



RAIN RFID:

A Key Enabler for Industry 4.0







RAIN RFID, a foundational element of Industry 4.0 applications, is reshaping how manufacturers produce, deliver, and manage their products. This paper looks at how RAIN RFID, which combines advanced track-and-trace functions with IoT connectivity, revolutionizes industrial processes, by giving machines and people new ways to securely identify, locate, authenticate, and engage each item – at any point in its life cycle.

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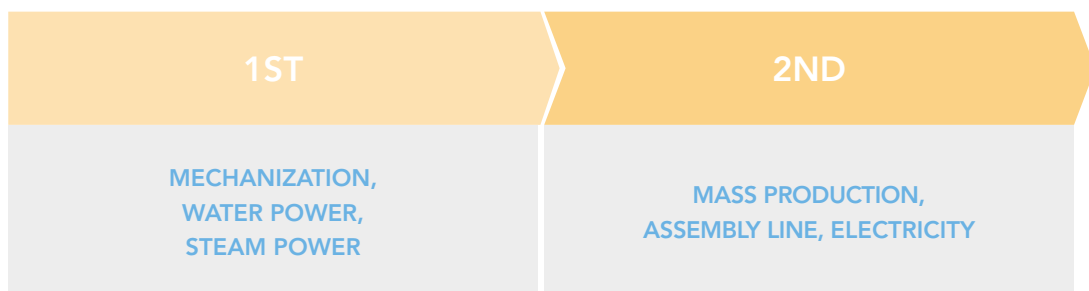
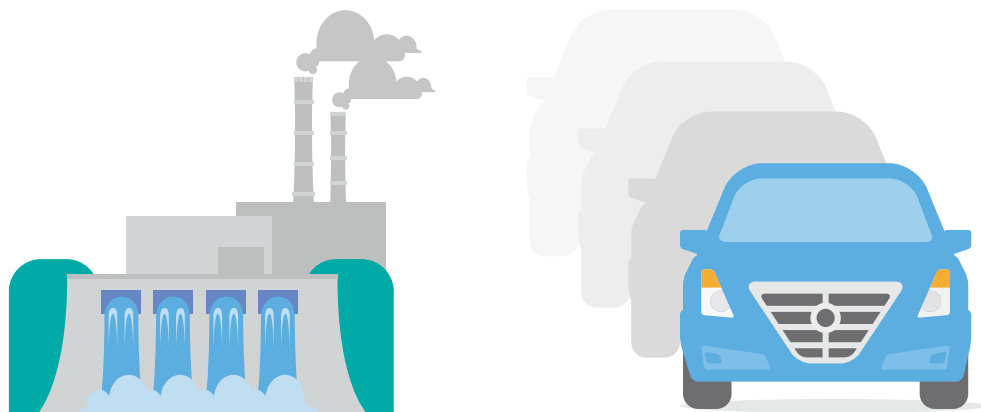


INDUSTRY 4.0

Within the last decade, **manufacturing** has undergone a dramatic transformation. The convergence of several fundamentally disruptive trends, including big data, advanced analytics, cyber-physical systems, smart connectivity, and the Internet of Things (IoT), has had such a profound impact on production processes and supply chains that analysts now say we're witnessing a fourth industrial revolution, or **Industry 4.0**.

Continuing in the traditions of the first three industrial revolutions – starting with mechanization and steam power, followed by mass production and assembly, and then computer-driven automation – the central concept of Industry 4.0 is the use of newly available technology. More specifically, Industry 4.0 focuses on the use of information technology, and its ability to automate, enhance, and streamline industrial applications.

Industry 4.0 has far-reaching implications, since the digitization and data analytics associated with information technologies can be applied to just about every aspect of operations. Using Industry 4.0 strategies and techniques, companies can create competitive advantages throughout the value chain, from raw materials and asset utilization to quality monitoring, inventory management, demand matching, and even aftersales operations, such as service, returns, and warranty support.



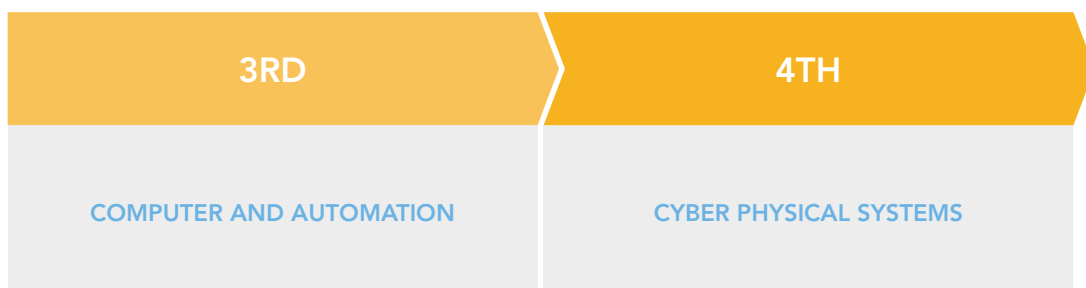
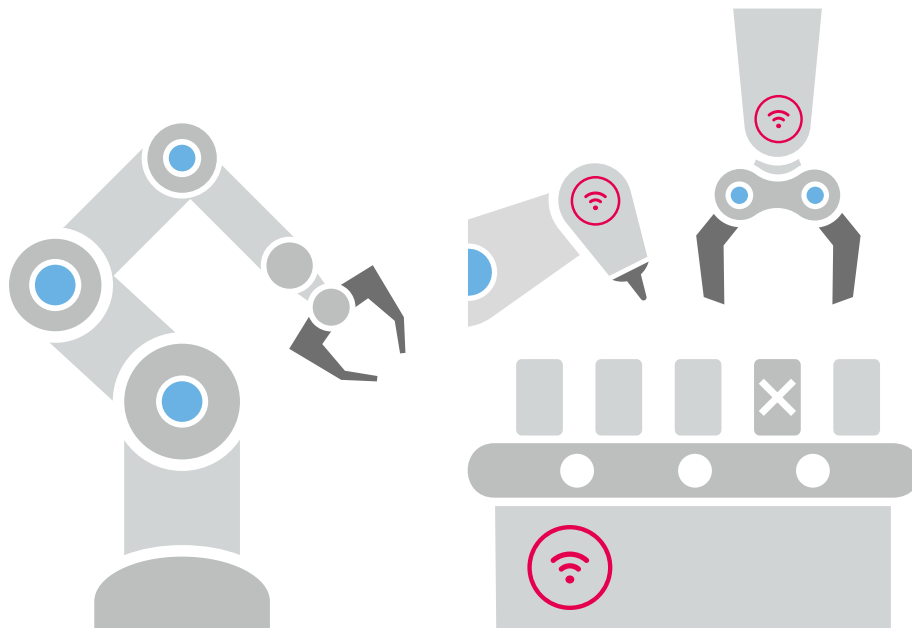
THE ISSUE OF DATA SECURITY

With all the promise of Industry 4.0, however, comes the challenge of how to manage and protect the data that is now so central to operations. Having every physical component of a smart factory, along with the people that interact with those components, become part of an integrated communication network can expose organizations to a considerable degree of risk.

The information that circulates in Industry 4.0 networks is both highly sensitive and highly valuable, so it's essential to use technologies that provide the highest levels of security while offering highest degree of flexibility.

RAIN RFID, which combines advanced track-and-trace functions with IoT connectivity, is one of those technologies. By assigning a unique identity to each tagged item, and using field-induced energy for wireless interaction with those items, RAIN RFID delivers a higher level of accuracy and efficiency, while enabling new ways to identify, locate, authenticate, and engage each item, anywhere along its journey from initial production to the final sale, and beyond.

This paper introduces the technical capabilities of RAIN RFID and reviews the many ways it supports Industry 4.0 strategies. We begin with a look at how the technology works.



Industry 4.0 uses cyber-physical systems to create smarter, more efficient workflows

THE RAIN RFID CONNECTION TO INDUSTRY 4.0

Radio Frequency Identification (RFID) has been used in the supply chain for nearly 50 years. That's because RFID readers and tags, especially those operating in the Ultra High Frequency (UHF) range, offer a cost-effective way to track and identify objects as they move from the factory to the warehouse and the store.

RAIN RFID takes item tracking to the next level, with added precision, speed, bulk-reading capability and security. Introduced as a standard more than 10 years ago and improved through several iterations since then, RAIN RFID uses protocols for the Electronic Product Code (EPC) data format, which gives every RFID tag a unique identity. RAIN RFID also lets data be stored, managed, and shared using an internet connection, which means tagged items can become part of the Internet of Things (IoT). (The name, which is an abbreviation for RAdio-frequency IdentificatioN, plays on the idea that the technology makes data drop down from the cloud, like rain into the sea.)





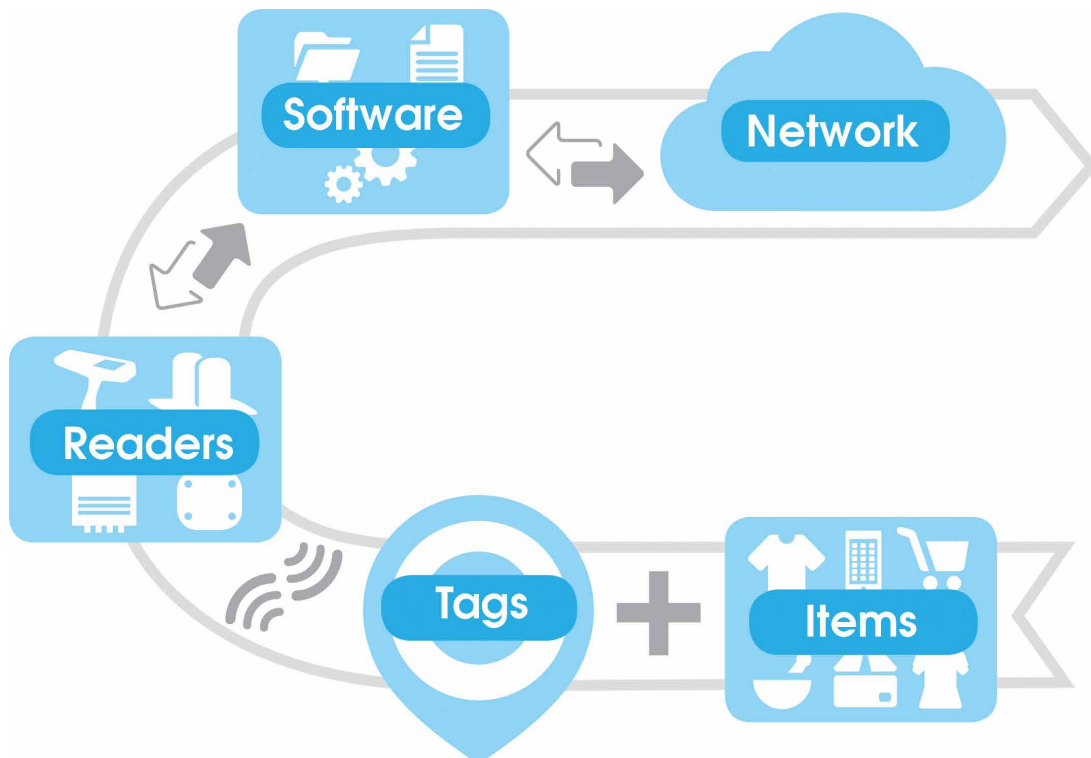
RAIN RFID lowers costs while raising efficiency

MANUFACTURED ITEMS JOIN THE WORKFLOW

Operating within the range of 860 and 960 MHz, RAIN RFID delivers a number of benefits throughout a product's lifespan. It lowers costs while raising efficiency, lets products become a part of the overall workflow, and delivers a higher level of security.

RAIN RFID is a passive wireless technology (meaning the tag can draw power from the reader and doesn't need to have a battery) and has a read range of several meters. Also, there's no need for the reader to have a direct line of sight with the tag, and the reader can identify many tags at once. This makes it possible to inventory lots of items at once, even if they're stored in a box or sitting as a group waiting to be processed.

RAIN RFID already connects billions of everyday items to the internet. It's been widely adopted in retail, where brand owners use RAIN RFID to identify, locate, authenticate, and engage each item. Not only does this streamline the supply chain and improve inventory management, it also reduces the impact of counterfeits and grey-market diversion, and overall makes tagged items an active part of operations, since tags can be easily read at any point throughout product lifecycle.



RAIN RFID makes tagged items an integral part of the workflow



ADDED VALUE FROM START TO FINISH

As part of Industry 4.0, **RAIN RFID** serves the entire product lifecycle, from the earliest stages of production to the distribution of finished goods – and even into the customer’s hands.



COMPONENT SUPPLY: ADDED SECURITY, EFFICIENCY

When materials and sub-components are being sourced, RAIN RFID makes it easier to identify items, verify their authenticity, and ensure they are stored and used most efficiently.

Incoming goods can easily be checked against the bill of delivery, to ensure shipments are in proper order before being accepted and stocked. Items can be verified for authenticity, before they’re accepted into inventory or before they’re used, so as to help combat counterfeits and maintain compliance with various standards, such as guidelines for automotive safety.

Items can be added to inventory more quickly and then located faster, with frequent checkpoints for automated scans. The ability to add information to each item, as it proceeds through the supply chain, makes it possible for items to “know” where they need to go, when they need to be used, and how long they can be stored.



MANUFACTURING: INCREASED INTELLIGENCE, FLEXIBILITY

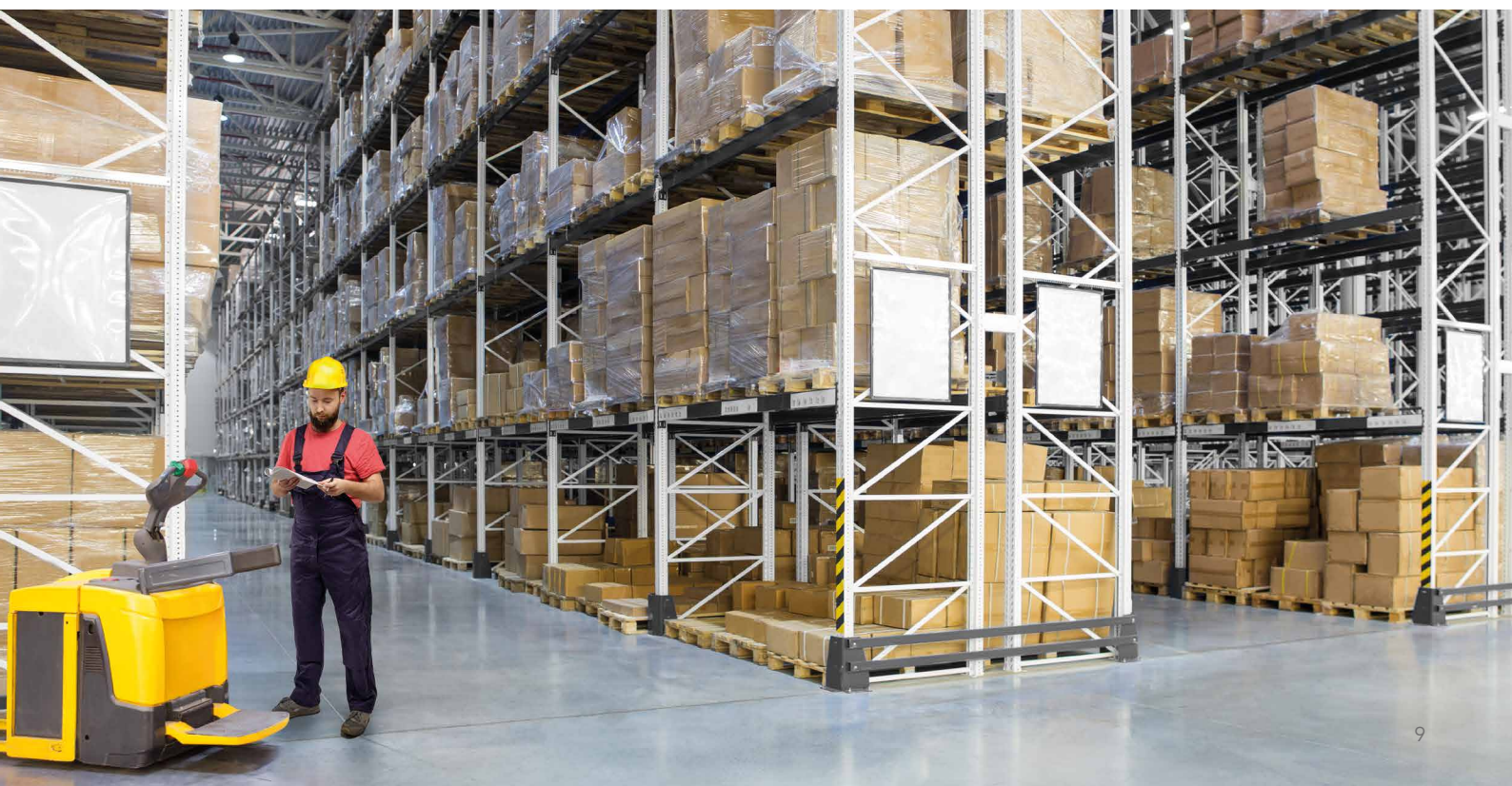
On the factory floor, RAIN RFID enhances automation, giving items the ability to instruct robots (or people) what procedure to follow, and letting them identify the proper tool before using it.

Incoming parts can be identified with a very high degree of accuracy, and can quickly trigger actions or load settings as parts arrive at a manufacturing station. Items can give machines specific instructions about what to do or where they need to go next. RAIN RFID tags can also help workers answer questions or verify settings, by linking users to manuals or reading out instructions before processing a part.

By enabling a higher degree of automation, RAIN RFID can help eliminate manual steps and the errors associated with them. Real-time identification of all work-in progress materials, along with process monitoring, drives the data analytics that support better decision-making, accelerates process optimization, and enhances quality control.

Replacement parts can be ordered automatically when stock levels reach a preset quantity, and critical assets can be inventoried at pre-determined intervals, to minimize workflow interruptions.

RAIN RFID is flexible enough to enable detailed variant management and customization down to single-unit lot sizes, for the ideal just-in-time and just-in-sequence production, and enabling the best combination of responsiveness and personalization. Secure authentication ensures only original parts are built into the finished product, and item tags can be updated to reflect the process of many components becoming a single unit.





FINISHED GOODS DISTRIBUTION: SIMPLER, SMARTER LOGISTICS

With the distribution of finished goods, RAIN RFID adds a new level of precision to item-level tracking, with real-time updates and the ability to know a given item's whereabouts and status at any given time.

The processes associated with goods moving in and out of industrial locations become faster and more effective, because items can be accurately verified and tracked in real time. Items become easier to find in inventory or as they move between warehouses or retail locations, and everything can be tracked throughout the entire supply chain. Older items can ensure that they go out first rather than being processed via first-in/last-out systems which are commonly associated with storages with poor inventory management.

Inventories at warehouses, distribution centers, and in stores can be monitored and replenished automatically, when stock levels go down, and retailers and their distributors can ensure that shelves are always adequately stocked with the most popular items. Items can record their progress at each point, and can provide details as to when and where they should go next, whether it's a shelf in the current warehouse or a distribution center in another country.

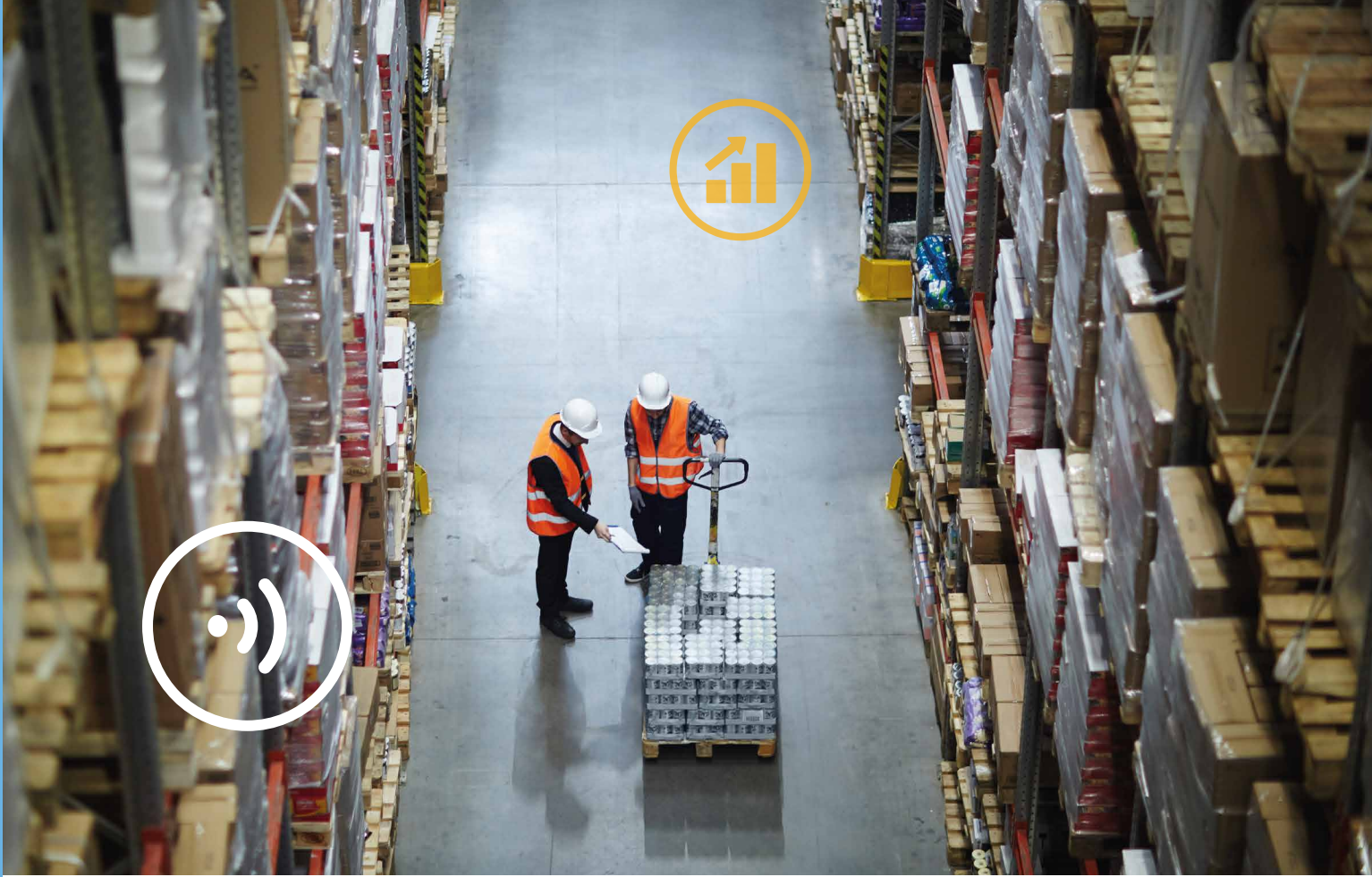
The supply chain becomes less vulnerable, too, as secure authentication helps combat counterfeits and makes it easier for customs officials and trade authorities to identify items that have been stolen or diverted into or from grey markets.



Honda North America reports **80% savings** on labor costs during peak new-model periods at a plant producing 1,000 cars per day.

Source: RFID Journal





AFTERSALES SERVICE: GREATER CONVENIENCE, RESPONSIVENESS

RAIN RFID can be used for late-stage configuration, for customization even after the product has been packaged, and can help simplify aftersales service calls, since the tag can help technicians troubleshoot problems and access item-specific information.

Aftersales service can be made more effective by attaching RAIN RFID tags to products at the point of manufacture. The tags let items track their own histories, for full traceability back to their origins, with details about all the steps in between. Having access to an individualized product history makes it easier to check warranty status or process returns, and helps answer questions should there be issues of provenance or concerns about how an item was processed.

Storing maintenance and repair data directly on the product reduces paperwork and enables predictive maintenance features, with real-time usage, and not the calendar, dictating when service calls should take place. The ability to verify authenticity ensures that fakes can't be returned as originals, and only eligible products are included in service contracts.

To protect consumer privacy, RAIN RFID also includes "untraceability" feature, which hides data until a tag is interrogated by an authorized reader. A sales clerk, for example, might use a reader with the untraceable privilege to scan a purchased product when it's returned for a refund or exchange.

RAIN RFID CAPABILITIES



IDENTIFICATION

Efficient, reliable readings,
without line of sight



TRACK & LOCATE

Real-time data, from source
materials to end user



TRACE

Detailed histories, from the
end user to the supplier



AUTHENTICATION

Secure, convenient methods
for establishing trust



PROCESS OPTIMIZATION

Eliminate manual steps,
increase productivity and
flexibility, prevent costly errors



LATE CONFIGURATION

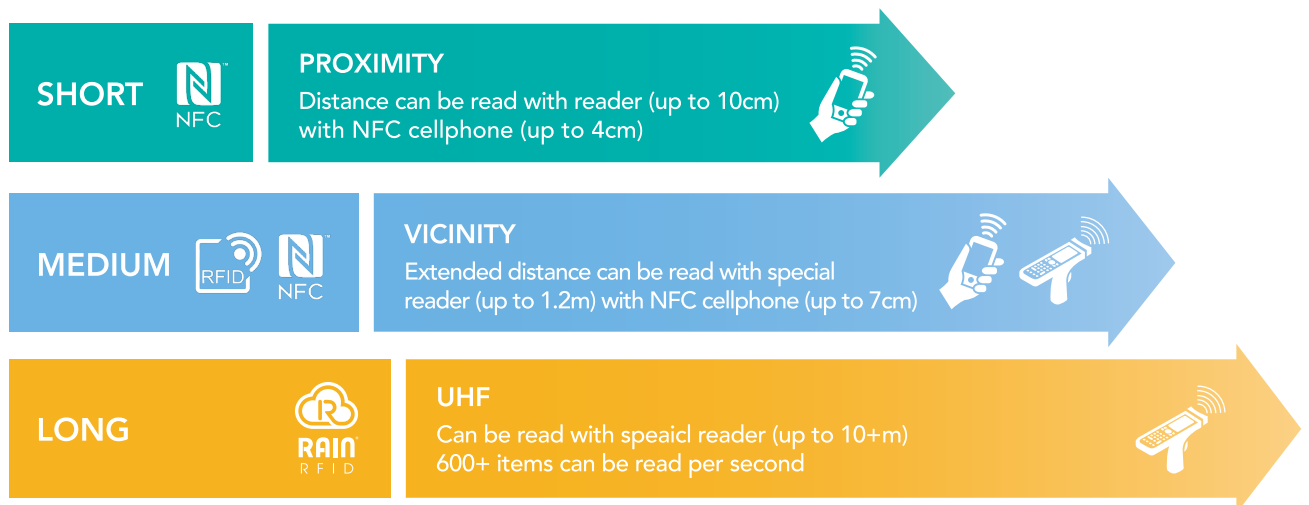
Engage items by loading regional
settings and other customization
data onto the product once
it's in the box



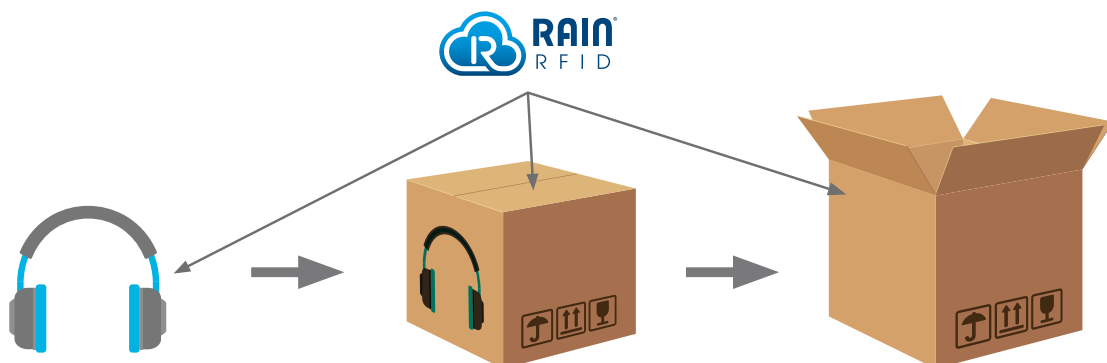
PART OF THE INDUSTRY 4.0 SPECTRUM

RAIN RFID is just one of several **wireless connectivity formats** used in contemporary manufacturing environments. The Industry 4.0 spectrum also includes wireless technologies that have become familiar in the consumer arena, such as Near Field Communication (NFC) and Bluetooth Low Energy (BLE).

Each wireless format has its own characteristics and features, and is best suited for a particular set of tasks. RAIN RFID, for example, in general has a longer read range and lower-cost tags than either NFC or BLE, but requires special readers to read the tags. NFC and BLE, on the other hand, have shorter read ranges, but can be read by most of today's leading smartphones and tablets, so there's less need to invest in specialized equipment. When it comes to reading a large number of items at once, though, RAIN RFID has a clear advantage, since it can bulk identify hundreds of items within seconds.



RAIN RFID offers the longest read range, and can read multiple units at once



RAIN RFID can read items individually or when packed for sale or transport

REPLACES OPTICAL FORMATS

RAIN RFID offers a level of **performance and interaction** that optical formats, such as bar codes, simply can't match.

As shown in the table, when compared to optical formats, RAIN RFID reduces or even eliminates the need for manual scanning, can read many more items in a shorter span of time, and can scan items in more situations, even when items are hidden from view or inside a package. RAIN RFID is equipped with memory, which can be updated or rewritten to create a more dynamic and responsive inventory process. What's more, RAIN RFID offers security features, such as authentication on an item level, that aren't available – or even possible – with optical formats.

	RAIN RFID	Optical Solutions
Automation	Highly efficient, automated scanning	Manual scanning or low-level automation
Speed	20,000 units per hour (ms/read)	450 units per hour (5-10s/read)
Convenience	Scan what's behind or inside	Scan only what you can see
Efficiency	Scan many at once	Scan only one by one
Intelligence	Dynamic data on chip memory	Static data on label
Security	Secure authentication on the item level	"Have to believe"

Daimler Germany reports a **saving of 8 seconds** (0.15 Euros of labor costs) per scan compared to barcodes

Source: RFID im Blick



RAIN RFID is also more flexible, in terms of form factors, than optical solutions. For example, the tags that identify items can be integrated into limited-use paper labels or reusable hard tags, or can be made part of the PCB in an electronic device. The reader mechanism can be built into a mobile, wirelessly connected device or a handheld reader, or can be built into a stationary gate that reads items as they pass by. The software associated with RAIN RFID functions can take the form of an application, stored on the reader device, can be made part of the backend system used in the enterprise, or can be part of the analytics algorithms used in the cloud.

Flexible Form Factors let RAIN RFID Support a Wider Range of Use Cases





REAL-WORLD RAIN RFID

LOWER COST: VEHICLE PRODUCTION

The Swedish car maker Volvo achieved significantly lower error rates at manufacturing sites in China and Belgium. Having moved from three legacy tags to one RAIN RFID tag, Volvo reports 99.96% reliability over the complete process, with more than USD 12 saved per car.

Source: Volvo

HIGHER AUTOMATION: AUTOMOTIVE BUMPER PRODUCTION

The manufacturers Magna, Rehau, and Valmet now use RAIN RFID in their production of automotive bumpers, which are supplied to likes of Audi, BMW, and Daimler. Valmet credits RAIN RFID with a higher level of automation and traceability, and Rehau updated their workflows to include a RAIN RFID tag on every bumper they make.



INCREASED EFFICIENCY: ELECTRONICS MANUFACTURING

When Jabil Circuits, the US-based manufacturing services company, added RAIN RFID tags directly to the PCBs they produce for international networking giant Cisco Systems, they found that production efficiency went up by roughly 80%.



THE NXP POSITION IN RAIN RFID



NXP is a **recognized leader** for RFID in general, and RAIN RFID in particular. The NXP brand of RAIN RFID, known as UCODE, is now in its eighth generation and delivers best-in-class features, speed, security, accuracy, and cost in Industry 4.0 applications.

Having shipped billions of units annually, and supplying to demanding and quality-oriented industries, such as automotive, NXP has gained a reputation for being a reliable, high-volume supplier. Building on a position of technology leadership, NXP continues to innovate in RFID, with new delivery formats, increased reliability in assembly, and lower total cost of ownership.

NXP currently chairs the RAIN RFID Alliance, the industry association that guides development of RAIN RFID, and is an active participant in the activities of other standards organizations, including GS1 and ISO. NXP's focus on security led the company to be an early supporter of UHF Gen2V2 and ISO/IEC 29167, which cover cryptographic security for automatic identification and authentication. NXP was also first to market with AES128 cryptography for RAIN RFID, in the form of UCODE DNA.

The UCODE portfolio reflects how NXP has optimized RAIN RFID for today's applications, with higher anti-collision rates to improve accuracy, higher sensitivity to extend read range, and wider frequency range, with EPCglobal compliance, to support worldwide use. Each UCODE family offers its own distinct set of features, with varying memory sizes, so it's easy to find the best cost-benefit match for a given application.

UCODE products are supported by a worldwide organization for design-in, with local support and a vast network of third-party partners. By supplying everything needed, from tags and readers to enterprise-compatible software and custom applications, the UCODE ecosystem helps developers save time while delivering innovative solutions.

To learn more about NXP UCODE and how RAIN RFID enables Industry 4.0, visit nxp.com/ucode.



Product Family	Best For	Highlights
UCODE 7, UCODE 8	Basic identification for track and trace	Unique 96-bit, pre-programmed serial number, best-in-class contactless performance
UCODE 7xm	Enhanced intelligence for dynamic interaction	Flexible (re)programmable memory: up to 2-kbit user memory and up to 448-bit EPC memory
UCODE I2C	Contact interface for late configuration	UHF RFID with a standard wired interface and 3-kbit user memory for configuration data
UCODE DNA	Secure authentication for establishing full trust	Crypto functionality with AES 128 keys: up to 2 keys and up to 3-kbit protected memory

