such as a product, case, or pallet. RFID provides identification and tracking capabilities by using wireless communication to transmit data.

The technology can provide a more efficient method for federal agencies, manufacturers, retailers, and suppliers to collect, manage, disseminate, store, and analyze information on inventory, business processes, and security controls, among other functions, by providing real-time access to information. The use of this technology also has the potential to assist agencies in tracking their assets, thereby maintaining more accurate inventory records.

In response to your request, our report discusses considerations surrounding RFID technology implementation in the federal government. Specifically, our objectives were to (1) provide an overview of the technology, with an emphasis on passive technology; (2) identify the major initiatives at federal agencies that use or propose to use the technology; (3) discuss the current standards, including those for interoperability, that exist; (4) discuss potential legal issues that the 24 Chief Financial Officer

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May 2005

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