INFLIGHT CATERING

RFID Technology Analysis

Document Status

REVISION

Version	Date	IATA StB - Authors	Notes
1.0	14.03.2007	↗ Nicolas Bondarenco, RFID Deputy Manager ↗ Andrew Price, RFID Manager	Initial Version

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1. Executive Summary

This document (in orange in the following picture) is the fourth report that is part of the IATA inflight project, the high level business case having been produced before.

IATA has undertaken technology trials that tested **passive** RFID products in the Low Frequency, High Frequency and Ultra High Frequency bands. Based upon the results of these trials products in the UHF band will be taken forward for the trial.

Inflight Project Process Description

Process	Description	Deliverables
Identify high level potential benefits	• Initial IATA view on the potential benefits of the use of RFID in Inflight	High Level Business Case
Identify issues and define needs	• Description of the detailed processes and main operational encountered issues • Identification and prioritization of the stakeholder needs for an RFID solution applied to inflight, peer reviewed by the inflight task force.	Process Analysis and User Requirements
Describe and set up a trial	• The elements of the user requirements to be tested in the trial, along with which party will provide what element of the trial.	Trial Requirements
Select Technology	• The technology to be carried forward to trial based upon tests and peer opinion for the use of RFID	Technology Report
Evaluate with trials	• The results of the trial applied to the inflight processes as well as technology performance results. Mainly focused on trolleys management and maintenance with some technology tests for trolley contents.	Trial Results Report
Detail cost & benefits analysis	• A report on the detailed business case for RFID on catering trolleys, supported by realistic costs from the industry and returns on investment from airlines.	Detail Business Case
Develop a Recommend Practice	• A new Recommended Practice to be included in future JPSC manuals	Recommended Practice

2. Project Objectives & Scope

2.1. History

In April 2006, the first RFID workshop was held in Madrid with airlines, caterers and suppliers invited to attend in order to identify potential area of application for Automated Identification Technology within inflight services. There were 23 attendees from 21 companies in attendance: Airlines, Caterers, Government, Vendors, and Specialists who discussed the areas that were of importance to the industry.

The workshop attendees were asked to list a number of industry issues. These issues were then collected into broad groups. Each issue within each group was given a nominal dollar value against the worth of solving the issues to their particular business. Therefore, an issue such as trolley maintenance may rate highly for airlines and caterers, but not at all highly for regulators.

The outcome of this exercise showed that the areas that can be offer the most immediate benefits are:

- Trolley Tracking
- Trolley maintenance
- Trolley Contents

IATA then documented a high level Business Case published in October 2006. Last December, the IATA Inflight RFID initiative received strong support from the Simplify the Business Board of Directors, based on this preliminary Business Case.

2.2. IATA Project Objectives & Scope

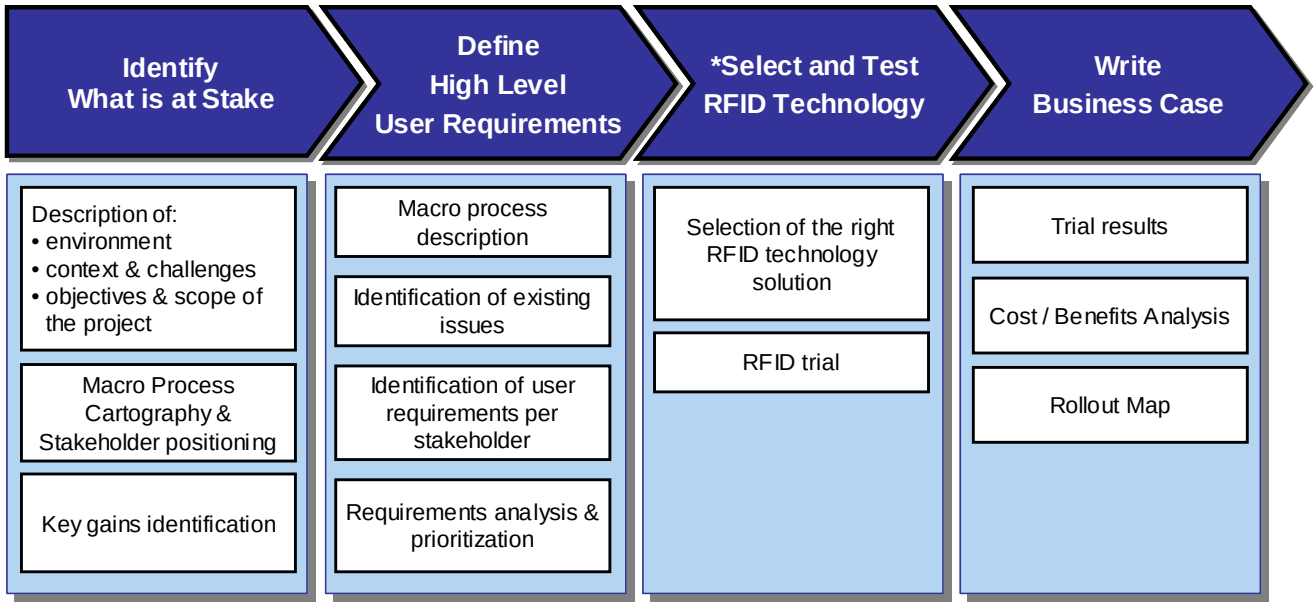
In January 2007, as part of IATA's Simplifying the Business initiative, IATA has thus started to analyse in detail what RFID could bring to Airlines and Caterers in the management of trolleys and stowage units, their maintenance, and the management of their contents as well.

IATA is now launching a process to identify user requirements to better manage these assets and needs the contribution of Airlines and Caterers to understand requirements as thoroughly as possible. After having met several airlines and caterers individually and after having consolidated all the identified needs in one document, a Task Force will review the user requirements.

Following this, next steps would include:

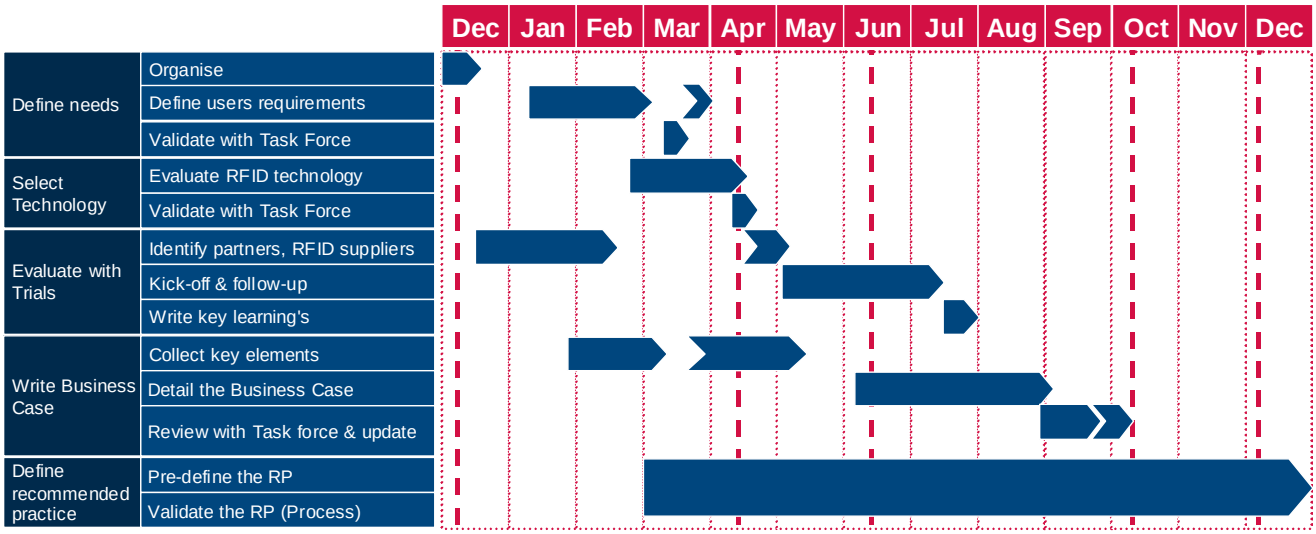
- Identification of the best RFID technology solution to cover documented needs
- Type trial with some stakeholders
- Documentation of a detailed Industry Business Case
- Development of Industry Standards

2.3. Global Approach



*Note: the main goal is to explore potential RFID solutions that could improve the inflight catering process for the benefit of stakeholders. Other solutions may be explored in addition to RFID.

2.4. Global Planning



The Recommended Practice activities will also run in 2008. Some of the activity dates may slightly be changed. As a first step the technology will be selected for the trial and will have to suit identified needs the best way and demonstrate the benefits of the technology. As new types of RFID technology are currently under development, those solutions might be tested for environment and compatibility.

3. Test description & Results

3.1. Objectives, scope and approach

The objectives of the tests are to:

- Evaluate the use of different RFID technologies for catering
- Locate the optimum tag position on the trolley

The tests are designed to measure the performance of each RFID tags type when positioned on a trolley.

The approach is described as follows:

	Steps	Approach
Static Tests	Pre-qualifier tests	• These tests are designed to ensure that the reader is correctly configured and that the antennae are arranged to provide maximum reader performance
	Free space read distance	• This test is designed to measure the read distance of an RFID tag from an antenna and also between two spaced antennae
	Direct mounting test	• The test checks whether an RFID tag directly attached to the trolley can be read at the previous observed read distance
	Minimum separation test	• If the tag cannot be read at all when directly attached to the trolley, find the minimum separation distance between the trolley and the RFID tag at which the first read can be made
	Read distance variation with separation test	• Measure the read distance with increasing separation pads
Dynamic Tests	Tag orientation test	• With the tag mounted in the optimum position orient the trolley in small steps and witness if a read is still possible. If a read is not possible in all orientations then measure the impact on read distance.
	Single & multiple trolley tests	• With the tag mounted in the optimum position the trolley is pushed through the reader field – slow, medium and fast. The readability of the tags is recorded. • With tags mounted on two trolleys perform a static read (both trolleys placed in the field, parallel and sequential)

3.2. Detailed Test description

Pre-qualifier tests

These tests are designed to ensure that the reader is correctly configured and that the antennae are arranged to provide maximum reader performance.

Free space read distance

This test is designed to measure the read distance of a tag from an antenna and between two spaced antennae.

Reference should be made to the system providers to understand what the expected best performance is and we should endeavour to achieve this. Factors to consider are the impact of the office environment (partition walls containing metal and filing cabinets) so an RF friendly mounting system should be used. If the suggested maximum read distance cannot be obtained then refer to the supplier to understand why (e.g. connector loss).

The result of this test is D_{fsmax}

Note the conditions for this result also – e.g. two antennae operating in tx/rx modes with the tag positioned between the antennae.

The tests are split into two categories:

- Static Tests: these tests should be undertaken in each of the three pre-determined tag positions. The tag shall be separated from the trolley by an optimum distance that needs to be identified to ensure readability.
- Dynamic tests: With the tag mounted in the optimum position the trolley is pushed through the reader field – slow, medium and fast. The readability of the tags is recorded.

Direct mounting test

In each of the three tag positions (singularly) mount a tag directly onto the trolley. Can the tag be read at D_{fsmax}? If not, reduce the separation between the antenna and the trolley until either a read is achieved or there is zero separation. Note the distance at which the read occurs D_{dmount}

Minimum separation test

If D_{dmount} is zero, find the distance at which the first read can be made. Use the felt separators for this – each separator is 2mm wide.

Read distance variation with separation test

Measure the read distance with increasing separation pads until D_{fsmax} is obtained.

- Underneath the trolley – Antenna Horizontal plane
- Underneath the trolley – Antenna Vertical plane (perpendicular orientation)
- On side of the trolley on top – Antenna Vertical plane
- On side of the trolley on the bottom – Antenna Vertical plane

Tag orientation test

With the tag mounted in the optimum position (i.e. the trolley position where D_{fsmax} is achieved with the minimum number of separators) orient the trolley in small steps and witness if a read is still possible. If a read is not possible in all orientations then measure the impact on read distance.

Dynamic trolley tests

With the tag mounted in the optimum position the trolley is pushed through the reader field – slow, medium and fast. The readability of the tags is recorded.

Should this test fail then further positions other than the previously found optimum position should be attempted.

3.3. Main Test Results

Additional detailed tests on UHF passive solution will be made during the trial in a Catering Facility.

Tests	Comments	UHF	LF	HF
Free Space read distance D_{fsmax} (tag alone)		**2.2 meters**	**67 cm**	**40 cm**
Direct mounting D_{dmount}		**2.2 meters**	**0**	**0**
Minimum separation		**0 cm (not required)**		**2.2 cm**
Read distance variation with separation test	Underneath the trolley - antenna Horizontal plane	**2.2 meters**	**20 cm**	**29 cm**
	Underneath the trolley - antenna Vertical plane			**No read**
	On side of the trolley (on top, on the bottom) - Antenna Vertical plane	**2.2 meters**		**23 cm**
Tag orientation	Onside of the trolley on the bottom / on the top - Vertical plane (tag attached on the trolley with separation when required)		**20 cm** with 0 degree orientation (trolley and antenna are parallel)	**23 cm** with 0 degree orientation (trolley and antenna are parallel)
			20 cm with 18 degrees orientation (between trolley and antenna)	**23 cm** with 18 degrees orientation (between trolley and antenna)
		Read up to 68 degrees with reflections	**Read up to 30 degrees**	**Read up to 32 degrees** orientation **at 17 cm** read distance (between trolley and antenna)
Dynamic tests	Slow	**OK**	**OK**	**OK**
	Medium	**OK**	**OK**	**OK**
	Fast	**OK**	**NOK**	**NOK**

4. Theoretical Analysis based on RFID expertise

This analysis has been realised by RFID experts prior to the RFID technology tests.

		Passive HF Technology	Score	Passive UHF Technology	Score	Passive Micro Waves Technology	Score
Tag position on trolley							
Under the trolley		Would likely communicate fine at close ranges (i.e. approximately 1 meter) and sporadically at greater ranges.	2	This technology should propagate fine to communicate with a tag at this location, virtually regardless of range.	3	2.45 GHz has ranges slightly better than HF, but with issues due to prolonged human exposure to reader energy.	2
On the long trolley side		Same as above, as reader signal 'splattering' should prove largely 'tag orientation' insensitive.	2	Same as above, as reader signal power & 'reflectivity' should prove largely 'tag orientation' insensitive.	3	Signal 'reflectivity' will provide some degree of orientation insensitivity; however, lower power constraints (in some regions) will limit range even further than direct propagation.	2
Inside the trolley		Will communicate if there is some 'place for the wave to get through metal' but the range will be even further reduced.	1	Will communicate easily if there is even a minuscule opening in the metal, especially since a very short wavelength.	2	Will communicate extremely well if even the very slightest opening in the metal as the wavelength is extremely short.	2
Durability	**Climate conditions**						
From dock to cleaning	➢ Thermic shock from –40 to 110 degree Celsius	Should be no problem as far as permanent damage is concerned, but performance will likely be degraded at extremes.	2	Should be no problem.	2	Should be no problem.	2
At Outdoor conditions	➢ -40 to +45 degree Celsius ➢ 0 to 100% humidity	Should be no problem, as far as permanent damage, but on low temperature extreme will show some performance degradation.	2	Will show no permanent damage but will show some minor performance degradation under snow and rain conditions only, but basic excessive range capability will more than compensate for rain/snow effect.	2	Will show no permanent damage but will show some minor performance degradation under snow and rain conditions only.	2

		Passive HF Technology	Score	Passive UHF Technology	Score	Passive Micro Waves Technology	Score
	➢ Sun, rain, snow, dust						
At Cleaning area	➢ Water / Vapour	Should be no problem with water and vapour, but chemical reaction will depend on the specific chemicals	2	Water and vapour will show temporary performance degradation, but chemical reaction will depend on the specific chemicals	2	Water and vapour will show temporary performance degradation, but chemical reaction will depend on the specific chemicals	2
	➢ Chemicals		2		2		2
At Drying area	➢ Airflow ➢ Heat	Should be minimal or no problem	2	Should be no problem	2	Should be no problem	2
On board Aircraft	➢ Cabin Pressure cycle	Should be no problem	2	Should be no problem	2	Should be no problem	2
Reading	**Capacity**						
At Docks	➢ Be robust to anti-collision: high volume of trolleys to identify, with multiple items in each trolley	Could be a problem if too many tags in reader field, depending on which specific protocol/technology is selected.	1	Should be no problem with tag volumes.	2	Should be no problem with tag volumes.	2
	➢ Mounted to protect tags on trolleys as they are banged around, tipped over and so forth	Mounting should provide adequately tag protection.	2	Mounting should provide adequate tag protection.	2	Mounting should provide adequate tag protection.	2
Reading	**Interferences**						
At Docks	➢ Be capable of metal mounting	Should be made capable of metal mounting.	2	Should be made capable of metal mounting.	2	Should be made capable of metal mounting.	2
	➢ Be robust to interference and not cause interference to others (lots of radio frequencies such as Walky talkies, other RF technology in use)	Will have some susceptibility to high powered select frequency interference, should not cause interference to other systems.	1	Could have only minimal potential 'for mutual co-site same reader configuration' interference, should not cause interference to other systems.	2	Will likely have only minimal potential 'for mutual co-site same reader configuration' interference, could potentially cause interference to other systems.	2
	➢ Be robust to anti-collision between readers	will be limited in high density environments	1	Will perform well , if programmed/designed properly	2	Will perform well, if programmed/designed properly	2

		Passive HF Technology	Score	Passive UHF Technology	Score	Passive Micro Waves Technology	Score
	➢ Be able to read trolley while moving	Will be able to read moving trolleys.	3	Will be able to read moving trolleys.	3	Will be able to read moving trolleys.	3
Read Range	**In Locations**						
	➢ Read distance long enough to be read across each dock door:	Will not have adequate read range.		Will have more than adequate read range.		Should have adequate read range.	
	1 meter if the reader is on floor		1		3		2
	3 meters if the reader is above doors		1		3		2
Safety / Security	**Placement of Reader to prevent damage**						
	➢ In floor, or	No problem	3	No problem	3	No problem	3
	➢ Above doors	No problem	3	No problem	3	No problem	3
Safety	**Radio Frequency Band**						
	➢ Power emitted by reader should comply with local health and safety legislation	No problem, but most regions' limited power will effect read range performance.	2	No problem, but some regions' limited regulation (largely bandwidth, not power) will effect range performance.	2	No problem, but some regions' limited power will effect range performance	2
Standard	**Common platform**						
	➢ Worldwide Standard or Recommended Practice is required	Frequency spectrum is worldwide standardized, but RP would be required.	2	Frequency spectrum is largely standardized (but not completely worldwide), RP would be required.	2	Frequency spectrum is largely standardized, RP would be required.	2
Certification	**On board Aircraft**						
	➢ Certification for any equipment boarded on aircraft to be obtained	Tags are passive and would not require on-aircraft certification. Readers would require on-aircraft certification.	2	Tags are passive and would not require on-aircraft certification. Readers would require on-aircraft certification.	2	Tags are passive and would not require on-aircraft certification. Readers would require on-aircraft certification.	2
Regulations	**Radio Frequency Band**						

		Passive HF Technology	Score	Passive UHF Technology	Score	Passive Micro Waves Technology	Score
	➢ Radio frequencies shall be in line with regulation requirements	Yes	3	Yes, but these will vary from region to region worldwide, necessitating a more complex on-aircraft reader.	2	Yes	3
Other	**Constraints**						
Liquid spills	➢ Tags shall withstand conditions that are hot, cold, sticky	Yes	3	Yes	3	Yes	3
Security Data Access							
	➢ Segregation of data by user	Can be done, but limited.	1	Can be done.	2	Can be done.	2
	➢ Secure read/write capability for RFID Tag – authorised write	Can be done, but limited.	1	Can be done.	2	Can be done.	2
Time to respond	**Wake – Sleep / Read cycle**						
	➢ Tag shall wake, respond within 0.5 second	Yes, in most cases.	3	Yes	3	Yes	3
Life of Tag							
	➢ Tags shall be capable of use for a period of a least 7 years without maintenance	Yes	3	Yes	3	Yes	3
		Passive HF Technology	**Score**	**Passive UHF Technology**	**Score**	**Other RFID Technology**	**Score**
TOTAL			**55**		**66**		**63**