RFID: alive and kicking after all

RFID tracking is used in line with the bag sortation system. Conveyor speed, variable baggage spacing and electromagnetical shielding are the main limiting factors to the quality of RF detection (Credit: Siemens)

Travel and security stakeholders are currently revisiting their strategy to cope with a lasting transportation market slowdown. RFID aficionados are no exception. ***Jean Salomon*** *and* ***Michel Banâtre*** *recall how and why IATA and the transportation community acknowledged that adopting universal RFID for bag tags did not bring the desired global benefits to the entire stakeholder community. And, following a straight review of the peaks and troughs of the RF saga in the transportation industry, they document an approach whereby specific, independent RF applications could profitably operate in a closed loop, increase operational security and deliver improved passenger service.*

It all started nicely...

Air transportation was the first historical beneficiary of RFID (Radio Frequency Identification) technology: during WWII, allied pilots derived a useful extension to the nascent radar technology when RFID was first introduced in the UK through the IFF (Identification Friend or Foe) application distinguishing friendly from hostile aircraft radar blips.

The first report on the potential use of RFID was described in a 1948 paper by Harry Stockman as "communication by means of reflecting power" set up the onset of a long series of developments in contactless technologies, the most recent being the anticipated growth of Near Field Communications (NFC) applications.

However, sixty years later, many acknowledge that some of the RF fruits we were collectively hoping to reap in the transportation industry were not hanging that low! No wonder, therefore, that many of the original scenarios and some RF-based illusions vanished as air transportation progressively dived into recession.

...with a good potential to outsmart Bar Codes

Over the last 15 years, innovative logistics applications in tracking and tracing (including baggage handling systems) focused on three distinct advantages of RFID technology over bar codes:

- First, no line of sight between the tag and the reader is required to identify, locate or count a given RF token, assuming that the appropriate electromagnetic field is active at or around the examination area. Activation is achieved either by the tag itself (in the case of an active tag containing a battery) or by an external RF emitting antenna which is also able to "listen" to any passive tag response by the energy radiated into it.

- The second definitive advantage of RFID tagging is its capacity to have the tag's own memory bank updated during the process, thereby writing useful information into the tag for further downstream usage in the logistics application. In an airport security world, RF bag tags first encoded during the check-in process with passenger and flight data could be updated in the bag sortation system with flags establishing the bags' clearance following an automated X-ray or other explosive detection screening process.

- Lastly, a particular advantage of RFID tags is their potential to be embedded inside valuable goods for asset tagging, either as simple anti-theft devices in mass retail products, or as part of more sophisticated "electronic seals", where parcels or precious large containers need logging and control over intrusion, temperature, light, biohazard, etc.

So far, one single conclusion has emerged from RFID field trials which ended in large-scale deployments: the only successful RFID implementations were those that operated in a closed loop environment, without claiming global interoperability. Thriving RF examples are found in public transportation, secure building access control, inventory management of medical equipment inside a hospital, tagging of precious paintings for museum security and of books to improve library management and in order to prevent theft, pet tagging too.

The RF baggage handling situation at airport premises turned out to be more difficult, because its infrastructure is convoluted, and, contrary to the aforementioned locally constrained examples, it implies world connectivity to make business sense.

What did the field expect?

The initial thrust, about 12 years ago, was towards the universal adoption of RF bag tags to increase the speed of baggage handling, introduce on-the-fly security tagging and improve the efficiency of bag transfers. Bar code read rates were known to drop from 90+% at the airport of origin to less than 70% at the next airport, thus hampering transfer bag sortation system performance, mainly because of crumpled or missing paper bag tags. The airline industry was more than willing to accept the manufacturers' claims that RF tags would bring an easy collective fix to the increasing delays, the misrouted baggage, and the extra manpower costs incurred at the transfer hub.

As air travel was still expanding, the "acceptable" industry price for a single disposable RF bag tag steadily decreased from 1 USD to 10 US cents within 10 years. Airlines were increasingly hesitant to embrace the new RF paradigm, even at its lowering bid price, and market response weakened since the promised 99+% RF read rates were hard to deliver, and even harder to maintain during live airport trials.

As the RF industry struggled to resolve outstanding technical issues, IATA changed its Recommended Practice set in the late 90's, and suggested its members move away from HF (13,56 MHz) to UHF (900 MHz), also launching a strong UHF RF programme as part of its global StB ("Simplify the Business") initiative in late 2004.

Initially, the market received a few positive inputs:

- In the wake of the overwhelming urge for increased security induced by 9/11, hopes did climax in 2005 with the "miraculous" convergence between ISO's and MIT's seemingly controversial recommendations to set up the new UHF Gen2 standard.

- In addition, the necessary UHF frequency band adjustments between countries were achieved, thanks to which RF bag tags encoded anywhere in the world could theoretically be read any place else. Initial testing, by flying a few hundred UHF RF tagged bags around the world was encouraging, yet the road to operational interoperability between US, Europe and Far East RF implementations proved much trickier. Two large hubs, Las Vegas and Hong Kong, undertook RF pilots, and went on to progressively deploy UHF tags on a large-scale, yet with limited vision on future expansion and no clear return on investment (ROI).

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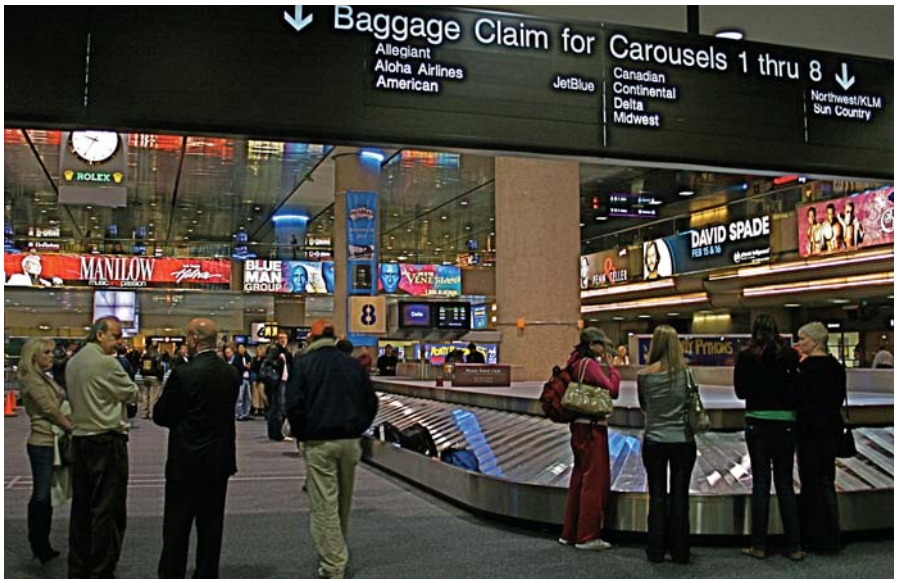

Las Vegas, being mostly an Origin and Destination airport, has limited transfer baggage issues. Most passengers flying there want to collect their baggage and head for town.

Nevertheless, RFID solution providers continued to promise somewhat better prices and performance levels, which did not entirely materialise. This generated additional customer distrust, which ultimately resulted in a significant RF market restructuring and in a reduction in the transportation industry's expectations from RFID. As stated today on IATA's web site:" *Simplifying the Business has closed the RFID project. Because the value of RFID is subject to the individual merits of each business case, there is no mandate for the universal adoption of RFID from IATA."*

Lessons learned

Besides Las Vegas and Hong Kong, other trials were run, for example in Schiphol (several times with different RF frequencies), Narita, Dubai and Paris. Each trial must be considered separately . Caveats issued below for the main ones may help defining safer boundaries for future RFID-driven enhancements in our industry.

- Las Vegas being mostly an Origin and Destination (O&D) airport has limited transfer bag issues and, as such, its case is rather unique. It built its initial business strategy on extended door-to-door service from hotel-to-airport and remote hotel check-in services. RFID helped setting a useful closed loop service with a good potential for specific local added value, like improving ID matching between a bag and its owner, or freeing extra airport check-in space for concession or casino activities while providing additional time for "hands-free" travellers to use these facilities.

- On the flipside, Hong Kong is one of the major Far Eastern hubs, with over 55% of its passengers being in transit and there being a legal requirement for EDS rescreening of all inbound luggage during transfer. The airport's original business case was to use RFID tags manually "slapped" on to transfer luggage to help containing baggage personnel costs, decrease mishandling and increase bag delivery performance.

Each of the above developments (LAS as stand-alone "spoke" vs. HKG as central "hub") took time to build up. Yet, both airports faced issues in further improving their project's ROI by extending the reach of baggage RF usage beyond its local mission:

- For Las Vegas, further usage of the RF tags delivered would mean setting up an RF infrastructure in a downstream airport, which could only make business sense if endorsed by a (US) carrier that would finance the RF infrastructure equipment at one of its own domestic hubs in order to benefit from RF tagged luggage upon arrival from Las Vegas. Such economics will remain unfavourable until RF usage spreads. A similar extension to the stand-alone RF application of Las Vegas has been developed in Orlando. Disney resorts have implemented a "last mile" approach using RF tags: early check-in to and from Disney with RF-based door-to-door bonded luggage and passenger transportation is available between the airport and the lodging area in both directions.

- For Hong Kong, there would be a large advantage of having Cathay Pacific utilising bag RFID at one of its foreign airport stops upstream, in order to prepare, simplify and bolster automation transfers at the hub. The potential from other domestic Chinese airports upstream is there, yet competition from

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RF inlays are usually enclosed in disposable bag tags. They could be permanently reused when mounted inside a frequent flyer's luggage. (Photo credit: Air France)

other growing Chinese hubs may preclude such an option to emerge altogether. Other more competitive and resilient hubs, such as Dubai, plan to develop a similar regional approach to try and further differentiate the airport-flagship carrier team from other Middle Eastern or global competitors.

The RFID "hub" business model has been adopted by several large airports, which ran pilots customised to their specific needs. The overall lesson from these different experiences is that RFID success, if any, will not happen without full stakeholder cooperation. After their initial investment, airports depend on a web of airline links to further extend the reach of RF usage, even if it stays limited to their closest hub's own feeding area. A recent example would be the twin Paris Charles de Gaulle and Amsterdam RFID approach linking Air France and KLM, being partner carriers, with their dual hubs. RFID might deliver some specific advantages to shared frequent flyers using, for example, permanent durable tags embedded in their luggage. Yet scalability and feeder sources need to be carefully analysed.

The light at the end of the tunnel

Revisiting and streamlining airport processes – especially those related to baggage handling – is one of the necessary challenges transportation industry stakeholders have to undertake as a whole. Regulatory authorities, airports and carriers, as well as technology suppliers, have to continue joining forces and strive for a more pragmatic process.

A practical example is the implementation of the "One Stop Security" (OSS) approach, initially advocated by IATA's SPTIG (Simplified Passenger Travel Interest Group) in which redundant and unnecessary document checks are eliminated to bolster traffic fluidity by airport flow redesign and improved risk assessment measures.

"…"Ubi-Check" could mean a lot to each of the reported 25,000 people who, every month, forget their laptops at the security checkpoints of one of the 50 largest world airports…"

Transfer Luggage Distribution	*Calculation rules*	Flagship Carrier	Airport Feeder #2	Airport Feeder #3	Other	Σ
Relative Feeder Importance	*(1)*	34%	20%	13%	33%	*100%*
Spread of the 55% Hub Transfer Rate	*(2) = (1) * 55%*	19%	11%	7%	18%	*55%*
Fast Bag Track Efficiency	*(3)*	75%	60%	50%	12%	-
Overall Time Gain	*(4) = (2) * (3)*	**14%**	**7%**	**4%**	**2%**	**-**
Expected Hub MCT decrease (from 45 min.)	*(5) = (4) * 45*	**6**	**3**	**2**	**1**	***11-12***

Table 1

Interestingly enough, implementing the OSS approach to transfer luggage security could drastically reduce hold baggage screening congestion by skipping redundant X-ray rescanning of those bags transferring from certified "OSS-compliant" airports. Obviously, assuming bi/multi-lateral country agreements are already enacted, one would also need stringent risk-assessment criteria in place, HBS site qualification, X-ray equipment certification, as well as biometric checks of screeners and baggage handling personnel.

Such process reengineering would be an alternative to the previously described RF technology implementation. It would be able to deliver a similar nett result with improved service and other compelling business advantages.

To estimate the market value of this "straight-to-security" approach, a quick calculation on a large hub with a 55% transfer rate and three major feeders representing 2/3 of the inbound traffic from "OSS-approved" countries is shown in Table 1 above.

With the assumptions used, the "One Stop Security" approach would yield a reduction of more than 20% of the mean connect time, i.e. from 11 to 12 minutes of a typical 45-minute value for the luggage transfer portion alone. Half of this gain would be directed to the main feeder. This is a strong hub argument to attract additional transit traffic, while significantly improving its own flagship carrier's scheduling performance!

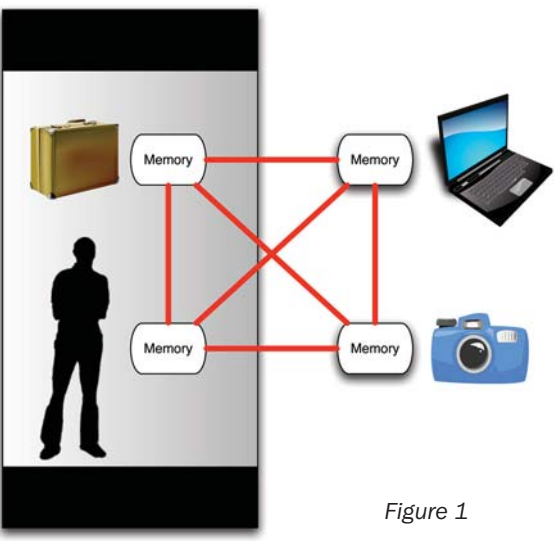


Figure 1

"Ubi-Check": a practical example of new "light" RF usage

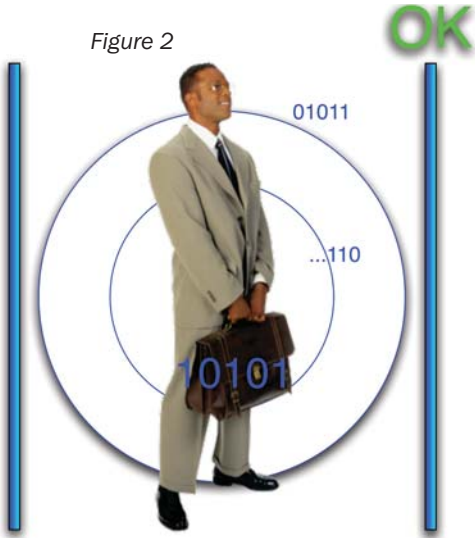
Several alternative RFID improvements could further improve service quality to passengers at an airport, without necessitating any significant infrastructure investment. As an example, forgetting one's belongings at some point, or mistakenly exchanging a similar item with someone else's, frequently occurs during a passenger's journey through an airport.

RFID-based solutions exist to link a set of elements, which the passenger wants to secure "around" him. They rely on active RF tags attached to the items that are monitored by an owner tag. Unfortunately, overall price, battery autonomy and radio emission limitations in an airport or aboard an aircraft would prevent passenger activation of this anti-theft/loss solution at the most critical time!

A more innovative and more affordable alternative (named "Ubi-Check") has been recently developed at INRIA (the French National Institute for Research in Computer Science & Control in Rennes) which uses a set of passive RF tags, by writing once into each of their memory the data required to establish the integrity of the desired group of items in a unique associative way.

Each RF tag would be uniquely coupled to the rest of the group by calculating a patented digital certificate from the various tags needed by the passenger. The tags would then be physically carried in/on every valuable item that the passenger wishes to keep around him, as shown on Figure 1. Tags associated with each item are only used for a locally computed integrity check, not for identification. Values could be written into the tags, for example, at the airport check-in, the exit of the duty-free, or even when leaving home, via a very simple "enrolment" station. Standard fixed RF antennas would be posted at critical airport locations, say at the exit of the security checkpoint or at the Jetway bridge, to monitor traffic. Coupling these stand-alone antennas with a local display system would verify the integrity of groups of items crossing the RF field while providing the required notification (see example on Figure 2), warning people in the case of a missing tag/item or the presence of someone else's item (an orphan tag unduly passing through the field).

Figure 2



The "Ubi-Check" solution is entirely autonomous and transportable. It can be flexibly adapted to changing locations and evolving security processes. It does not require any link to an airline/airport IT system, nor does it store any personal information on any passenger. In this particular case, RFID is used (again!) in stand-alone mode. Airports or airlines can link commercial services around the concept, to further differentiate their service and improve the passenger experience by removing the fear of loss of his personal belongings.

"Ubi-Check" could mean a lot to each of the reported 25,000 people who, every month, forget their laptops at the security checkpoints of one of the 50 largest world airports!

Is it not reassuring to realise that there is hope at the end of the tunnel?

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