



NO MORE LOST BAGGAGE:

RAIN RFID and **R753** will help airlines
save money while improving service

NXP



A new IATA regulation, called **Resolution 753 or R753**, imposes a stricter standard for baggage handling, to be implemented by June 2018. Today's barcode systems will struggle to meet the requirements of R753, but RAIN RFID supports all the steps in the R753 process. This paper looks at how RAIN RFID drives down costs and improves customer service while meeting the requirements of R753.

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WHERE'S MY BAG?

Waiting at the **luggage carousel** can be an anxious time for airline passengers, since there's often that momentary doubt, before the bag arrives, that maybe it's been delayed, damaged, lost, or even stolen.

As it turns out, though, there's fewer reasons for passengers be anxious about their luggage, since bag mishandling rates are at historic lows. In their 2017 report on baggage, the aviation technology group SITA found that the air transport industry has already cut the number of mishandled bags by 69.7% globally since 2007, even though passenger counts have continued to go up.

The aviation industry's largest trade group, the International Air Transport Association (IATA), reports similar progress in mishandling rates. In 2016, they found that more than 3 billion bags were checked in, but only 5.74 bags were mishandled per thousand passengers, yielding a mishandling rate of just 0.57%.



WHY MISHANDLING RATES HAVE IMPROVED

What's led to this **dramatic improvement in mishandling** rates over the past decade or more? Two things stand out in particular: barcodes and loop tags.



BARCODES

Airlines have been using barcodes, printed on the bag's destination tag, since the early 1990s. Inspired by the supply-chain and inventory-control benefits that barcodes brought to the retail and manufacturing segments, airlines have standardized on barcodes as a way to track a bag's progress from check-in to retrieval. Each bag is assigned a unique code, and that code is scanned by readers at key points to ensure the bag gets where it needs to go.



LOOP TAGS

The barcode is typically printed on a loop tag, which is a tag made of special tear-resistant material and coated with an adhesive backing that distributes force over the entire width of the tag. Loop tags are easy to apply yet difficult to detach, so the barcode has a better chance of staying attached to its bag. Recent research from Intermec, a producer of loop tags, shows that only 3% of all lost bags involve detached tags.



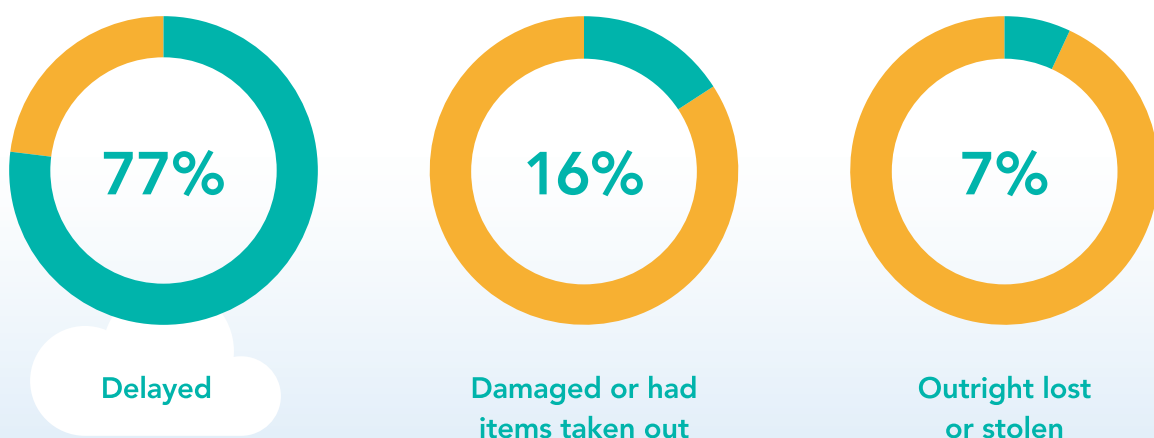
COSTS ARE STILL HIGH

But even though **barcodes and loop tags** have helped bring mishandling rates to all-time lows, problems with bags still represent a significant cost to the industry. Every bag that is somehow misdirected, damaged, or lost is expensive, in terms of the harm it does to customer loyalty and the actual cost to the airline of making things right. Airlines report that lost bags cost them as much as **USD 100 per bag**.

In all, the IATA estimates that the overall cost of mishandled bags reached USD 2.1 billion in 2016. Research from SITA confirms the annual rate of over USD 2 billion a year, finding that, over the ten-year period between 2007 and 2016, bag mishandling cost the air transport industry over **USD 27 billion**.

Adding to the concern of present-day costs is the fact that more people are traveling. SITA reports that 3.77 billion passengers enplaned in 2016 and predicts that the number of passengers will double within the next 15 years. Industry baggage systems expect to handle over 4.5 billion bags in 2017, and the increase in travelers means more checked bags. Even if mishandling rates stay at their present lows, the cost of delayed and lost baggage will increase simply because more bags are checked.

WHAT'S HAPPENING TO MISHANDLED LUGGAGE?



Transfers between flights cause **nearly half** of all **bag mishandling** episodes

Source: SITA 2017





BARCODE LIMITATIONS

Looking ahead, and keeping in mind the **expected increases** in baggage handling, industry experts are concerned that barcodes won't be able to keep up. Although barcodes were instrumental in lowering mishandling rates when they first arrived, the **technology is reaching its limit**. That's because barcodes are held back by the slowness and inaccuracy of their reader technology.

Bag tags printed with bar codes are read either by a hand scanner or an in-line array that's part of the baggage conveyor system used at check-in. As each bag passes by the reader, it's scanned for data. For a successful read with an in-line array, the barcode needs to be presented cleanly, without wrinkles, scoring, or other damage, and needs to be clearly visible to the reader, with direct line of sight.

These conditions can be hard to meet, with the result that read rates of in-line arrays can be frustratingly low. The general expectation is that in-line arrays have a read rate of about 85%, but some airlines report experiencing rates as low as 60% or 70%. In other words, as many as a third of all bag reads are likely to involve some kind of error. Each bag that the in-line array can't read properly needs to be diverted and read manually, and that adds labor and introduces delays.

THE ARRIVAL OF R753

The need to have more data to better handle baggage and the desire to minimize the cost of bag mishandling are two reasons why the IATA has issued Resolution 753, or R753, a **standard for tracking baggage** in baggage handling operations. R753 requires that all of the IATA's 275 member airlines – covering 83% of total air traffic – meet the specified guidelines by June 2018.

R753 is designed to address the complexity of today's luggage logistics. Even the simplest of air journeys now involves multiple steps and several different groups. A single bag passes through many hands, and is processed by people from various organizations, ranging from airlines and security screeners to ground handlers, third-party partners who prepare flights, and transport agencies. R753 gathers data at key points, documents what happens during key handoffs, and makes all this information available in real time.

As part of the **R753** process, IATA member airlines must do the following:

- Demonstrate delivery of baggage when custody changes
- Demonstrate acquisition of baggage when custody changes
- Provide an inventory of bags upon departure of a flight
- Be capable of exchanging data about these events with other airlines as needed



To support these actions, **R753** mandates that airlines assign a unique, **10-DIGIT BAG-TAG NUMBER** to each checked item, and then must track the following data:

- Acquisition of the bag from the passenger by the member airline or its agent
- Delivery of the bag onto the aircraft
- Delivery and acquisition of the bag between members or their agents when custody changes between carriers
- Delivery of the bag to the passenger



While barcodes can track the data required by R753, the reality is that barcodes are likely to be too slow, too unreliable, and too inaccurate to make R753 work cost effectively. In terms of technology, the R753 guidelines reflect nearly a decade's worth of work in baggage tagging standards, and incorporate recommendations from the IATA's 2005 standard on the use of wireless technology for baggage handling.

Although the IATA doesn't specify a wireless standard to be used in meeting R753 guidelines, the industry is moving toward RAIN RFID as a cost-effective way to implement R753-compliant baggage systems. The IATA has done extensive research on RAIN RFID and has recommended its use in other airline applications. The IATA has even issued its own definition of RAIN RFID, using C1G2 UHF and known as RP1740c, so the air travel industry can standardize on the technology.



RAIN RFID FOR R753

There are a number of reasons why **RAIN RFID** is an ideal choice for R753 compliance. To begin with, it's a proven wireless technology that's been used in assembly lines, inventory control, supply chains, and livestock management for several decades. Defined for operation in the UHF band, between 860 and 960 MHz, RAIN RFID is known for its ability to provide end-to-end tracking with real-time location, for reduced costs and greater efficiency.

Now, with the arrival of the Internet of Things (IoT), RAIN RFID is connecting to the cloud, and enabling new kinds of supply-chain and logistics applications. One of the fastest-growing RAIN RFID applications is in retail, where it offers a fast, accurate, and flexible way to identify, locate, authenticate, and engage lots of items.

RAIN RFID is a passive wireless format, meaning the tag placed on an item doesn't need its own battery to operate. When a reader is within reach, the tag uses energy provided by the reader to transmit and receive small amounts of data. This lowers the cost of the solution, and reduces the complexity of its implementation. Economies of scale have brought down the price of RAIN RFID, to the point where it's now a viable option for bag tags, too.

A 2017 report from SITA, a leading specialist in air transport communications and IT solutions, states that for as little as ten cents (USD 0.10), a RAIN RFID chip embedded in a bag tag can improve accuracy while generating a saving of twenty cents (USD 0.20) per passenger. That's a significant return on investment, and the numbers add up quickly. Looking at only the error rates during transfers between flights, when 45% of mishandling incidents occur, RAIN RFID offers the potential save more than USD 3 billion over the next seven years. Improvements at other points in a bag's journey will only add to the savings.

"Resolution 753 provides the data that baggage operations need to continue to reduce mishandling and increase cost effectiveness. RAIN RFID is a strong enabler of resolution 753"

Andrew Price, IATA



THE RAIN RFID SETUP



The **RAIN RFID** setup for an R753-compliant bag-tagging system involves tags and readers supported by enterprise software.

01

RAIN RFID TAG



The tag can be disposable or designed for repeated use. The inlay of a tag IC is mounted on a substrate, along with an antenna. The antenna uses **passive RF techniques** to harvest a small amount of energy from the reader when it gets within range, and uses that energy to transmit and receive data. For a printable bag tag, intended for one-time use, the tag IC and its antenna are placed between the loop label and its adhesive backing. To create a reusable luggage tag, the tag IC and antenna are placed in a plastic card, similar to a smartcard or ID card.

02

RAIN RFID READER

The reader scans tags and provides the energy necessary for tags to communicate data. Unlike a barcode reader, a **RAIN RFID reader** does not need line of sight for an accurate read. The reader can communicate with tags that are facing away from the reader or blocked by other pieces of luggage.

03

RAIN RFID DASHBOARD

Readers are connected to enterprise software that provides a dashboard for viewing data and managing reader operation. Using an online portal or app, data from the **enterprise system** can be made available to service agents, partner organizations, and passengers, all in compliance with R753.





WHAT RAIN RFID DOES FOR BAGGAGE

In bag-handling applications, **RAIN RFID chips** that are embedded in luggage tags can be used to track individual bags in real time as they pass through all the points in their journey. Since the radio waves used to read data from RAIN RFID chips can pass through solid objects, **tags can be read even if they're hidden from view.**

RAIN RFID can also read tags in groups – up to 400 items per second -- with an exceptionally high degree of accuracy. In just a few seconds, reader machines can scan bag tags from an entire flight's worth of luggage, whether the bags are piled together or stored in a container, with an accuracy rate as high as 99.9%. That means faster inventory counts with fewer mistakes, and almost no overlooked bags.

Because RAIN RFID is so accurate, it significantly decreases the need for manual processing of bags. That helps reduce loading and offloading times, and helps free up staff for other, value-added tasks. Airplanes spend less time on the ground, waiting for luggage to be processed, so passengers reach their destinations faster and airlines can achieve a higher average of miles per seat.

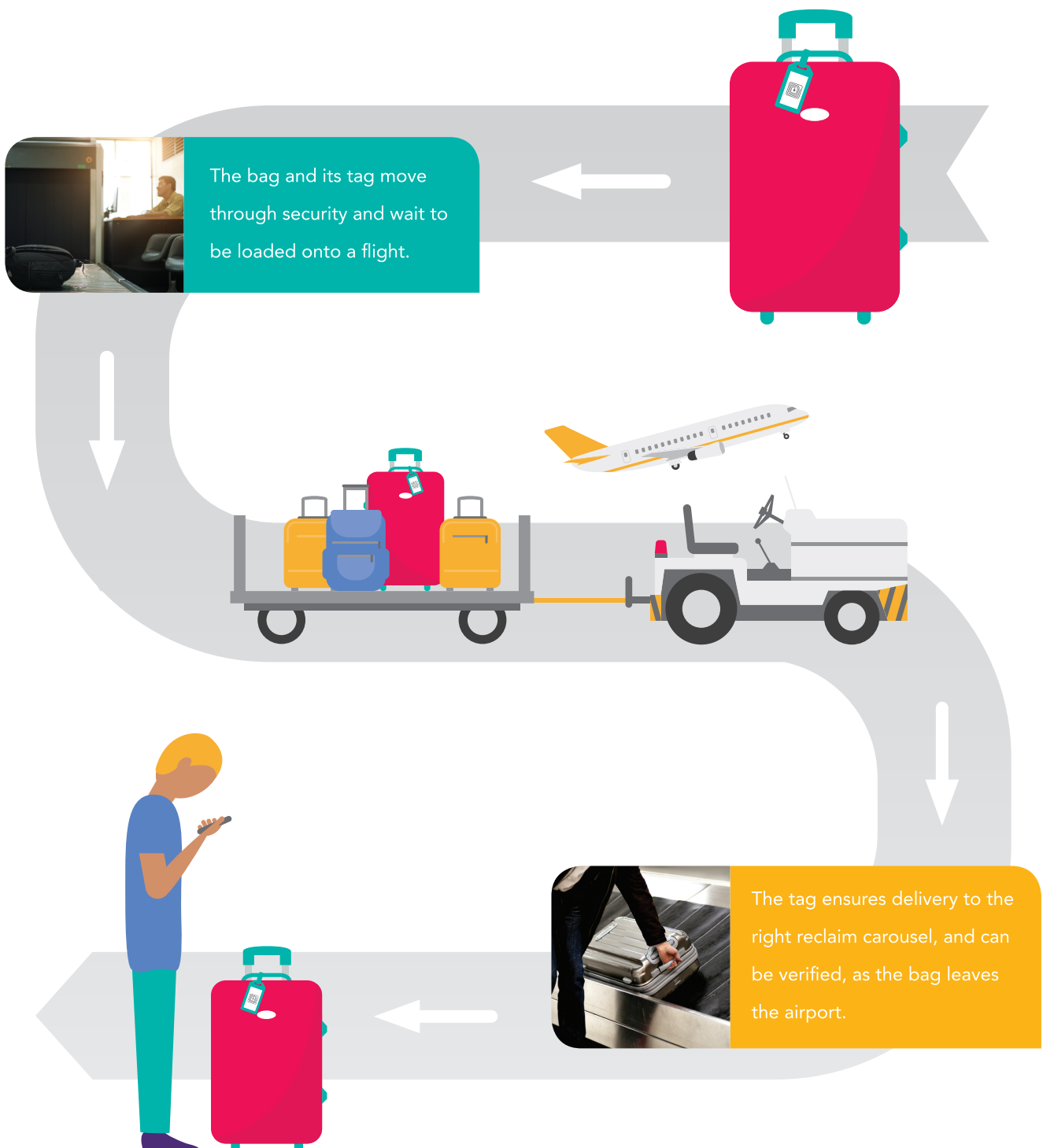
Compared to using barcodes, the RAIN RFID approach is more secure, since algorithms that prevent unauthorized access and protect privacy can be embedded in the tag. RAIN RFID readers also tend to deliver more reliable operation and need less maintenance than barcode readers, so there are fewer unexpected delays and repair costs are lower. RAIN RFID tags are more durable and more resistant to damage than barcodes, so they last longer and are more likely to remain readable.

BARCODES VS RAIN RFID

	BARCODE	RAIN RFID
Read without line of sight	No	Yes
Read speed on production line	1 at a time	Up to 400 items per second
Read point cost	About USD 10,000	About USD 1000
Read/write capability	No	Yes
Tamper detection	No	Yes
Read accuracy	Up to 80% (typically 60 to 70%)	Up to 99.9% (typically 97%)
Security	No	Yes
Price	\$	\$\$

ONE BAG'S JOURNEY

A RAIN RFID tag, embedded in a loop tag, is coded and assigned to the bag when it's dropped off at a check-in counter or at a self-service kiosk. The bag and its tag move through security and wait to be loaded onto a flight. The tag ensures the bag is put on the right plane, and confirms that the bag and its associated passenger are both on the same flight. When the flight arrives, group tag reads save time and ensure proper handling if a transfer's needed. At the bag's final destination, the tag ensures delivery to the right reclaim carousel, and can be verified, as the bag leaves the airport, that it is, in fact, in the proper hands and hasn't been tampered with. At each point in the bag's journey, a status update can be sent to the passenger's mobile device.



WHAT RAIN RFID DOES FOR PASSENGERS

As part of a baggage tracking system that's compliant with R753, RAIN RFID offers new capabilities that **improve customer satisfaction** and enhance the passenger experience.

REAL-TIME BAGGAGE UPDATES IN A MOBILE APP

The RAIN RFID system can be used to send real-time bag status to passengers while they're in transit, with updates sent to their mobile devices. By adding real-time baggage updates to their mobile apps, airlines can increase differentiation, emphasize their loyalty programs, and promote their dedication to customer service. Interest in this type of mobile app, with real-time status updates for baggage, has been shown to be quite strong. In 2017, when the IATA asked more than 7,000 passengers, from 17 countries across the Americas, Asia, Europe, Middle East, and Africa, if they would use a mobile app that provided real-time updates on bag status, 67% said they would definitely use it and 29% said they might use it.





SELF-SERVICE BAG DROPS

As part of increased airline automation, self-service bag drops automatically detect and scan bag tags and dispatch luggage into the bag-handling system. The bag can be assigned an R753-compliant RAIN RFID tag without involving airline staff. Where these kiosks are available, adoption rates have been fairly high. IATA reports that, in 2017, 47% of passengers used automatic bag tagging kiosks and 18% used automatic bag-drop stations.

BENEFITS OF RAIN RFID



Lower operating cost



Better customer service



Improved efficiency



Increased passenger satisfaction



BROAD-BASED SUPPORT FOR R753

Added regulations and the need to comply with new rules don't always go over well with industry, but R753 has received broad-based support, because it promises to **bring benefits to just about every key stakeholder**, from the airlines and airports to the passengers themselves.



AIRLINES

The majority of IATA's member airlines are in favor of R753, with 77% saying they expect the resolution will offer **major benefits in terms of customer satisfaction**. Airlines also like R753 because it promises to reduce the costs associated with mishandled bags, and because it will increase their operational transparency. The promise of fewer delayed or lost bags is especially attractive, given the high costs associated with each bag that has problems.



AIRPORTS

Those working on the ground to support the airlines like R753 because it promises to **improve their performance as transit hubs**, with fewer delays while planes are being loaded and unloaded. Better read rates on transfer bags can improve an airport's reputation, for greater loyalty from airlines and passengers alike. Also, the data gathered by R753 can also be used to make airport signage in baggage areas more informative, with wait-time estimates and real-time updates.



PASSENGERS

Today's travelers are increasingly connected, carrying phones, tablets, laptops, and even smartwatches when they fly. The IATA reports that 70% of passengers now carry two or more devices and 98% carry at least one. Surveys have shown that passengers from all demographics like the idea of **bag update notifications**, being able to report a mishandled bag via a mobile phone, and receiving bag collection information. The data collected by R753 makes all these things easier to provide to customers, and helps increase loyalty, while reducing the chances of bag mishandling.





"Arriving without a bag is a very frustrating experience for our customers. Over the last decade we have reduced mishandled baggage by 54% with improved processes. The next step is to realize the full benefits of baggage tracking to further improve performance. In the rare cases when a bag does not arrive with the passenger there will be much more information available to facilitate a quicker reunion. And the benefits don't stop there. Tracking bags will, enable proactive reporting, speed up aircraft readiness for departure, facilitate the automation of baggage processes and also reduce fraud."

Andrew Price, IATA's Global Head of Baggage



BEYOND BAGGAGE

The June 2018 deadline for R753 conformance places the focus on **RAIN RFID for baggage handling**, but for many in the aviation industry, investing in RAIN RFID is often part of a larger plan that brings technology to other aspects of airport logistics. The benefits include reduced fraud, faster aircraft readiness for departure, and increased automation.

The IATA has done several studies on the use of RAIN RFID in airport operations, and sees a number of opportunities for using it to enhance operations and lower costs. In 2004, for example, the IATA initiated a two-year study on the use of RAIN RFID to manage and maintain the trolleys that carry food and duty-free items on airplanes. The tags saved time by eliminating the need for airline employees to do a manual inventory of onboard trolleys and their contents. Tags placed on meal trays, bar items, and duty-free products resulted in less waste and better alignment with passenger demand. In the results from their study, the IATA estimated that, by tagging these trolleys, the airline industry as a whole could **save as much as USD 470 million worldwide**.

The IATA also cites the benefits of using RAIN RFID for cargo tracking, as part of its e-freight initiative. The tags can be used to track air-cargo containers, heavy machinery (like fuel trucks), baggage carts, and more. Other applications of RAIN RFID include tracking tools and parts used by maintenance teams, real-time inventory checks of onboard safety equipment, reduction of waste in the food-service chain, and streamlined retail operations within airport concourses.

Tag readers can be mounted at specific checkpoints or gates, and airport personnel can carry handheld readers. Each type of equipment has its own tracking requirements, but having a common RFID infrastructure throughout the airport makes it possible to create customized data sets for each category. A unified RAIN RFID network also makes it easier for interdependent groups to share information and thereby increase efficiency even further. The entire setup can be managed from a single location, either onsite or off, making it easier to monitor facilities that span multiple locations.

With RAIN RFID as part of the airport infrastructure, day-to-day operation can become more efficient, with the ability to optimize over time, since data generated by the system makes it easier to refine workflows and improve business processes. RAIN RFID also helps improve overall security, as systems can ensure only authorized personnel can operate vehicles or use vehicles to access restricted areas.



THE NXP POSITION IN RAIN RFID



At NXP, we offer the industry's **broadest RFID portfolio** and support R753 with our UCODE and UCODE DNA families of RAIN RFID ICs.

The UCODE architecture delivers the speed, accuracy, and security required for peak performance in airline applications. UCODE's read sensitivity of -23 dBm, with a self-adjust feature and 20% lower power consumption than other solutions, ensures reliable read rates and robust performance against detuning effects. UCODE's write sensitivity of -18 dBm delivers safe writing operation in the printer, and UCODE's quick encoding speed of 32 bits in 1.2 ms means efficient handling of even large volumes of luggage.

UCODE RAIN RFID can read luggage tags without line of sight, at a rate of up to 400 bags per second. UCODE also offers read/write capability, so bag tags can be updated and reused. Airlines can issue specially equipped reusable luggage tags to their frequent flyers, so check-in is faster and easier. Tamper detection helps combat theft, and the exceptionally high accuracy rate of 99.9% minimizes misreads and faulty data. UCODE DNA is the first RAIN RFID format to support cryptographic encryption, for an extra level of security and protection.

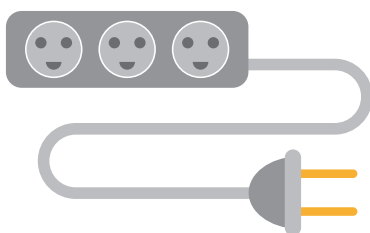
NXP'S UCODE 8 DELIVERS BEST-IN-CLASS PERFORMANCE



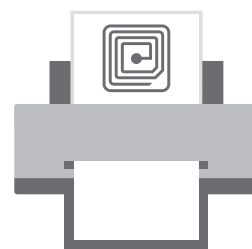
Read sensitivity: **-23 dBm**



Encoding speed: 32 bits in
1.2 milliseconds



Power consumption: 20% lower
than nearest competitor



Write sensitivity: **-18 dBm**

PARTNERING FOR THE LONG TERM

To deliver true process improvement, a **RAIN RFID deployment** needs to take into account the needs of all the stakeholders involved, from airport staff, baggage handlers, and airline service agents, to technology providers, app developers, and passengers themselves. For this reason, choosing the right partners for the design, deployment, and management of a RAIN RFID implementation can be as important as choosing the right technology.

As a leader in HF and UHF security, NXP is active in standards groups and industry forums, and even chairs the RAIN Alliance, which maintains the RAIN RFID specification. NXP supports UCODE and UCODE DNA with an extensive network of support partners, for local application and solution expertise anywhere in the world, and is the only UHF supplier offering 12-inch wafers, for increased supply capacity.





"RAIN RFID is a cost efficient and highly effective method of data capture for Resolution 753, as it allows a high degree of automation and therefore consistency of data provision for the operation. This is essential as baggage tracking is only effective if you capture data on all the bags and can use this effectively."

Andrew Price, IATA



CONCLUSION



R753 promises to bring **significant benefits to the airline industry** and the passengers it serves. With R753, every bag is tracked during its entire journey, from the moment it's surrendered by the passenger at check-in to the moment it's retrieved at their destination. Support for R753 also means airlines will be tracking the data needed to provide real-time bag information to a customer app.

It's important to keep in mind that today's airline passengers are increasingly tech-savvy, using technology at more points throughout their journey. From mobile apps for booking and check-in, to Wi-Fi use in the airport, digital entertainment while in flight, and electronic passports at border crossings, passengers are showing their preferences for automation. This shows promise for other aspects of travel, including bag tags that provide real-time tracking. There is strong customer demand for more advanced bag tracking, and airlines are motivated to meet this demand while also improving the way they work.

With NXP's UCODE RAIN RFID technology as the basis for R753 compliance, airlines can make mishandled bags a thing of the past, while building toward a future of higher overall efficiency, lower operating costs, greater security, and increased customer satisfaction. What's more, the UCODE infrastructure for baggage handling creates a foundation for a larger RAIN RFID network that brings efficiency and savings to other parts of airport operations.

"RAIN RFID tags provide the ability to accurately and efficiently track/trace baggage through its journey. The use of RAIN RFID tags in baggage provide the visibility and data that enables process improvements, increases customer satisfaction, and reduces missed baggage. RAIN RFID has made fundamental shift in the ability to track/trace items and has provided significant value in retail, manufacturing, and healthcare in the past five years. It's high time airlines start investigating whether they can make use of this technology to deliver a better experience for the customer and run an efficient operation that saves money."

Senthilkumar Chinnappa Gounder Periswamy, Technical Director RFID Lab, Auburn University



To learn more about how NXP is using **UCODE** to support R753 and other aviation applications, visit www.nxp.com.

