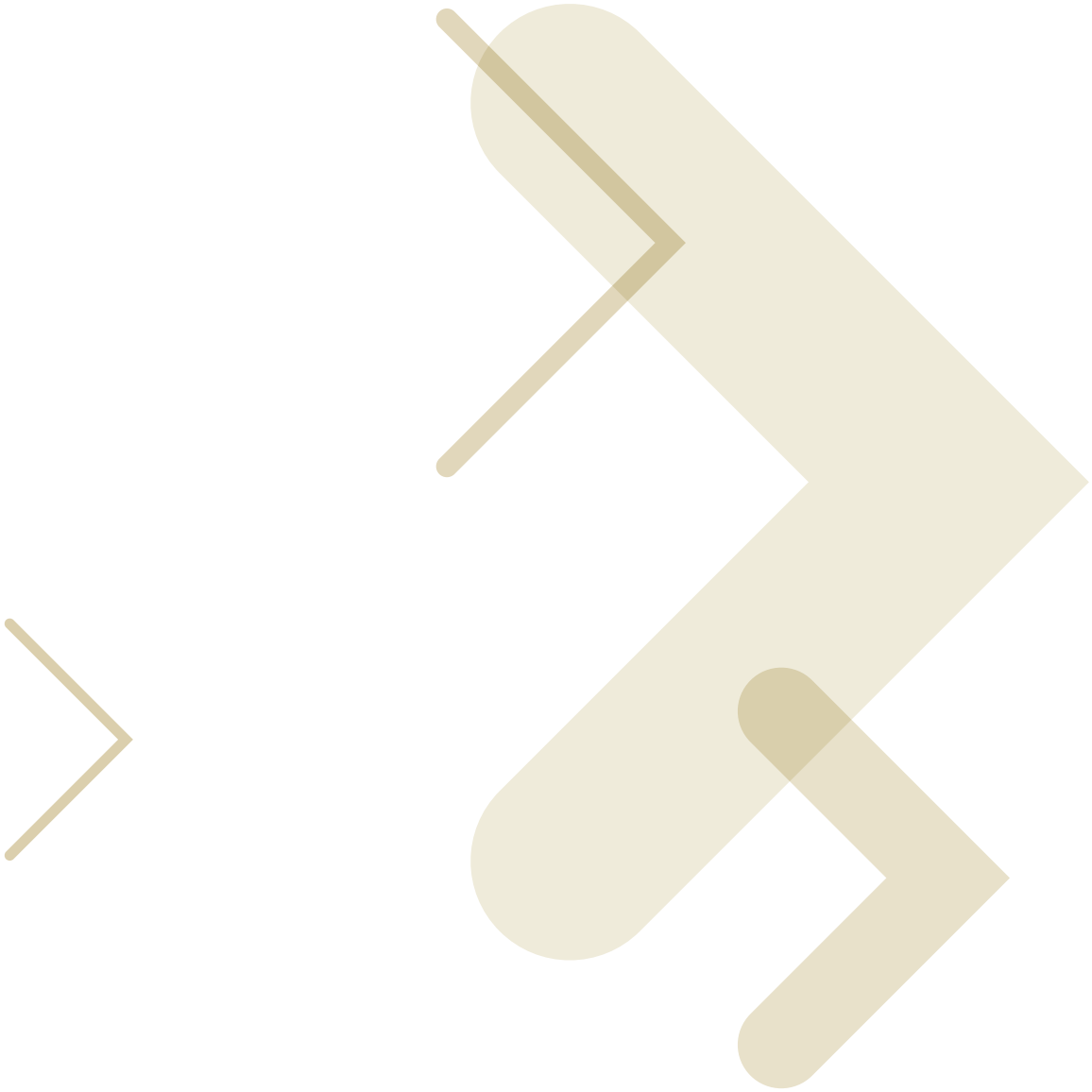
WHITE PAPER

Synchronize your Supply Chain with RFID



Executive summary

Driving efficiencies throughout your supply chain and increasing the velocity of items through the supply chain from creation to consumer is more than a business mandate today; it's a matter of business survival. If your company doesn't do it, your competition will.

Radio Frequency Identification (RFID) is a true next-generation technology — ready, available and being implemented today — that is transforming how companies manage and extract more business value from their supply chain operations.

Whether your focus is in manufacturing, wholesale distribution, retailing, travel and transportation or throughout government, RFID will drive profitability, increase revenue, reduce operating expenses and shrink inventory levels. It promises to have the same, if not more business impact as bar code technology, which automated global supply chains and created industry leaders of its early adopters a generation ago.

RFID directly affects a company's bottom line by creating new value in the supply chain, synchronizing the movement of material and products all along the way. It allows companies to:

- Increase visibility into their supply chain operations
- Respond more quickly to real-time disposition and dynamic business conditions
- Reduce errors and labor costs through increased automation
- Increase customer service, satisfaction and loyalty

RFID is quickly moving through a rapid adoption phase and gaining momentum, as:

- Major companies and organizations with global scope are demanding business partners or companies develop and deploy RFID applications and solutions.
- A powerful, single global standard — Gen 2 — has emerged that offers significant performance benefits, enables scalability and offers a clear deployment path.
- The benefits and return-on-investment are proven, significant, measurable — based on extensive piloting and early adopter deployments — and provide incremental profits that justify the investment.

In the following pages you will see how RFID can impact organizations all along the supply chain, from the evolution of RFID — through real-world implementation case studies. As you read on, imagine the power that RFID solutions can deliver to your organization; the technology is here today, and it can help you synchronize your supply chain — delivering a true competitive advantage.

RFID and the Supply Chain

There's an information technology revolution in the supply chain that's changing the way business is conducted — RFID — a technology with the promise for dramatically increasing operational efficiencies.

RFID isn't a new technology. It has been in use for years, studied even longer, and has already brought its unique identification benefits to toll collection, large container tracking and access control for some time now.

The supply chain — the ultimate production and delivery engine — has been around for nearly 100 years. Leveraging RFID technology as a complement to bar codes in the supply chain is a natural evolution of technology, driving efficiency and productivity all along the way.

RFID, the "Talking Bar Code" shrinks the Supply Chain

Collapsing the supply chain — shrinking the time it takes for finished products to get from the front end of manufacturing, through distribution and transportation, to the shelves of a store and into the hands of the consumer — impacts the bottom line for all businesses. Master the supply chain and succeed; fall behind and fail.

The supply chain has been affected by various technologies over the years. Few, if any, have had the promise of RFID. Unlike other technologies that might have provided incremental benefits, RFID can significantly increase the speed of information and maximize supply chain efficiencies. RFID allows users to know the location and status of RFID-tagged containers, pallets, cartons, or individual assets at all times. Unlike a bar code, which must be visually located and scanned for on-demand operation, an "always-on" RFID tag simply awaits the reader signal to access real-time critical business information at any time.

RFID is a technology that allows companies to:

- Increase visibility and accuracy of the supply chain by providing real-time visibility to product flow
- Reduce the time it takes to make important supply chain decisions by providing access to real-time information
- Respond quicker than ever before to customer demands through better information management
- Improve error correction ratios by increasing levels of automation

What makes RFID different from bar coding?

RFID technology is a natural fit for some applications offering incremental benefits and works in a complementary fashion, or partners with bar codes in others. Although RFID tags and bar codes provide similar data capture functionality, there are a number of differences:

- Bar codes require line-of-sight reading and have limited read ranges, while an RFID reader can detect a tag that is not visible at distances considerably greater than bar codes
- Multiple RFID tags can be read simultaneously, while bar codes must be read individually
- RFID tags have memory which can be updated, while bar code data remains static
- RFID tags can identify a specific item as well as the item's pedigree or other pertinent information, while a bar code identifies the type or class of item as part of a category
- RFID systems provide full automatic data collection, while the bulk of bar code applications require manual intervention, introducing the potential for human error
- RFID significantly reduces the time required to locate assets, operating in a manner similar to a Geiger counter, automatically seeking the location of specific tagged items

RFID and rapid adoption

Why is RFID suddenly so important and vital to the supply chain? What's driving companies to scrutinize RFID? And, most importantly, is it viable today? RFID has generated excitement in the industry, primarily because of the promise of dramatic business and operational benefits. The rapid adoption of RFID is being driven by companies that are facing both external and internal pressures as well as:

"The DoD has run a number of pilots over the past few months that has produced no surprises and justified the military's view that RFID was worth the investment. It is not just that the DoD can reduce inventory. RFID could help the DoD better support soldiers in the field. Better management of inventory means weapons systems are up and operating more of the time. That is where the big savings are."[1]

Alan Estevez,
Asst. Deputy Undersecretary of Defense,
Supply Chain Integration

- Industry mandates and direct guidelines outlining specific labeling requirements:
  - Wal-Mart and other global retailers such as Target and BestBuy are mandating that suppliers apply RFID tags to all pallets and cases, phasing in the technology
  - The U.S. Department of Defense, which runs what is considered the world's largest and longest supply chain with more than 60,000 suppliers, has mandated a phased-in approach for RFID labeling to its suppliers
  - The U.S. FDA (Food and Drug Administration) is looking to RFID to control the nation's drug supply to ensure quality and reduce counterfeiting
- Standards adoption, once considered a barrier to RFID adoption, is a diminishing issue. In particular, there is convergence around Gen 2, a global standard that promises a single, clear development path
- Tag pricing continues to drop as demand increases and the benefits of volume production are phased in
- Comprehensive RFID systems and solutions are available today. These solutions vary from get-started RFID kits, to full system implementations that include advanced fixed and mobile RFID readers, to packaged systems like portals and reader stations
- The proliferation of a true, "global" economy, increasing competition and complex trading networks, are applying pressure to the bottom line, driving interest in a technology that can dramatically improve efficiency across their operations, cut costs and deliver a competitive advantage
- Clear real-world business benefits have been documented by independent studies and early pilot programs by some of the world's leading companies and organizations

It is well known that companies that focus on improving the efficiency of their supply chain are improving their ability to meet their customers' demands and driving increased customer satisfaction and loyalty. RFID can help make it happen by synchronizing the supply chain — from raw materials entering a manufacturing plant to incoming shipments of finished product at the back door of a retail operation.

The bottom line: RFID is real, it's here and it's ready to be invested in and implemented today.

RFID — The next generation of data collection

Think of RFID as the next generation of, or an "enhanced" bar code. Just like bar codes, it is an essential element of an enterprise mobility system, offering even greater access to information across your systems. With RFID, data capture takes a quantum leap forward, with much higher information capacity, non-contact information transmission and always-on identification with limited or no human intervention. It takes the ability to capture, move and manage information to the next level.

Just as bar code technology revolutionized the supply chain, raised the bar on customer demand and has been the key automatic identification data capture (AIDC) technology for the past 25 years, RFID will be a key AIDC technology for the present and the future. And just as the bar code was a leapfrog technology that rewarded its early adopters, so, too, is RFID an essential technology today.

RFID basics

There are four basic elements of an RFID system: tags, readers, antennas and software with a number of options available for each component. Simply put, an RFID tag, like a bar code, stores information but has the capacity to store considerably more information than bar codes. RFID tags exchange information with RFID fixed or mobile readers by radio signal or radio frequency (RF).

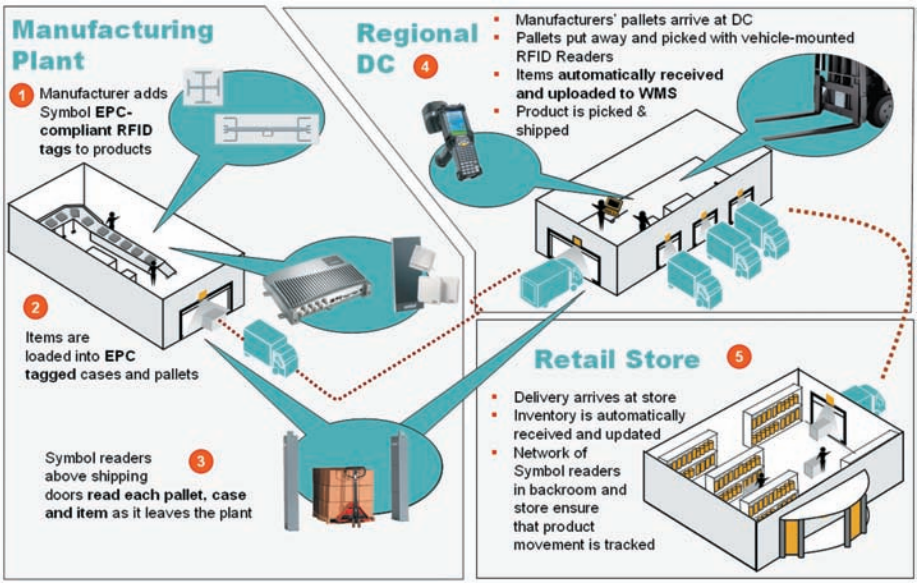
RFID tags

At the heart of any RFID system is the tag, also known as the transponder. Two types of tags and their variants – active and passive – dominate the marketplace and are designed for specific applications. Active tags are battery powered with on-board battery power sources, contain up to hundreds of kilobytes of memory and can communicate data over longer ranges than passive tags. The tags are always on and always talking. Active tags, especially because of the built-in batteries, are far more expensive than passive tags. Active tags have been used for years and are typically used in long-range tracking applications and to track high-value inventory.

Active Tags	Passive Tags
Battery Powered	Beam Powered[1]
100's of KB Memory	64 — 256 bits Memory
Expensive	Inexpensive
Limited Battery Life	Long Life
Active Transmit	Backscatter[2] Transmit
Long Range	Short/Medium Range
Tag Talks First (TTF)	Reader Talks First (RTF)

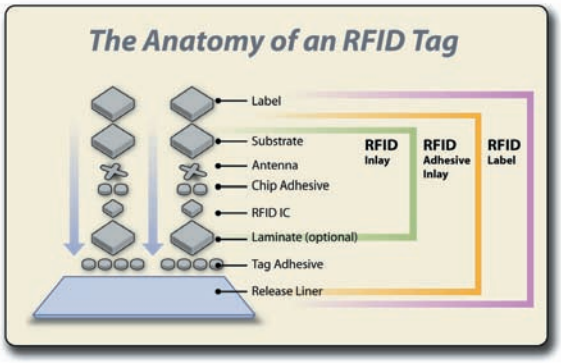
1 - A circuit that derives ALL operational power from the RF environment (no on board power sources such as batteries, capacitors, etc). Reader transmits "illumination" carrier which powers tags at all times of activity.
2 - Extremely low power communication technique, works by changing the reflectivity of the tag antenna used to encode data sent from tag to reader.

The diagram on the right provides an example of how RFID products and solutions could be deployed from the manufacturer to the retail store.



Companies managing their supply chains primarily focus on passive UHF RFID tags. These passive tags, because their low cost and relatively long read ranges (up to 25 feet), offer the best performance/value ratio across the supply chain. Passive tags communicate with readers leveraging backscatter technology and are "beam powered", meaning they derive all of their operational power from the RF environment. The RFID reader generates a radio signal and broadcasts it via the connected antenna configured in a radio frequency (RF) field. A tag, with an on-board antenna senses the radio signal and is energized; releasing its preprogrammed data and reflecting it back to the reader via a modulated radio signal. The reader then decodes the reflected signal, aggregates the data and passes the data to the host system. It all happens in an instant.

Physically, passive RFID tags are made up of a semiconductor chip attached to a printed antenna and mounted on a substrate, such as mylar or plastic. The type and design of the substrate, antenna and chip depends on the application.



There are also read or read-write versions of passive tags, similar to CD/DVD technology.

Read/Write Reprogrammable Data	
Advantages	**Disadvantages**
• Dynamic updates	• More costly
• Redundancy	• Complex procedures
	• Duplicate databases
	• Delays - write process
	• Range limitations
	• Potential for error

Readers

There are various types of readers including mobile handheld devices, fixed-mounted readers and vehicle-mounted readers — and form-factor variations of each. The environment, application and a customer's individual supply chain requirements will determine the choice of reader. Choosing the best reader for the job will optimize performance. It is not a one-tool-fits-all equation.

A reader that is right for a high-speed conveyor in a factory might not be the best tool for a chilly, 1.2 million square foot warehouse that is densely filled with RFID tagged cartons and pallets.

A fixed reader would more likely be deployed for applications at the dock door such as shipping/receiving or aligned along a conveyor belt as part of a work-in-process application. Handheld RFID readers are typically used where the most flexibility is required. For example, exception processing, stock picking, price audits or price changes are typical applications for a handheld RFID reader. Basically, a handheld makes sense when it is more convenient to bring the reader to the item. Multi-protocol readers provide the capability to read Gen 1 and Gen 2 tags, protecting the investment of those early adopters who have deployed Gen 1 RFID. Advanced RFID readers will provide a firmware upgrade capability to Gen 2 and will be dense-reader mode certified by EPCglobal.

Read ranges between tags and readers vary and the user should look for readers that offer longer read ranges as well as higher yield quality and flexible orientation. A reader offering a more industrial design is better prepared to face the challenges of real-world use; and in addition, look for readers that offer multi-reader modes, particularly dense-reader modes if the work environment is operating a large number of readers in a small area. Readers are also offered as reader systems or packaged systems which deploy readers in multiple form factors including portal systems, conveyor systems and vehicle-mounted (e.g. forklift) readers. Packaged systems provide turnkey solutions which are designed for rapid enterprise deployment. Point product solution offerings are characteristic of early market technology. In order for RFID to reach broad, mainstream deployment, RFID solution vendors must offer packaged solutions to minimize the deployment complexity.

"This is no longer a take-it-on-faith initiative. This study provides conclusive evidence that EPCs increase how often we put products in the hands of customers who want to buy them, making it a win for shoppers, suppliers and retailers."[2]

– Linda Dillman, Executive Vice President and CIO, Wal-Mart

Antennas

The antenna is a key operational component for both the tag and the reader. Again, selecting the best antenna will depend upon the application, operating environment and also your performance requirements.

There are a number of antennas available offering the ability to operate indoors or outdoors, or the ability to withstand extreme heat and cold as well as moisture and vibration. In addition, polarity (RF emission pattern), power levels (usually from under one watt to high power applications up to 20 watts), long range and large area RFID tag reading and high speed RF signal conversion are also factors.

RFID benefits: Operational and business

Companies who have achieved a higher level of efficiency are more agile, more effective and more profitable with their trading networks and in their business processes. Efficiency drives bottom-line savings and yields un-arguable competitive advantage from concept to consumer.

RFID, working in tandem with other technologies as part of a larger enterprise mobility system, vastly enhances supply chain efficiency and profitability by providing greater visibility throughout the supply chain increasing automation, reducing shrinkage, enhancing inventory visibility and lowering out-of-stock items. It's ready today with the speed, range, and reliability needed to track products better than existing systems and with proven ROI to track products at the pallet and case level.

RFID allows more frequent data collection and greater information capture. Every dock door, conveyor and work-station becomes an important data collection oasis with vital information that can be read in real time to measure exactly what is in the supply chain.

A four point benefit compass

The tangible benefits from RFID are derived from access to the information resulting from optimized business processes and can be categorized as follows:

- Automation: Reducing labor touches and manual processes, reducing costs and error rates
- Speed: RFID dramatically increases product flow and handling speeds
- Visibility: It increases material visibility, handling flow and reduces inventory levels accordingly
- Business Intelligence: RFID accelerates decision making by providing access to real-time information

All paths lead to the ability to make faster, better decisions and the ability to be more responsive to the customer.

ROI proven-today

An independent University of Arkansas study, commissioned by Wal-Mart, led to compelling data that RFID dramatically improves efficiency in the supply chain by streamlining and improving operational performance. Businesses that were gingerly considering an RFID investment or took a "prove it to me" attitude now have documented proof.

The 29-week study,[3] which examined 24 Wal-Mart distribution centers — 12 of which were receiving RFID-tagged products and 12 that did not — provides conclusive evidence that an RFID solution puts products in the hands of customers who want to buy them far more often than a solution that does not include RFID, making it a win for shoppers and all supply chain contributors. The study also found:

- RFID decreased out-of-stock items by 16%
- Out-of-stock items were replenished three times faster on tagged items than on items with only bar codes
- A 10% reduction in manual orders placed by stores with RFID tagged items

The Wal-Mart study is a one of many to come as companies roll-out RFID across their enterprises. The key take away is that the promise of RFID is turning into reality.

The promise of RFID has been touted as delivering benefits on such a wide scale that it is hard to know what to expect when you implement various applications. RFID does offer significant benefits that will vary depending on how it's used. The following chart show the functional applications, key users and the benefits that can be achieved. The benefits are no longer just a promise, they're real. Everyday, there are new studies published highlighting the real savings and real productivity benefits.

The importance of global standards

Just as bar code technology passed through a standards alignment phase, RFID has faced similar challenges. EPCglobal, a not-for-profit organization established to promote and support the Electronic Product Code (EPC) network, led the drive to create global RFID standards for air interface protocol, data content, testing methodology and performance.

Today, RFID has evolved into a viable technology with a single, global standard in place that allows a company's technology investment to grow stronger by withstanding and anticipating new specifications as they are introduced.

Industry	RFID Benefit Improves/Enhances	Users
Manufacturing	• WIP Monitoring • Inventory Management • Supply-Line Replenishment • In/Out Control • Customer Mandates & Compliance • Product Flow Visibility (Receiving, WIP, Inspections Shipping) • Enhanced Traceability • Mobile Track & Trace (prevent product diversion, counterfeiting)	• Assembly Workers • Shipping/Receiving • Management • Compliance Personnel
Wholesale Distribution	• Returns Processing • Warehouse Management • Receiving/Put Away/Shipping	• Loading Dock Personnel • Warehouse Personnel
Travel & Transportation	• Delivery Confirmation • Warehouse Management • Enhance Asset Tracking • Tracking Trailers/Containers • Package ID • Baggage Tracking • Security/Access • Parts Tracking	• Warehouse Personnel • Baggage Handlers • Security Personnel • Maintenance Personnel
Retail	• Stock Control • Warehouse Management • Price Audits/Change • Store Receiving • Inventory Management • Replenishment	• Sales Associates • Receiving Dock Personnel • Stock Room Personnel • Supervisors
Government/DoD	• Logistics/Supply • Instant Personnel Tracking • Increased Security	• Service Personnel

"The concept of an EPC global network that securely connects products to manufacturers and retailers throughout the supply chain is becoming a reality."[3]

– Scott McNealy, Chairman and CEO, Sun Microsystems, Inc.

The EPC Gen 2 standard offers a global, single-standard protocol delivering significant operational efficiency and security improvements and enables hardware manufacturers and system providers to develop equipment that is interoperable, performs better and provides greater flexibility.

Motorola has actively supported global standards and has a deliberate approach with a structured upgrade strategy and migration path for RFID. Motorola believes that Gen 2 will allow RFID to reach its full potential and is a natural progression from Gen I.

Single global protocol: Greater flexibility, versatility and performance

Unlike Gen 1, which offered two different protocols for tags and readers, (class 0 and class 1), Gen 2 provides a single, unified global standard. The standard also sets minimum performance standards on read ranges and read rates to ensure vendor product compatibility.

A single protocol brings all global technology developers and solution providers together to hasten the development of the technology, ultimately driving costs and, therefore, prices down as volume demand increases.

Gen 2 improves on performance, throughput, accuracy and operational reliability, in diverse regulatory environments — including North America, Europe and Asia. Gen 2 delivers greater flexibility and more choices: Gen 2 readers can read more classes of tags — from an active tag with a sensor to a simple tag with a unique ID and was developed to allow for RFID products with expanded functions. Gen 2 tags provide greater versatility and performance, and use advanced filtering techniques which eliminate multi-reader and noise issues.

The standard allows readers to operate in single reader, multi-reader or dense-reader mode. Dense-reader mode provides optimum performance for work environments such as a warehouse, distribution center or manufacturing facility where readers may be operating in close proximity to one another. Gen 2 defines the specification for the spectral bandwidth, cutting through noise and preventing readers from interfering with each other. Gen 2 readers are not required to support the enterprise-critical Gen 2 dense-reader mode. The Gen 2 standard specifies that a reader must perform in one of the three reader modes, so a reader could be considered compliant, yet not capable of dense-reader mode. EPCglobal has certified a limited set of readers meeting the dense-reader specification.

RFID leadership and support

Motorola, a founding member of the EPCglobal standards body, and an instrumental leader in developing the EPC RFID Gen 1 and Gen 2 specifications, understands the importance of global standards. The company is also a founding member of the RFID Industry Licensing Program Consortium. This 20-member patent-licensing consortium, comprised of the world's leading RFID technology development companies, brings advanced solutions to market faster by providing access to pooled intellectual property and to essential RFID patents via a single license. The consortium will also drive down the cost and complexity of managing IP, promote rapid adoption of RFID and allow RFID to be widely implemented across the marketplace.

Motorola, your partner for RFID solutions

Now is the right time to invest in RFID. Choosing the right vendor for your enterprise operations is a critical business decision that will impact your bottom line. The right decision will mean the difference between implementation success or failure.

Having led the bar code revolution and with 30 years of proven experience and technology leadership, Motorola is now actively developing and deploying the next generation of automated data capture — standards-based RFID technology solutions.

Motorola's RFID product portfolio provides comprehensive solution coverage across many industries and multiple applications. Our products are based on Electronic Product Code (EPC) standards, include multi-protocol, fixed and handheld readers,

HISTORY OF RFID

Mid 1970s
Bar code data capture (Symbol invented and brought to market handheld laser scanning, which ushered in the age of the mobile worker).

Mid 1980s
Ruggedized mobile computing (allowing information to be captured and managed at the point of decision and not behind a desk).

Mid 1990s
Wireless local area networks (a quantum leap for communicating and quickly acting upon important information).

Late 1990s
Two dimensional symbologies (Symbol invented and put in the mainstream PDF417, perhaps the most prolific 2d symbology).

Early 2000s

- 2000: Developed and donated to EPC Gen 1 protocol specification 2003: First EPC RFID handheld
- 2004: First EPC multi-protocol fixed reader
- 2004: Patented, RFID energy-harvesting, charge-pump technology
- 2005: Over 60M EPC RFID inlays/tags manufactured
- 2005: Deployed over 10,000 EPC RFID readers

and reader systems, packaged for industrial deployment, performance and manageability. Through a worldwide network of partners, Motorola offers a broad variety of hardened tag and inlay solutions optimized for a variety of applications.

Motorola's RFID expertise goes beyond products. Motorola understands the supply chain and has the deep vertical market expertise to ensure proper system design. Alongside our partners, we've focused on just that — helping companies implement solutions that enhance the efficiency of their supply chain.

Motorola's proven technology, experience and standards-based philosophy provide a unique value proposition.

Technological leadership

Motorola continues to be instrumental in the development and deployment of technology and products that enable enterprise mobility. Over 900 patents to date span all areas from advanced data capture, mobile computing, wireless LAN infrastructure, mobility software platform and RFID.

For more than thirty years, Motorola, working closely with its customers, has led the development and brought to market a number of important technologies critical to enhancing efficiencies across the supply chain.

Standards leadership

Motorola has explored the possibilities and benefits of RFID since the early stages of the technology.

As a founding member of EPCglobal, Motorola continues to drive standards adoption to facilitate interoperability among vendors and scalable solution development. Motorola was the first to market and deploy EPC multi-protocol fixed readers, EPC handheld RFID readers and EPC RFID portal systems.

Motorola's tag and reader innovation includes early dense-reader mode operation for readers, flexible RFID antenna product designs that can provide a migration path to accommodate new standards, and tags designed for any surface and/or environment. Motorola holds a number of patents specific to RFID, such as a charge pump designed to boost power from tag to reader, and more than 900 mobility-centric patents overall.

RFID leadership

Motorola was one of the first vendors to offer a complete line of RFID systems and products to many large retailers and manufacturers facing compliance mandates. Our installed base also consists of those early adopters who sought new avenues for competitive advantage across multiple supply chain applications in retail, aviation, pharmaceutical and others.

Motorola's services and support offerings are the broadest available providing on-site, go-live and on-going support. Our extensive real-world experience runs from business need assessment training, rollout and support — everything from pilot through deployment. We help companies select the right products, choose the correct tags to ensure optimal reading, execute a pilot with measurable results, investigate the impact of RFID on its business and customer satisfaction, determine and calculate the return on investment, and demonstrate, quantitatively, the benefits of RFID.

The enterprise mobility solution

RFID is a critical technology that impacts the entire supply chain. Today, Motorola deploys RFID not only on an individual project basis, but also as an integral part of a larger enterprise mobility system that encompasses bar code data capture, wireless networks, mobile computers, and mobility software and services to manage and maintain the system. It's the next generation of enterprise mobility that is happening now. Motorola offers this end-to-end systems approach to streamlining your business from the start of the supply chain all the way to the customer.

Motorola's collaboration with technology and application partners ensures forward looking design as well as expands on our vertical knowledge and expertise. Our best-in-class partners allow us to offer an unmatched array of applications that target specific industries and functions and the capabilities to help you assess, implement and manage your investment based upon industry specific best practices.

At the end of the day, your choice of vendor when implementing RFID solutions should be a company that offers technology leadership, standards-based solutions, vertical market expertise, optimal TCO (total cost of ownership) and the overall RFID solution experience. Motorola has a proven track record and can ensure the success of your RFID solution. Motorola is your RFID partner.

A glossary of important RFID terms[5]

Active tag: An RFID tag that has a transmitter to send back information, rather than reflecting back a signal from the reader, as a passive tag does. Most active tags use a battery to transmit a signal to a reader. However, some tags can gather energy from other sources. Active tags can be read from 300 feet (100 meters) or more, but they're expensive (typically more than US $20 each). They're used for tracking expensive items over long ranges. For instance, the U.S. military uses active tags to track containers of supplies arriving in ports.

Air interface protocol: The rules that govern how tags and readers communicate.

Antenna: The tag antenna is the conductive element that enables the tag to send and receive data Passive, low- (135 kHz) and high-frequency (13.56 MHz) tags usually have a coiled antenna that couples with the coiled antenna of the reader to form a magnetic field. UHF tag antennas can be a variety of shapes. Readers also have antennas which are used to emit radio waves. The RF energy from the reader antenna is "harvested" by the antenna and used to power up the microchip, which then changes the electrical load on the antenna to reflect back its own signals.

Backscatter: A method of communication between passive tags (ones that do not use batteries to broadcast a signal) and readers. RFID tags using backscatter technology reflect back to the reader radio waves from a reader, usually at the same carrier frequency. The reflected signal is modulated to transmit data.

Circular Polarized Antenna: A UHF reader antenna that emits radio waves in a circular pattern. These antennas are used in situations where the orientation of the tag to the reader cannot be controlled. Since the waves are moving in a circular pattern, they have a better chance of hitting the antenna, but circular-polarized antennas have a shorter read range than linear-polarized antennas.

Closed-loop systems: RFID tracking systems set up within a company. Since the tracked item never leaves the company's control, it does not need to worry about using technology based on open standards.

Commissioning a tag: This term is sometime used to refer to the process of writing a serial number to a tag (or programming a tag) and associating that number with the product it is put on in a database.

Dense Reader Mode (DRM): Dense Reader Mode is a mode of operation that prevents readers from interfering with one another when many are used in close proximity. Readers hop between channels within a certain frequency spectrum (in the United States, they can hop between 902 MHz and 928 MHz) and may be required to listen for a signal before using a channel. If they "hear" another reader using that channel, they go to another channel to avoid interfering with the reader on that channel.

Frequency hopping: A technique used to prevent readers from interfering with one another. In the United States, UHF RFID readers actually operate between 902 and 928 MHz, even though it is said that they operate at 915 MHz. The readers may jump randomly or in a programmed sequence to any frequency between 902 MHz and 928 MHz. If the band is wide enough, the chances of two readers operating at exactly the same frequency is small. The UHF bands in Europe and Japan are much smaller so this technique is not effective for preventing reader interference.

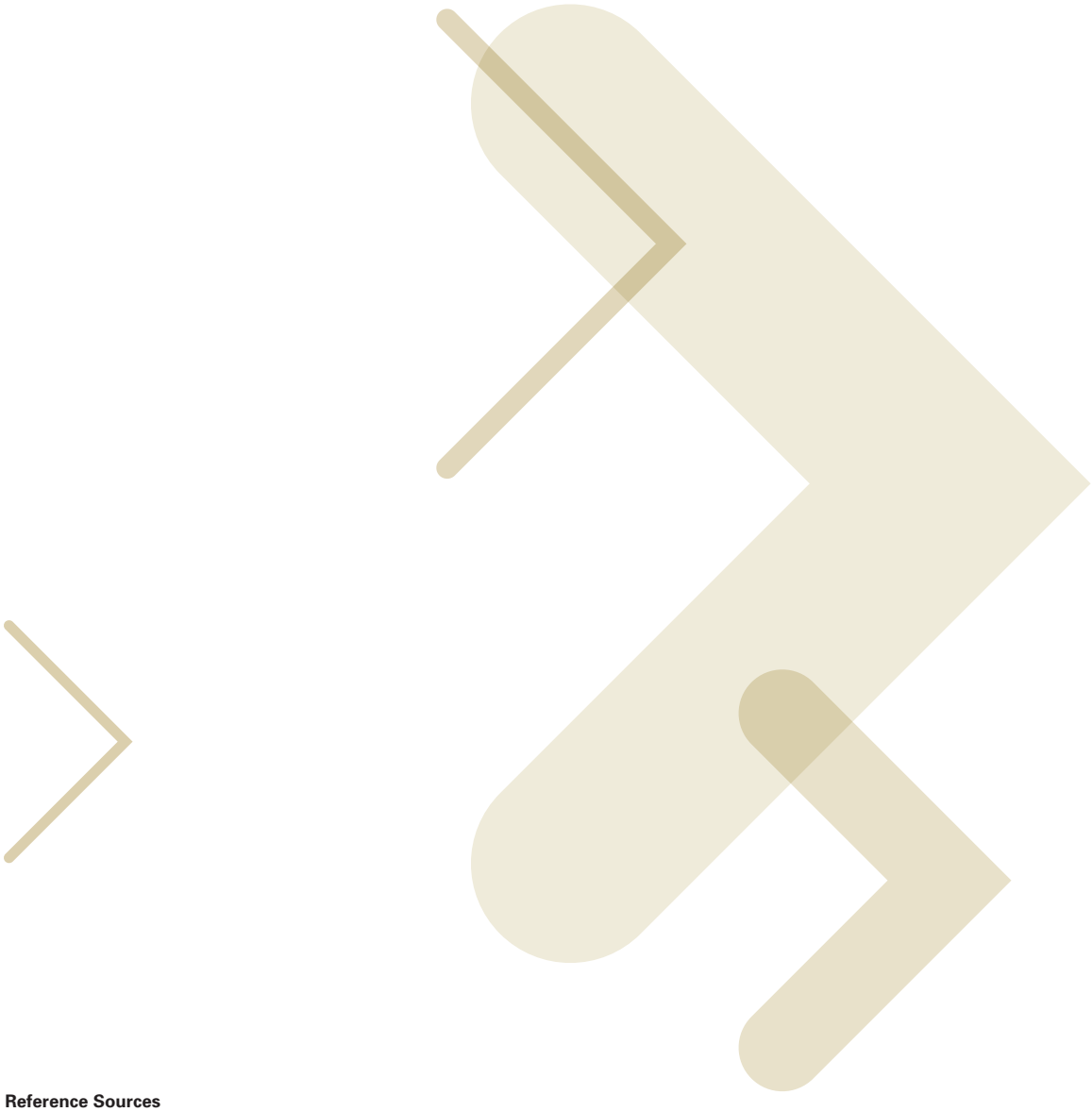
Inlay: An RFID microchip attached to an antenna and mounted on a substrate. Inlays are essentially unfinished RFID labels. They are usually sold to label converters who turn them into smart labels.

Linear Polarized Antenna: A UHF antenna that focuses the radio energy from the reader in a narrow beam. This increases the read distance possible and provides greater penetration through dense materials. Tags designed to be used with a linear polarized reader antenna must be aligned with the reader antenna in order to be read.

Passive tag: An RFID tag without a battery. When radio waves from the reader reach the chip's antenna, the energy is converted by the antenna into electricity that can power up the microchip in the tag. The tag is able to send back information stored on the chip. Today, simple passive tags cost from US $ 0.20 to several dollars, depending on the amount of memory on the tag and other features.

Sensor: A device that responds to a physical stimulus and produces an electronic signal. Sensors are increasingly being combined with RFID tags to detect the presence of a stimulus at an identifiable location.

Ultra-high frequency (UHF): From 300 MHz to 3 Ghz. Typically, RFID tags that operate between 866 MHz to 960 MHz. They can send information faster and farther than high and low frequency tags. But radio waves don't pass through items with high water content, such as fruit, at these frequencies. UHF tags are also more expensive than low-frequency tags, and they use more power.



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