

# RFID IN THE SUPPLY CHAIN

End-to-end Guide

Curious about  
**Radio  
Frequency  
Identification  
Technology**  
and its  
potential to  
transform  
your business?



## ***What is RFID technology?***

RFID technology, radio frequency identification, is an automated tracking system that uses small asset tags to store and communicate data wirelessly.

RFID sensors, commonly referred to as RFID tags contain a microchip with a coiled antenna that emits radio waves intercepted by readers to gain data from the tag, such as serial numbers and other identifiers. This technology has grown increasingly popular over recent years due to its efficiency. It can provide quick information and support different processes that have not been possible with traditional methods.

## ***Is it similar to Barcode scanning?***

There is a misconception that RFID is like barcode scanning but it's not. When it comes to the barcode, the barcode reader and the object need to be in the line of sight to transmit the data but in the case of RFID technology the line of sight is not required, the object will be able to transmit its feedback to the reader within the range of the reader.

## ***How RFID systems are categorized?***

RFID systems can be categorized in several ways, the most common of which are by RFID frequency types and by whether the system is active or passive.

## ***RFID Frequency Types***

There are three RFID frequency types based on frequency range: low frequency, high frequency, and ultra-high frequency. The read rates and read ranges of RFID tags vary depending on frequency band uses.



Low Frequency (LF)  
RFID

30 KHz - 300 KHz



High Frequency (HF)  
RFID

13.56 MHz



Ultra-High Frequency (UHF)  
RFID

900 MHz +

## **Low Frequency (LF) RFID Systems**

These systems operate at frequencies between 30 KHz and 300 KHz. These systems are typically used for short-range applications such as control or inventory tracking.

Low-frequency RFID tags are relatively inexpensive, but they limit range and speed.

## **High Frequency (HF) RFID Systems**

These systems operate at a frequency of 13.56 MHz. These systems are typically used for longer-range applications such as supply chain management or asset tracking.

High-frequency RFID tags are more expensive than low-frequency tags, but they offer greater range and speed.

## **Ultra High Frequency (UHF) RFID Systems**

These systems operate at frequencies above 900 MHz. These systems are typically used for very long-range applications such as vehicle tracking.

Ultra-high frequency RFID tags are the most expensive type of RFID tags but offer the greatest range and speed.

## **How does RFID technology work?**

RFID technology is fundamentally a two-way communication between a reader and a tag via radio waves. There are two types of RFID tags: Active and Passive.

Passive RFID tags are the most common, which contain tiny electric circuits that allow data to be transmitted wirelessly when the passive tag comes in range of the reader. These tags do not have an internal power source and instead, draw energy from the reader that is scanning it to respond with its stored data.

When the RFID reader scans the passive tag by sending out radio signals, the tag responds by sharing its stored data which the reader then collects and delivers to the processing system (e.g., Warehouse Management System WMS).

Active RFID tags, on the other hand, do contain a battery and can actively send data over an extended time. These types of tags will cost more, but they possess greater reading ranges since they are not reliant on ambient radio waves to be energized, giving them greater mobility capability.

## Active RFID

Operate off their own power source

Ideal for tracking large objects or for applications where long range scanning is necessary.

## Passive RFID

Derive their power from the electromagnetic energy transmitted by the reader

Low cost applications such as a product tracking in retail environments.

## Benefits of RFID technology

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- Inefficient Operations
- Increased Risk
- Inaccurate Data
- Unmitigated Disruptions
- Higher Emissions
- Poor Relationships

### Increased Efficiency

One of the primary advantages of RFID technology is that it can help businesses to operate more efficiently.

RFID tags can be attached to Assets or Inventory, and businesses can use RFID readers to track the real-time locations of these items. This information can help businesses optimize their inventory management and supply chain operations and reduce costs.

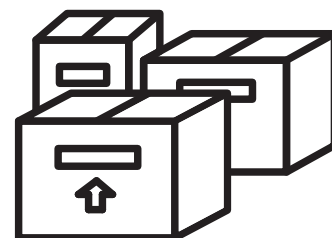


#### Assets are:

- Long Term Investments
- Typically Expensive
- Owned by the Business
- Managed for Productivity

#### Inventory is:

- A short-term Investment
- Smaller, Less expensive
- Usually purchased from Suppliers
- Managed for Profitability



- **Reduce Costs**

Another advantage of RFID technology is that it can help businesses to reduce their costs, for example, businesses can use RFID tags to track when products need to be replaced or serviced. Additionally, RFID technology can be used to automate such things as stock taking, which can lead to labor cost savings.

- **Improved Customer Service**

RFID technology can also be used to improve customer service. For example, businesses can use RFID tags to keep track of customer orders and ensure that they are fulfilled on time. Additionally, RFID tags can be used to track the location of products in a retail store, which can help customers find what they are looking for more quickly.

- **Enhanced Security**

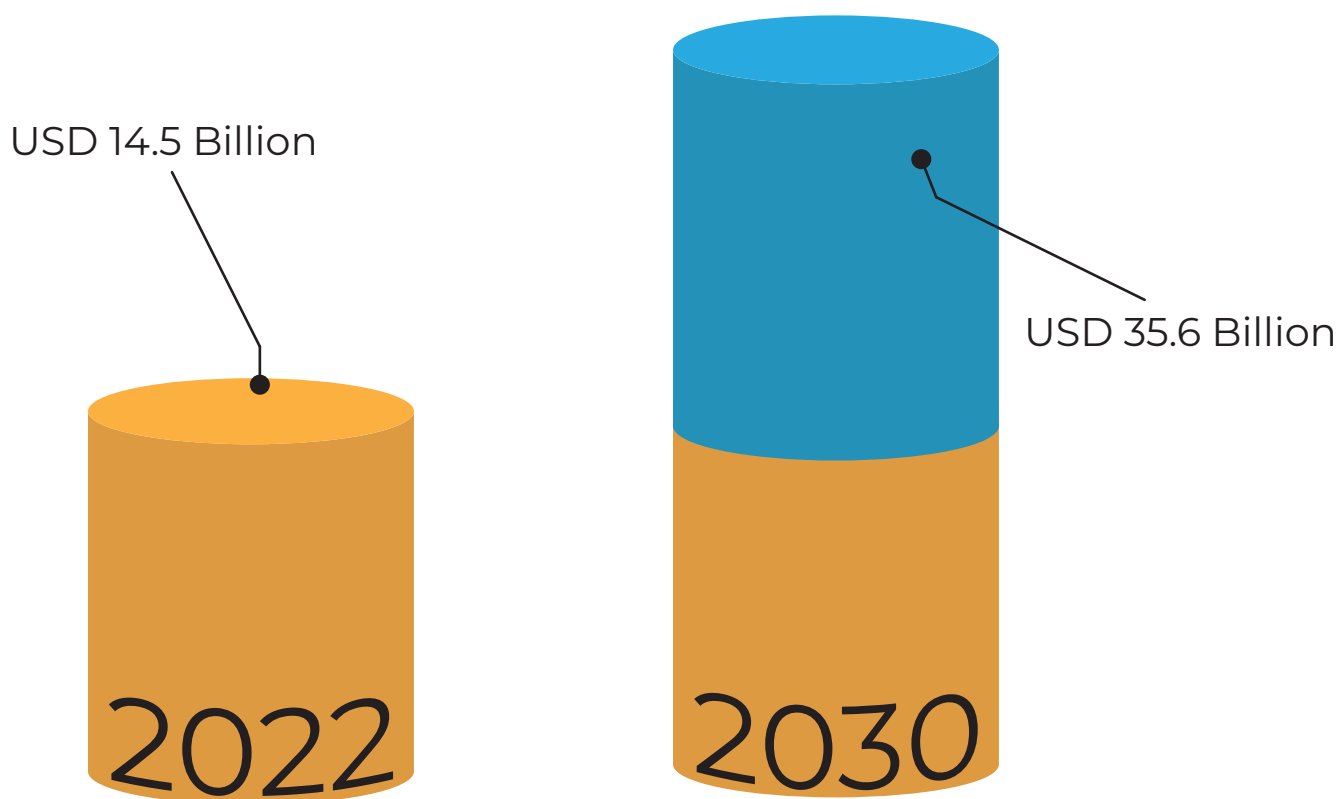
Another advantage of RFID technology is that it can help businesses to enhance security. Businesses can use RFID to track high-value assets such as equipment and tools. RFID tags can be used to track the location of employees in a building, which can help with emergency response planning.

- **Greater Sustainability**

RFID technology can also help businesses to improve their sustainability practices. For example, businesses can use RFID tags to track the lifecycle of assets and ensure that they are properly recycled or disposed of at their end-of-life, helping to reduce their overall carbon footprint.

# The Global RFID Market

The global RFID Market is projected to reach 35.6 billion USD by 2030 from 14.5 billion USD in 2022, it is expected to grow at a CAGR of 11.9% from 2022 to 2030.



## Key Market Drivers

The major key growth of the RFID market outlook is the healthcare, manufacturing, and warehousing industries.

## Increased Adoption in Manufacturing

The increasing adoption of RFID systems in manufacturing to improve productivity will boost market growth over the forecasted period. Manufacturing facilities must integrate specialized tools

and apply quality management methods to ensure predictive maintenance of equipment and systems and to monitor equipment conditions and performance, process flaws, and system failures. The management of plant assets using RFID technology aids firms in achieving this objective. A combination of RFID tags and scanners/sensors is the appropriate solution to manage and maintain the quality and output of the manufacturing process.



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### **Growing Demand in Healthcare will offer a Robust Opportunity**

The healthcare sector has a significant demand for RFID technology, which is driving the global market. A growing focus on RFID technology for patient tracking, surgery asset management, prescription verification and control, and

sorting medical equipment is boosting the market for RFID technology globally. The market for RFID tags in the healthcare sector is also being propelled by rising demands to lower operational costs, and rising worries about the safety and security of medications. RFID technology has great promise for improving supply chain effectiveness, upholding patient safety, and reducing human erroring medical procedures.

### **The Continued adoption in Warehousing and Distribution leads to growth**

The continued adoption of RFID technology in the warehouse and distribution sector has driven the growth of the technology. The need for agility and efficiency when identifying the products and inventory, and tracing and managing the products error-free in

each logistic phase offers the warehouse infinite possibilities. RFID technology has provided a wide variety of advantages for warehouses and distribution operations, by improving its processes and automation, leading to increased profitability.



# RFID in the Supply Chain Management

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Supply chain management is an essential part of any business. It's the process that ensures that the right products and materials are picked, packed, and delivered to the right places at the right times.

RFID technology is an effective way to manage supply chain processes.

## ***RFID in the Supply Chain Management***

- Inventory Management
- Condition Monitoring
- Enhancing Security
- Facilitating Compliance
- Asset Tracking
- Reducing Theft & Loss
- Optimizing Routing
- Process Automation

### • **Inventory Management**

One of the most common use cases for RFID technology in the supply chain is managing inventory. RFID Tags can be attached to products or packaging and then scanned to track the movement of goods throughout the supply chain, helping to improve inventory accuracy. This data can be used to optimize stock levels at distribution centers, identify bottlenecks, and improve overall efficiency.

### • **Monitoring Environmental Conditions**

RFID tags can also be used to monitor environmental conditions such as temperature and humidity. This information can be used to ensure products are stored in optimal conditions and that they are not damaged during transport.

### • **Enhancing Security**

In addition to reducing theft, RFID tags can also enhance security throughout the supply chain. RFID tags can be used to track the movement of dangerous goods, such as chemicals, and ensure that these items are not delivered to unauthorized locations.

- **Optimizing Transportation & Routing**

RFID can also be used to optimize transportation in a supply chain. The information can be used to track the location of vehicles and shipments and ensure that they are being routed efficiently.

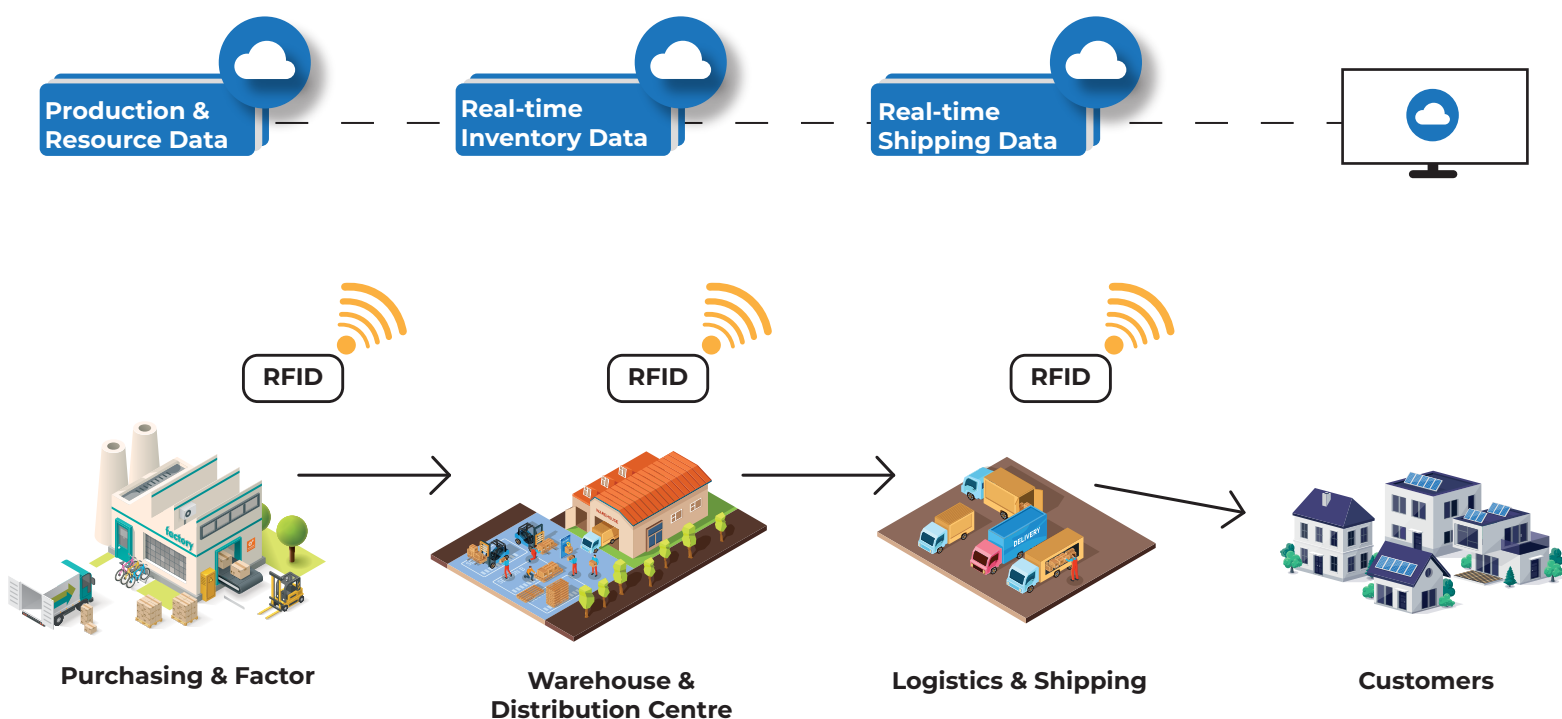
- **Facilitating Compliance with Regulations**

RFID enables compliance in the supply chain. This is because RFID tags can be used to track the locations of products, as well as the conditions in which they are being stored. This data can then be used to ensure that products are being handled following relevant regulations.

- **Automating Processes**

RFID tags can be used to automate various processes throughout the supply chain, such as stock management and order fulfillment. By Tracking the location of products in real time, businesses can automatically update inventory levels and trigger alerts when items need to be restocked or shipped out. Additionally, RFID tags can be used to automatically generate packing lists and shipping labels, reducing human errors, and saving time.

## ***How RFID in the Supply Chain Tracking Works***



## ***Automated Warehouse and Distribution network***

automated warehouse and distribution network.

RFID technology has the potential to automate the audit and piece-counting process for carrier drivers and warehouse employees. This provides automation potential with SKU data, to enable a fully

## ***Item-Level Visibility***

RFID technology allows users to have item-level visibility throughout the supply chain to prevent out-of-stock events and helps to prevent incorrect shipments.

## **The Benefits of RFID in the Supply Chain**

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RFID in supply chain management can provide many benefits over traditional methods.



## ***Automatic Data Collection***

One of the primary benefits of RFID technology is that it allows for automatic data collection. RFID tags can be read automatically, which means that data can be collected without the need for manual input. This helps to improve the accuracy of the data and reduces the amount of time needed to collect it.

## ***Real-Time Tracking***

RFID always allows for real-time tracking of assets. This means that businesses can always know exactly where their products are and how many they have in stock. Real-time information can be used to improve inventory management and also make sure that products are always available when customers need them.

## ***Reduced Costs***

Another benefit of RFID technology is that it can help to reduce costs. For example, tags may not need to be manually scanned as barcodes do, which can save labor costs. Also, RFID tags are more durable than barcodes, which means they will not have to be replaced as often.

## ***Increased Efficiency***

RFID tags can help to increase the efficiency of supply chain management by allowing real-time tracking of means inventory. This means that businesses can always know exactly the location of each product, which can help to reduce the amount of time and money that is wasted on lost or misplaced items. RFID can help to automate the process of inventory management, which can further increase efficiency.

## ***Improved Customer Service***

The increased accuracy and efficiency made possible by RFID technology can also lead to improved customer service. For example, when a customer orders a product, businesses can use RFID tags to quickly locate the product and deliver the product to the customer. Businesses can use RFID tags to keep track of customer orders and ensure that they are delivered on time.

## ***Greater Visibility***

RFID technology allows for increased visibility throughout the supply chain. RFID tags can be used to track the location of inventory in real time, which allows managers to quickly identify any potential problems or delays so that they can work with their supply chain partners to address any issues. This data can be combined with other data sources like demographic data. RFID can be used to create flexible and scalable supply chain management solutions that can be adapted to changing business needs. RFID tags are becoming affordable, and more widely available, making RFID an increasingly attractive option for supply chain management.

## **Challenges of Implementing RFID Technology in the Supply Chain**

RFID technology has the potential to revolutionize supply chain management, but implementing RFID systems can pose several challenges. One key challenge is managing the data generated by RFID tags. Unlike barcodes, which simply store a product's identification number, RFID tags can store a wealth of information about the product's history, location, and condition. This data can help manage inventory and track shipments but can also be overwhelming.

One other challenge is ensuring that RFID tags are read consistently and accurately. RFID tags can be blocked by metal, liquid, or dirt, and they often need to be positioned just right to be read properly. This can make it difficult to track products throughout the supply chain. Despite these challenges, RFID technology offers many benefits that make it worth exploring for any business that relies on supply chain management.



# RFID in the Healthcare Industry

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The global medical Internet of Things (IoMT) market which includes RFID technology is expected to grow from 72.5 billion in 2020 to 188.2 billion by 2025 at a CAGR of 21%. IoMT is popular for remote patient monitoring, hospital asset tracking, medical staff location tracking, and more. It enables uninterrupted real-time monitoring and helps automate care delivery operations and administrative tasks and ensures secure patient stay at hospitals.

## **Connected Medical Devices will be Central to Delivering Value and Efficiency for Healthcare Providers**



# Uses Cases for RFID in Healthcare

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## ***Medical Asset Tracking***

Equipped with RFID tags, all medical tools (Disposable, and /or reusable) and durable assets (Beds, medical equipment) are monitored in the IoT tracking system to ensure their availability. The information on their location can be tracked by the medical staff using a mobile or web application with a facility map.

## ***Medication Inventory Management***

RFID-enabled medication inventory tracking enables hospitals to timely spot medication shortages and expirations, prevent theft, and ensure the intended use of medication (Due to the use instructions stored in the tracking system).

## ***Patient Tracking***

RFID tracking helps medical staff to pinpoint the location of any patient in the hospital to ensure their safety and sustain the care process. Patient tracking is especially relevant in neonatal units, Pediatric departments, Mental facilities, or for tracking Geriatric Patients.

## ***Medical Staff Tracking***

Medical specialists wear RFID-equipped bracelets or badges and their locations and interactions are displayed for medical supervisors in IoT tracking software. This data helps the supervisors find the doctors or nurses in the case of emergencies, identify bottlenecks in hospital workflows (e.g., lack of doctors in the ER), reduce workflows, etc.

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## ***Hospital Visitor Tracking***

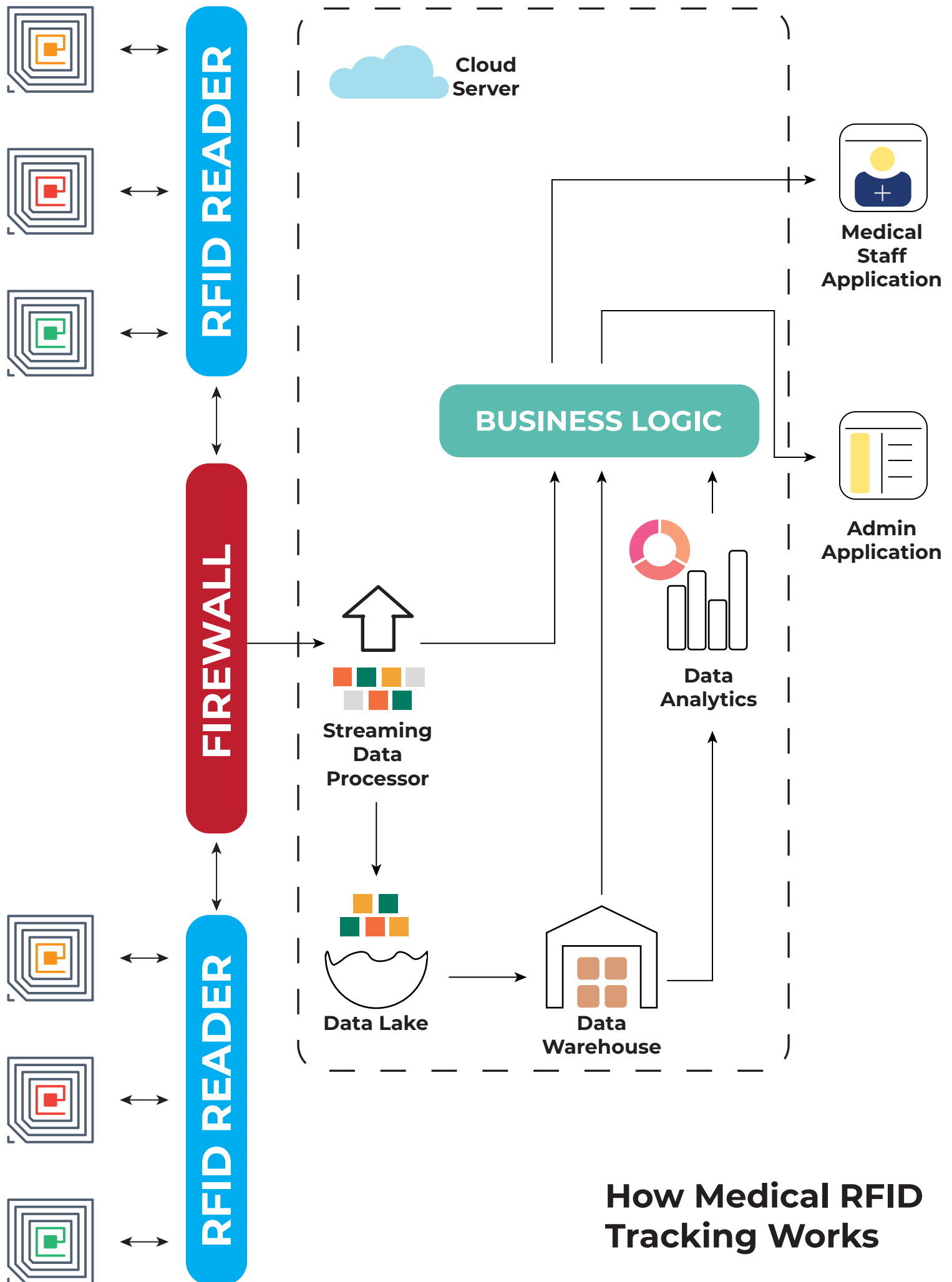
Hospitals can track visitors' locations to ensure the safety of the patients, prevent visitors from accessing the surgery rooms or inventories, etc. Visitors are linked

to patients and if the visitor is not near the patient or in the hospital common area, an alert is sent to the hospital security.

## ***Prediction of Patient Flow and Hospital Admission Rates***

Data accumulated in the RFID tracking system is analyzed to help hospitals predict patient flow, plan medical supply and equipment purchases, and identify the hospital's overall load, the load of its departments, and individual doctors

and nurses. Based on the analytics insights, the hospital management can Adjust staff workflows patient treatment schedules, surgeries plan, etc.



## How Medical RFID Tracking Works

- RFID Tags (Active or Passive) Attached to or embedded into hospital assets or tracking bracelets/badges for patients, visitors, and staff and transmit information on their location to RFID readers.
- RFID Readers Located in hospital corridors, wards, etc., identify the location of RFID tags and send this data to the cloud gateway.
- Firewall To securely transmit collected data to the cloud server.
- Streaming data processor to transfer the input data about hospital assets.
- Data lake to store the data about tracked patients, staff, and hospital assets sent by RFID tags in their original format.
- Big data warehouse to store filtered and preprocessed data for further analysis of hospital staff workflow efficiency, movements of patients, medical asset utilization, etc.
- Data Analytics to identify patterns and tendencies in hospital asset use and movements of tracked people and provide insights aimed at improving asset availability, medical staff schedules, and patient safety.
- RFID tracking software business logic to process hospital assets requests and high-priority events (e.g., the patient leaves the hospital premises without being discharged), provides information on the location of patients, visitors, and staff members.
- Staff application to enable the medical staff, equipment technicians, etc., to view locations of hospital assets and request them for use, get information on patient location, and get alerts on unusual patient or visitor behavior. The application also helps supervisors view the locations of each hospital unit employee and get insights on workflow optimization.
- Admin application to view the list of monitored assets, tracked patients, visitors, medical specialists, and information about them, add new assets, and staff members, edit key data about tracked items and people, grant access to assets tracking system for the medical and administrative staff.

# The Benefits of RFID Technology in Healthcare

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## ***Patient Safety***

Although the healthcare industry accounts for a large portion of the economy, at its core, it is about saving lives, and RFID tags and sensors are helping to make a critical difference in this regard.

- Wrist bands utilizing RFID chips enhance safety via point-of-care scanning which facilitates retrieval of a patient's medication and meal scheduling, prescribed medicines, and the patient's medical history. With just one scan potential errors are reduced.
- RFID tags embedded in devices for replacement surgeries such as those involving hips and knees can reduce the potential for infection.
- Wrist bracelets utilizing RFID tags connect newborn infants with their parents and help medical personnel to monitor the infant's safety from possible unauthorized removal.
- Worry of one patient encountering another who has a severe contagious infection is remedied through a screening made possible by RFID technology.

## ***Inventory Control***

RFID technology is helping to ensure medical facilities have the equipment, devices, and medicines on hand and

available through advances in inventory control and management.

- Medical facilities save millions of dollars through RFID-assisted advances in asset management.
- Control of inventory for critical devices ranging from heart pumps to bedpans is made efficient through RFID technology.
- Medical supplies including prescription drugs are ordered, sorted, and tracked via RFID, ensuring more reliable flows and positive results for patients.

## ***Quality Control***

No matter how advanced the inventory control system is, a comparable advance in quality control is required to better

serve the medical facility and its patients.

- The right medication must be administered in the correct dosage to achieve desired results. RFID helps to ensure this through tags that provide medical personnel with the information they need to make correct decisions.
- One field in which RFID technology is making large inroads is organ donor processes. RFID tags placed on corpses in morgues and medical examiner offices allow for an automated record accessible to a specialist who performs transplants. This allows them to better determine the viability of organs available for transplant, potentially increasing the number of life-saving transplants performed.

## ***Monitoring Critical Systems***

Throughout the healthcare industry, much life-saving technology exists around critical systems involving everything from medical devices, surgery

equipment, and instruments to refrigerated environments.

- RFID tags reduce errors in the laboratory process. Better tracking of lab equipment like slides, test tubes, and blood vials promotes efficiency and better inventory control.
- One essential area where RFID technology has proven to be effective is in instruments and equipment associated with surgical procedures, both large and small. This helps not only in proper accounting for instruments and equipment but also ensures nothing is left inside the patient during surgery.

- One noteworthy example where RFID technology has brought about vital improvements in processes is those related to refrigerated storage environments utilized for monitoring and tracking samples of blood and tissue, or those medical devices with expiration dates, all of which require specific storage temperatures. This RFID technology is found in many facilities including research where human tissues and cancer elements can be safely monitored and stored.

## **Personnel Management**

It's no surprise that even in medical personnel RFID technology is making a positive difference in healthcare departments, and individual doctors.

- Whether it be tracking medical staff members to ensure availability, to ensuring hygiene standards, these advances translate to more efficient use of manpower.
- One example of this is in surgery where nurses, due to RFID, are freed from physically tracking and counting surgical instruments and equipment and are better able to assist surgeons.

## **The Future of RFID Technology in Healthcare**

As with all technology innovation and improvement in RFID will continue, further expanding its capabilities and scope. While it is true that some healthcare facilities have historically been hesitant to adopt RFID technology, it's clear that this sentiment is changing, particularly following the unique industry-altering pandemic.

Continued technological advancement combined with an increase in industry adoption, marks an important tipping point for RFID technology in healthcare. This industry-altering shift will lead to increased opportunities for RFID and significant improvements for all, from hospitals and health systems to distributors and manufacturers to patients.



# How is RFID revolutionizing the manufacturing industry?

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Manufacturers are aware of the benefits radio frequency identification (RFID) can bring to the supply chain, but they often overlook the technology's opportunity in manufacturing processes. RFID can address numerous manufacturing challenges, including security, quality control, production execution, and asset management. When implementing the technology in a manufacturing environment, however, the key is not the tag, the reader, or part identification. Rather it's the data that can be obtained. The objective is to use RFID to become a data-enabled enterprise. A manufacturer that obtains data and uses the information to further its competitive edge.



## ***Uses cases for RFID in Manufacturing***

RFID tracking tags can enhance tracking in production even in the harshest environments. It can withstand intemperate conditions typically found

in factories, including extreme heat, high pressure, and hazardous elements.

While most manufacturers appreciate the importance of **RFID**, **MANY DON'T TAKE FULL ADVANTAGE OF THE DATA IT GENERATES.**

## ***Advancing Production Execution***

Critical industrial applications require the right materials, tools, and labor to be readily available without compromises.

RFID technology can provide factory operations with necessary product execution information in real time.

With read-write passive tags, you can monitor, configure, or modify production steps to match various project requirements. Custom projects can have RFID stickers programmed with project specs.

Workers at the different stations will read the details and implement the instructed steps.

## ***Supporting Inventory Management***

Another application in manufacturing is RFID inventory management. Taking inventory manually can be tedious, inaccurate, and time-consuming.

Passive RFID tags can eliminate hand scanning, resulting in a notable improvement in inventory tracking.

RFID technology can also achieve lean manufacturing by maintaining low inventory and reducing wastage. Without a picture of the work in progress (WIP) requirements, you may resort to bloating your warehouse to take care of unpredicted situations.

An RFID inventory management system can increase the visibility and tracking of inventory in a factory.

## ***Enhancing Equipment Efficiency***

For an industrial facility to run at optimum levels, all machinery and equipment should run without major failures.

It calls for prompt maintenance, repair, and overhaul attention. Modern manufacturing plants are highly automated. They rely on computerized maintenance management systems for insight into when to inspect, repair, or replace the equipment.

Passive RFID tags can collect accurate and timely data about the health of your equipment. They can provide detailed information regarding the usage, cleaning, and maintenance history.

## ***Quality Control***

RFID in manufacturing can support processes that demand excellent quality. It may be the solution when you must

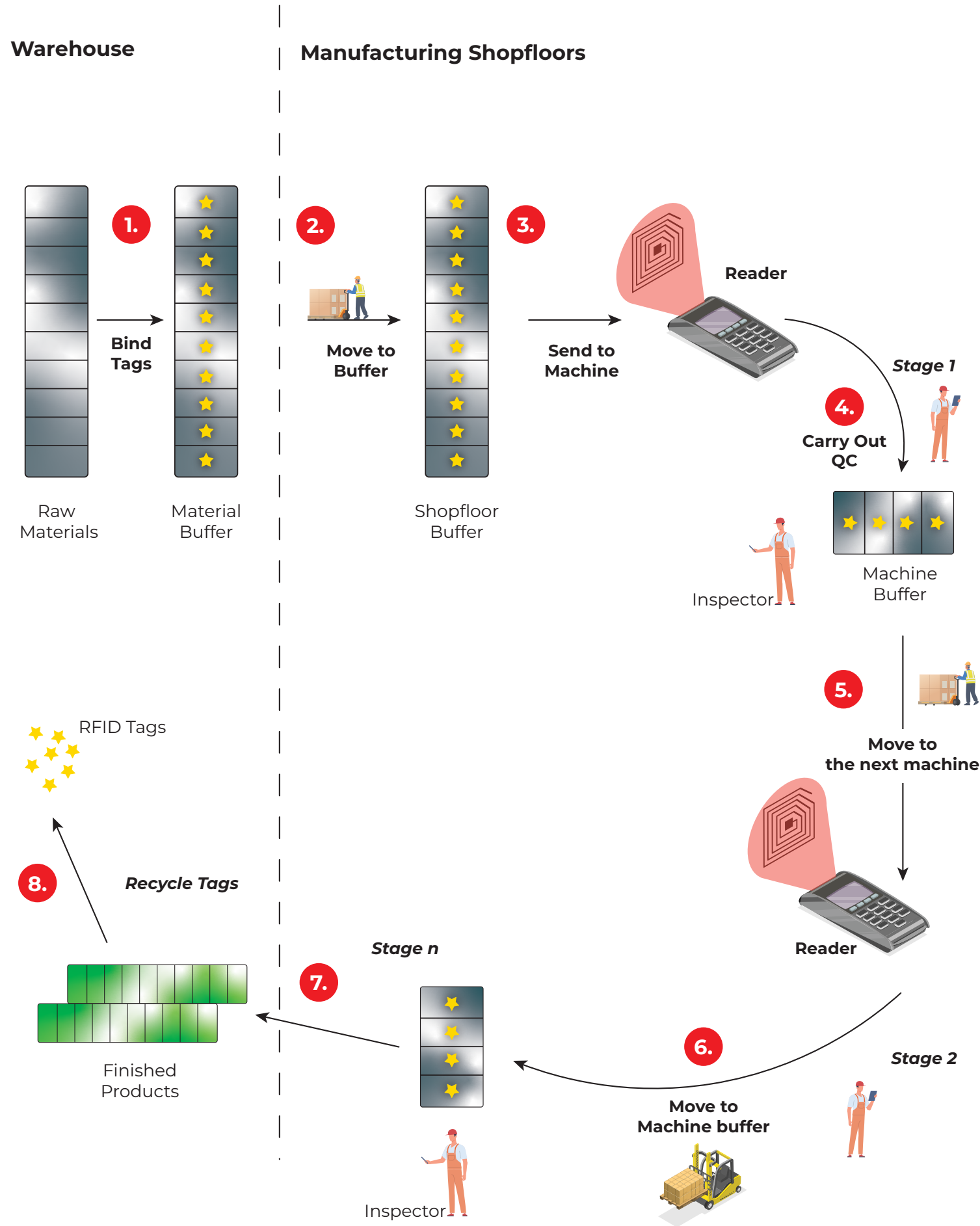
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## ***Tracking in Challenging Sites***

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# How RFID in Manufacturing Works



## ***Automate your Processes and Gain Better Control of Production***

RFID is a cost-effective way to track components or materials through the production process and ensure they are in the right place at the right time. By attaching RFID tags to components or batches of raw materials, you can track their progress along the production line,

check how long they have spent at any stage, and ensure they have completed all the required steps.

## **The Benefits of RFID in Manufacturing**

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## ***Operational Benefits***

It does not matter what area of manufacturing you are working in, having to do stock or inventory checks is tedious, and frankly, the traditional

method can be a waste of time. Having a way to scan a whole room or sections of a warehouse efficiently and automatically is significantly easier and more productive. Allowing you to spend valuable time on more important tasks.

## ***Supply Chain Visibility***

Having an increased level of visibility in the whole supply chain has its benefits, helping with resource management, reducing errors, and planning.

One of the major issues traditionally with the supply chain is the fact that huge portions of it can be shrouded with disorganization that presents issues along the way, RFID technology helps alleviate those issues.

## ***Asset Tracking***

With RFID technology everything from the smallest component to a complete automobile can be tracked.

## ***Reduces Errors***

By creating a more visible chain from start to finish you can identify patterns or highlight issues, pinpointing where they occurred.

For instance, shipping volume errors can be eliminated by knowing the exact amount of assets being shipped.

## ***Controlled Environment***

Information provided by the addition of RFID technology in manufacturing creates a much more controlled environment and makes its management

similar. Putting this into a real-life scenario will allow you to have access to data such as instant inventory checks, or if there has been a production error.

## ***New Layer of Security***

Having a system that can streamline operations and double up as a form of security is the perfect example of “two birds, one stone”.

Having stricter control over your products and raw materials, you can limit internal and external threats, in addition to tracking your assets and destination.



# What is the Future of RFID Technology?

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Analysts have been predicting an explosion of RFID technology adoption for the past decade; however, the market has grown slowly and steadily. Experts also anticipate the rapid growth of RFID technology used in the Pharma industry for anti-counterfeiting applications. Along with wider adoption, new technologies will help make RFID more reliable and cost-effective for a larger number of applications.

Innovative manufacturing will create durable and versatile tags. These advancements in printed electronics will help create new classes of extremely thin, flexible RFID tags that will be combined with printed sensors, printed batteries, thin film photovoltaic solar cells, and other technologies. Some companies are working on 3D printing technologies that would enable the direct printing of electronics in products as they are rendered.

**A new antenna design could increase range.** The key to RFID tag performance is the antenna design. It's the antenna that determines where and how a tag can be used, and how well it will perform. Over the next few years expect to see new antennas and inlays as the competition for RFID heats up. This will help in building better solutions to get around refractive and absorbent materials.

**Increased memory will create smart tags,** by building intelligence into the tag, by extension, the asset being tagged is another key activity. Expect tags with more memory at a lower cost to enable these "smart asset" applications. High-value assets will be an early application for this technology, as the cost of those assets will make it easier to amortize the increased cost of more robust tags, this could be very promising for security applications where it might make more sense for inventory to track its own attributes rather than distributing that information across a computer network.

## ***Final Thoughts and Takeaways***

RFID can potentially enable a whole host of new applications in warehousing and logistics, manufacturing, healthcare, and other sectors, but one stumbling block has always been the management of the data flowing in from thousands of tags. With cloud-based applications and services taking the heavy lifting of IT support away from the point of activity, companies can deploy

centrally managed and centrally available solutions without the traditional support and development costs. Cloud-based applications enable coordination from anywhere, allowing for real-time updates on inventory across global supply chains, making just-in-time production possible across borders.



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Our customer-centric approach is reflected in the long-term relationships we build with our clients. This commitment to excellence has earned Ahearn & Soper a reputation for reliability and trustworthiness and made us a preferred partner for businesses of all sizes.



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