

# RFID Technology

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### □ Radio Frequency Identification

- Auto-identification of persons, objects, services
- Contactless Technology : data transmission by radio waves
- Toward the Internet of things and communicating objects

### □ RFID architecture:

- *Base Station* : a reader, a mobile phone, a terminal, etc.  
That identifies and deals with data read by radio waves



- A tag: electronic support, contactless card



- A system: web service web, information system, middleware  
deals with data for analysis, log.

## Application examples



Velib' in Paris



The gallery of art Granite State MetalWorks endowed its paintings With RFID chips containing data readable thanks to a bluetooth pe The pen is connected to a PDA that gives more detailed informatio Concerning the painting.

<http://www.journaldunet.com/solutions/0703/070322-rfid/11.shtml>

Apr. 28, 2005

## Application examples



500 000 British trash cans equipped with RFID chips. The English authorities hope to identify the recycling negligence and to reduce the volume of household waste. During the collection, the serial number is so read by the truck and the trash car weighing. Every citizen damaging voluntarily the chip fixed to its trash can would see itself deprived of collection of garbage.  
<http://www.journaldunet.com/solutions/0703/070322-rfid/14.shtml>



The radio frequency technology is used by the industrialists for the follow-up of their containers, to optimize the inventory control and master their losses.  
<http://www.journaldunet.com/solutions/0703/070322-rfid/12.shtml>

## Application examples



To replace the bar code, RFID tags on luggage will allow reducing from 30 to 40 % the rate of routing error. This device is already used in the McCarran international airport of Las Vegas.

In the Charles-de-Gaulle airport of Paris , there is an infrastructure that allows the optimization of the taxi flows. So, every car has an RFID tag helping a system to manage the movements of vehicles to supply to the users a real-time information on the waiting time.  
<http://www.journaldunet.com/solutions/0703/070322-rfid/10.shtml>



The first use of RFID technology was to identify the cattle at the beginning of the 80s.

More recently, a company announced the development of one ink biocompatible RFID. This tattoo by injection under the skin for the identification could be applied to the breeding sector or even to the military staff.

<http://www.journaldunet.com/solutions/0703/070322-rfid/8.shtml>

## Application examples



The products of the Wal-Mart store are already marked by RFID chips. DirectVideo and Videomatic use RFID on their DVD rented to check the returns.

<http://www.journaldunet.com/solutions/0703/070322-rfid/7.shtml>



The RATP markets since 2001 electronic pass Navigo provided with a RFID chip.

<http://www.journaldunet.com/solutions/0703/070322-rfid/6.shtml>

## Application examples



The electronic toll system, set up in Australia, Singapore or in the United Kingdom, allows to automate payments and to reduce bottlenecks by identifying vehicles on which RFID tags are embedded.

<http://www.journaldunet.com/solutions/0703/070322-rfid/5.shtml>



95 000 trees of Paris own an inserted RFID chip 2 cms under the bark. The purpose of the operation is to supply for each tree an ID card and to insure a follow-up.

The RFID tags are read thanks to nomadic terminals put at a distance of 15 cms.

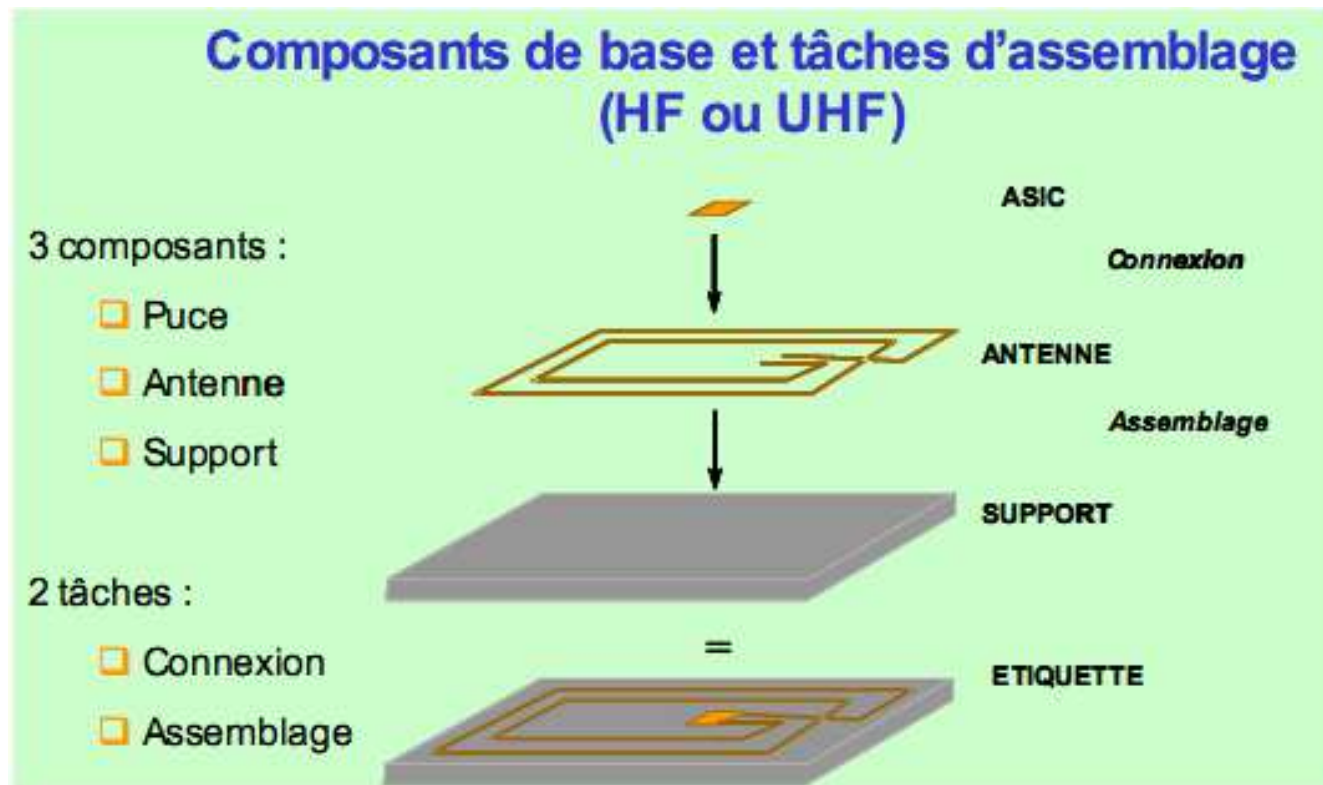
<http://www.journaldunet.com/solutions/0703/070322-rfid/4.shtml>





### NFC and Computer ticketing at the stadium of Stade de France for 2011

The mobile phone will replace this year (2011) the ticket used to access to two French stadiums, Stade de France (Saint-Denis) and Malherbe of Caen, according to Orange that carries the project.



- ❑ **Memory tags**
  - Memory of type EEPROM or FLASH
  
- ❑ **Micro-processor tags**
  - Memory
  - Processor

- ❑ Low frequencies **LF** ( $\leq 135\text{kHz}$ )
- ❑ High frequencies **HF** (frequencies around 13,56 MHz)
- ❑ Ultra-high frequencies **UHF** ( $\sim 434\text{ MHz}$ , 869-915 MHz, 2,45 GHz)
- ❑ Micro-waves ( $\sim 2,45\text{ GHz}$ )

## With/without battery

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- ❑ **Passif** : the RFID chip is feed with the electromagnetic wave provided by the reader. The response of a RFID tag is a unique number called UID.
- ❑ **Semi-passive**: the RFID chip is endowed with a battery to feed the circuit but the communication uses the antenna.
- ❑ **Active**: the chip includes energy (battery).

- ❑ Passive tags have a reading distance that varies from 10 cms (ISO 14443) to some meters (EPC and ISO 18000-6) depending on the radio-frequency and the antenna type.
- ❑ RFID EPC tags the cheapest cost 8 cents per tag. They are the standard used by Wal Mart, Target, Tesco in Great Britain and Metro AG In Deutschland.

- Are passive tags endowed with a battery (refillable or not)
- The reader provides sufficient energy to communicate with tags.
- The battery is used only to perform internal computations
- Reading is more efficient than with passive tags in environments like (liquid, metal)

- Have their own source of energy (the battery is refillable or not)
- Reading is more efficient than with semi-passive tags in environments like (liquid, metal)
- The scope may be hundred of meters and the battery may last until 10 years
- Own a processor and a memory
- May have light, temperature, or humidity sensors.

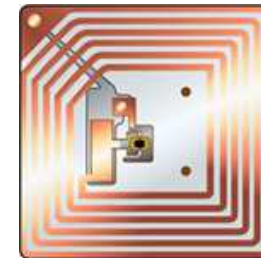


- ❑ Procedure of error detection **CRC (Cyclic Redundancy Check)**
  
- ❑ Anti-collision Protocols
  - **Deterministic Protocol**
  - **Probabilistic Protocol**

## RFID tag GID

### □ RFID tag

- antenna
- a chip of silicium (25 mm<sup>2</sup>)
- encapsulation



header –version  
number

8 bits

General manager number  
Compagny / organisation

28 bits

Object class  
Object type

24 bits

Serial number  
Unique for object type

36 bits

Global Identifier EPC (GID 96 bits)

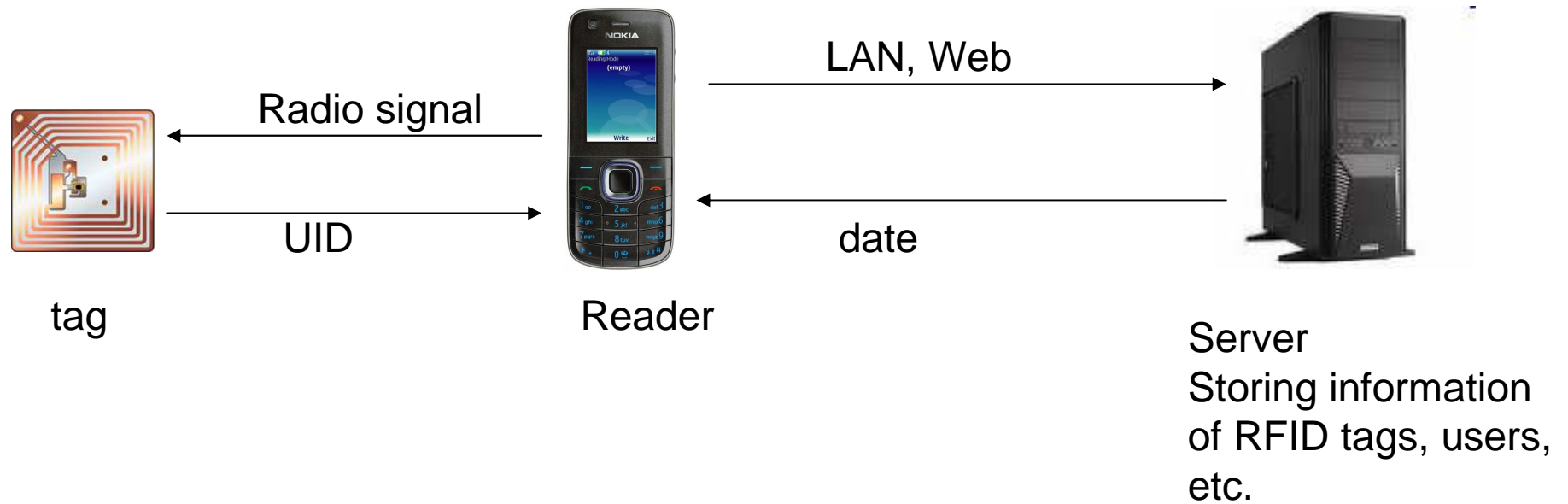
### □ RFID tag

- contains a unique identifier (UID) fixed during manufacturing
- embed a memory (1 à 128 Ko)
- 3 types of tags: passive, semi-passive, active

### □ RFID system (Server side)

- Storage of data that are related to tags
- Storage of data that are relative to users
- Access rights of the users according to tag data.

## RFID System



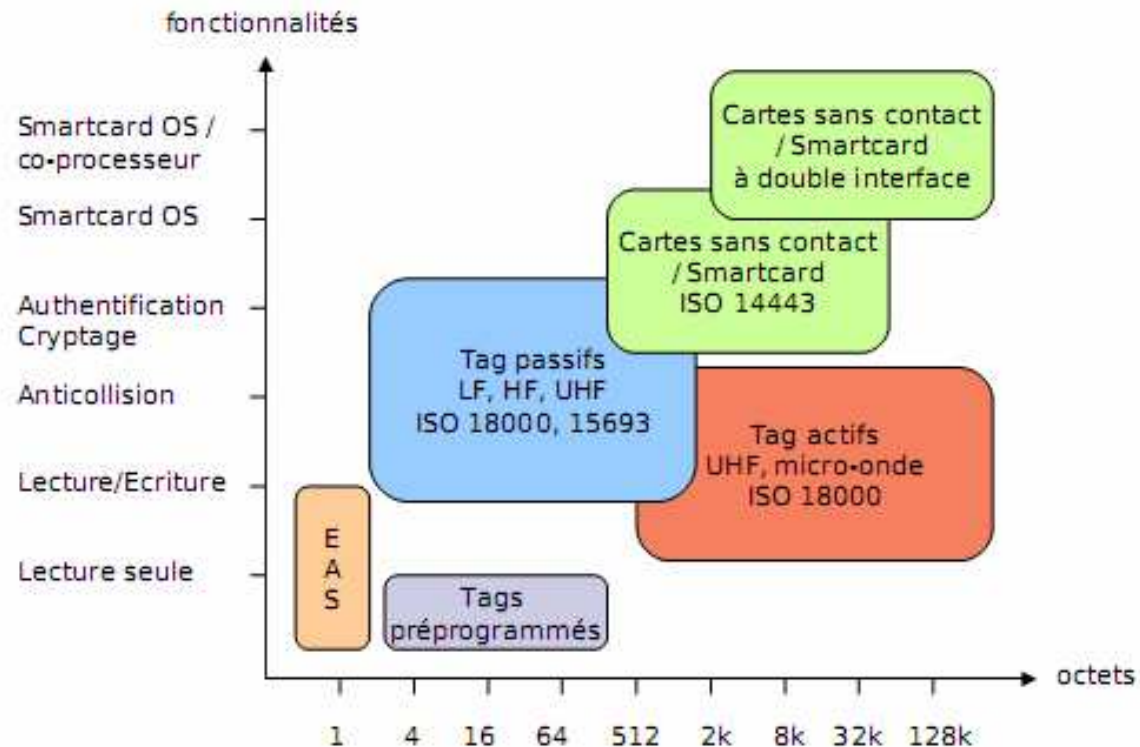
- The frequency depends on the power of the signal

	LF	HF	UHF	Micro onde
Fréquence	30-300KHz	3-30 MHz	0,3-3 GHz	2-30 GHz
Fréquences RFID typiques	125-134 KHz	13,56 MHz	433 MHz 860-930 MHz 2,45 GHz	2,45GHz
Standard ISO	18000-2	18000-3	18000-7 18000-6 18000-4	18000-4
Portée ~	< 0,5m	1,5 m	>100m 0,5 à 5 m idem	> 10m
Bande passante ~	< 1KBit/s	25 KBit/s	30 kBit/s idem 100 KBit/s	> 100 KBit/s
Utilisation typique	Identification animaux	Cartes d'accès	Logistique	Véhicules en mouvement

- Other standards: contacless cards ISO-14443 (HF, scope<10cm), toll ISO-15693 (HF, scope from 1 to 1.5m)

## The embedded memory of a tag

### □ Limitations in terms of functionalities



EAS : Electronic Article Surveillance

Dual interface smart card: RFID chip and the smart card

## Systems providing RFID

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- ❑ Available systems
  - EPCglobal
  - IBM WebSphere RFID Middleware
  - Oracle Fusion middleware RFID support
  - Sun Java System RFID Software
  
- ❑ Concurrent Standards
  - ETSI, ANSI, ISO, IEC, EPCglobal
  
- ❑ The current solutions are not interoperable
  
- ❑ For markets, RFID means « product identification »
  - Electronic Product Code (EPC)

## Electronic Product Code

### ❑ Electronic Product Code (EPC)

- set up by MIT Auto-ID Center, consortium of more than 120 industrial companies and academic laboratories
- to replace bar codes
- EPC system is proposed by EPCglobal
- objective: a reference standard

### ❑ Maximum number of :

- bar codes (EAN): 8900 billions of distinct codes
- EPC codes : 79 billions of billions of distinct codes





## Advantages of RFIDs

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- ❑ Easy update of data contained within RFID chips
- ❑ Storage Capacity: on 1mm<sup>2</sup> we can store 1000 to 10 000 characters
- ❑ Rapid recording speed (reading/writing)
- ❑ Security: data may be encrypted
- ❑ Tags may be positioned anywhere
- ❑ Long life cycle (up to 10 years)

## Desadvantages of RFIDs

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- ❑ **The cost may be high** (passive tags : 8 cents of euros,  
Active tags : 25 euros, sensors : hundreds of euros)
- ❑ **Disturbance by the physical environment:** in presence of metal for example
- ❑ **Privacy Respect :**
  - The CNIL calls up to the vigilance « *Tout en étant un enjeu économique majeur du secteur de la grande distribution, les RFIDs constituent une menace potentielle pour le respect de la vie privée des individus* »
  - EPCglobal incites companies to indicate the presence of RFIDs on products and to inform the consumer.

## Some addressed issues on RFID

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### ❑ Security

- Basic tags have UID, allow updating data without authenticating the reader
- Privacy : Ex: biometric passport

### ❑ The geo-localization of objects

### ❑ Standardization: Many diverging solutions

### ❑ Environment respect

- Technology is used to be disseminated
  - Tags with biodegradable components



## Near Field Communication

## NFC in the world



- Japon with Sony FeliCa, **NTT DoCoMo**
- Cingular Wireless, Citigroup, **New York subway**, MasterCard Worldwide, Nokia, Venyon
- **StoLPaN** « Store Logistics and Payment with NFC » a pan-european : <http://www.stolpan.com>
- **Touch&Travel**: Vodafone, Deutsche Bahn, Motorola, Giesecke&Devrient, ATRON electronic, Germany
- **Manchester City Football Club**, Orange, Barclays, **TfL Oyster card**
- Smart poster
- etc.



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- Bouygues Telecom, RATP, Gemalto, NEC in Paris
- NRJ Mobile (MVNO), Crédit Mutuel, CIC, Master Card, Gemalto, Sagem in Strasbourg
- Orange, Veolia, Clear Channel, Laser Cofinoga in Bordeaux
- Pegasus workgroup: opérateurs (Orange, Bouygues Telecom, SFR), banques (BNP Paribas, Groupe Crédit Mutuel-CIC, Crédit Agricole, Société Générale) with MasterCard, Visa Europe and Gemalto for the mobile payment at: Caen and Strasbourg
- Campus Nova
- Cityzi at Nice with Samsung mobiles compatible with NFC
- Tests during 2011 at Bordeaux, Caen, Lille, Marseille, Nice, Paris, Rennes, Strasbourg and Toulouse.

## Specifications of NFC Forum

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- ❑ **NFC : « Near Field Communication »**
- ❑ **NFC Forum** includes many industrial companies:  
Samsung, Sony, Nokia, Nec, Panasonic, Visa ...
- ❑ **Objective of the standardization**
  - Interoperable Architecture
  - Data model
  - Aims the cell phones
- ❑ **Frequency** of 13,56MHz (HF)
- ❑ **Rate** de 424 Kb/s
- ❑ **Standardized by**
  - **ISO 18092**
  - **ISO 21481**
  - **l'ECMA** (European Computer Manufacturer Association)•
  - **ECMA 340** NFC IP-1
  - **ECMA 352** NFC IP-2+
  
- ❑ **Compatible with ISO 14443-A**, Felica (Sony), Mifare (Philips)

## Smart Poster

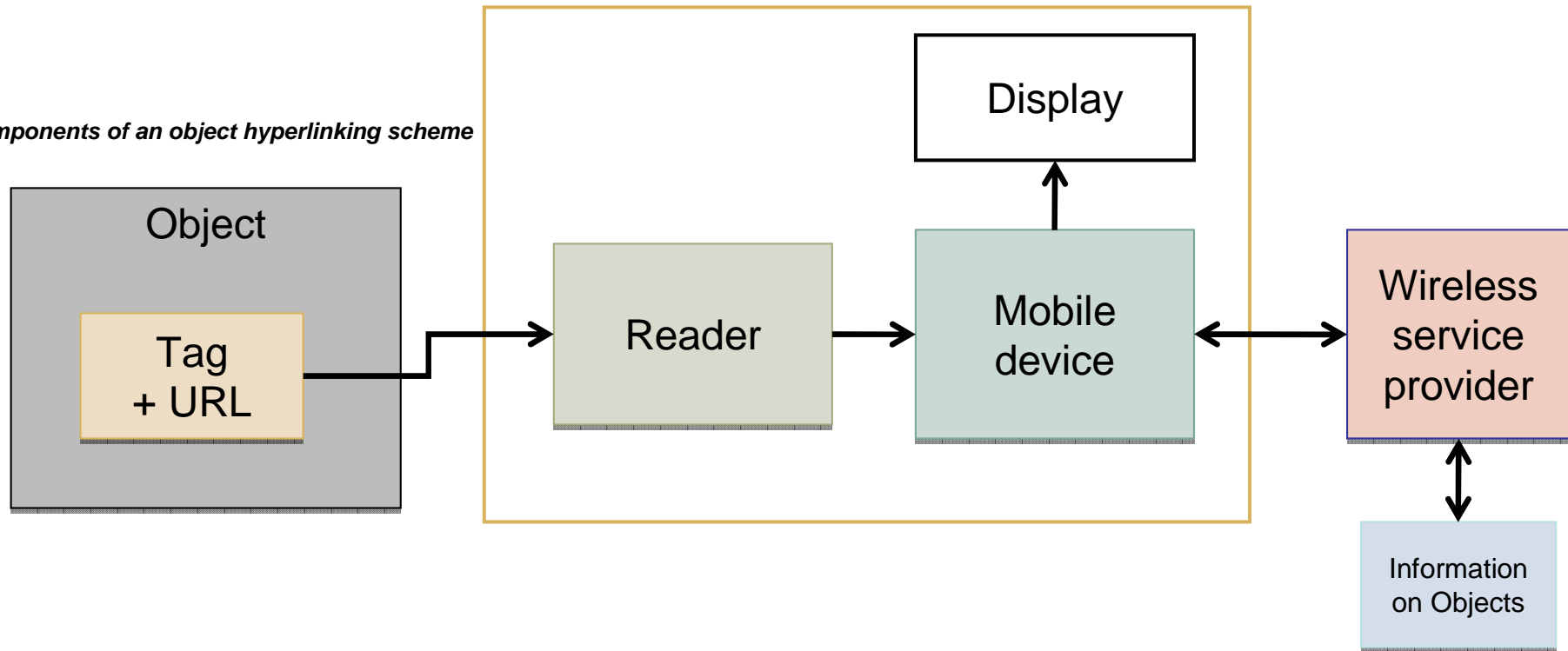
*Smart Posters are signs, billboards, or any other form of advertising which will incorporate a passive (unpowered) NFC Tag, from which a user can extract data by touching it with their NFC-enabled handset. The data could be a free ringtone, a URL, or even the configuration for a local Wi-Fi hotspot. [http://www.theregister.co.uk/2006/10/11/nfc\\_smart\\_posters/](http://www.theregister.co.uk/2006/10/11/nfc_smart_posters/)*



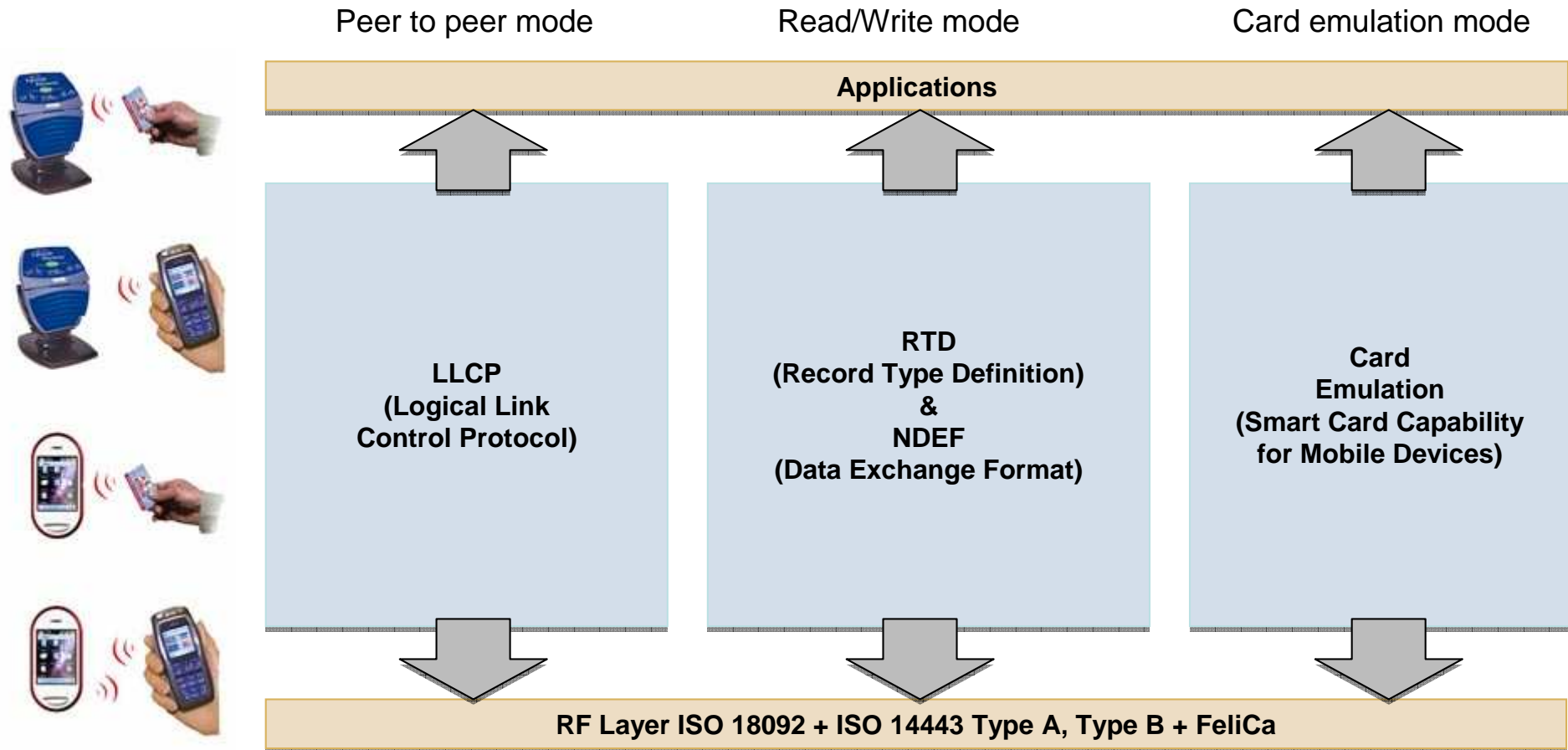


# Smart Poster

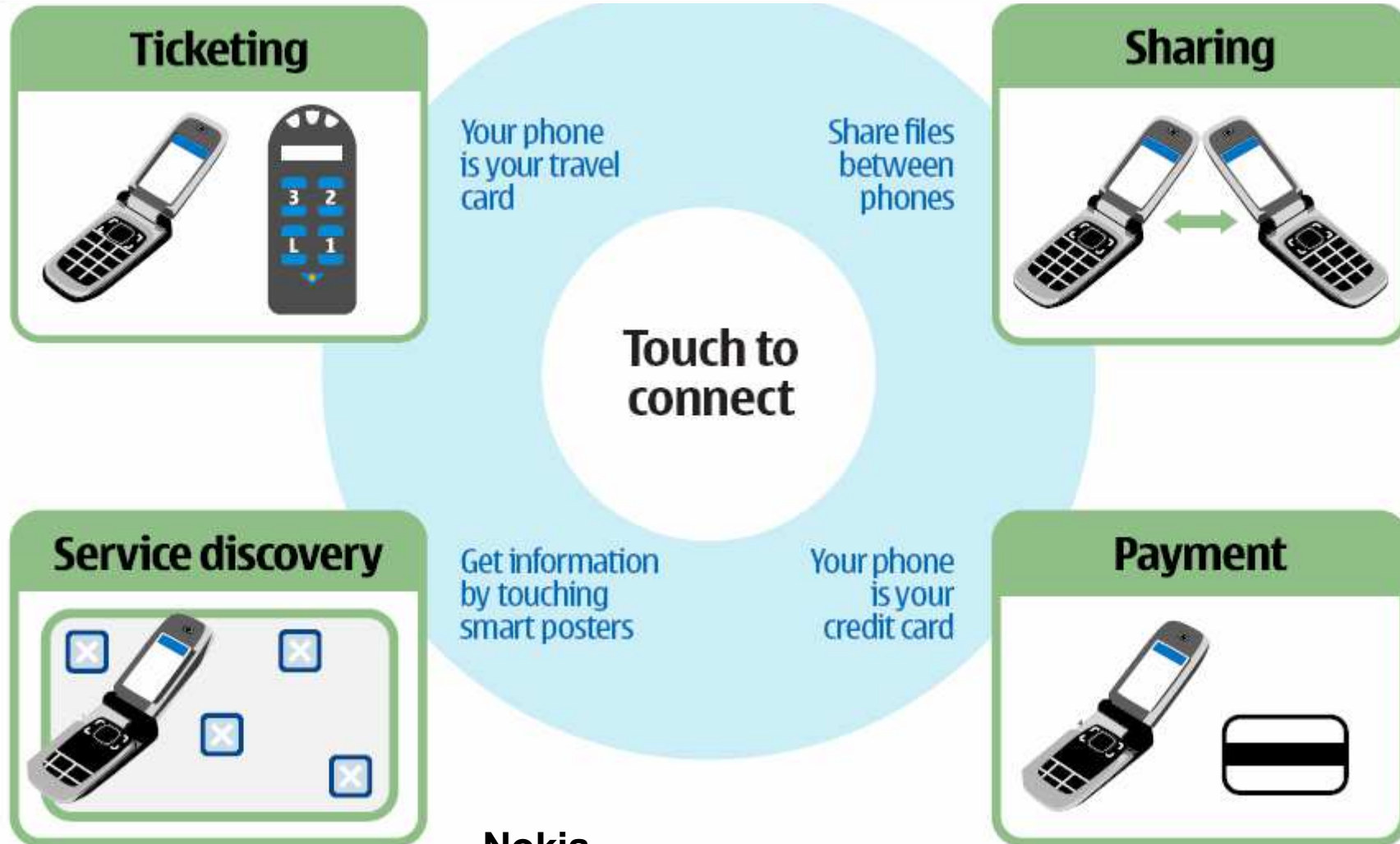
Components of an object hyperlinking scheme



# NFC Forum specifications



## NFC Use cases

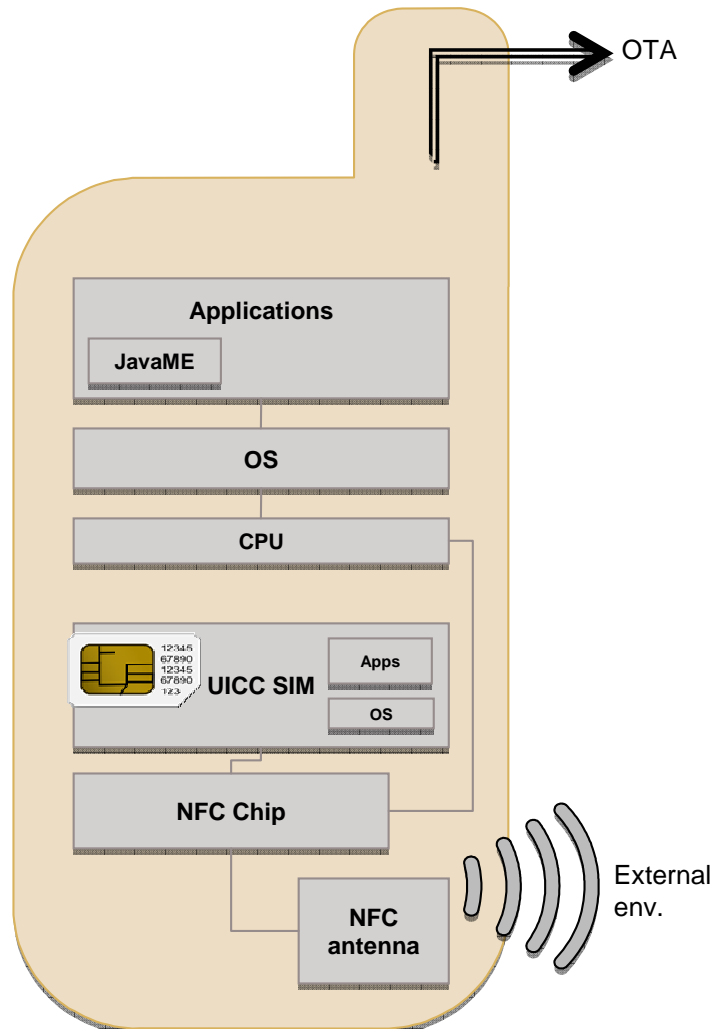


Nokia



etc.

## NFC Cell phone architecture



- Single Wire Protocol (SWP) : the SIM card and the Secure Element (SE) are viewed as the same Java Card.
- GlobalPlatform defines security domains
- MIFARE is a storage memory

*From a developer's point of view it does not matter at all where the SE is located. You will still code against the GlobalPlatform specs. The only difference comes with the distribution/lifecycle model; and since in most cases, the operators control both the SIM card and the phone, the difference is largely academical anyway. Of course, business people may think differently, but that's their problem.*

*Jalkanen, Nokia discussion boards*

- "RFID et l'internet des choses", sous la direction de Hervé Chabane, Pascal Urien et Jean-Ferdinand Susini, Ed. Hermès, Lavoisier, Avril 2010.
- Support de cours de Romain Pellerin sur les RFIDs dispensé en Master SEM, 2009, CNAM.
- Sun Java System RFID Software, Fev. 2006
- JSR-000257 Contactless Communication API, Juin 2005,  
<http://jcp.org/aboutJava/communityprocess/edr/jsr257/index.html>
- EPCglobal: <http://www.gs1.org/epcglobal>
- Supports de cours de Thomas de Lazzari, ingénieur software à Stockholm (<http://tdelazzari.blogspot.com>)
- NFC Forum : <http://www.nfc-forum.org>
- <http://www.rfidjournal.com>  
RFID Information
- <http://mobilepayment.typepad.com>  
Mobile payment blog