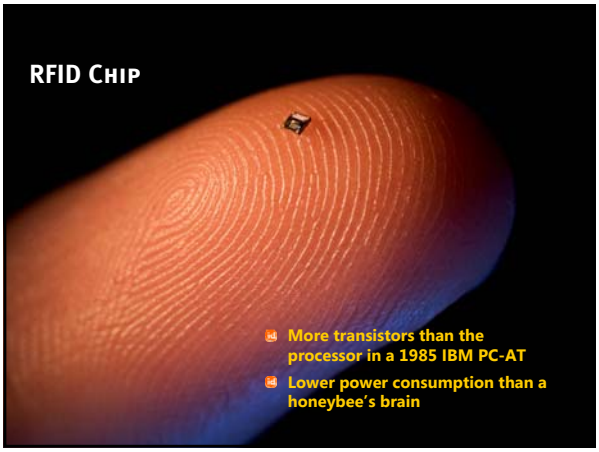
RFID Hands-On Workshop

Identify Limited
In co-operation with
Thai National Shipper Council

8 February 2006

RFID Chip



- More transistors than the processor in a 1985 IBM PC-AT
- Lower power consumption than a honeybee's brain

Smith Suksmith

- MD Siriraj Medical School
- MIS University of Washington
- MBA Seattle University
- Consultant to USDA, US Custom, Dept Home Land Security, US Treasury
- Involvement in RFID since 1999 with AutoId Center @MIT
- Involvement in WalMart trial, DHL trial
- Managing Director, Identify Limited – RFID company

Identify RFID

Wiroj Ngamsukkasamesri

- MBA Cambridge, UK
- Thammasart University, Gold medal
- 10+ years experiences in various MNC
- 3 years experience in Mitsubishi Corp.
- Supply Chain Research Manager
- General Manager, Identify Limited – RFID company

Identify Limited

- Founded in 2002 with more than 5+ years in prior RFID experiences
- World-class experiences in Technology, Implementation and Consultation
  - US Governments : USDA, US Customs, Dept Homeland Security, US Treasury
  - Auto-ID Center: Walmart, DHL pilot sites
- Develop & Own RFID products & patents
  - Active Tags, Passive Labels, Electronic Seals
  - RFID Readers
  - Software/Middleware
- Most Clients & Site References in RFID Implementation

Agenda

- 9:00 a.m. – 10:30 a.m. RFID Fundamentals
  - Birds eye view of RFID system, Why RFID now? Benefits of RFID
  - Hardware: tags, readers, antennas and networks
  - Tag Features, choices, and affixing methods
  - RFID compare to Barcode, Pros and Cons
  - Global development in using and implanting of RFID
- 10:30 a.m. – 10:45 a.m. Refreshment Break
- 10:45 a.m. – 12:00 noon RFID Applications and Standards
  - RFID in logistics and supply chains
  - RFID in access controls and securities
  - RFID in tracking and traceability
  - RFID in assets management
  - RFID standards
  - ISO standards involving in RFID
  - ISO vs EPC
  - Regulatory frequency issues

Agenda (cont.)

- 1:00 p.m. – 2:00 p.m. The EPCglobal Network: Real-Time Supply Chain
  - EPCglobal, Inc organization and its structure
  - EPC (Electronic Product Code) - a global object numbering system
  - Middleware - software that connects objects to
  - EPC Network architecture , ONS, ALE, EPC-IS, PML
  - Benefits to supply chain
- 2:00 p.m. – 3:00 p.m. RFID and Business Process Integration Issues
  - Comparison between RFID Software and Enterprise Software
  - Preparing for integration, Data requirements, Preparing for RFID driven business process changes
  - Various levels of integration, Integration layers - device, application, business
- 3:00 p.m. – 3:15 p.m. Refreshment Break
- 3:15 p.m. – 4:00 p.m. RFID Demonstration
  - Environments like metal, liquid
  - Moving Environments, Stationary Environments
  - Orientation demonstrations
  - Read Distance Tests, Write (if applicable) Distance Tests

Identify RFID

Agenda

1. RFID Fundamentals
2. RFID Applications and Standards
3. EPCglobal Network: Real-Time Supply Chain
4. RFID Business Process Integration Issues
5. RFID Demonstration

Identify RFID

The History

- 1935 RFID transponders were used to identify Friend or Foe (IFF) of approaching aircraft
  - Versions of this same IFF system did not appear in civilian circraft until the mid-1950's
  - A modified version of this is still used today
- Late 60's, the US Government developed RFID technology to tag & monitor nuclear and other hazardous materials

242 Interrogator 253 Transponder

Interrogator and Transponder stand several feet tall.
Photos Courtesy of The British Admiralty
Reproduced from a paper by Jerry Proc

Identify RFID

The History (cont.)

- 1972 Schlage Electronics (now Westinghouse developed an RFID card embedded
- 1977 Los Alamos Scientific Laboratories transferred their technology to public sector
- Two companies initially explored use of RFID
  - Amtech in New Mexico
  - Identronix Research in California

The History (cont.)

- Identronix Research explored animal ID
- RFID devices were implanted into animals
- Uses were for
  - Identification
  - Temperature monitoring
  - Automatically dispensing food
- Eventually, RFID animal tagging became important enough for the ISO organization to set standards (ISO 11784/85)

The History (cont.)

- By mid 1980's, RFID technology research focused on
  - Performance improvements
  - Cost reduction
  - Size reduction
- Once RFID circuits could be embedded into a card
  - RFID technology become very popular for access control and security applications

What is RFID

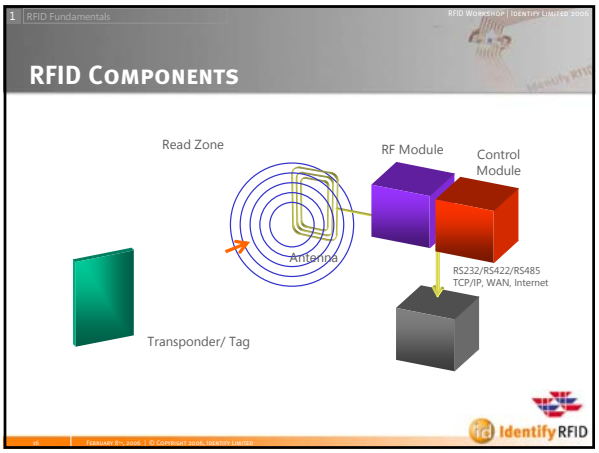
- RFID is **R**adio **F**requency **Id**entification
  - Used for automatic identification or data collection (AIDC)
- Similar to bar code in concepts
  - RFID tag stores data ~ barcode label
  - RFID reader ~ barcode scanner
- Radio waves vs. Light waves

How RFID works

- Relies on Radio Frequency Waves
- A transponder communicate with a reader when is in the reading range
- **Contact-less** technology, No Line-Of-Sight required
- Read through various environment conditions
- One-way or Two-way (RO or RW)

RFID basic components

Tags	Antenna	Reader	Host Computer
			
• Device made up of an electronic circuit and an integrated antenna • RF used to transfer data between the tag and the antenna • Portable memory • Read-only or read/write • Active or passive • Usually attached to specific items	• Receives and transmits the radio frequency signals • Wireless data transfer • May be integrated in the reader for short range applications or structural for warehouse applications	• Communicates with the tag via antenna • Receives commands from application software • Interprets radio waves into digital information • Provides power supply to passive tags	• Reads/writes data from/to the tags through the reader • Stores and evaluates obtained data • Links the transceiver to an applications, e.g. ERP


1 RFID Fundamentals
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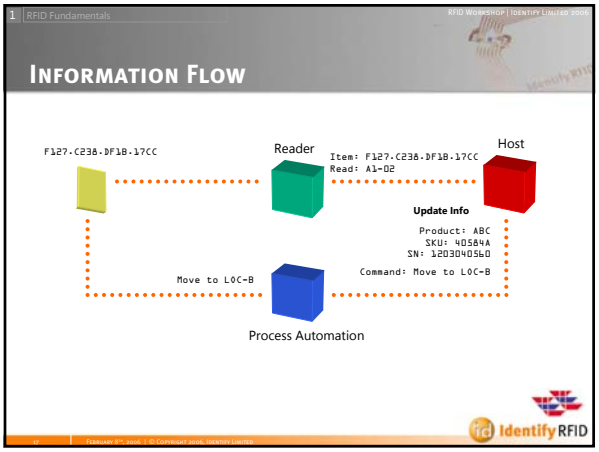
RFID Components
Read Zone
RF Module
Control Module
Antenna
RS232/RS422/RS485
TCP/IP, WAN, Internet
Transponder/ Tag
Identify RFID


1 RFID Fundamentals
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Information Flow
F127·C238·DF1B·17CC
Reader
Item: F127·C238·DF1B·17CC
Read: A1-02
Host
Update Info
Product: ABC
SKU: 40584A
SN: 120304560
Command: Move to LOC-B
Move to LOC-B
Process Automation
Identify RFID


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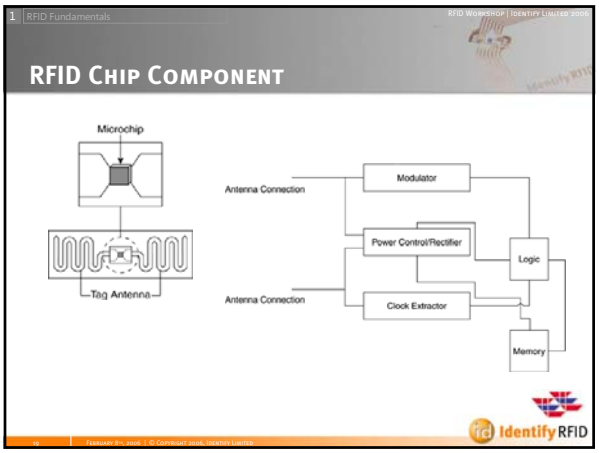
RFID Chips
Identify RFID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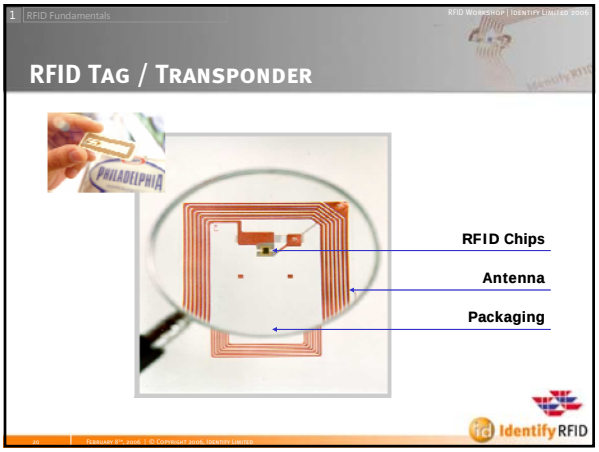
RFID Chip Component
Microchip
Tag Antenna
Antenna Connection
Antenna Connection
Modulator
Power Control/Rectifier
Clock Extractor
Logic
Memory
Identify RFID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RFID Tag / Transponder
PHILADELPHIA
RFID Chips
Antenna
Packaging
Identify RFID


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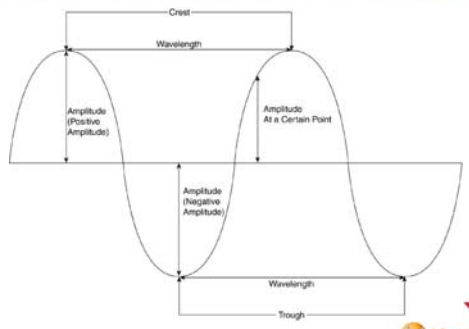
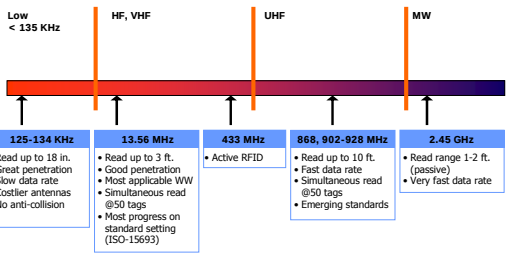
Technical Aspects of RFID

- Frequency
- Tag Power Source
- Read – Read/Write
- AntiCollision
- Who talks first?
- Air Interface Protocol

Fundamental Concepts of Wave



Frequency Spectrum



RF Properties

- Radio Lucent or Radio Friendly
  - lets radio waves at this frequency pass through it without any substantial loss of energy
- Radio Absorbent
  - blocks, reflects, and scatters RF waves.
- Radio Opaque
  - A material can allow the radio waves to propagate through it but with substantial loss of energy
  - The RF-absorbent or RF-opaque property of a material is relative, because it depends on the frequency

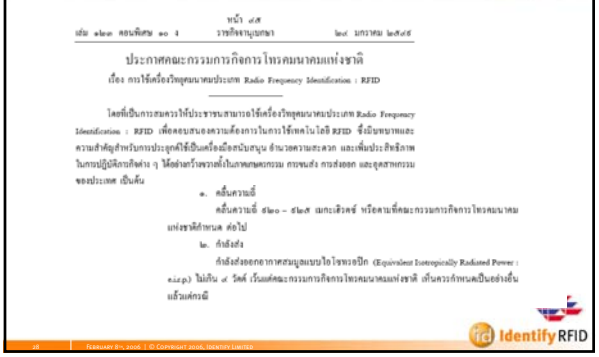
RF Properties of Example Materials

Material	LF	HF	UHF	Microwave
Clothing	RF-lucent	RF-lucent	RF-lucent	RF-lucent
Dry wood	RF-lucent	RF-lucent	RF-lucent	RF-absorbent
Graphite	RF-lucent	RF-lucent	RF-opaque	RF-opaque
Liquids*	RF-lucent	RF-lucent	RF-absorbent	RF-absorbent
Metals	RF-lucent	RF-lucent	RF-opaque	RF-opaque
Motor oil	RF-lucent	RF-lucent	RF-lucent	RF-lucent
Paper products	RF-lucent	RF-lucent	RF-lucent	RF-lucent
Plastics*	RF-lucent	RF-lucent	RF-lucent	RF-lucent
Shampoo	RF-lucent	RF-lucent	RF-absorbent	RF-absorbent
Water	RF-lucent	RF-lucent	RF-absorbent	RF-absorbent
Wet wood	RF-lucent	RF-lucent	RF-absorbent	RF-absorbent

International RFID Freq Regulations

Country/Region	LF	HF	UHF	MW
US	125-134 KHz	13.56 MHz 10w ERP	902-928 MHz 1w ERP or 4w EIRP with FHSS	2400-2483.5 MHz 4w ERP 5725-5850 MHz
Europe	125-134 KHz	13.56 MHz	865-865.5 MHz 0.1w ERP LBT 865-867.6 MHz 2w ERP 867.6-868 MHz 0.5w ERP	2.45 GHz
Japan	125-134 KHz	13.56 MHz	Proposed 950-956 MHz	2.45 GHz
Singapore	125-134 KHz	13.56 MHz	923-925 MHz 2w ERP	2.45 GHz
China	125-134 KHz	13.56 MHz	Proposed 840-843, 917-925 MHz	2446-2454 MHz 0.5w ERP
Thailand			920-925 MHz 4w EIRP	

Thailand Development



หน้า ๑๕
เล่ม ๑๒๓ ตอนพิเศษ ๑๐ ง ราชกิจจานุเบกษา ๒๗ มกราคม ๒๕๔๙

ประกาศคณะกรรมการกิจการโทรคมนาคมแห่งชาติ
เรื่อง การใช้เครื่องวิทยุคมนาคมประเภท Radio Frequency Identification : RFID

โดยที่เป็นการสมควรให้ประชาชนสามารถใช้เครื่องวิทยุคมนาคมประเภท Radio Frequency Identification : RFID เพื่อตอบสนองความต้องการในการใช้เทคโนโลยี RFID ซึ่งมีบทบาทและความสำคัญสำหรับการประยุกต์ใช้เป็นเครื่องมือสนับสนุน อำนวยความสะดวก และเพิ่มประสิทธิภาพในกระบวนการปฏิบัติกิจกิจต่าง ๆ ได้อย่างกว้างขวางตั้งในภาคเกษตรกรรม การขนส่ง การส่งออก และอุตสาหกรรมของประเทศ เป็นต้น

๑. คลื่นความถี่
คลื่นความถี่ ๕๒๐ – ๕๒๕ เมกะเฮิรตซ์ หรือตามที่คณะกรรมการกิจการโทรคมนาคมแห่งชาติกำหนด ต่อไป

๒. กำลังส่ง
กำลังส่งออกอากาศสมมูลแบบไอโซทรอปิก (Equivalent Isotropically Radiated Power : e.i.r.p.) ไม่เกิน ๔ วัตต์ เว้นแต่คณะกรรมการกิจการโทรคมนาคมแห่งชาติ เห็นควรกำหนดเป็นอย่างอื่นแล้วแต่กรณี

Thailand Frequency :: RFID Related

- <135 KHz <150mW E.I.R.P
- 13.56 MHz <10mW E.I.R.P
- 300-500 MHz <10mW E.I.R.P (Medical, RLS)
- 920-925 MHz 4W E.I.R.P (0.5W unlicensed)
- 2400-2500 MHz <100mW E.I.R.P

Tag Power Source

- **Passive**
  - Power by energy from reader
    - Backscatter technology
    - Smaller, Lighter, less expensive
    - Almost unlimited life
    - Shorter range
    - Requires higher power from reader
- **Active**
  - On-board battery power source
    - On-board transmitter
    - Greater range but higher cost
    - Requires less power from reader
    - Finite life

Tag Power Source

- **Semi-Active or Battery Assisted Passive**
  - On-board battery power source
    - Uses Passive Technology (no transmitter)
    - Greater range but higher cost (less than active)
    - Requires less power from reader
    - Finite life (but longer than active)
    - Not create RF pollution

Read vs. Read/Write

- **Read Only**
  - Information can only be read from an RFID device – Programmed at manufacture
- **User Programmable**
  - WORM – Write Once Read Many, Ability to initialize an RFID device outside of the RFID manufacturer's facility after manufacture
- **Read/Write**
  - Information can be read from or written to an RFID transponder during the time it is presented to a reader/writer
  - Typically asymmetric read and write operating range

Anti-Collision / WTF

- **Anti-Collision**
  - Ability to communicate with several transponders simultaneously
  - Important in longer range readers
  - Must be implemented in the RF Chips design
- **Who Talks First**
  - Tag Talks First (TTF) – I'm here
  - Reader Talks First (RTF) – Who's there

Long Range vs. Short Range

- **Long-range**
  - > 3m
  - Active transmit or battery assisted backscatter technology
  - More memory
  - Complex functions
  - Battery
  - $$ to $$$
- **Short-range**
  - < 3m
  - Passive technology
  - Simple functions
  - No battery
  - $

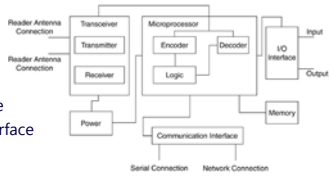
Protocol

- The method used to talk from a reader to a tag
- Includes modulation method, error correction, anti-collision technique, message format, commands etc.

Reader

Reader

- Main Components
  - Transmitter
  - Receiver
  - Microprocessor
  - Memory
  - External I/O Interface
  - Communication Interface
  - Power Supply

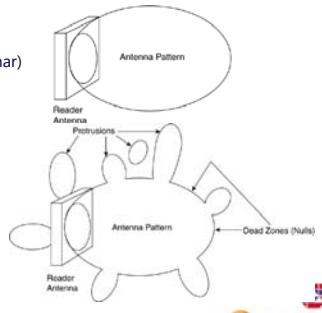


Reader Types

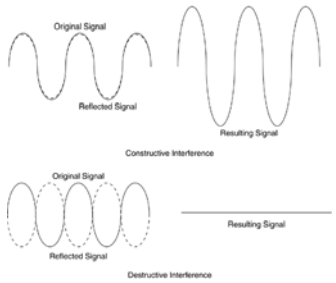
- Station Reader
  - Functional Mode
    - Interactive mode
    - Autonomous mode
  - Antenna Type
    - External (Single/Multi)
    - Internal
  - Agile
- Handheld Reader
- Embedded Reader

Antenna Footprint

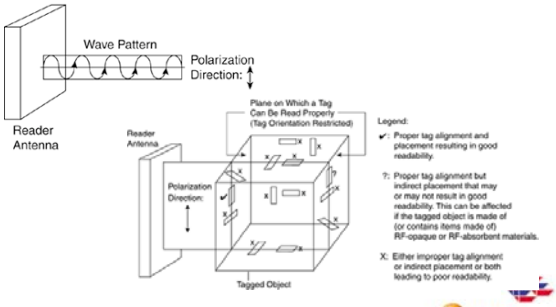
- Pattern
  - Patch Antenna (Planar)



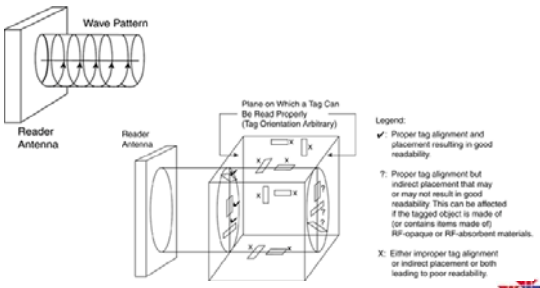
Multipath Schematic



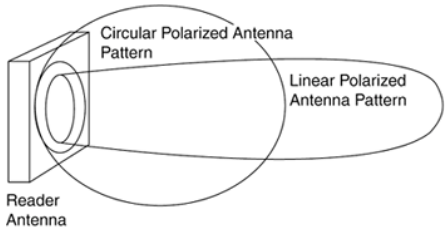
Linear Polarized Antenna



Circular Polarized Antenna



Polarized Pattern



RFID Benefits

- Eliminate human error
- Uniquely identify the object
- No line of sight required
- Performs in rugged, dirty, oily, wet or harsh environments
- Simultaneous reading & identification of multiple tags
- Have no moving parts
- Very difficult to copy and counterfeit
- Fast reading

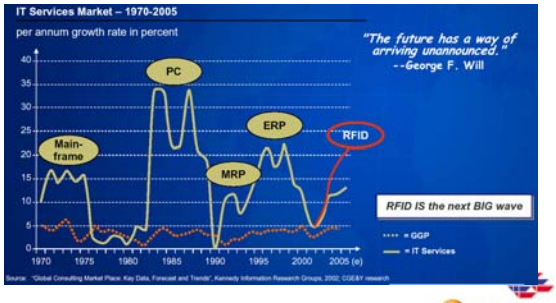
RFID vs. Barcode

+	No need for line of sight Store significantly more data Dynamic, data can be added, changed at every steps Difficult to counterfeit Can process multiple reading Tags is reusable	Low cost Widespread Human readable
−	Higher cost but dropping (but reusable) Uncertain "universality" Currently too dependent on environmental condition Tightly linked to the infrastructure	Clear line of sight required Information storage is limited Read-only, one at a time Read capability can be affected by dirt, water, scuffing

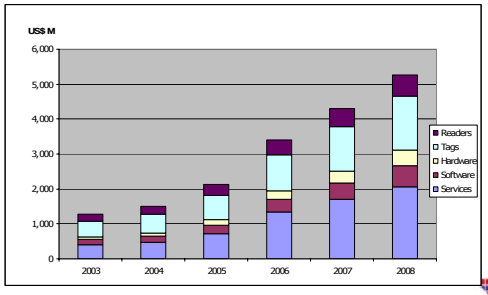
A Hybrid World

- Traditional bar codes
  - Will remain the dominant auto ID technology in most mainstream applications for the foreseeable future
  - Lowest cost, broadest applicability, huge infrastructure investment
- 2D bar codes
  - Will be increasingly adopted for value added applications
  - Portable data files, supplementary retail coding etc.
- RFID
  - Will be increasingly adopted where non-line of sight, read/write, multiple detection offers real advantages

IT Services Market

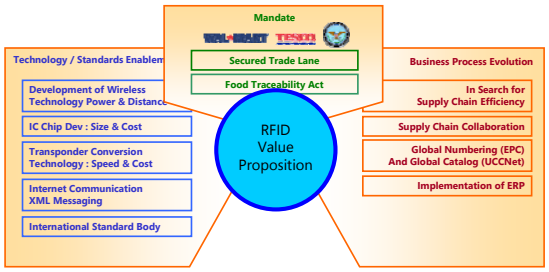


RFID Market is Expanding at CAGR 36%



Source: Venture Development Corp., ABI Yankee Group, AMR

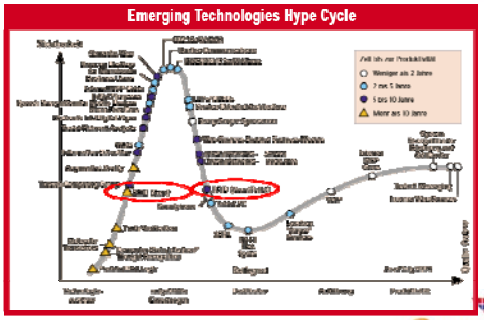
Why's it time for RFID?



Major RFID Initiatives

- Wal-Mart: 2005, 2006 mandates
- DOD Logistics Air Office: 2005–2010 phase-in
- Target: Spring 2005, 2007
- Albertsons: April 2005
- Metro Group: Nov 2004 mandate
- Tesco: April 2004, Sept 2004, 2006 mandates
- Best Buy: Jan 2006, May 2007

RFID Hype Cycle



Source: Jackie Fenn, Gartner Group

Agenda

1 RFID Fundamentals

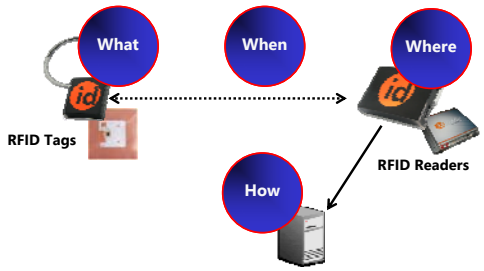
2 RFID Applications and Standards

3 EPCglobal Network: Real-Time Supply Chain

4 RFID Business Process Integration Issues

5 RFID Demonstration

Key Factors for Efficiency



RFID Major Application Areas

- Assets Management
- Track & Traces
- Identification
- Authentication / Anti-Counterfeit
- Security / Monitoring / Access Control
- Electronic Payment

Access Control

- The ubiquitous employee badge is RFID
- Vehicle access
- NEXUS border inspection program at Peace Arch

Electronic Toll Collection, Rail Tracking

- Toll tags speed regular users through toll gates
- RFID tag on windshield identifies vehicle and enables toll deduction from account
- 99% of every North American railcar in interchange service equipped with RFID

Identification

- Medical Treatment
- Protection
- Monitoring
- Access Control
- Verification
- Traceability

Baggage Tracking

- Positive Passenger-Bag Matching initiatives (PPBM)
- Bar code systems work today but line-of-sight requirements make complicated solutions
- 1 to 2 billion tags/year
- Many pilots to date
- Tag price is key

Industry Automation

- Automated Assembly
- Customized Product

Automated Warehouse

- Enhance Efficiency
- Reduce Error Rate
- Improve Customer Services

RFID Value Chain & Key Benefit Areas

Cost	Revenue	Operational Effectiveness
• Reduced labor costs • Lower shrink costs • Lower inventory costs • Reduced reconciliation costs • Reduced returns costs	• Improved product availability on shelf • Increased cross channel selling opportunities • Enhanced 'point of decision' sales capabilities	• Improved product visibility • Improved asset & labor visibility • Improved data accuracy • Reduced handling requirements • Greater temperature & rotation capability • Improved planning, forecasting & allocation

Source: IBM Business Consulting Services analysis, Auto-ID Center

Electronic Payment

Mobile Phone Payment

Product Authentication

- Embedded directly into products
- FDA focus to reduce counterfeiting of pharmaceuticals

Container Security

- ☑ Container No
- ☑ Container Type
- ☑ Shipment No
- ☑ Destination
- ☑ Weight
- ☑ Seal Time

- ☑ License
- ☑ Number
- ☑ Truck Type
- ☑ Company
- ☑ Weight
- ☑ GPS (Optional)

Assets Tracking/Location

- The software generates a geo-referenced map or floor plan of the tracked area.
- The assets are then placed on the floor plan in real-time with an average resolution of five to ten feet, depending on vendor technology and infrastructure.


2 | RFID Applications
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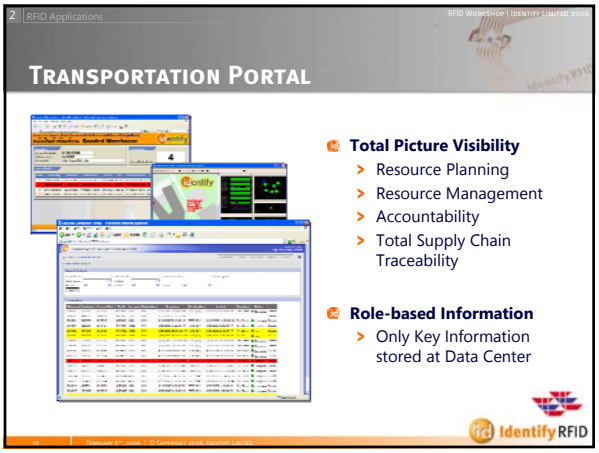
RFID in Exhibition Events
REGISTRATION SYSTEM WITH RFID
Identify RFID


2 | RFID Applications
RFID Workshop | Identify Limited 2006
Customs e-FreeZone
Western Digital
Identify RFID


2 | RFID Applications
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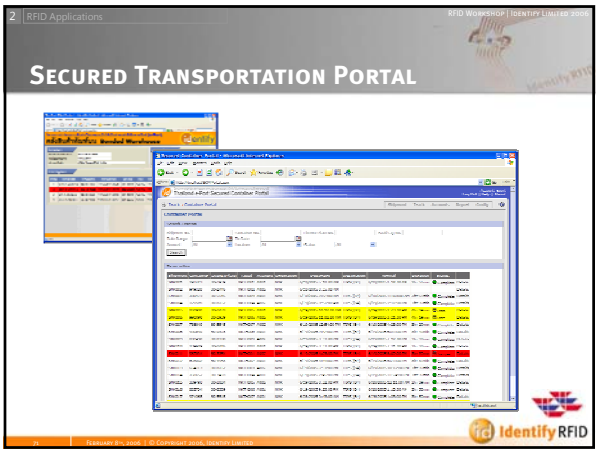
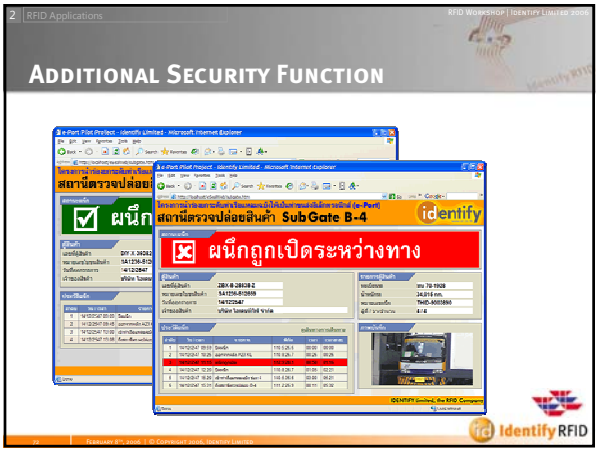
Transportation Portal
Total Picture Visibility
Resource Planning
Resource Management
Accountability
Total Supply Chain Traceability
Role-based Information
Only Key Information stored at Data Center
Identify RFID


2 RFID Applications
RFID Workshop | Identify Limited 2006
Secured Transportation Portal
Identify RFID


2 RFID Applications
RFID Workshop | Identify Limited 2006
Additional Security Function
สถานีตรวจปล่อยสินค้า SubGate B-4
ผนึกถูกเปิดระหว่างทาง
Identify RFID


2 RFID Applications
RFID Workshop | Identify Limited 2006
Vehicle Tracking
Identify RFID


2 | RFID Applications
RFID Workshop | Identify Limited 2006
RFID in Warehouse Management
Identify RFID


2 | RFID Applications
RFID Workshop | Identify Limited 2006
RFID in Exhibition Events
REGISTRATION SYSTEM WITH RFID
Identify RFID


2 | RFID Applications
RFID Workshop | Identify Limited 2006
RFID Mobile Payment
Identify RFID

Agenda

1 RFID Fundamentals

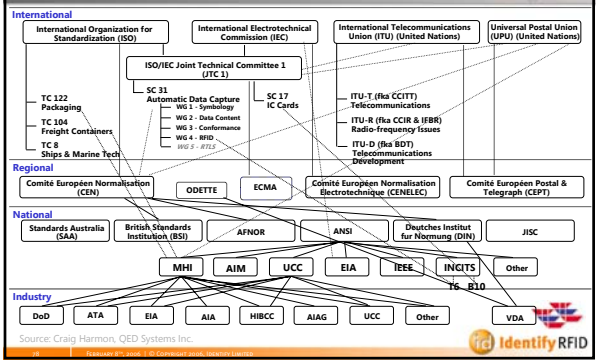
2 RFID Applications and Standards

3 EPCglobal Network: Real-Time Supply Chain

4 RFID Business Process Integration Issues

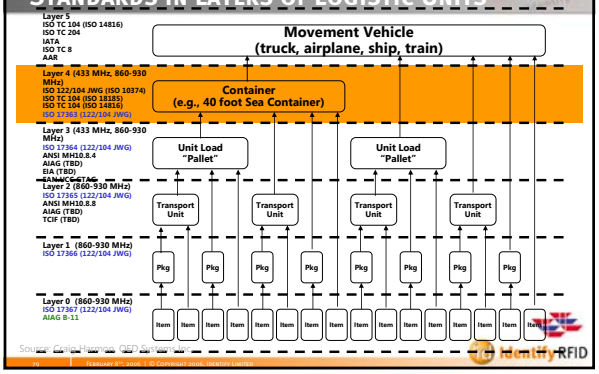
5 RFID Demonstration

Standards Organizations



Source: Craig Harmon, QED Systems Inc.

Standards in Layers of Logistic Units



Source: Craig Harmon, QED Systems Inc.

Types of Auto-ID Standards

- Technology (Symbology, RFID, I.C. Card)
- Data Content (DIs, AIs, Syntax)
- Conformance (Print Quality, Test Specifications)
- Application Standards (Ship Label, Product Package)

Technology Standards

- ISO/IEC 18000 - RFID for Item Management
  - Part 2 - < 135 kHz
  - Part 3 - 13.56 MHz
  - Part 4 - 2450 MHz
  - Part 6 - 860 - 960 MHz
  - Part 7 - 433.92 MHz (active)

Data Standards

- ISO/IEC 15418 - Application Identifiers & Data Identifiers
- ISO/IEC 15434 - Syntax
- ISO/IEC 15459 - Transport License Plate
- ISO/IEC 24721 - Unique Identification
- ISO/IEC 15961 - Data Protocol: Application Interface
- ISO/IEC 15962 - Data Protocol: Data Encoding Rules and Logical Memory Functions

Conformance Standards

- ISO/IEC 18047 - RFID device conformance test methods
  - Part 2 - < 135 kHz
  - Part 3 - 13.56 MHz
  - Part 4 - 2450 MHz
  - Part 6 - 860 - 960 MHz
  - Part 7 - 433.92 MHz (active)

Application Standards

- ISO 10374 - Freight containers — Automatic identification
- ISO 18185 - Freight Containers - Radio-frequency communication protocol for electronic seal
- ISO 11785 - Radio-frequency identification of animals — Technical concept
- ANSI MH10.8.4 - RFID for Returnable Containers
- AIAG B-11 - Tire & Wheel Identification Standard
- EAN.UCC GTAG
- ISO 122/104 JWG - Supply Chain Applications of RFID
  - ISO 17363 - Freight Containers
  - ISO 17364 - Returnable Transport Items
  - ISO 17365 - Transport Units
  - ISO 17363 - Product Packaging
  - ISO 17364 - Product Tagging


EPCglobal
http://www.epcglobalinc.org
http://www.epcglobalus.org
86
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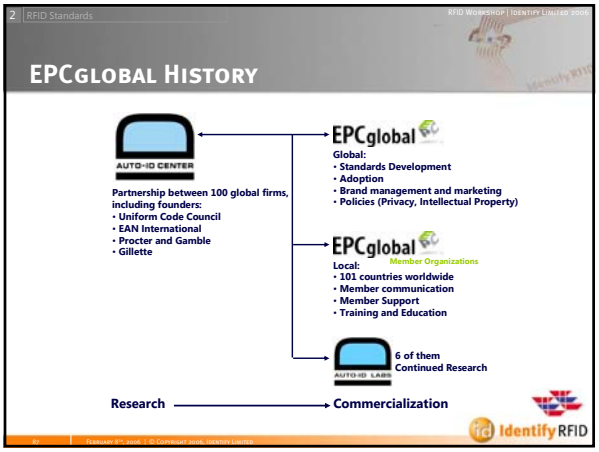
2 | RFID Standards
RFID Workshop | Identify Limited 2006
EPCglobal History
AUTO-ID CENTER
Partnership between 100 global firms, including founders:
• Uniform Code Council
• EAN International
• Procter and Gamble
• Gillette
EPCglobal
Global:
• Standards Development
• Adoption
• Brand management and marketing
• Policies (Privacy, Intellectual Property)
EPCglobal
Member Organizations
Local:
• 101 countries worldwide
• Member communication
• Member Support
• Training and Education
AUTO-ID LABS
6 of them
Continued Research
Research
Commercialization
Identify RFID
87
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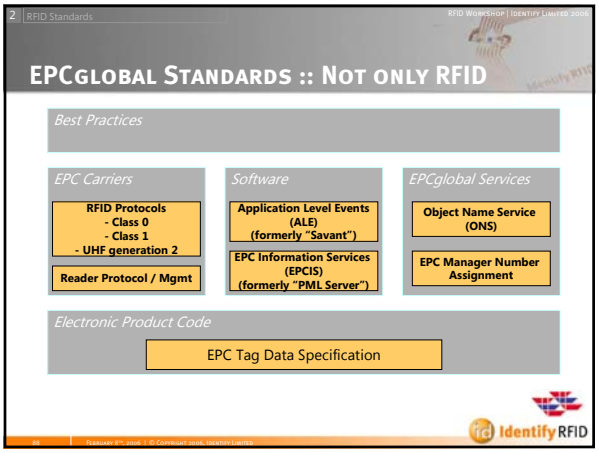
2 | RFID Standards
RFID Workshop | Identify Limited 2006
EPCglobal Standards :: Not only RFID
Best Practices
EPC Carriers
RFID Protocols
- Class 0
- Class 1
- UHF generation 2
Reader Protocol / Mgmt
Software
Application Level Events (ALE) (formerly "Savant")
EPC Information Services (EPCIS) (formerly "PML Server")
EPCglobal Services
Object Name Service (ONS)
EPC Manager Number Assignment
Electronic Product Code
EPC Tag Data Specification
Identify RFID
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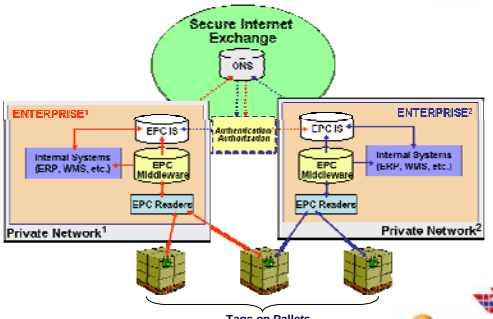
EPCglobal Network



EPC Class I-V

Class V tags
Readers. Can power other Class I, II and III tags; Communicate with Classes IV and V.

Class IV tags:
Active tags with
broad-band peer-to-peer communication

Class III tags:
semi-passive RFID tags

Class II tags:
passive tags with additional functionality

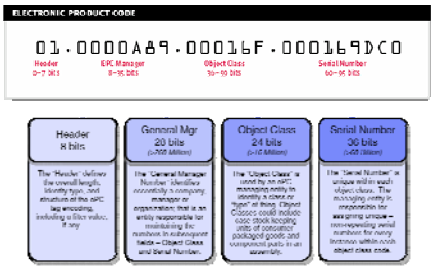
Class 0/Class I:
read-only passive tags

EPC-96 Structure

Element	Header	EPC Manager	Object Class	Serial Number
Bits	8	34	20	34
$Values_{10}$	0-256	0-17,179,869,183	0-1,048,575	0-17,179,869,183 (inc 0-9)

- Class 0 - 64 bits
- Class 1 - 96 bits
- Class 1 G2 - 128/256 bits
- Class 2 - Class 1 with larger memory and read/write
- Class 3 - Class 2 with sensors (semi-passive)
- Class 4 - Active tags

Electronic Product Code (EPC)



ePC is flexible enough to capture identification information at any level and is supported by current standards bodies like UCGnet and EAN

96 bits – Is it enough?

BITS	UNIQUE NUMBER	OBJECTS
23	6.0×10^{6} per annum	Automobiles
29	5.6×10^{8} in use	Computers
33	6.0×10^{9} total	Humans
34	2.0×10^{10} per annum	Razor blades
54	1.3×10^{16} per annum	Grains of rice

EPC, Extension of GTIN

GTIN / UCC
- **14-digit structured number**
- **Limited name space**
- **Item level only**

EPC
- **96-bit structured code**
- **Larger name space**
- **Unique instance level ID**

- EPC, and similar, can be mapped to GTIN / UCC
- Standard adopted by both UCC and EAN via EPCGlobal

ISO vs EPC

	ISO	EPC
Technology	ISO/IEC 18000-x All Frequency	Class I-V 13.56 and UHF only
Data Content	ISO/IEC 15418, 15434, 15459, 15961, 15962	EPC
Conformance	ISO 18047	N/A
Application	Vary by Industries e.g. 18185, 11785, etc.	
Others		EPCIS, ONS, Reader Protocol, ALE, Registration Services
Active	433.62 MHz 2450, 860-960 Applicable	Not specified

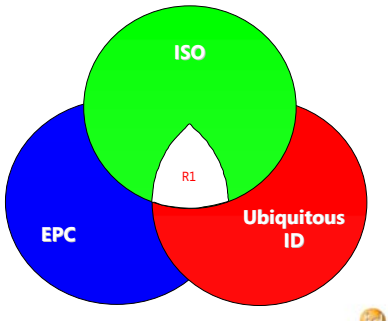
ISO vs EPC

	ISO	EPCglobal
Architecture	Top-down architecture	Bottom-up architecture
Technology	ISO/IEC 18000-x All Frequency	Class I-V 13.56 MHz and UHF (860-960) only
Data Content	ISO/IEC 15418, 15434, 15459, 15961, 15962	EPC
Applications	Standard to embrace global applications	Restricted to EPC applications
Others		EPCIS, ONS, Reader Protocol, ALE, Registration Services
Active RFID	433.62 MHz, 2450 MHz, 860-960 MHz Applicable	Not Specified

ISO vs EPC Gen2

ISO Requirement	EPC UHF Gen2 v1.0.7
Standard to cover the widest possible set of applications for a common protocol	Restricted to "96-bit Write Once" technology
Top-down architecture	Bottom-up architecture
Standard to embrace global applications	Restricted to EPC applications
Active tags to comply with ISO/IEC 18000-7	Active tags share spectrum with passive
Extensible commands, e.g., sensors, write	No extensibilities
RAND	EPC's I.P. not disclosed, "royalty-free"
AFIs for multi-application use	No AFIs
Consistent and common use of Tag ID, Item ID Object ID, Chip ID, etc.	Usages are not mainstream and are confusing
EPC + AFI + DSFID ≈ 128 bits	96 bits

Finding Common Ground



Which Technology?

- How far?
- How fast?
- How many?
- How much?
- Geometry of tagging space
- Interferers (physical and radio)

Regulations :: ITU

How far, How fast, How many, How much?

Frequency	Regulation	Range	Data Speed	Comments
120-150 kHz 18000, Part 2 (passive)	Basically unregulated	< 1m	Low	Animal identification and factory data collection systems
13.56 MHz 18000, Part 3 (passive)	ISM band, differing power levels and duty cycle	< 1m	Low to moderate	Popular frequency for I.C. Cards (Smart Cards), Libraries
433 MHz 18000, Part 7 (active)	Non-specific Short Range Devices (SRD), Location Systems	1 - 100 m	Moderate	Container Security and Tracking. Asset tracking for U.S. DoD (Pallets) - Active
860-960 MHz 18000, Part 6B (passive)	ISM band, increasing use in other regions, differing power levels and duty cycle	2 - 5 m	Moderate to high	MH10.8.4 (RTI), AIAG B-11 (Tires), EPC, 18000-6c, DoD Passive
2450 MHz 18000, Part 4A (passive)	ISM band, differing power levels and duty cycle	1 - 2 m	High	IEEE 802.11b, Bluetooth, Cordless Tel

Global RFID UHF Spectrum Allocation

Country/ Region	UHF RFID Spectrum Allocation	Max. Power Limit (ERP)
U.S.	902 – 928 MHz	4 W (EIRP)
Europe	868 – 870 MHz	500 mW
Australia	918 – 926 MHz	1 W (EIRP)
New Zealand	864 – 868 MHz	4 W (EIRP)
Brunei Darussalam	866 – 869 MHz 923 – 925 MHz	500 mW 2 W
Hong Kong	865 – 868 MHz 920 – 925 MHz	2 W 4 W
Indonesia	866 – 869 MHz (proposed) 923 – 925 MHz (proposed)	500 mW 2 W
Korea	908.5 – 914 MHz (proposed)	4 W (EIRP)
Japan	952 – 954 MHz (proposed, 2005Q1)	4 W (EIRP)
Malaysia	868.1 MHz 919 – 923 MHz (considering)	50 mW 50 mW
Singapore	866 - 869 MHz 923 – 925 MHz	500 mW 2 W

Updated February 2005, EIRP : Equivalent Isotropic Radiated Power

Minimum Requirements

Passive Technology		Active Technology	
How far	3 meters	How far	100 meters
How fast	10 mph	How fast	35 mph
How much	256 bits[Note]	How much	256 bytes[Note]
How many	500 tags/second	How many	500 tags/minute
Technology	860-960 MHz ISO 18000-6 UHF Gen 2 EPC Class I, II, III	Technology	433 MHz ISO/IEC 18000-7 EPC Class IV

Note: While minimums are stated, supply chain applications are common for passive tags at 256 bytes and active tags at 128 kBytes

Recent Developments :: UHF 860-960MHz

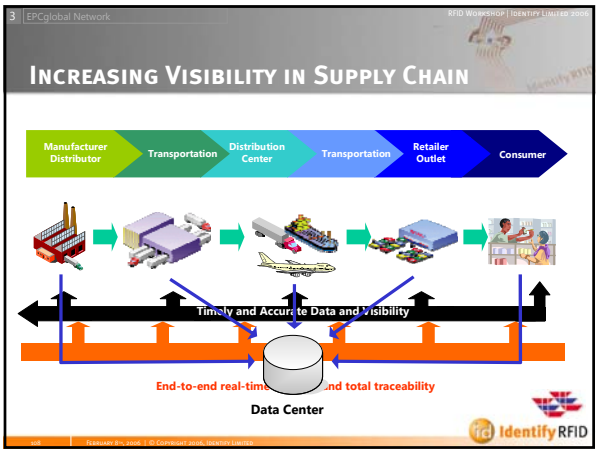
- Industrial, Scientific, & Medical (ISM) band (902 - 928 MHz)
- Originally 902 - 928 MHz Spread Spectrum in the U.S.
- Technology enhancement (frequency agile and listen before talk) permits
  - 902 - 928 MHz used in Region 2 (U.S.)
  - 865.6 - 867.6 MHz nearing finalization in Region 1 (Europe)
  - 908.5 - 914 MHz regulations finalized in Region 3 (Korea)
  - 950 - 956 MHz regulations in process in Region 3 (Japan)
- ISO/IEC 18000-6 (860-960 MHz) re-opened to address new developments, such as Gen2
  - If Gen2 is positioned to ISO, it must support other ISO standards such as "data content" (ISO/IEC 15961, 15962, 15963, 15434, 15418, 15459, 24721
  - ISO/IEC 18000-6c expected to eclipse Part 6a and 6b

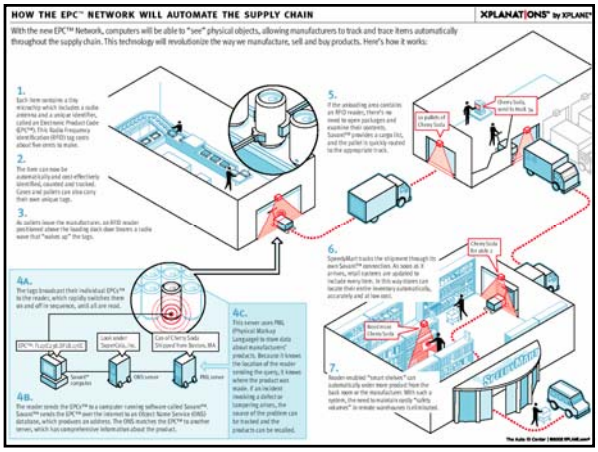
Recent Developments :: UHF 433.92MHz

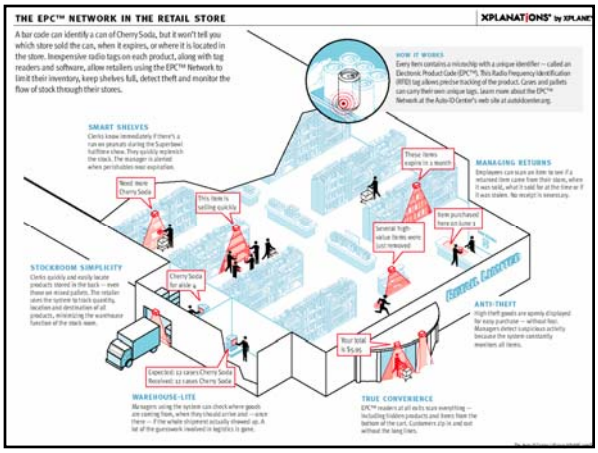
- ISM band permitted by ITU (implemented in Region 1 but for different parameters in Regions 2 and 3)
- ITU receptive to Regions 2 and 3 supporting Region 1 for a 433 MHz allocation for freight containers
- Chairman of ISO TC 104 (Freight containers) has made request to ITU and WCO to embrace both passive (860 - 960) and active (433.92 MHz) calling out 18000-6 and 18000-7
- Under serious consideration in both Japan and Korea
- Both Japan and Korea have requested U.S. governmental letters of support, i.e., FCC, NTIA, DoD, NATO
- Received support through new (April 2004) FCC rules, specific to RFID, that increases both power and duty cycle.

Agenda

1 RFID Fundamentals
2 RFID Applications and Standards
3 EPCglobal Network: Real-Time Supply Chain
4 RFID Business Process Integration Issues
5 RFID Demonstration


3 EPCglobal Network
RFID Workshop | Identify Limited 2005
Increasing Visibility in Supply Chain
Manufacturer Distributor
Transportation
Distribution Center
Transportation
Retailer Outlet
Consumer
Timely and Accurate Data and Visibility
End-to-end real-time and total traceability
Data Center
Identify RFID


HOW THE EPC™ NETWORK WILL AUTOMATE THE SUPPLY CHAIN
XPLANATIONS™ by XPLANE™
With the new EPC™ Network, computers will be able to "see" physical objects, allowing manufacturers to track and trace items automatically throughout the supply chain. This technology will revolutionize the way we manufacture, sell and buy products. Here's how it works:
1.
2.
3.
4A.
4B.
4C.
5.
6.
7.


THE EPC™ NETWORK IN THE RETAIL STORE
XPLANATIONS™ by XPLANE™
A bar code can identify a can of Cherry Soda, but it won't tell you which store sold the can, when it expires, or where it is located in the store. Inexpensive radio tags on each product, along with tag readers and software, allow retailers using the EPC™ Network to limit their inventory, keep shelves full, detect theft and monitor the flow of stock through their stores.
HOW IT WORKS
SMART SHELVES
MANAGING RETURNS
STOCKROOM SIMPLICITY
ANTI-THEFT
WAREHOUSE-LITE
TRUE CONVENIENCE


3 EPCglobal Network
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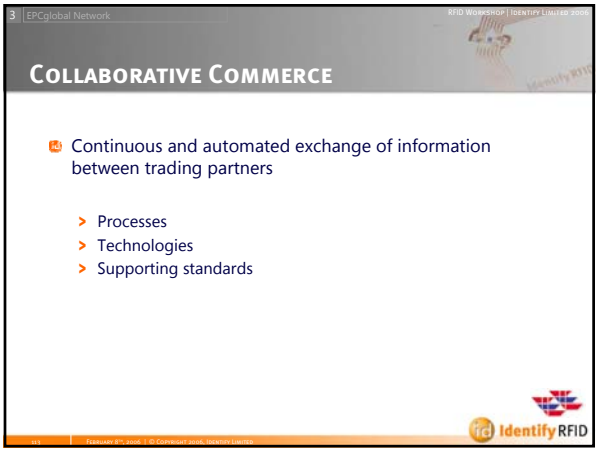
RFID in Logistics Units
RFID Tag
Electronic Seal
RFID Tag
Identify RFID


3 EPCglobal Network
RFID Workshop | Identify Limited 2006
Collaborative Commerce
Continuous and automated exchange of information between trading partners
Processes
Technologies
Supporting standards
Identify RFID


3 EPCglobal Network
RFID Workshop | Identify Limited 2006
The Path to Collaborative Commerce
Collaborative insight & product development 7
Collaborative sales & promotion planning 6
Collaborative supply chain management 5
Collaborative transaction management 4
Item synchronization 3
Single item registry 2
Common data standards 1
Foundational Steps
Benefits
Time/Degree of trust & complexity
Identify RFID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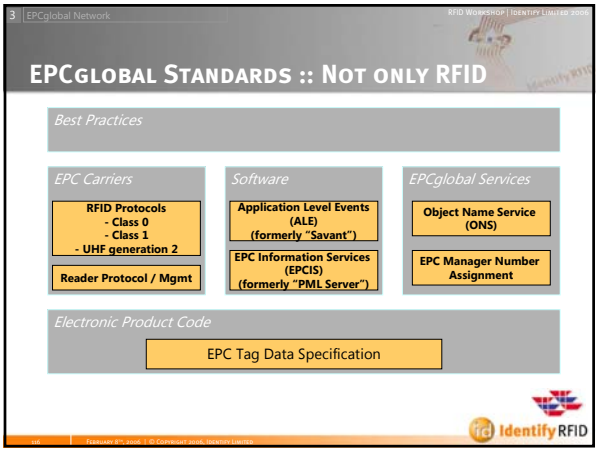
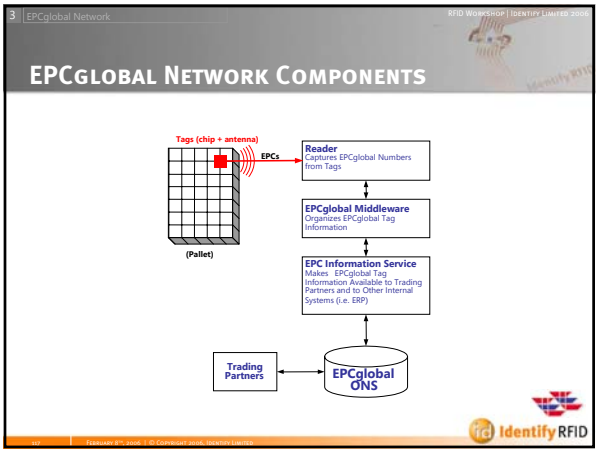
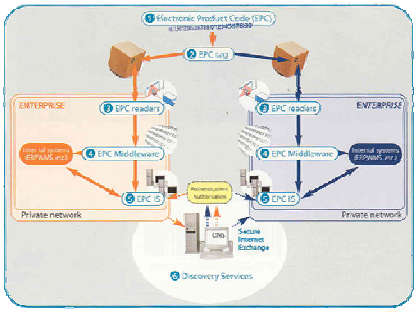
The EPCglobal Community
UNISYS
Imagine it. Done.
Ahold
MATRICS
SAP
BT
Johnson & Johnson
accenture
GENERAL MILLS
Kimberly-Clark
METRO Group
P&G
Campbell's
Unilever
Carrefour
The Gillette Company
DNP
WAL★MART
ALWAYS LOW PRICES. Always
Georgia-Pacific
PEPSICO
Texas Instruments
TESCO
Every little helps
Deloitte.
Identify RFID

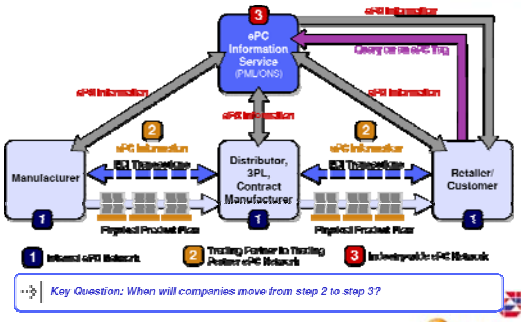

3 EPCglobal Network
RFID Workshop | Identify Limited 2006
EPCglobal Standards :: Not only RFID
Best Practices
EPC Carriers
RFID Protocols
- Class 0
- Class 1
- UHF generation 2
Reader Protocol / Mgmt
Software
Application Level Events (ALE) (formerly "Savant")
EPC Information Services (EPCIS) (formerly "PML Server")
EPCglobal Services
Object Name Service (ONS)
EPC Manager Number Assignment
Electronic Product Code
EPC Tag Data Specification
Identify RFID


3 EPCglobal Network
RFID Workshop | Identify Limited 2006
EPCglobal Network Components
Tags (chip + antenna)
EPCs
(Pallet)
Reader
Captures EPCglobal Numbers from Tags
EPCglobal Middleware
Organizes EPCglobal Tag Information
EPC Information Service
Makes EPCglobal Tag Information Available to Trading Partners and to Other Internal Systems (i.e. ERP)
Trading Partners
EPCglobal ONS
Identify RFID

EPCglobal Network



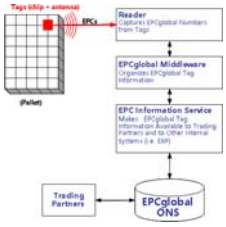
Real time tracking of Inventory



Key Question: When will companies move from step 2 to step 3?

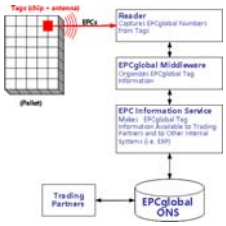
EPCglobal Middleware

- Formerly Known as "Savant"
- Reader Management
- Data Filtering and Collection
- Transient Data Store
  - Resolves reading one item more than one time
  - Resolves mixed pallet reads, where tags are present on pallets, cases and items
  - Selective reads, such as from a particular supplier



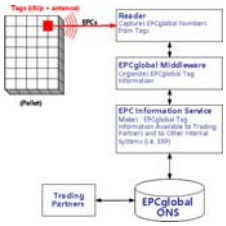
EPCIS - EPCglobal Information Services

- Network Service
- Provides EPCglobal Network-generated data
  - Location
  - Time
  - Data from Active Tags
- Use to Track & Trace Serial items
- Direct data to Persistent Storage



ONS - EPCglobal Object Name Service

- Local Copy of Frequently used ONS data
- Registration for Static and Dynamic ONS
- Collaboration on Asset Tracking



PML - Physical Markup Language

- A "language" for describing physical objects such as products.
- Based on the widely accepted eXtensible Markup Language (XML).
- Include data that changes constantly (dynamic data) and data that changes over time (temporal data).
  - Dynamic data: temperature of a shipment of fruit, or vibration levels from a machine.
  - Temporal data: an object's location

EPCglobal Network Services

World Wide Web	EPCglobal Network
DNS Authoritative system that routes requests for Web sites and email	**ONS** Authoritative record of manufacturers that routes requests for product information
Web Sites Resource that contains information on a particular topic	**EPC Information Services** Resource for specific information about a product, e.g. date of expiration
Search Engines A tool for finding Web sites on the network	**EPC Discovery Services** A tool for finding EPC Information Services on the network
Security Services Provide trusted access control and information sharing	**EPC Trust Services** Provide security and access control for EPC product data

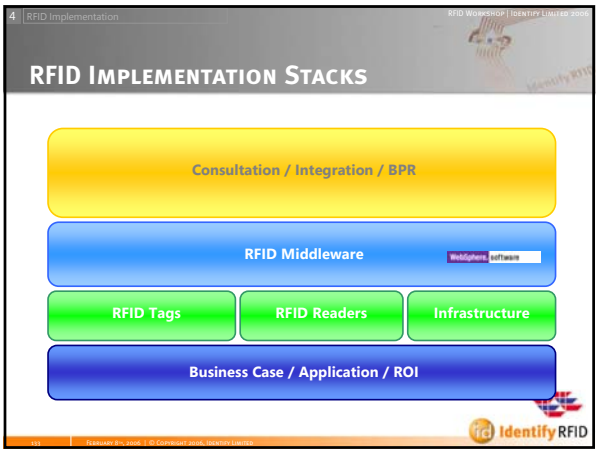
Agenda

1. RFID Fundamentals
2. RFID Applications and Standards
3. EPCglobal Network: Real-Time Supply Chain
4. RFID Business Process Integration Issues
5. RFID Demonstration

RFID is not just Tags & Readers

- Tags + Readers ≠ Transformation
- Tags + Readers = Efficient data collection & New visibility

- Transformation =
  - Tags + Readers
  - + Business Process Change
  - + Proactive Decision Making
  - + Integration to Enterprise Systems and Infrastructure


4 RFID Implementation
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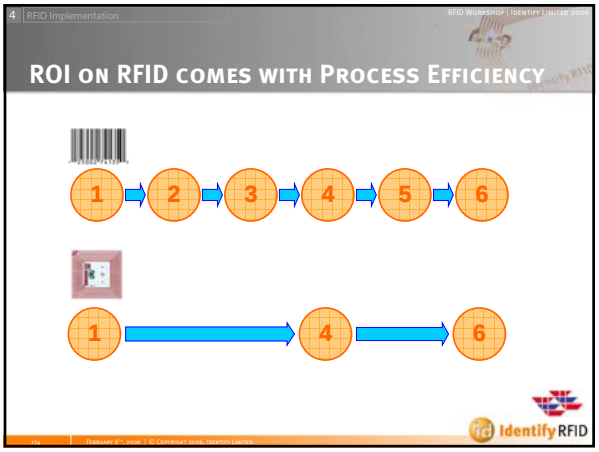
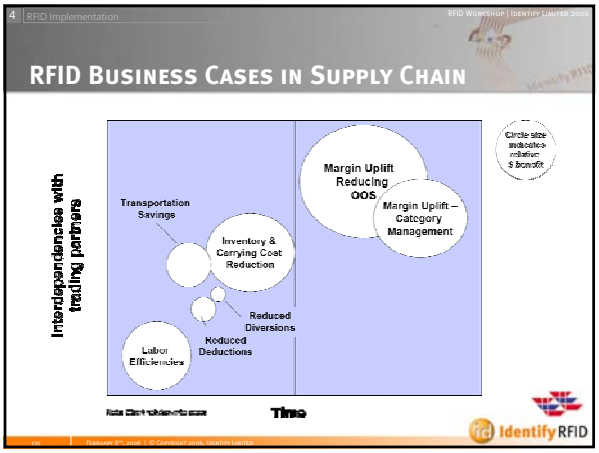
RFID Implementation Stacks
Consultation / Integration / BPR
RFID Middleware
RFID Tags
RFID Readers
Infrastructure
Business Case / Application / ROI
Identify RFID


4 RFID Implementation
RFID Workshop | Identify Limited 2006
ROI on RFID comes with Process Efficiency
1
2
3
4
5
6
1
4
6
Identify RFID


4 RFID Implementation
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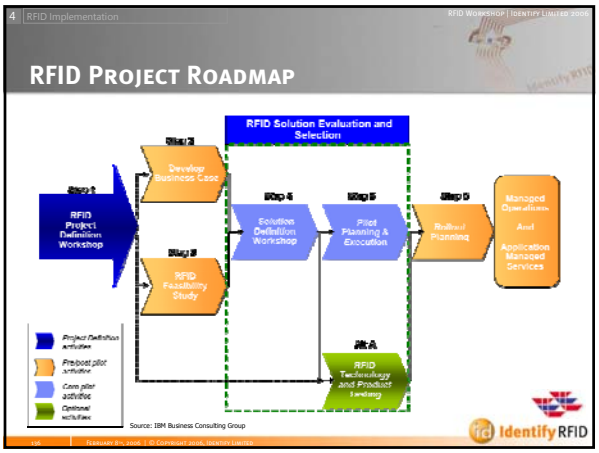
RFID Business Cases in Supply Chain
Interdependencies with trading partners
Transportation Savings
Inventory & Carrying Cost Reduction
Reduced Diversions
Reduced Deductions
Labor Efficiencies
Margin Uplift Reducing OOS
Margin Uplift – Category Management
Time
Identify RFID


4 RFID Implementation
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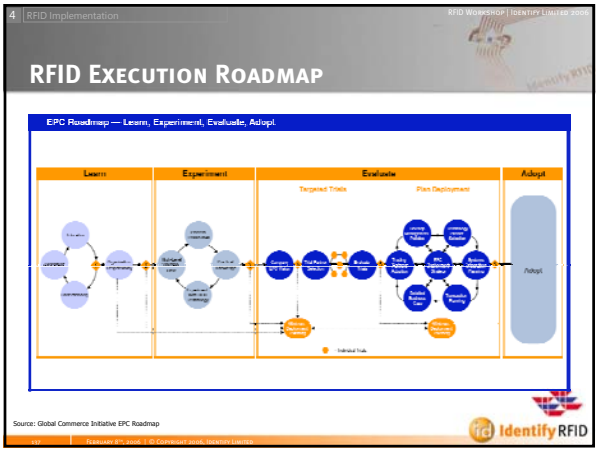
RFID Project Roadmap
RFID Solution Evaluation and Selection
Step 1
RFID Project Definition Workshop
Step 2
Develop Business Case
Step 3
RFID Feasibility Study
Step 4
Solution Definition Workshop
Step 5
Pilot Planning & Execution
Step 6
Rollout Planning
Managed Operations And Application Managed Services
Step A
RFID Technology and Product Landing
Project Definition activities
Preshoot pilot activities
Core pilot activities
Optional activities
Source: IBM Business Consulting Group
Identify RFID


4 RFID Implementation
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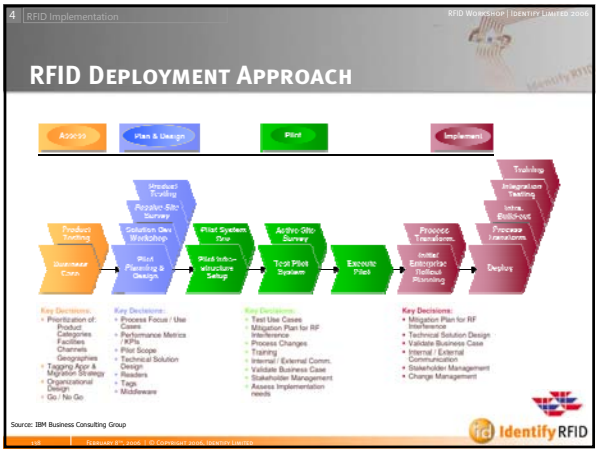
RFID Execution Roadmap
EPC Roadmap — Learn, Experiment, Evaluate, Adopt
Learn
Experiment
Evaluate
Adopt
Targeted Trials
Plan Deployment
Source: Global Commerce Initiative EPC Roadmap
Identify RFID


4 RFID Implementation
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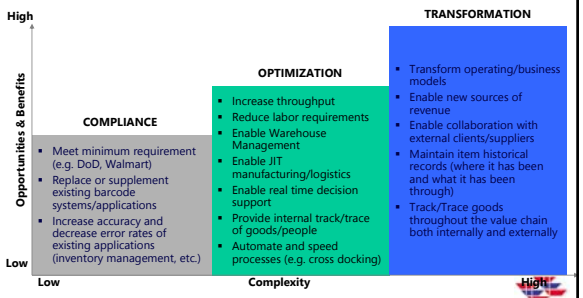
RFID Deployment Approach
Assess
Plan & Design
Pilot
Implement
Product Testing
Business Case
Product Training
Assess Site Survey
Solution Des Workshop
Pilot Planning & Design
Pilot System Stro
Pilot Infrastructure Setup
Active Site Survey
Test Pilot System
Execute Pilot
Process Transform.
Initial Enterprise Rollout Planning
Deploy
Training
Integration Testing
Intra. Build-out
Process Transform.
Key Decisions:
Key Decisions:
Key Decisions:
Key Decisions:
Source: IBM Business Consulting Group
Identify RFID

Why moving toward RFID



Developing RFID Strategy

Strategic

- How can RFID enable our overall strategic vision?
- Should we be a leader or a "fast follower"?
- Which trading partners should I pilot with and when?
- How will we operate in a world of dual processes? And for how long?

Financial

- What is the expected return on our RFID investment?
- What specific RFID applications can drive value for us?
- What is a realistic adoption pattern/rate of RFID and how will that impact my business case?

Organizational

- What are the change management implications?
- What are the risks involved in an RFID implementation?

Technological

- What are our technology requirements for an RFID implementation?
- What is the architecture that best delivers on my strategic technology plan?
- How will an RFID implementation impact our current applications?

RFID Myths

- RFID is a technology with potential for change in business processes, influencing
  - Cost structure
  - Security
  - Comfort
- In a few years, RFID will be as ubiquitous as barcode is today
- RFID requires you to follow a learning curve. Starting early gives you a massive advantages
- ROI is achievable today in many areas of your business

Conclusion

- RFID is here
- Define your company's RFID strategy
- RFID does not replace the barcode
- Allow time for your individual RFID learning curve
- Chose the right partner

Agenda

1 RFID Fundamentals
2 RFID Applications and Standards
3 EPCglobal Network: Real-Time Supply Chain
4 RFID Business Process Integration Issues
5 RFID Demonstration

Thank you

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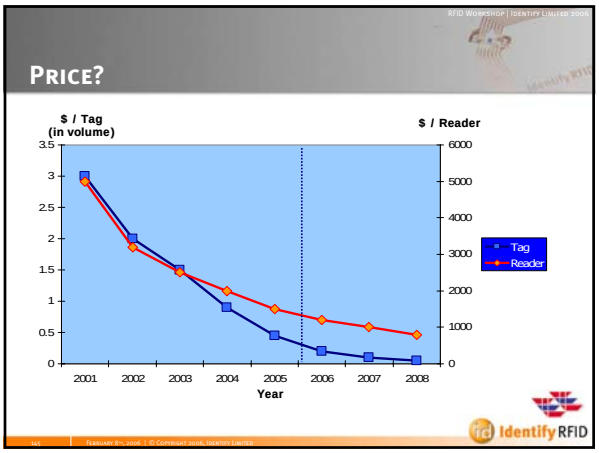
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Price?
$ / Tag
(in volume)
$ / Reader
3.5
3
2.5
2
1.5
1
0.5
0
6000
5000
4000
3000
2000
1000
0
2001
2002
2003
4
2005
2006
2007
2008
Year
Tag
Reader
Identify RFID