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Mobile and Ubiquitous Computing

Auto-identification

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Session Overview

- Auto-identification and its role in ubicomp
- Radio Frequency Identification
  - RFID operation
  - Numbering systems
- Network support for Auto-identification
  - Object Naming Service
  - Information Service
  - Identity Management
- Systems architectures
  - Examples: Sun, Oracle, Cisco
- Ethical and legal implications and challenges

Supply-chain applications

- Track products
  - SKU level
  - Item level
- Monitor inventory
- Efficient replenishment JIT
- Current stock error 8-12%
- Replace POS estimates

More about supply-chains

- Introduced by US Army after first Gulf War
- Wall-Mart has set deadline in 2005 for top 100 suppliers
- IBM, SAP, Sun, Microsoft, BT all offer solutions
- M&S is running now item-level trials to validate business case

Tag people

- Use approved on people
- Many applications:
  - Kidnap victims
  - Surgery
  - Nightlife
  - Track offenders (150k people currently tagged in the UK)
  - Mobile ID inc. EPR
  - Kids and students
- Cognitive assistance

Payment

- E-pass for road toll payments
- Injectable RFID used by bars in Barcelona, Spain, on clubbers
- FeLiCa by NTT DoCoMo uses it for payment at POS
- ECB explores its use in euro notes
- Mobil SpeedPass

Just side-effects?

- Consumer shopping: Metro's *Supermarket of the Future™* in Germany
- Traffic monitoring using e-Pass in Florida, USA
- Wal-Mart and P&G 4-month secret trial of Lipfinity lipstick at Broken Arrow, OK, USA.
- Utah,USA "Right to Know" Act passed 26 Feb 2004. California to follow in early 2005.
- 26 Oct 2004 requirement for biometric info embedded in all US VWP passports (image and fingerprints)

Public debate ensues

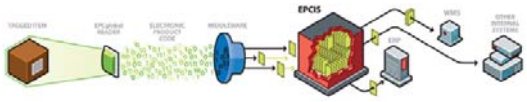
- RSA CEO "would be very worried of his privacy" (quoted by InfoWorld, April 2004)
- EPC Europe VP says "there are more myths in RFID than there are in Greek mythology" (quoted by BBC, April 2004)
- Sisley trial (Sisley is a Benetton brand)
  - Announced 11 Mar 2003,
  - CASPIAN calls for boycott 13 Mar 2003,
  - Sisley withdraws plans 15 Mar 2003

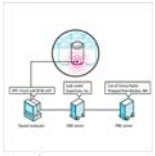
  (details at http://boycottbenetton.org)

Why RFID today?

- Available since WWII as part of Identification Friend or Foe (IFF) airplane systems
- It is cheap
  - About 10 cents per tag in high volumes
  - Possibly under 1 cent in the next 2-3 years
- Wireless communications
  - Widely available bandwidth
  - High mobility
- Passive tags need no power
- The first viable solution to electronic physical object identification

Putting it all together





EPCglobal

How does RFID work?

- Reader initiates communication
- Tag detects reader request
- Responds with ID transmission
  - Possibly performs challenge-response authentication step

RFID Reader

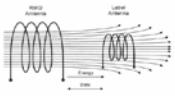
- Two types of tags
  - Active (with battery)
  - Passive (completely powered by reader)

RFID Tag

RFID Operation in More Detail

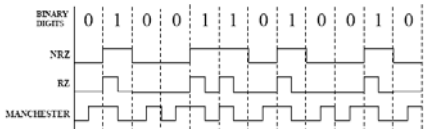
- Tag components
  - Microcontroller
  - Antenna (wire/conductive carbon ink)
  - Polymer enclosure
  - Battery (optional)

- Reader detected by voltage difference at the antenna endpoints caused by inductive or capacitive coupling
  - Magnetic (near) field (LF or HF)
  - Electric (UHF)



RFID and Modulation

- Process of changing the characteristics of radio waves to encode data and to transmit it to the other end
- Technique used depends on the power consumption, reliability and available bandwidth.

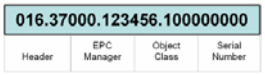


Numbering Systems for Objects

- Barcodes (many different types!)
- IPv6 addressing (not necessary for objects in many cases, require superior processing capability and >100KB stack)
- Internet 0, reduced IP stacks with ISO-1800/IRDA etc link layer
  - asymmetric end-to-end
- Other MAC addresses (cf. end of presentation)

UCC/EAN-128, EAN-13, EAN-8, ITF 14.

Electronic Product Code



- *Header:* which identifies the length, type, structure, version and generation of EPC (supports EAN.UCC keys)
  - Global Trade Identification Number (GTIN)
  - Serial Shipping Container Code (SSCC)
  - GLN (Global Location Number)
  - Global Returnable Asset Identifier (GRAI), and GIAI.
- *Manager Number:* which identifies the company or company entity (today: same as EAN)
- *Object Class:* similar to a stock keeping unit or SKU
- *Serial Number:* which is the specific instance of the Object Class being tagged

Object Naming Service

Bit Format:
[10 00000000000000101100 00000000000001111 00000000000000000001000001]

Decimal Format: [2.44.15.65]

Step 1: EPC event manager receives the ID

2.44.15.65

Step 2: EPC EM creates URI:

epc://2.44.15.65

Step 3: URI is sent to local ONS resolver

Step 4: ONS resolver concerts the URI to the equivalent DNS NAPTR query

15.44.2.epcinc.org

Step 5: DNS returns result set

ONS to DNS conversion

- Remove URI pre-fix
  epc://2.44.15.65 → 2.44.15.65
- Remove Serial Number
  2.44.15.65 → 2.44.15
- Invert
  2.44.15 → 15.44.2
- Append ONS root
  15.44.2 → 15.44.2.epcinc.org
- Issue DNS query e.g.
  nslookup 15.44.2.epcinc.org
  gethostbyname(15.44.2.epcinc.org)

ONS Result Set

- NAPTR is a type of DNS resource record that uses a regular expression for specifying a delegation point within some other namespace
- Designed for Dynamic Delegation Discovery System (DDDS) applications
- NAPTR fields:
  - **Order** And **Pref** show priority of this result within the set
  - **Flags** when set to “u” means regular expression containing URI
  - **Service** designates different types of services. The format of this field is EPC+service_name where service_name can be pml, html, xmlrpc, and ws
  - **Regexp** specifies a URI for the service being described (cuurently the hostname and additional path information
  - **Replacement** specifies the replacement portion of the rewrite expression (not used)

ONS Result Set Example

Orders	Pref	Flags	Service	Regexp	Replacement
0	0	u	EPC+pml	!^.*$!http://somewatches.com/epcis/cgi-bin/epcpml.php!	
0	0	u	EPC+html	!^.*$!http://somewatches.com/epcis/epcpml.jsp!	
0	0	u	EPC+xmlrpc	!^.*$!http://somewatches.com/servlet/epcis somewatches.com!	
0	0	u	EPC+ws	!^.*$!http://somewatches.com/epcis/ws/epc.wsdl!	

EPC+pml: Product Markup Language document

EPC+html: Web page description

EPC+xmlrpc: XML Remote Procedure Call interface

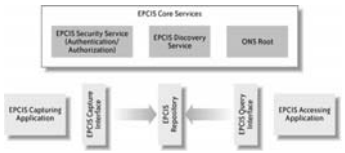
EPC+ws: Web Service interface (WSDL)

XML RPC Example:

```
<methodCall>
  <methodName>someservice.somemethod</methodName>
  <params>
    <param><value><string>coke</string></value></param>
  </params>
</methodCall>
```

EPC Information Service

- EPC IS: Standard Interface for capture and sharing of EPC data (still draft)
- Works at the Semantic Level
- Common model for location data
- EPC Discovery: track-and-trace applications

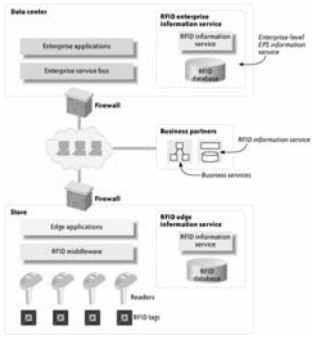


Identity Management

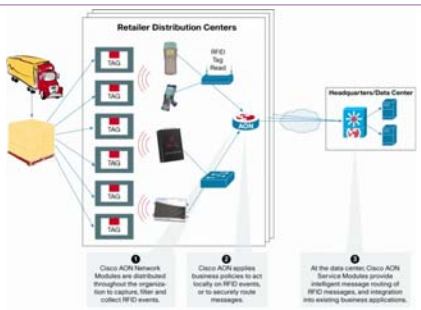
- RFID data is also used to identify people
  - security cards, oyster, car club
- People have different requirements than objects!
- Several standards: Liberty Alliance (open), MS Passport (proprietary), Simtel (mobile, proprietary)

Systems

Supply-chain reference implementation from EPCGlobal

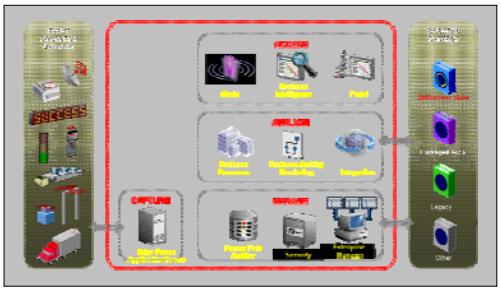


Cisco: Application Oriented Network



http://www.cisco.com/web/strategy/retail/RFID.html

Oracle: Sensor Based Computing

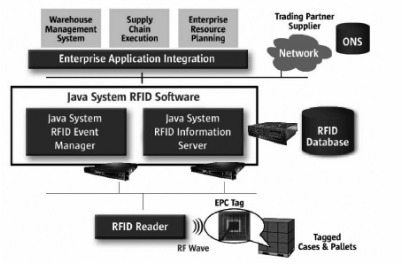


http://www.oracle.com/technologies/rfid/

Oracle Edge Server

- Filter Framework
  - Remove unwanted or low-level events
  - Extensible filter architecture
  - Generates high level events and optimize flow and responses
- Filters
  - PassThru : Filter for portal readers or “choke” or “point” reads
  - Shelf : Filters for shelf and proximity readers producing enter/exit events, or “period” read
  - PalletPass, PalletShelf : Aggregation filtering for both Pass and Pallet filters
  - CrossReader : All filters can be applied to groups and individual devices
  - CheckTag : Test tag to verify reader health
- Device Groups
  - Allows administrators to logically group devices together
  - Group devices for logical processing and filtering

Sun: Java System RFID



http://www.sun.com/software/solutions/rfid/

Two Major Issues

- System operation is transparent
  - invisible, everywhere computing
  - guarantee the rights of consumers
- Trust is a non-cognitive process and thus is hard to compute with (trust is different to trustworthiness)
  - overall acceptance of RFID retail depends on whether it is perceived as “fair” by consumers
  - strategy cannot be based on expected public apathy because this can backfire cf. nuclear power

Transparent Operation

- The product contains an RFID tag
- Option to remove or destroy tags when product is purchased
- No penalty for opting out of RFID use
  - Price discrimination
- Access to information and mechanisms for modification of erroneous information
- Notification of RFID monitored areas

Three Decisions

1. Initial entitlement:
   - Allocation of property rights
   - Who should get the initial right to control the information generated by RFID?
2. Coercion and choice:
   - If you want discount you will get the chip.
3. Societal overrides:
   - When does society, regardless of your preference, get access to the data anyway?

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