RFID
for the European Automotive Industry

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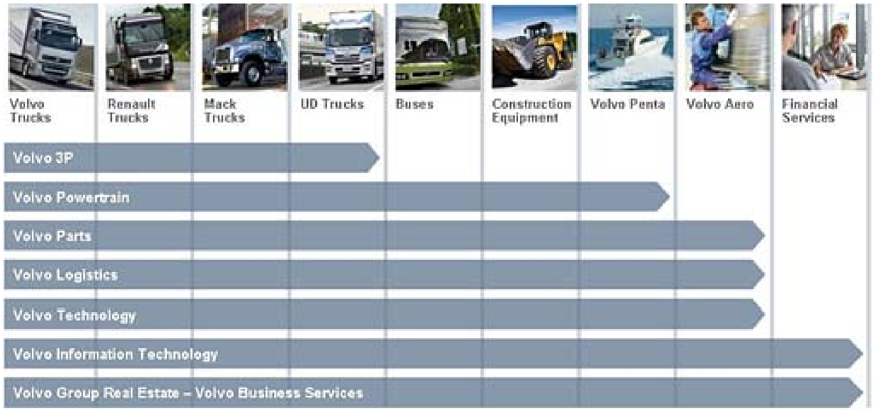
2010-10-06


Volvo Trucks
Renault Trucks
Mack Trucks
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Buses
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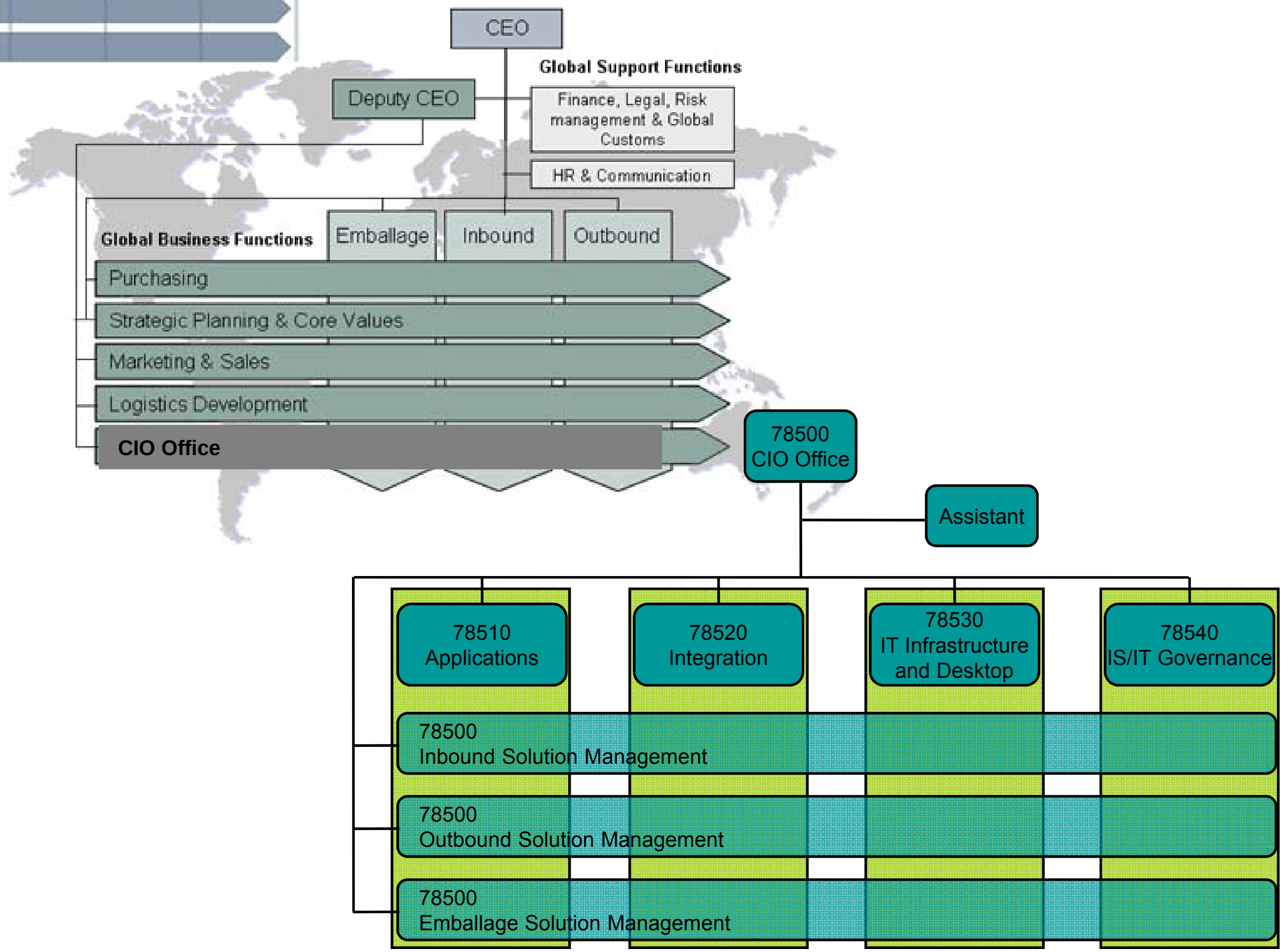
CEO
Global Support Functions
Deputy CEO
Finance, Legal, Risk management & Global Customs
HR & Communication
Global Business Functions
Emballage
Inbound
Outbound
Purchasing
Strategic Planning & Core Values
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Logistics Development
CIO Office
78500 CIO Office
Assistant
78510 Applications
78520 Integration
78530 IT Infrastructure and Desktop
78540 IS/IT Governance
78500 Inbound Solution Management
78500 Outbound Solution Management
78500 Emballage Solution Management

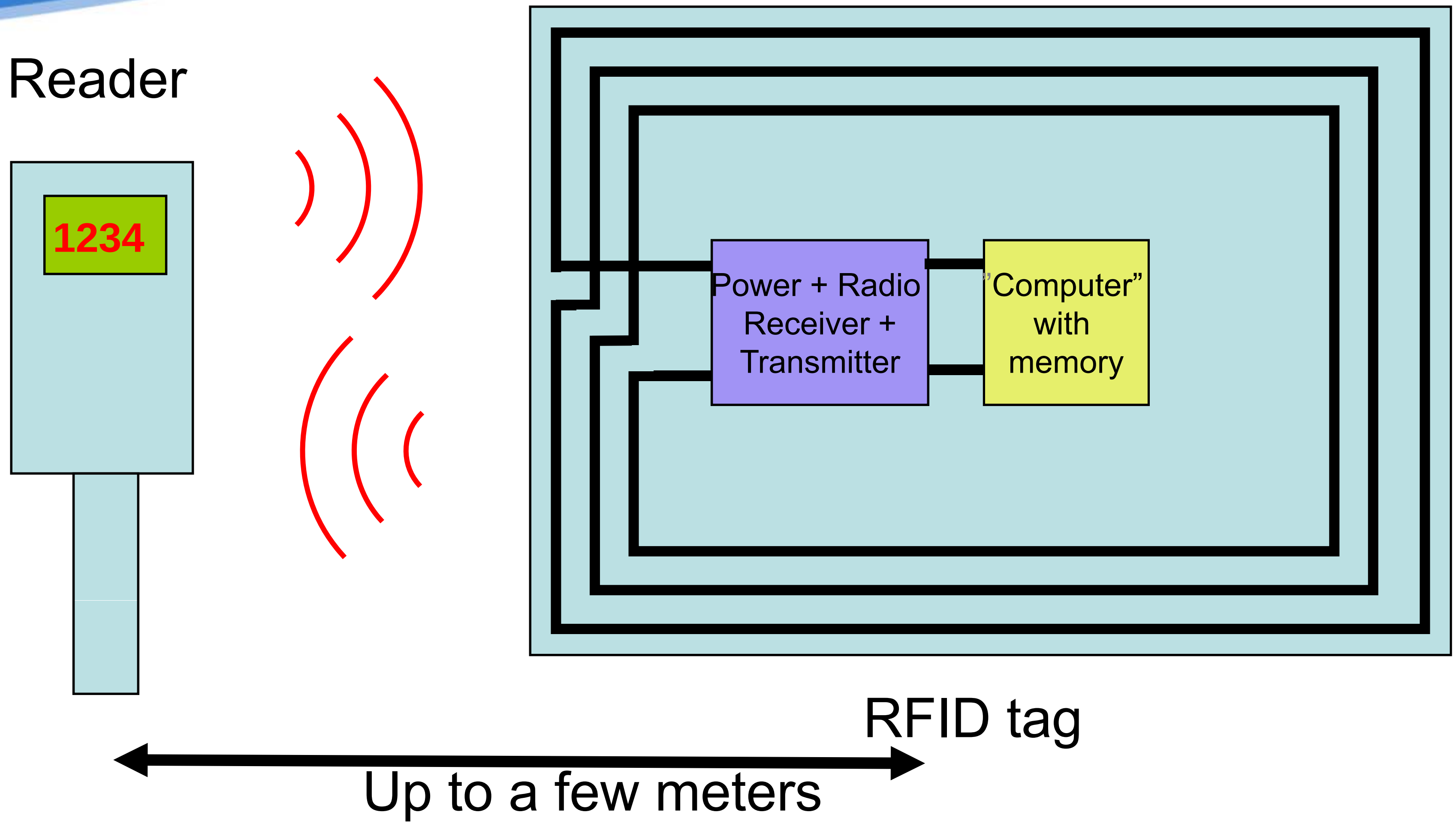
Independent RFID consultants

Everyday RFID applications

RFID Tags in cars today

- Tyres (tracking)
- Bumpers, spoilers (prod. QA)
- Dashboard (prod. QA)
- Immobilizer (anti theft)
- Etc.

A simple RFID system



Typical RFID Readers

- Readers (interrogators) can be so called “fixed”, at e.g.
  - Entrances/exits
  - Point-of-sale terminals
  - Warehouses

- Readers may also be mobile or hand held, with e.g. wireless communication

Typical Reader antennas

Mini GuardRail
Near field antenna
< 6cm distance
LP

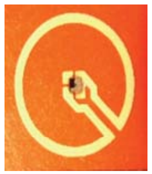
Near field: $< 2A^2/\lambda$
Far field: $> 2A^2/\lambda$

BrickYard
Near field antenna
< 50cm distance
LP 6dBi

IA39B
Far field antenna
> 50 cm distance
CP LH 10.5dBic

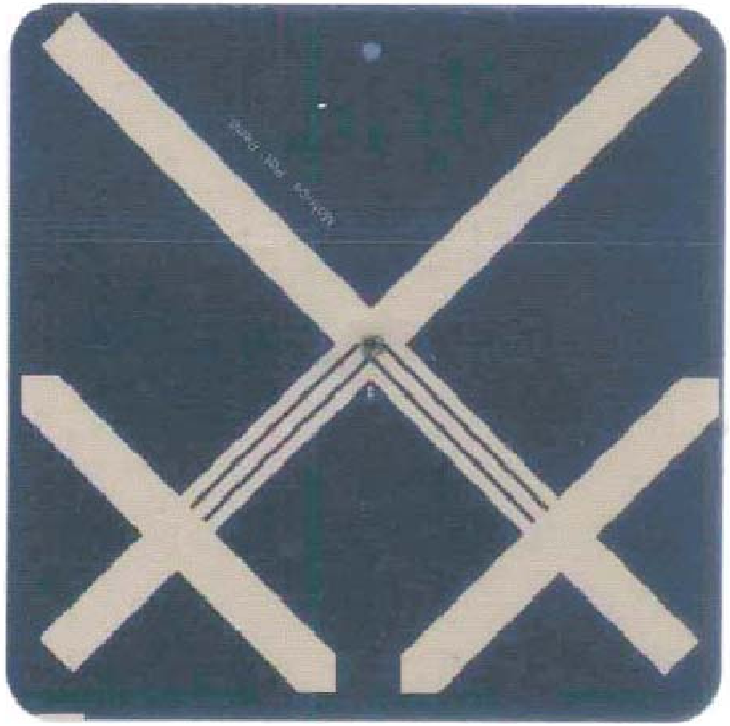
Typical RFID tags

9mm

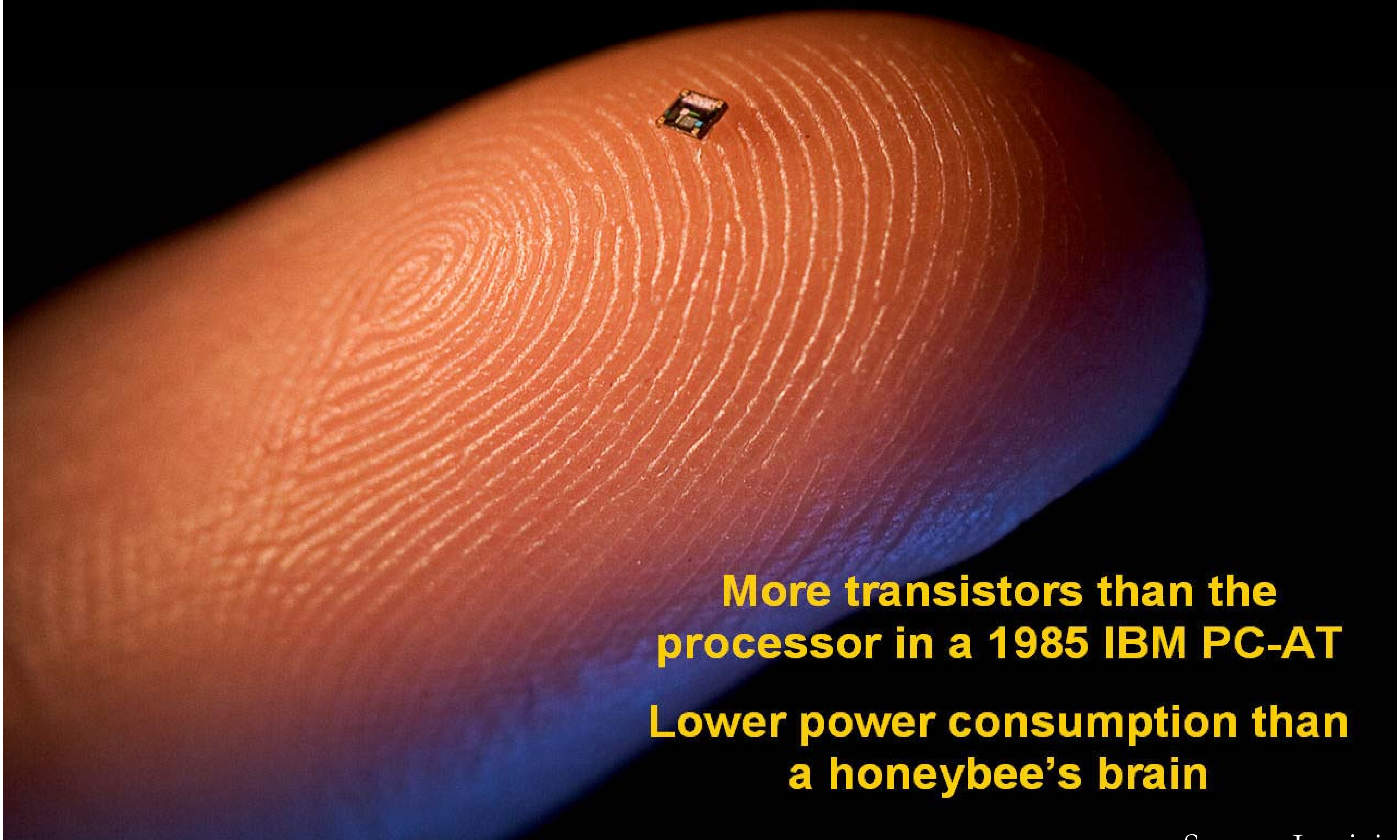


100mm

90mm

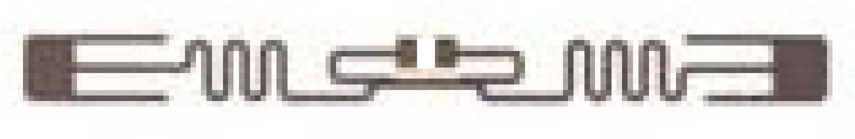


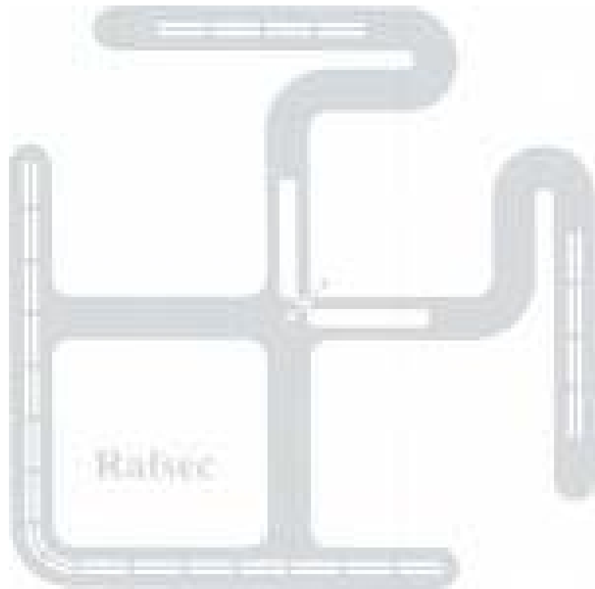
An RFID chip +

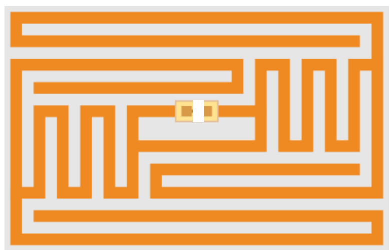


Source: Impinj

an antenna +







a plastic backing =

= “dry” RFID tag

A dry RFID tag has;

NO printable surface and
NO adhesive

but is the cheapest variant and

the price reference.

A “dry” RFID tag +

adhesive

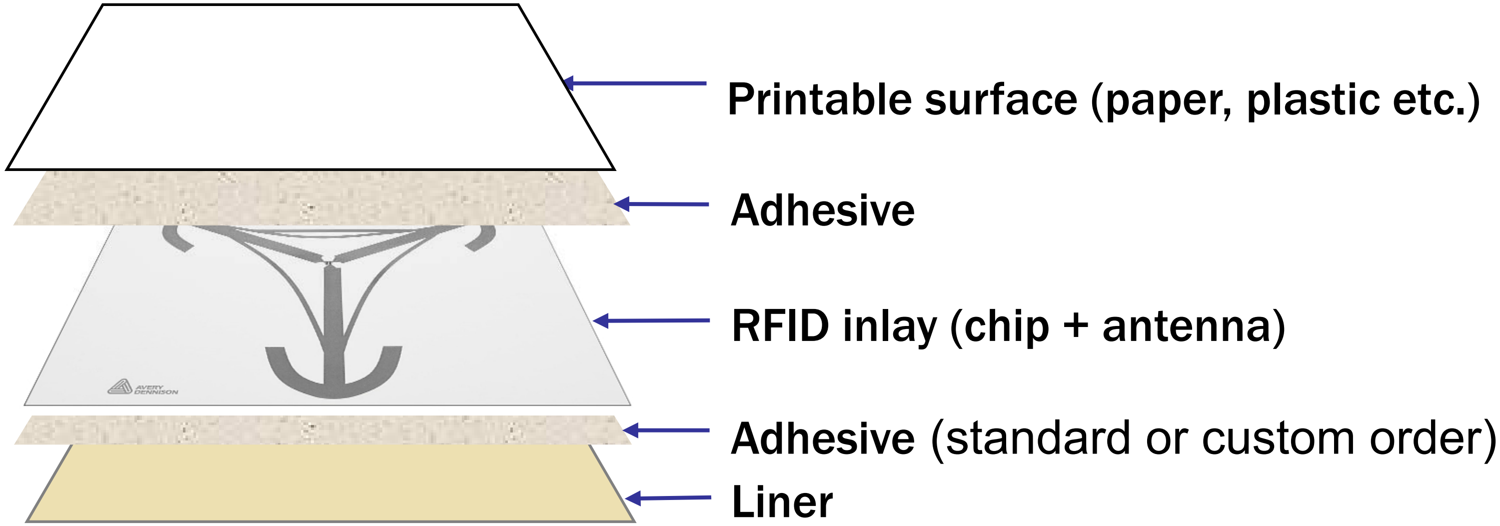
=

a “wet” RFID tag

A wet RFID tag + label stock

=

a Smart Label



Courtesy: Avery Dennison

A brief history of RFID in Odette

- Odette Int’l concluded in 2006 that EPC is not sufficient for most automotive industry applications
- January 2008: a local Swedish proposal for data semantics for RTI
- March 2008 Stuttgart: a handful of different European proposals
- 2 weeks to come up with a “joint” proposal!
- The requirements were not yet well established in detail
- One OEM estimated the cost to change their part number system to fit EPC, in excess off 50M€.
- A tight working group was set up (S.Lindgren/Odette Sweden, B.v.Broeckhoven/Volvo and I)
- 1st task - collect all requirements for an RTI standard!

The Odette RFID Standards Targets and Requirements

RTI, Parts and VIN

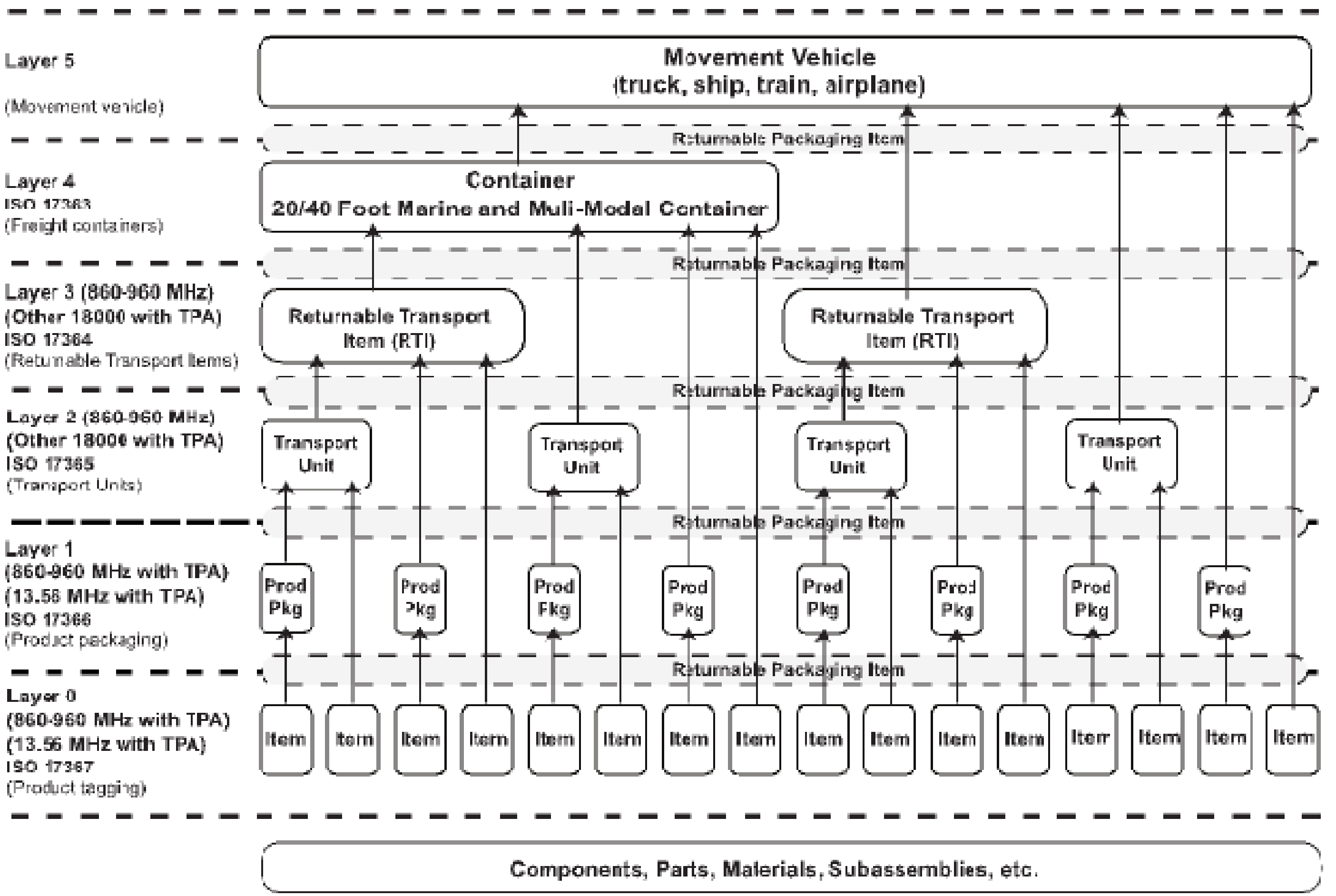


Figure 1 – Supply chain layers

Situating the ISO 18000- 6C tag in the RFID landscape

The application should cover:
RTI
ITEM/PART
VEHICLE

Application

Tag Types
- **Passive**
- **Semi-Passive**
- **Active**

Frequencies
- **LF 125-135 KHz**
- **HF 13,56 MHz**
- **UHF 860-960 MHz**
- **µWave 2,45 GHz**

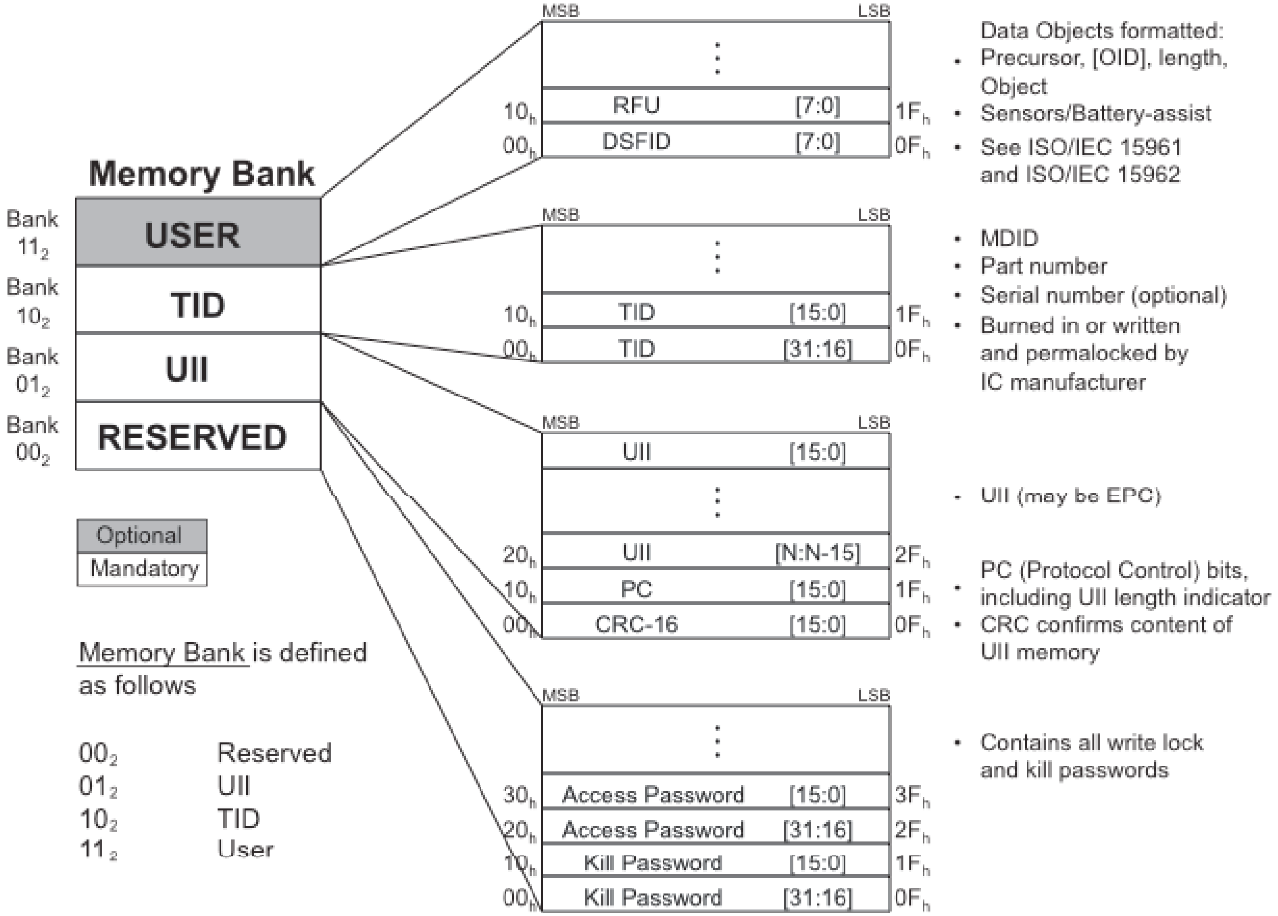
Memory type
- **Access: Read/Write**
- **UII 96 bits**
- **UII 240 bits**
- **User Mem. 512 bits**

Data
- **Data Format**
- **Identifiers:**
- **ISO/ODETTE**
- **EPC**

The tag chosen by the automotive industry is a passive UHF 860-960 MHz tag called ISO 18000-6C with a UII Memory Bank (MB01) of 240 bits and a User Memory Bank (MB11) of 512 bits capacity. This tag will be encoded in Europe according to the ISO/ODETTE encoding scheme.

ISO 18000-6 MEMORY MAP and ODETTE ENCODING SCHEME

The ISO 18000-6 Memory Map for segmented memory tags



860 - 960MHz (UHF)

Overview:

- Works “in vicinity of” metals but
- can NOT be read through water or metal.
- Tag sizes – postage stamp to soap size
- Reading distances: up to 3-6m.
- The reading zone can easily be controlled
- Standardized by EPC and ISO
- The only true global solution for logistics

Eliminating RFID tag naming confusion

EPC Generation-2 Class-1

=

ISO/IEC 18000-6C

Specifies only required hardware compatibility!

The ODETTE approach to encode ISO 18000-6C tags

- Approach based on reading performance and critical data
- The tag's Memory Banks and their behaviour

MB00	MB01	MB10	MB11
Reserved	UII	TID	User Memory

When a tag enters into the read range of the antenna an inventory is made and the tag always backscatters MB01. Reading all other memory banks require extra reads.

- The critical data according to ODETTE that should be stored in MB01:
Note that MB01 must be globally unique
  - Required fields are CRC-16, PC word, AFI, DI followed by the ODETTE proposed fields
  - IAC Issuing Agency Code
  - CIN Company Identification Number
  - Object Type (OT): object can be RTI, Item or Vehicle(VIN)
  - Object Serial Number (unique sequence number for the OT)

The ODETTE approach to encode ISO 18000-6C tags (Continued)

- The OT in MB01 is where Odette differs from the other proposals. The reason why we want to have the OT in MB01:
  - Complete MB01 content is always backscattered at Inventory
  - OT is critical data that will always be required when reading a tag at each reading step in the total supply chain.
  - We believe that in roughly 75% of the total supply chain reading actions, the Object Type will be sufficient for the track and trace functionality.
  - So only 25% of the reads would require a secondary read to MB11
  - A secondary read at least doubles the reading time

- Compaction is required to use the 240 bits of MB01 in an optimal way
  - Data is not humanly readable anyway
  - In ISO 18000-6C tags the compaction/de-compaction time is negligible in view of the total processing time when reading tags

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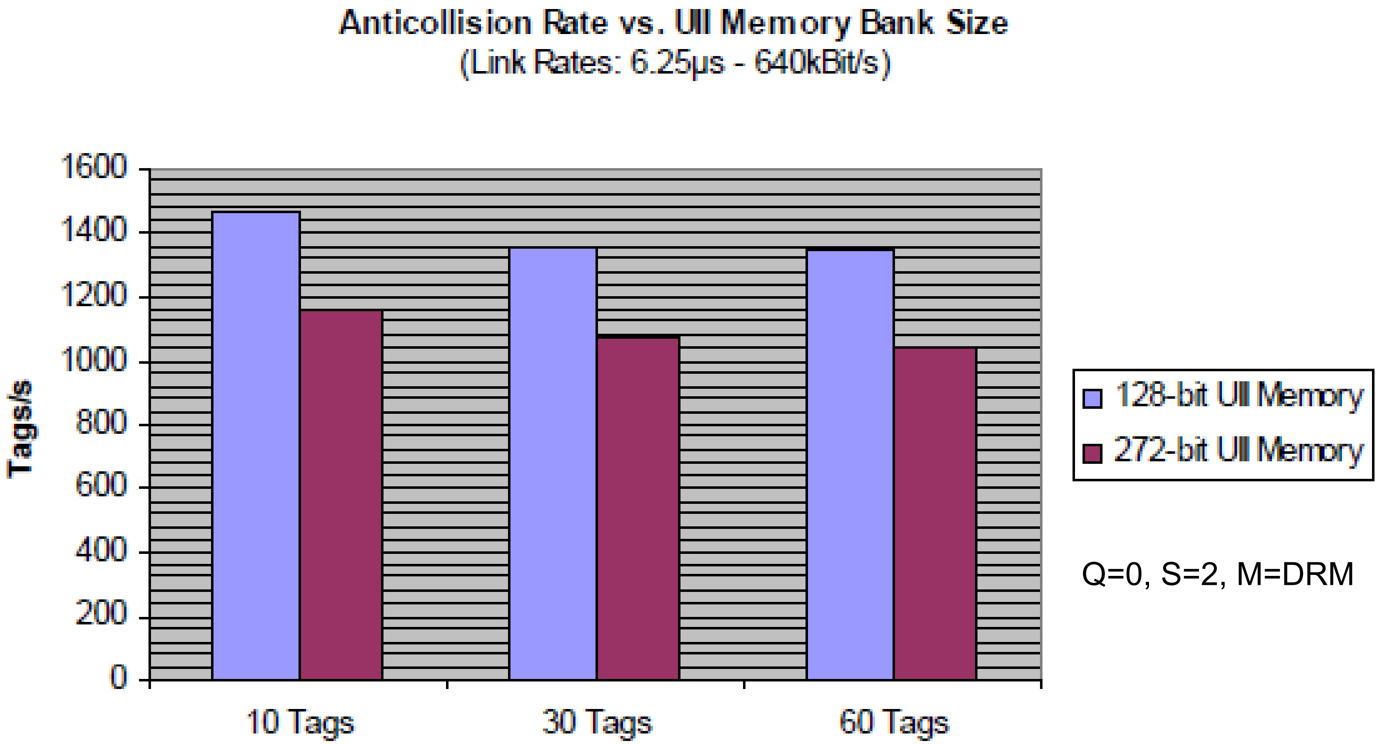
Some more requirements

- Read speed performance – data in MB1 or MB3 - Simulations
- EPC vs. ISO models schemes?
- Ambiguous bit definition for using MB3!
- How to guarantee globally unique tags?
- What are the worst case size of RTI part numbers & serial numbers?
- Using Data Compaction?
- Using the same data format layout, even for VIN
- What data is most important and must reside in MB1?
- How can we minimize data network failure impacts if we use RFID tags to steer production?
- Should we include the DUNS and the Japanese numbering schemes?

- Make sure we can use standard COTS hardware!
- Secure backwards compatibility with used Barcodes!
- Convince the parties that the scheme would work, both for coding and decoding!

MB1 read performance, optimal case

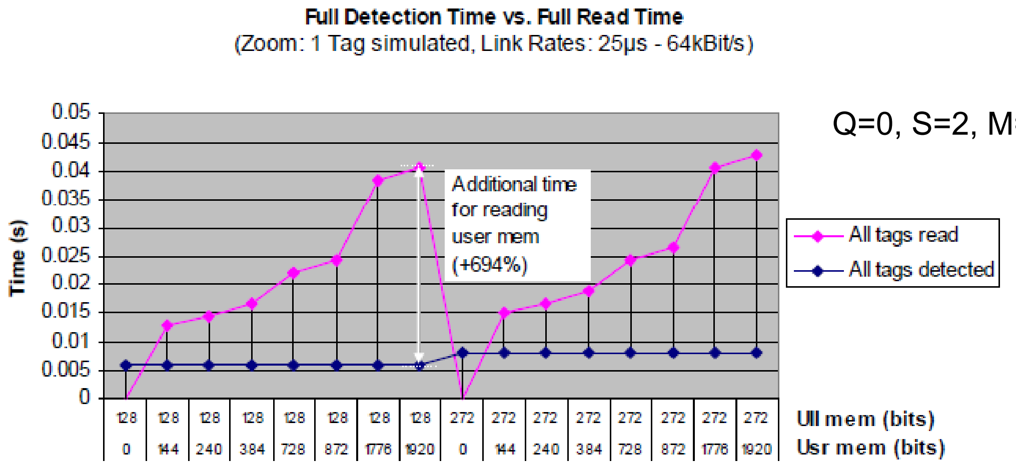


Q=0, S=2, M=DRM

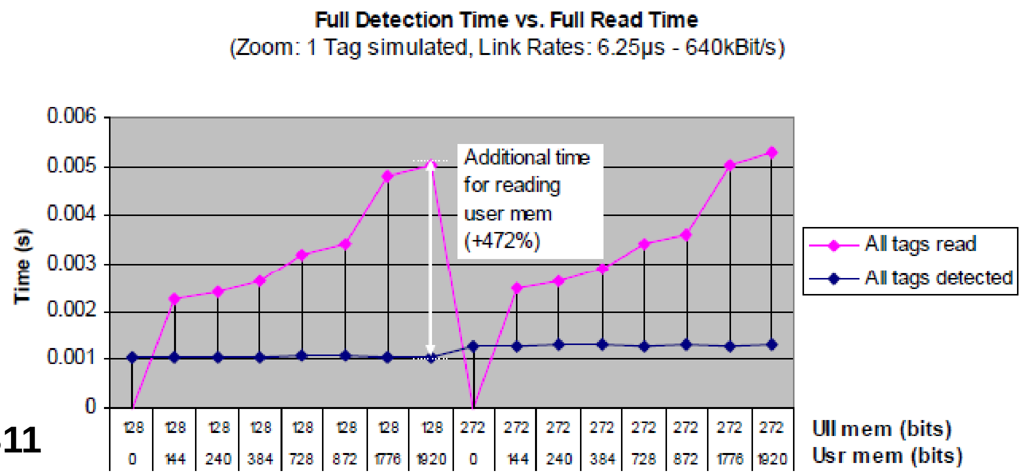
Courtesy: CISC Semiconductor Design+Consulting GmbH

~ 20% overhead to read 240 bit tags

Estimated tag read times - mod



Q=0, S=2, M=DRM

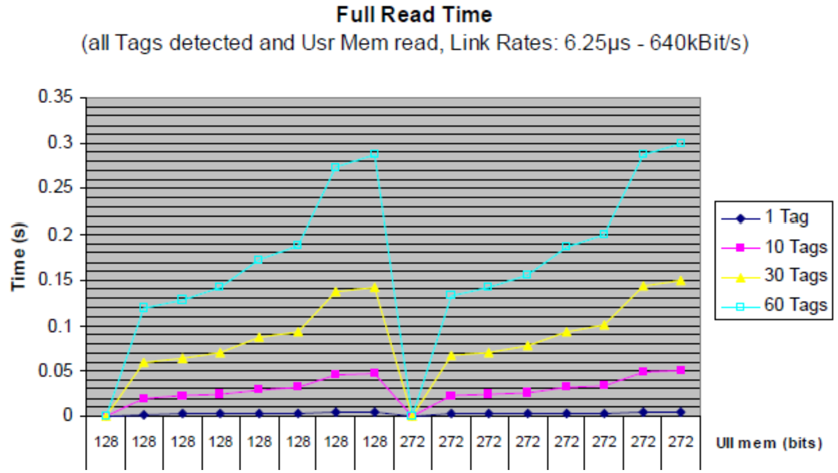


> 150% overhead to read 512 bit MB11

Courtesy: CISC Semiconductor Design+Consulting GmbH

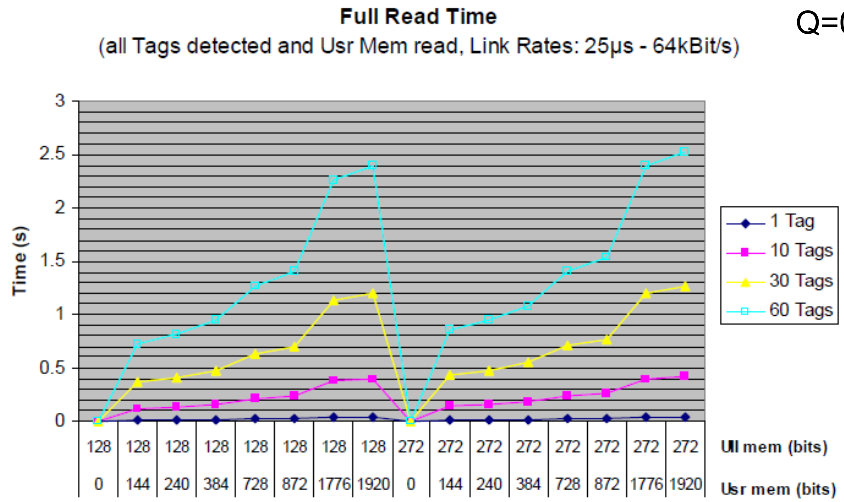
MB1 + MB3 read times, optimal vs. slow

Optimal



Q=0, S=2, M=DRM

Slow



Courtesy: CISC Semiconductor Design+Consulting GmbH

Proof of Concept leading to a Demonstrator and used equipment

- Develop a demonstrator as a Proof of Concept to prove that the hardware and software existed to encode several schemes in an ISO 18000-6C tag with 240 bit capacity in MB01

- Following activities were started in July 2008:
  - Describing the basic requirements for the demonstrator
  - Searching for sponsors
  - Purchasing the hardware
  - Developing the software (C-function for encoding/decoding and a GUI)
  - Testing the whole set-up
  - First live demonstration was given in Stuttgart end of September 2008

- Here is the right time to thank our sponsors:

NGIL Next Generation Innovative Logistics

ODETTE SWEDEN

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VOLVO Information Technology

VOLVO Volvo Logistics Corporation

Proof of Concept leading to a Demonstrator and used equipment (Continued)

- The requirements for the demonstrator:
  - cover Odette, DUNS and JIPDEC encoding schemes
  - store the critical data into MB01
  - assure that the content of MB01 is globally unique
  - apply the same scheme principal for RTI, Item/Part and Vehicle objects
  - use the memory efficiently as by using compaction where required
  - prove that compaction/de-compaction has no negative effect on performance
  - be compliant with all the standards in this field (see normative references)
  - measure performance in relation to reading and writing time

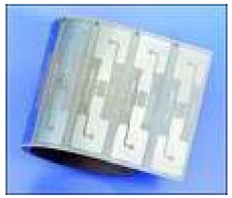
Proof of Concept leading to a Demonstrator and used equipment

Used equipment:

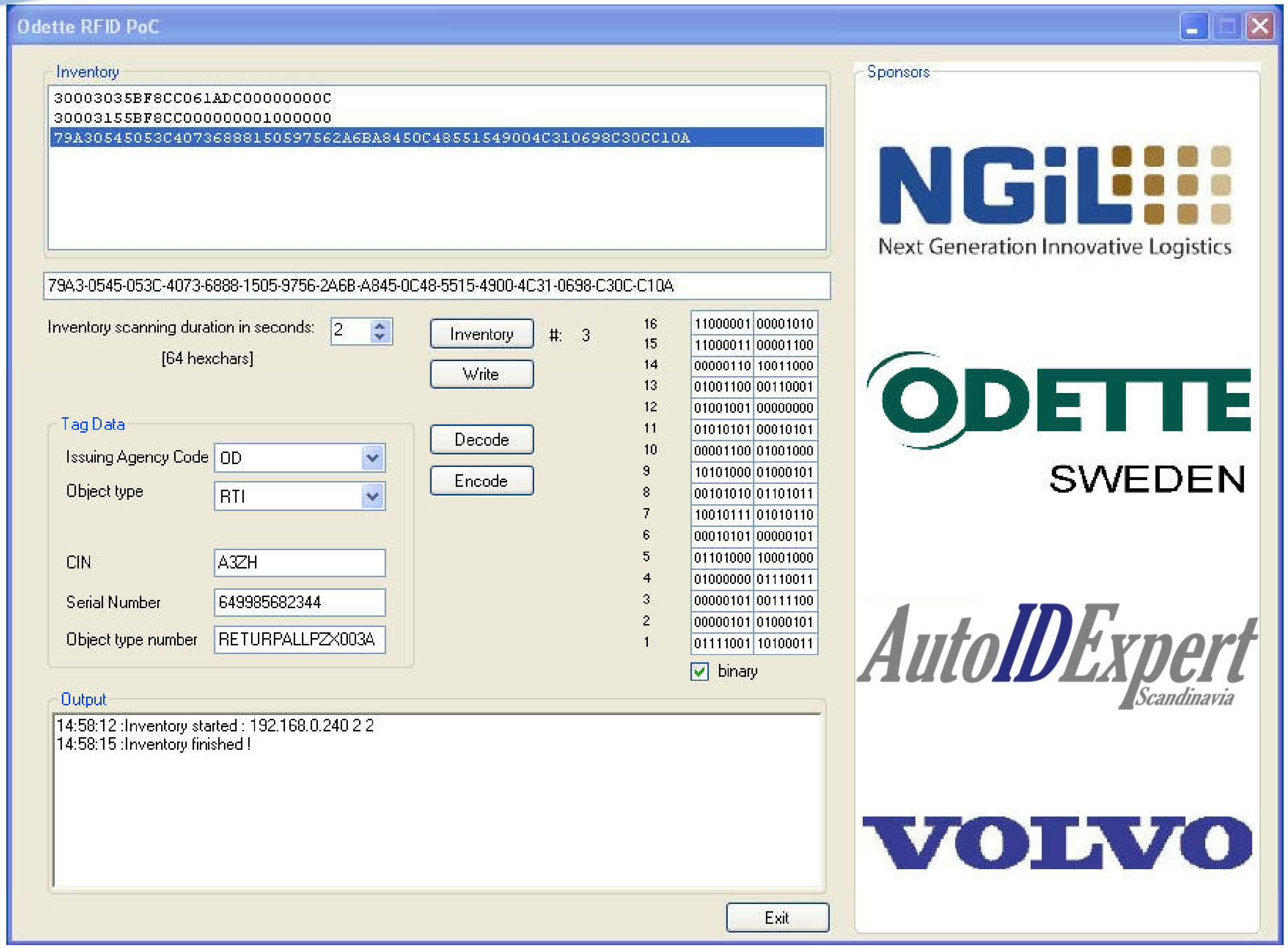
- ❖ Impinj UHF GEN2 Speedway® Reader

- ❖ Sensormatic RFID antenna

- ❖ UPM Raflatac tags with NXP G2XL chip:
  - ➢ DogBone 240 bit UII Wet Inlay
  - ➢ ShortDipole 240 bit UII Dry Inlay
  - ➢ ShortDipole 240 bit UII + 512 bit UserMemoryWet Inlay



The Demonstrator



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Findings

❖ How were our requirements for the demonstrator met:

- ➢ cover Odette, Duns and JIPDEC encoding schemes
- ➢ store the critical data into MB01
- ➢ assure that the content of MB01 is globally unique
- ➢ apply the same scheme principal for RTI, Item/Part and Vehicle objects
- ➢ use the memory efficiently as by using compaction where required
- ➢ prove that compaction/de-compaction has no negative effect on performance
  our software set-up didn't allow us to do precise time measurements
- ➢ be compliant with all the standards in this field (see normative references)
- ➢ measure performance in relation to reading and writing time
  our software set-up didn't allow us to do precise time measurements

Findings (Continued)

- Other findings from the demonstrator exercise:
  - writing a 240 bit tag in one go is not possible
    - ✓ we write the last 5 bytes and in a second write we fill the first bytes
    - ✓ the problem lies with the tags that are not active long enough
  - reading speed with 50 tags in the reading field of the antenna is between 350 to 400 tag reads per second
  - backscattering 50 240 bit tags takes less than one second, de-compaction included
  - reading performance increases drastically when objects are moving
  - reading performance increases when tags are applied on containers
  - a number of ambiguities found in and amongst ISO standards
  - ISO and EPC standards are changing at a fast rate

Possible next steps

- Next steps we consider for the demonstrator:
  - adapt the software to allow more precise performance measurements
  - refine the encoding scheme to be in line with the ISO standards
  - start to experiment with the content of MB11 (User Memory)
  - create a full pilot in a warehouse environment
  - explore the limits of reading distance (we have reached 12 meters)
  - explore the speed limit to pass by an antenna (35 km/h required)
- Next steps for ODETTE:
  - get an agreement that the proposed encoding scheme is a valid one, compliant with all standards, to support "open loop" applications

The ODETTE approach to encode ISO 18000-6C tags (Continued)

- ❖ Next to the ODETTE encoding scheme we wanted to accommodate the DUNS encoding schemes
- ❖ This is a challenge since both have different definitions and formats for the critical data. Thus different encoding/decoding schemes will be required.

			Serial Number	
	IAC	CIN	OT	OSN
Odette	OD	4 an	17 an	8 an
DUNS	UN	9 n	17 an	8 an

We foresee the maximum length for each attribute within one IAC.
Not used positions are padded with leading zeros

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The ODETTE approach to encode ISO 18000-6C tags (Continued)

- ❖ Next to the ODETTE encoding scheme we wanted to accommodate the DUNS encoding schemes
- ❖ This is a challenge since both have different definitions and formats for the CIN in the critical data. Thus different encoding schemes were required.
- ❖ We also strived for communality in the encoding schemes op RTIs, Parts and VIN

For RTIs and Parts the Serial Number consists of the OT and the OSN			Serial Number	
	IAC	CIN	OT	OSN
ODETTE	OD	4 an	17 an	8 an
DUNS 1	UN	9 n	17 an	8 an

For Vehicles the Serial Number consists only of the OT which is the VIN number			Serial Number
	IAC	CIN	OT
ODETTE	OD	4 an	17 an
DUNS 1	UN	9 n	17 an

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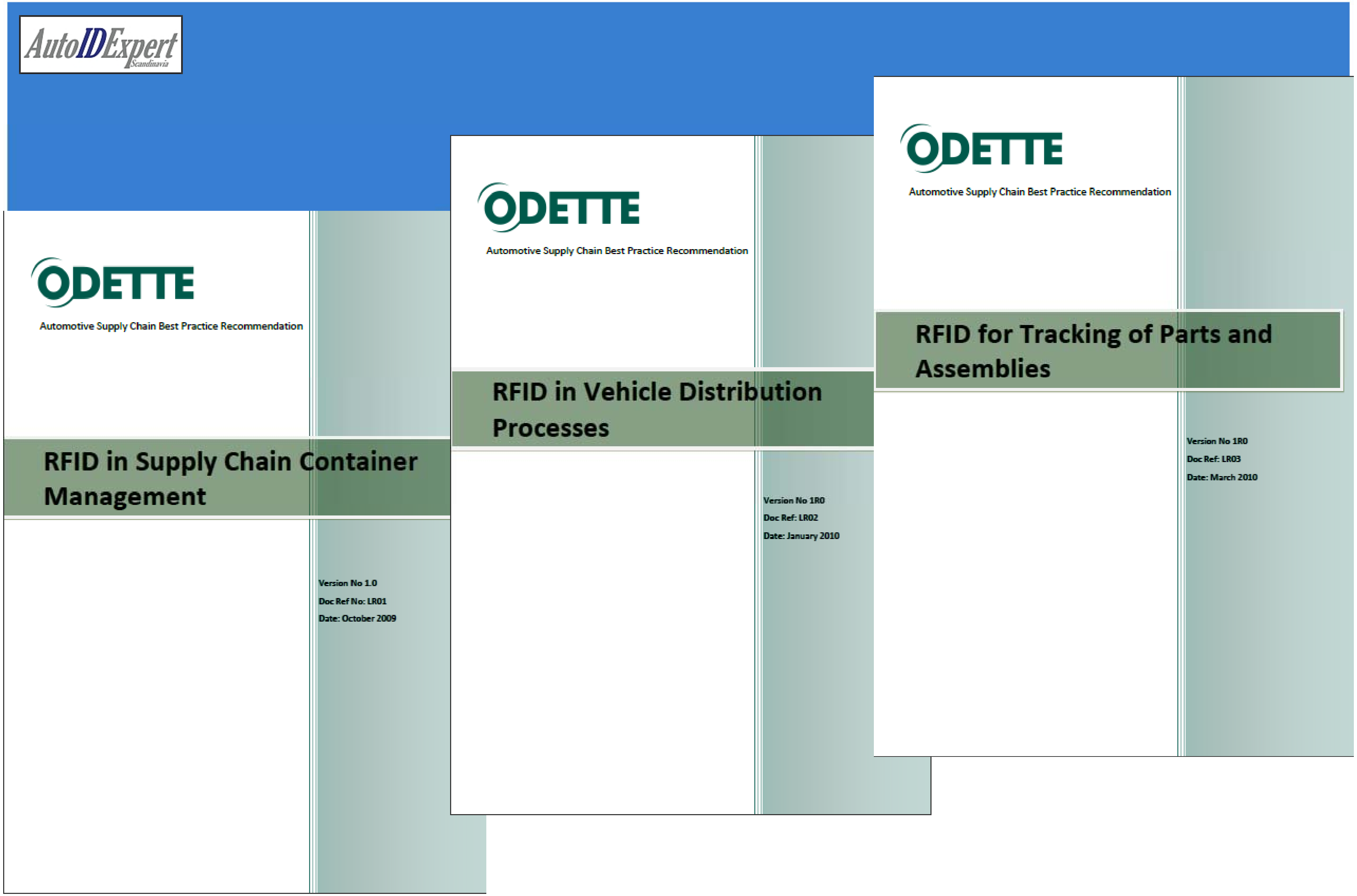
ISO 18000-6 MEMORY MAP and ODETTE ENCODING SCHEME (Continued)

Detailed description of MB01 describing each field and giving the bit position in the tag

Bit Pos.	Field Name	Remarks	# bits
100-10F	Padding Zeros	To complete compacted data to a full word if so required	
38-107	Compacted Data containing DI, I/		
18-1F	AFI (application format identifier)	A1 for Vehicle VIN (finished vehicles are considered Items)	8
10-14	PC-word (Protocol Control - word)	Length: in words (=2 bytes) without CRC-16 and PC Word	5
15		User Memory: 0 = No Data in User Memory and 1 = Data in User Memory	1
16		Extended Protocol Control Indicator:	1
17		NSI Indicator: 0 = EPC and 1 = ISO(AFI)	1
00-0F	CRC-16 CRC-16	CRC-16: Cyclic Redundancy Check	16

ISO/IEC 15962 Data Compaction Schemes & Codes

Character				
Low	High	Description	Name	Code
		As presented by the application	Application defined	000
30	39	Integer	Integer	001
30	39	Numeric string (from "0" to "9")	Numeric	010
41	5F	Uppercase alphabetic	5 bit code	011
20	5F	Uppercase numeric, etc…	6 bit code	100
00	7E	US ASCII	7 bit code	101
00	FF	Unaltered 8-bit (default = ISO/IEC 8859-1)	Octet string	110
		External compaction of ISO/IEC 10646	UTF-8 string	111



ODETTE
Automotive Supply Chain Best Practice Recommendation

RFID in Supply Chain Container Management

Version No 1.0
Doc Ref No: LR01
Date: October 2009

ODETTE
Automotive Supply Chain Best Practice Recommendation

RFID in Vehicle Distribution Processes

Version No 1R0
Doc Ref: LR02
Date: January 2010

ODETTE
Automotive Supply Chain Best Practice Recommendation

RFID for Tracking of Parts and Assemblies

Version No 1R0
Doc Ref: LR03
Date: March 2010

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- NGIL (Lund University, Vinnova, …)
- Craig Harmon, Q.E.D. Systems / ISO /ANSI
- Bill Hoffman, Hoffman Systems LLC
- …

A final thought …

"People have a tendency to overestimate technology in the short term, and underestimate it in the long term."

Bill Gates

Thank You
from

Bob van Broeckhoven, Volvo Logistics

and

Olle Hydbom
Olle.Hydbom@AutoIDExpert.se
http://www.AutoIDExpert.com

who already has a prototype of a complete Odette RFID coder/decoder available!

Questions and Answers