Radio Frequency Identification (RFID) on Cisco Catalyst 9000 Family Switches

Overview

RFID is an automatic identification technology that uses radio waves to capture data from tags, rather than optically scanning the bar codes on a label. One of the primary benefits of an RFID system is that the tag does not need to be in the line of sight for the reader to read its stored data, and multiple tags can be read simultaneously.

Common areas of RFID usage are:

- Inventory and asset management
- Tracking of products
- Access control

RFID technology can be used in different frequency ranges depending on the distance, type of tags, and type of usage (Table 1). With Low-Frequency (LF) RFID, the signal will travel only a few centimeters, but the cost of ownership is lower. With High-Frequency (HF) RFID, the signal can travel up to 1 meter but the cost will be higher than for LF. Among the frequency types, passive UHF has gained popularity because of its low cost, good read range, and adopted standards.

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Table 1. RFID frequency ranges

Type	Frequency	Distance	Sample application
LF	125 kHz	Few cm	Auto immobilizer
HF	13.56 MHz	0.4 m	Building access
UHF	860 to 960 MHz	1 to 4 m	Supply chain
µWave	2.4 GHz	> 10 m	Traffic toll

Architecture

The basic architecture of an RFID system includes **three** main components (Figure 1):

1. RFID tag
2. RFID reader
3. Data processing station.

Figure 1. How an RFID system works

RFID tag

The RFID tag is the entity that is affixed to the asset. RFID tags come in three different types: passive, active, and semiactive. Each type has a different power source, with corresponding differences in ranges, life spans, and costs (Table 1).

Table 2. RFID tag types

Passive	Active	Semiactive
Powered by an RFID reader (no internal battery)	Onboard transmitter and has power source	Onboard battery power source but no onboard transmitter
Least expensive but short range (1 to 4 m)	Higher cost but greater range (100 m or more)	Greater range (up to 50 m) than pure passive Higher cost than passive but less than active
Small, light, up to 50 years	Dependent on battery life	Finite life

RFID tags can also be delivered with the following data-handling capabilities:

- **Read only:** Data is written into the tag at the time of production and cannot be changed thereafter.
- **User programmable:** Data can be written multiple times with or without access control after the production cycle.
- **Read/write:** Data can be read from or written to the tag when the tag is in range of a reader/writer. The amount of memory available to write the data can vary depending on the type of tag.

RFID reader and data processing station

A reader is basically a radio frequency transmitter and receiver, controlled by a microprocessor. The reader captures data from RFID tags and then passes the data to a computer for processing.

Like tags, readers come in a wide range of sizes and offer different features. Readers can be affixed in a stationary position, can be portable, and can even be embedded in electronic equipment such as a small chip on a circuit board or handheld device (Figure 2).

Figure 2. RFID readers

RFID on Cisco Catalyst 9000 family switches

The Cisco® Catalyst® 9000 family of switches is the next generation of enterprise-class switches, built for security, Internet of Things (IoT), mobility, and cloud. The Cisco Catalyst 9000 family is based on an x86 CPU and Cisco Unified Access™ Data Plane (UADP) Version 2.0, which support full programmability and serviceability as well as convergence between wired and wireless over a single platform. The switches provide superior high availability and unmatched security features for the next generation of enterprise network designs.

Cisco is adding RFID technology to the many features and capabilities of the Cisco Catalyst 9000 family, with front-facing passive UHF RFID technology that provides the latest auto-ID capabilities for asset management, location, and tracking (Figure 3).

Figure 3. RFID-enabled Cisco Catalyst 9000 family switches

Type of RFID tag

The passive RFID tags on the Cisco Catalyst 9000 family are compatible with the Generation 2 GS1 EPC Global Standard (as well as being ISO 18000-6C compliant) and operate in the 860- to 960-MHz UHF band.

Each RFID tag on the Cisco Catalyst 9000 family switches has an Alien Higgs 3 memory chip (or equivalent) that has three portions:

1. Electronic Physical Code (EPC): 208 bits
2. Tag ID (TID): 96 bits
3. User memory partition: 384 bits

Cisco has chosen the Alien Higgs 3 for the extra EPC memory capacity available to encode in EPC Serialized Global Trade Item Number (SGTIN)-198 format.

The Cisco Catalyst 9200, 9300 and 9500 Series, which are one-rack-unit (1RU) switches, have one built-in RFID tag in the front panel of the switch. The modular Cisco Catalyst 9400 and 9600 Series chassis features built-in RFID on several system components: the supervisor, line card, and fan tray. The RFID tag on the Cisco Catalyst 9400 and 9600 Series line cards are embedded in the ejector arm handle (Figure 4).

Figure 4. RFID tags

EPC partition

The EPC is used as a universal identifier for physical objects and uses a specific encoding format that includes serial number, vendor ID (company prefix), and reference number (item number of product) (Table 4).

Table 4. EPC partition format

SGTIN-198 EPC partition (access locked), 208 bits						
Logical segment (bit count)	EPC header (8)	Filter (3)	Partition (3)	GS1 company prefix (20)	Indicator/ item reference (24)	Serial number (140)
Cisco encoding data	36 (hex) 00110110	Varies, 0 to 7 Default: 000	5 101	**0746320** (10110110001101010000) 0764494 0882658	Unprogrammed	7-bit encoded 11-character alphanumeric SN: **AAA#######AA**

Access to the EPC partition is locked; users cannot access it. Cisco preencodes the tag's EPC memory with the data listed in Table 5 per global SGTIN-198 format.

Table 5. Cisco EPC memory SGTIN-198 (208 bits)

EPC SGTIN-198 header	36 (hex)
Filter	0 to 7
Partition	5
EPC global assigned Global Company Prefix (GCP)	0746320 (alternate GCP: 0764494 and 0882658)
Item reference	NA
Serial number	Cisco alphanumeric serial number in the format AAA#######AA
Example:	
EPC SGTIN-198 header = 36	
Filter = 3	
Partition = 5	
GCP = 0746320	
Item reference = NA	
Serial = FOC12345ABC	

TID partition

The TID is a unique 96-bit field that is programmed before the tag is placed on the product, and TID information is permanently locked. The TID has specific product information from manufacturing, such as IC manufacturer, chip version, and factory-programmed unique ID.

User memory partition

The user memory partition has the Cisco product ID, version ID, and other user information. This partition is unlocked by default and can be replaced or augmented with custom information by the customer. User memory can be locked using a custom password (Table 6).

Table 6. User memory partition format

User memory partition (access unlocked)	384 bits
Cisco encoding data (7-bit encoding)	Cisco PID (i.e., C9500-24Q), Cisco VID (i.e., A01), custom user information

How end users access tag data

Tag contents are accessed by using EPC Global Class 1, Generation 2, ISO 18000-6C-compliant fixed or mobile readers. Any RFID system that supports EPC Generation 2 is able to access data from Cisco Catalyst 9000 family RFID-enabled products for asset tracking and asset management.

End users are also able to access a tag's data by using Telnet, a web browser, serial communications to the reader, and third-party middleware applications.

Conclusion

RFID technology can increase the efficiency of processes and reduce costs by providing improved visibility, less monitoring, less human intervention for asset management with fewer errors, and higher reliability. The Cisco Catalyst 9000 family chassis and line cards are some of the latest Cisco products to launch with front-facing passive UHF RFID technology, providing the most current auto-ID capabilities for asset management.