RFID Reader Common Communication Protocols
and an Implementation Using Such Protocol

ATA e-Business Forum
Budapest, Hungary
Oct 21 - 23, 2008

Kevin Ung  Associate Technical Fellow, Boeing Phantom Works
Thanh Hoang  GoldCare Chief Architect, Boeing Commercial Aviation Services
Agenda

- Communication Protocol in General
- RFID Common Application Programming Interface (API) Focus
- Benefits of a Common API
- A Common API Implementation –
  - Reader Interoperability Module (RIM)
- Contacts
Two General Types of Communication Protocols

In general, software communication protocols can be divided into two major areas: application layer protocol level, e.g. Application Programming Interface (API), and transport layer protocol level, e.g. at the TCP/IP level.

The communication protocol addressed in this presentation focuses only on the application layer protocol level, e.g. API at a handheld reader device.
**Application Programming Interface (API) Focus**

**ATA RFPT API**
- `writeBirthRecord(birth_record_xml);`
- `addPartHistoryRecord(history_record_xml);`
- `addMechanicComment(comment_xml);`
- ...
- `readBirthRecord(tag_id_xml);`
- `readCurrentRecord(tag_id_xml);`
- `readMechanicComments(tag_id_xml);`
- ...
- `getDirectoryOfRecords(tag_id_xml);`

**RFID Ops API**
- `getTags();`
- `writeEPC();`
- `getTID();`

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**ATA Spec 2000**
- **Chapter 9-5**
- **Data Record**
  - Birth Record
  - Part History 2
  - Part History 1
  - Mechanic Comments
  - Current Record

---

**RFID Reader Device**
- **RFID Application**
- **ATA RFPT API**
- **RFID Ops API**
- **Reader’s Software Development Kit (SDK)**
- **RFID Tag**
Benefits of A Common Interface

Because the same application can be “plugged” into different readers for accessing the same tag, a common interface can provide:

- Consistent application interface for RFID operations
  - Increase operation efficiency
  - Reduce operation errors
  - Reduce training costs
- Reduce software development and maintenance costs
Boeing and Fujitsu are “experimentally” implementing this set of APIs and our goal is to turn the final product to the open source communities.
Contacts

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RFID on Parts Status Report

ATA eBusiness Forum
Michael Scheferhoff
Budapest, 23rd October 2008
# Agenda

- What is the goal of the group?
- What does the new memory layout look like?
- Who are the workgroup members?
- What are the achievements so far?
- What are the reasons to use RFID?
- Which challenges do exist?
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RFID on Parts - Charter

- The purpose of the RFID on Parts Project Team is to develop industry standards for the encoding of data on RFID tags which are to be affixed to parts for the life of the part
Primary Work Goals

- Definition of a flexible and scalable standard for RFID / AutoID on parts concerning ...
  - Data structure on the RFID tag for the tag itself as well as the memory areas (being: birth record, current data record, mechanic scratch pad, part history)
  - Format of data stored on the tag
  - Definition of traceability database requirements
  - Define the needed security needs
- ... to achieve the following results:
  - Accelerate innovations
  - Avoid proprietary solutions
  - Assure interoperability among the RFID users
  - Reduce risk
  - Establish clear guidelines for technology providers and users
- ... in alignment with the other ATA chapters
## Agenda

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Status of the standard RFID / AutoID on parts
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Initial thoughts for a memory design for RFID on parts

Results:
- Inflexible for future layout changes
- Integration of new data sections not possible
- Only certain chip sizes may have adopted this layout
- Large amount of memory not useful in many business cases
- Waste of memory due to large block sizes

- The initial layout was based on a fixed block structure
- The content of each block as well as the quantities were roughly estimated
- At that time only on chip vendor was on the development track for high memory chips
Switch to a new memory layout

The main reasons for the switch:

- No fixed block boundaries
- Support of low and high memory data structures
- Scalability for future available memory sizes
- Nearly no memory waste
- Faster data access through the point architecture
- New data areas e.g. for documents may be integrated
ATA Memory Structure for RFID Tags

User Memory (defined by ATA e-Business RFID)

- EPC Data
- Birth Data
- Current Rewriteable
- Mechanic’s Scratchpad
- Part History

EPC Memory / Identification Memory (in collaboration with EPCglobal standards)
ATA Memory Structure for RFID Tags

- **EPC Data**
- **Birth Data**
- **Current Rewriteable**
- **Mechanic’s Scratchpad**

Manufacturer CAGE Code, Serial Number, Original Part Number, Manufacture Date, Expiration Dates, Haz Mat info, ESD, Customs & Export Information, Software Part Indicator, etc.

- **Part History/Action Log 1**
- **Part History/Action Log 2**
- **Part History/Action Log 3**
- **Etc.**
ATA Memory Structure for RFID Tags

- EPC Data
- Birth Data
- Current Rewriteable
- Mechanic’s Scratchpad

Current Part Number, Mod Status, Airline Part Numbers, etc.

- Part History/Action Log 1
- Part History/Action Log 2
- Part History/Action Log 3
- Etc.
ATA Memory Structure for RFID Tags

- EPC Data
- Birth Data
- Current Rewriteable
- Mechanic’s Scratchpad

Freeform text for operator’s use

- Part History/Action Log 1
- Part History/Action Log 2
- Part History/Action Log 3
- Etc.
ATA Memory Structure for RFID Tags

- **EPC Data**
- Birth Data
- **Current Rewriteable**
- Mechanic’s Scratchpad

**Record “important” part status changes or traceability information**

- Part History/Action Log 1
- Part History/Action Log 2
- Part History/Action Log 3
- Etc.

**e.g. – Service Bulletin, Repairs, NFF, Ownership changes, etc.**
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The photo was of course taken in front of a RFID gate!

Participants of the September ATA workgroup meeting hosted by LHT in Hamburg
Major companies of the aviation industry and technology specialists participate (list of currently active working)

- Airbus
- Boeing
- Dassault Aviation
- Embraer

Airframe manufacturers

- Rockwell Collins
- Thales
- Hamilton Sundstrand

OEMs

- Cambridge Auto ID
- Fujitsu
- Kortenburg
- Intelleflex
- MacSema

Techn. Providers and Standards Org.

- RFID Sec
- SITA
- Technology Solutions
- Tego

We want to encourage more Airlines and MROs to participate as they currently are underrepresented!
The work in sub teams speeded up the creation of work results moving towards the standard for ATA chapter 9.5

- Have met every 2-3 months (Feb, Geneva; June, Tokyo; September, Seattle; plan: November, Washington)
- Telcos between meetings are held to ensure progress is made
More details on the sub team work topics

### Process / business team
- Process modeling, use case development
- Adoption of RFID technologies
- Definition of data elements for the memory areas of the tag (e.g. birth record, spare part history, …)

### Technology team
- Definition of memory layout
- Alignment with data elements
- Integration of new technical possibilities

### Security team
- Coordination with the DSWG (Digital security working group)
- Identification of (new) threats
- Risk assessment
- Risk management
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First version of the standard expected ready for approval in August

Results achieved by the workgroup so far:

- EPC header constructs are defined but need to be reworked (due to recommendations of non-ATA EPC members)
- The list of the birth record data elements for small and large memory tags is complete
- The major portion the part history data elements including their structure has been defined
- The container memory layout for the user memory has been published in the 2008 specification to enable first developments (draft ready in January 2008)
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Different companies in the aviation industry have different approaches regarding the usage of RFID for permanent parts marking e.g. of high value components:

- Generally the data on RFID tags is secondary and supplemental to the data in the backend systems.
- Companies having a strong IT integration and accessibility as well as closed loop processes think about using RFID-data as a “fat pointer” into their backend systems meaning only a few data elements will be needed on the tag.
- Companies acting in open loop environment may want to store a full part history on the tag to ask maintenance provider to enter the data into the tag’s memory.
- The decision regarding the amount of data is very much related to the business case companies want to achieve by tagging their parts.
RFID technology and MRO-processes

Potential benefits of RFID: MRO-logistics & Asset-Management

Aircraft Configuration Management

- Improvement of data quality and currentness
- Traceability and authenticity of aircraft parts
- Aircraft Configuration Control
- Simplification of transition checks at aircraft purchase and sale

Life Time Control

- Improvement of data quality and currentness
- Lift time control of non-serialised parts (e.g. life-vests, batteries)
- Optimization of warranty transactions
RFID technology and MRO-processes

*Potential benefits of RFID: MRO-logistics & Asset-Management*

**Reduction of incorrect deliveries**
- Additional (automatic) tracking points
- Real-time feedback on handling-errors

**Accelerated receiving-process at the LTL logistic hubs**
- Paperless processes / avoidance of media-breaks
- Simplification of identity-checks (part vs. documentation)
- (Storage of repair-history and certificate directly on the component)

**Unserviceable component return: Advance information**
- Improved ability to manage inbound supply-chain
- Advance planning of repair-process
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There are still some challenges ahead

- Meeting the time schedules of OEMs, airlines and MROs which are already in the adoption process
- Finalization of the chapter 9.5 document
- Management of the restriction of technology availability mainly in the area chip-technology
- Coordination between aviation industry, EPC-community and ISO
Status of the standard RFID / AutoID on parts

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Thank You for Your Attention!
Technology/Product Status

Takehisa Matsuda
Defense System Unit
Fujitsu Limited
What is AIT/RFID?

AIT: Automated Identification Technology

RFID: Radio Frequency Identification

- 1D bar codes
- 2D bar codes
- Contact Memory Button
- RFID tags
Typical RFID Implementations

- **Linen Tag Uniform Management**
  - Uniforms
  - Hotel

- **Building Management**
  - Factory

- **Reusable Containers Management**
  - Plastic containers
  - Basket Cart

- **Assets Management**
  - Files
  - CD-ROM etc.

- **Entering/Leaving Rooms, Positioning Management**
  - Basket Cart
  - Security

- **Files**
  - Basket Cart
  - Security
RFID/AIT solution for Aviation industry

Low memory RFID solutions for Interior equipments, such as Oxygen Generators, Life Jackets, etc

RFID/AIT technology as a process improvement enabler that can reduce defects, cycle time, and maintenance and engineering cost.

High memory RFID solutions for parts lifecycle management, MRO, etc
ATA Spec 2000 Ch9-5 Data Record

Memory layout
ISO/IEC 18000-6 TypeC (EPC Gen2)

- **BANK 3**: USER
- **BANK 2**: TID
- **BANK 1**: UII (EPC)
- **BANK 0**: RESERVED

- **User memory (Option)**
  - Chip Manufacture code, etc
  - 96bit~ : EPC
  - 16bit : Protocol Control
  - 16bit : CRC-16
  - 32bit : Access Password
  - 32bit : Kill Password

**Identification => Memory**

- **Birth Record**
- **Current Data Record**
- **Mechanic Comments**
- **Parts History**
Requirement of Aviation RFID

- Passive, reader talk first protocol
- 860 – 960 MHz frequency range
- Read/Write secure memory
- Complies with ATA SPEC 2000 Chapter 9
- Environmental tests per AS5678 requirements
- Metal mount, surface insensitive packaging
- 10 year service life
- Complies with FAA policy
- Air interface in accordance with EPC global (ISO18000-6 Type-C)

Etc

* Resource from Boeing
### Ex. Current Available AIT List

<table>
<thead>
<tr>
<th></th>
<th>High-mem RF Tag</th>
<th>Mid-Mem RF Tag</th>
<th>CMB</th>
<th>Low-Mem RF Tag</th>
<th>Garment RF Tag</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Appearance</strong></td>
<td>![High-mem RF Tag Image]</td>
<td>![Mid-Mem RF Tag Image]</td>
<td>![CMB Image]</td>
<td>![Low-Mem RF Tag Image]</td>
<td>![Garment RF Tag Image]</td>
</tr>
<tr>
<td><strong>Standard</strong></td>
<td>EPCglobal C1 Gen2 ISO/IEC18000-6 TYPE C</td>
<td>EPCglobal C1 Gen2 ISO/IEC18000-6 TYPE C</td>
<td>N/A</td>
<td>EPCglobal C1 Gen2 ISO/IEC18000-6 TYPE C</td>
<td>EPCglobal C1 Gen2 ISO/IEC18000-6 TYPE C</td>
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<tr>
<td><strong>Memory Size</strong></td>
<td>64K Byte</td>
<td>1.5K Byte</td>
<td>Up to 1 GigaByte</td>
<td>512 bit</td>
<td>96 bit</td>
</tr>
<tr>
<td><strong>Weight Dimensions</strong></td>
<td>13.6 / 8 g</td>
<td>4g</td>
<td>0.77g (Height: 0.11 inch, Diameter: 0.56 inch)</td>
<td>N/A</td>
<td>2.0 g</td>
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<tr>
<td></td>
<td>2 x 1 / 2 x 0.6 inch</td>
<td>1.3 x 0.6 inch</td>
<td>N/A</td>
<td>2.36 x 0.6 inch</td>
<td>2.36 x 0.6 inch</td>
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<td><strong>Flammability</strong></td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
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<tr>
<td><strong>AS5678</strong></td>
<td>OK</td>
<td>OK</td>
<td>N/A</td>
<td>Ready</td>
<td>Ready</td>
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<tr>
<td><strong>Environment</strong></td>
<td>Exterior</td>
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<td>Exterior</td>
<td>Interior</td>
<td>Interior</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ready</td>
<td>Ready</td>
</tr>
<tr>
<td><strong>Readability</strong></td>
<td>110 / 90 cm</td>
<td>120 cm</td>
<td>-</td>
<td>&gt; 400 cm</td>
<td>150 cm</td>
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<tr>
<td>(4WEIRP)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td><strong>Availability</strong></td>
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<td>Feb, 2009</td>
<td>Available</td>
<td>Feb, 2009</td>
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</tr>
</tbody>
</table>
Introduce One of Technologies (High Memory RF Tag)

Fujitsu 64 Kbyte FRAM RFID tag

Innovation on Plant Operation, Production and Maintenance Process!
RFID tag complies with EPC Global Class1 Generation2 standard.

World’s highest-capacity RFID tag
64KByte high-capacity FRAM, High-speed data writing, High durability and security function.

International standard
EPC global Class1 Generation2 compliance, Supporting a variety of radio frequencies globally.

Key specifications
- Memory size: 64KByte FRAM Memory
- EPC global Class1 Generation2, ISO/IEC 18000-6 Type C
- Security function: EPC spec. & Write Once (Unique Spec.)
- Supporting a various radio frequencies
  Europe(865-868MHz) - America(902-928MHz) - Japan(952-954MHz)
- SAE AS5678 specification compliant
- Direct tag on metal surface
- Dimensions: 2 x 1 inch

SAE: The Society of Automotive Engineers
How to read and write data into Tag

- Reading and Writing
- A large User Memory

Having a large memory in RFID passive tag was Big Challenge
This is not only RF “ID” anymore
Advantages of FRAM

FRAM (Ferroelectric Random Access Memory)

Advantages

- High Speed Writing
- High Endurance
- Low Power Consumption
- Strong in the Radiation

☆☆FRAM has a very well balanced combination of features of RAM and ROM☆☆
High Speed Writing

Fast initial data writing before shipment
Advantage for applications require throughput up

Writing Time (Cycle Time)

Data size Written in 1 sec.
(3,418 [Byte/sec])

Data size Written in 1 sec.
(126 [Byte/sec])

Compared with EEPROM, Writing time of FRAM was 27 Times FASTER @ 1 Mbps, SPI I/F

FRAM: MB85RS256 (Fujitsu, 256Kbit FRAM, SPI I/F)
EEPROM: M95256W6 (STM, 256Kbit EEPROM, SPI I/F)
High Endurance

10 billion rewritable (practically infinite for tag application)

- “Fast Writing” feature with “High Endurance”
  FRAM can write the data of used amount etc. over and over!

Endurance

[Times]

10^{12}  \quad 10^{10}  \quad 10^{8}  \quad 10^{6}  \quad 10^{4}  \quad 10^{2}  \quad 10^{0}

EEPROM  \quad FRAM

100,000 Times of EEPROM

Drive Recorder

Monitor of Any sensor
Low Power Consumption (No high voltage for writing)

Advantage for applications with UHF tag that requires long communication distance

Power Consumption (@ 64Byte Write)

- FRAM:
  - I can read within 3m!
  - I can write within 3m!

- EEPROM:
  - I can read within 3m!
  - I cannot write by 3m.

1 / 1,000 Times of EEPROM
Strong in the radiation

★ Tested device: 2KByte FRAM

★ Conditions:
  • Radiation : Gamma ray
  • Radiation Strength : 45[kGy], 3[hour]

★ Result: No soft error

Reference: Radiation unit

<table>
<thead>
<tr>
<th>Unit</th>
<th>Symbol</th>
<th>Description</th>
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<tbody>
<tr>
<td>Becquerel</td>
<td>Bq</td>
<td>Unit for radiation strength</td>
</tr>
<tr>
<td>Gray</td>
<td>Gy</td>
<td>Unit for absorbed energy</td>
</tr>
<tr>
<td>Sievert</td>
<td>Sv</td>
<td>Unit for danger to public health</td>
</tr>
</tbody>
</table>
Technology is ready

Takehisa Matsuda (Fujitsu Limited)
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