RFID

Radio Frequency IDentification: Concepts, Application Domains and Implementation

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UNIVERSITAS FRIBURGENSIS
UNIVERSITÉ DE FRIBOURG / DÉPARTEMENT INTERFACULTAIRE D'INFORMATIQUE
computer science

Sun microsystems
ELCA

Agenda

- Introduction
- The EPCglobal Architecture Framework
- Application Domains
- RFIDLocator: a Localization Framework
- Demonstration Video
- Extension Mechanism of the RFIDLocator
- Using the Framework: the Smart Badge project
- Conclusion

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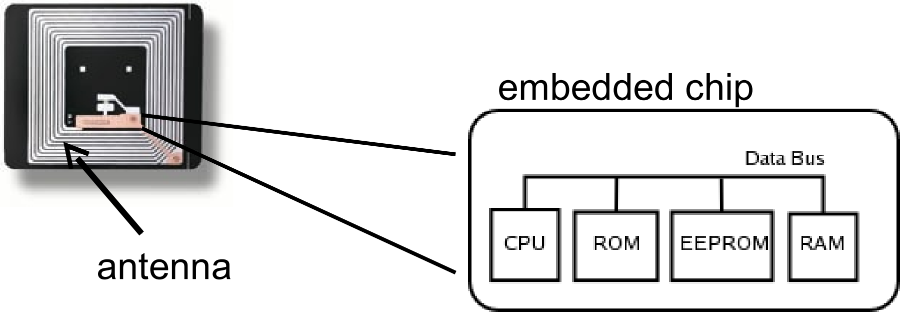
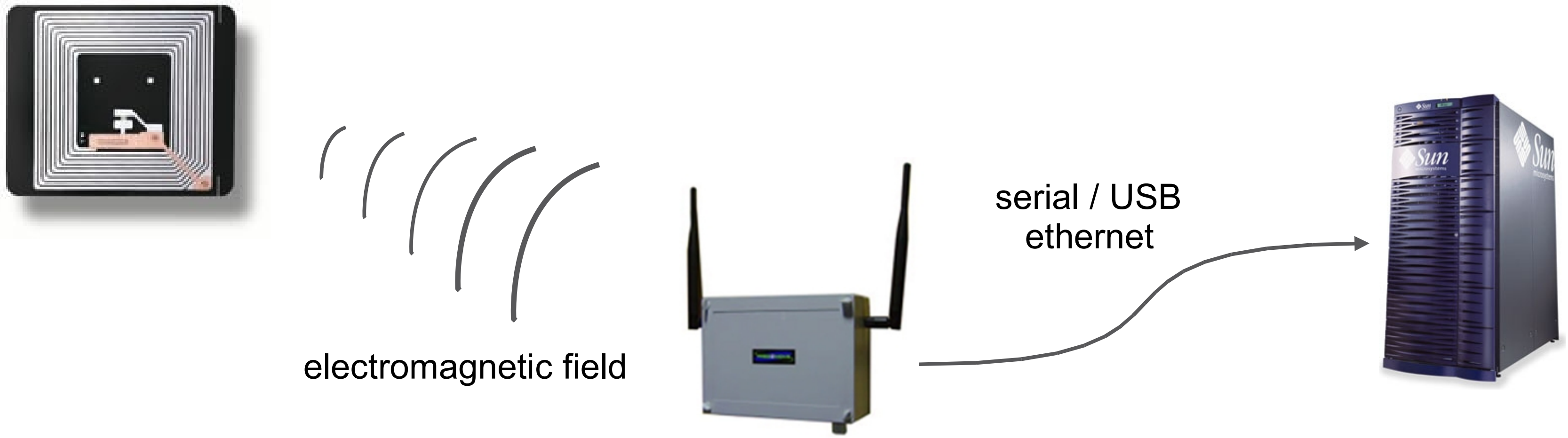
RFID Tags

- Radio Frequency Identification (RFID) is a method for remotely storing and retrieving data using devices called tags.
- RFID tags (often presented as the new generation of barcodes) are composed of:
  - an antenna.
  - a microchip containing a small amount of data.
- RFID technology enables:
  - Contact-less identification.
  - The reading of identifiers that are in motion.
  - The detection of objects that are not in line of sight.



RFID Readers



> The RFID readers (aka sensors) emit an *electromagnetic field*.

> The tag converts the field into a source of power.

> As the tag is powered, the sensor can start reading/writing the tag's content.

> Such a reading is called an RFID event and is transmitted to a computer in charge of processing it.

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Towards the Internet of Things

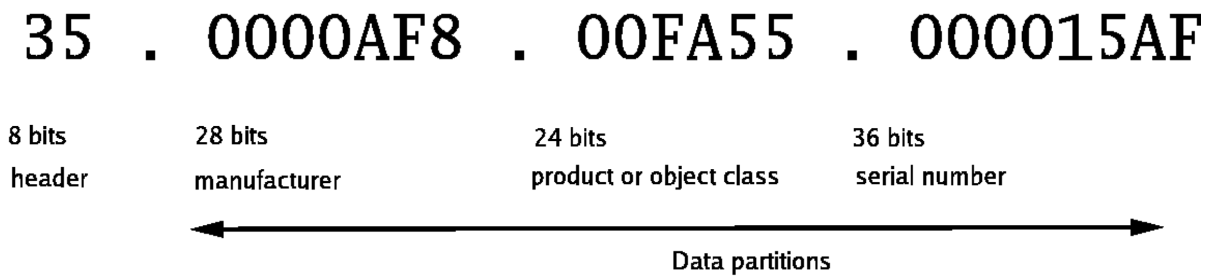
- > World-wide standards are required for global interoperability.
- > Auto-ID Labs and EPCGlobal are two non-profit organizations tackling this goal.

AUTO-ID LABS
Identify Any Object Anywhere Automatically

EPCglobal

- > Both have a simple motto:
  developing an open standard architecture for creating a seamless global network of physical objects called the EPC Network, aka the "Internet of Things".
- > The EPCGlobal Architecture Framework regroups various standards:
  - – Electronic Product Code (EPC) – March 8, 2006 (v1.3)
  - – EPC Information Services (EPCIS) – April 12, 2007 (v1.0)
  - – Object Naming Service (ONS) – October 4, 2005 (v1.0)
  - – Application Level Events (ALE) – September 15, 2005 (v1.0)

Electronic Product Code (EPC)



35 . 0000AF8 . 00FA55 . 000015AF

8 bits	28 bits	24 bits	36 bits
header	manufacturer	product or object class	serial number

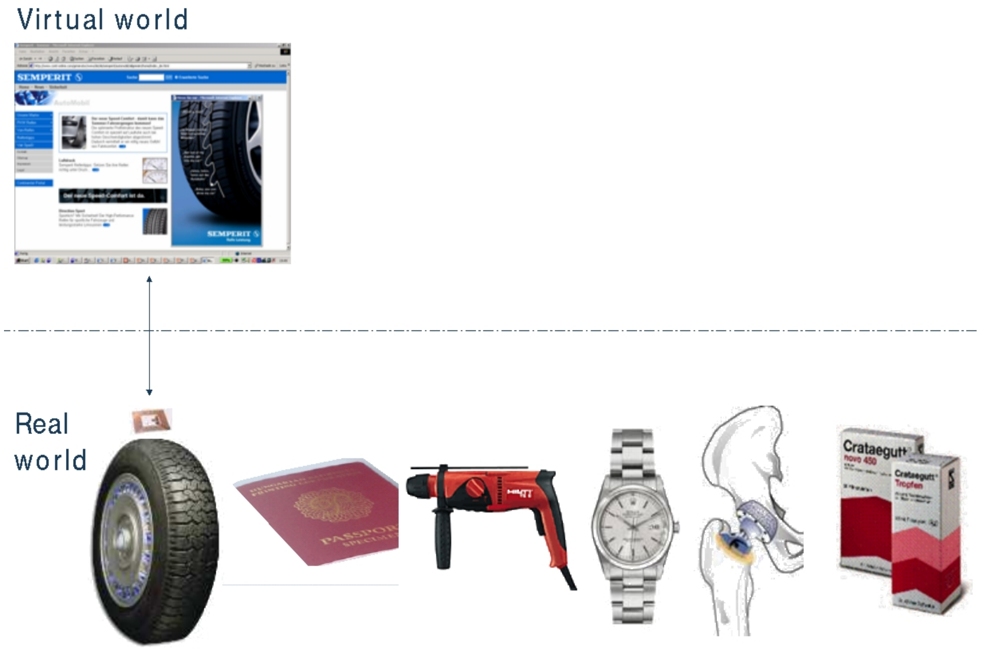
Data partitions

- First standard supporting the “Internet of Things”: the EPC (Electronic Product Code) Tag Data Specification.
- A world-wide unique number identifying a particular instance of a physical object.
- Often represented in an URI form (Uniform Resource Identifier), e.g.: `urn:epc:id:gid:2808.64085.88828`
  - `gid`: header
  - `2808`: manufacturer
  - `64085`: product or object class
  - `88828`: serial number

EPC Information Services (EPCIS)

- The EPCIS are the primary vehicle for data exchange between trading partners.
- The EPCIS Standard specifies two interfaces and one data model.
  - EPCIS Event Query Interface defines how business events can be requested from repositories and other sources of EPCIS data.
  - EPCIS Event Capture Interface specifies a standard way to communicate data to applications that wish to consume it.
  - EPCIS Data Specification defines the format and the meaning of the exchanged information. This information takes the form of “events” describing the *what*, *when*, *where* and *why* for physical object movements.

Object Naming Service (ONS)



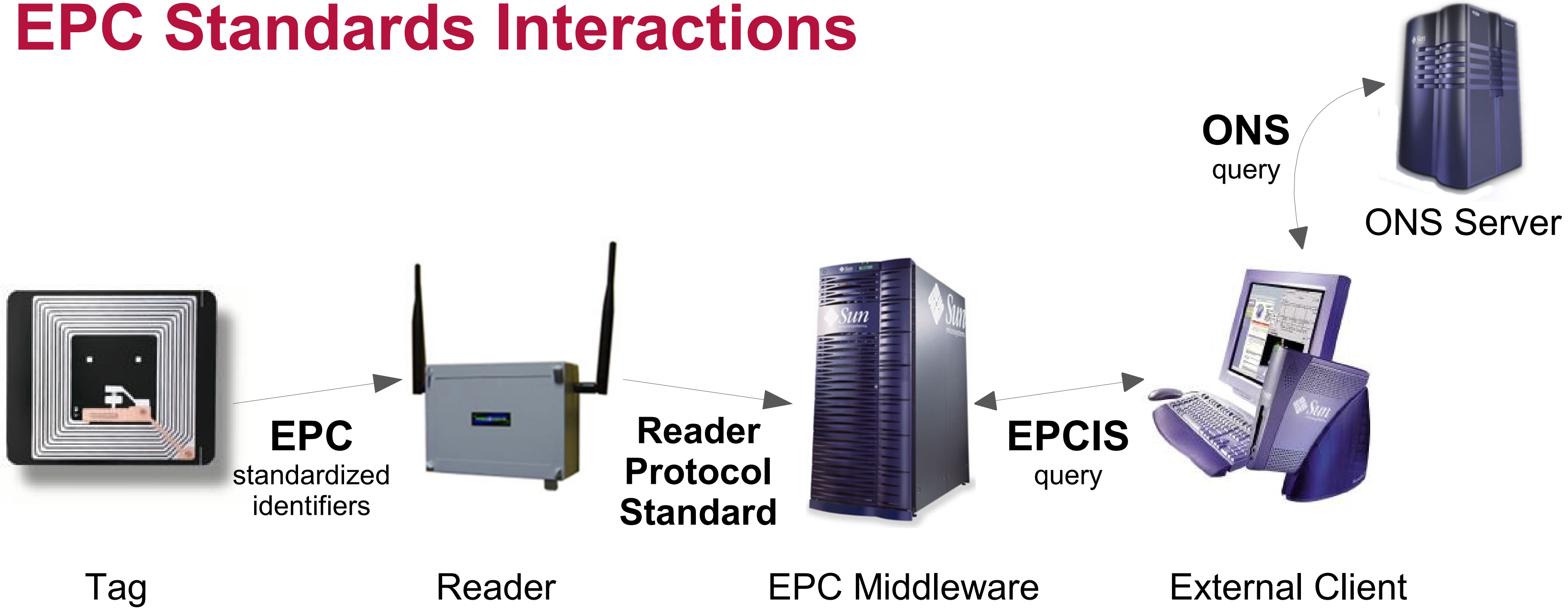
> A simple idea: having the EPC of an object, where can I retrieve (authoritative) data about it?

> Designed on top of DNS (Domain Name Service).

Filtering Collection Interface

- Reducing the volume of data that comes directly from EPC data sources typically involves:
  - receiving EPCs from one or more data source such as readers;
  - accumulating data over intervals of time, filtering to eliminate duplicate EPCs and EPCs that are not of interest, and counting and grouping EPCs.
- The Filtering Collection (Application Level Events or ALE) Interface provides a standardized format for reporting such collected and filtered EPC data.

EPC Standards Interactions



- Put all together, the EPC standards converge towards a global network of the physical objects surrounding us: the EPC Network.
- The EPC Network is still young but its potential might well boost the number of adopters. Examples: Wall Mart, Metro Group, Gillette,...

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Application Domains

- Matching a computer-readable standardized number to any object surrounding us has an incredible number of applications in various domains:
  - Assets Identification and Tracking
    - ➔ Document tracking in attorney/lawyers offices
  - Supply Chain Management
    - ➔ Wall Mart and its “Top 100 Suppliers” challenge
    - ➔ Metro Group and its “Future Store” initiative

Application Domains (2)

- Matching a computer-readable standardized number to any object surrounding us has an incredible number of applications in various domains:
  - Anti-Counterfeiting
    - ➔ Pfizer to fight fake Viagra
  - E-health
    - ➔ blood tracking
    - ➔ patient identification
    - ➔ smart operation theatres

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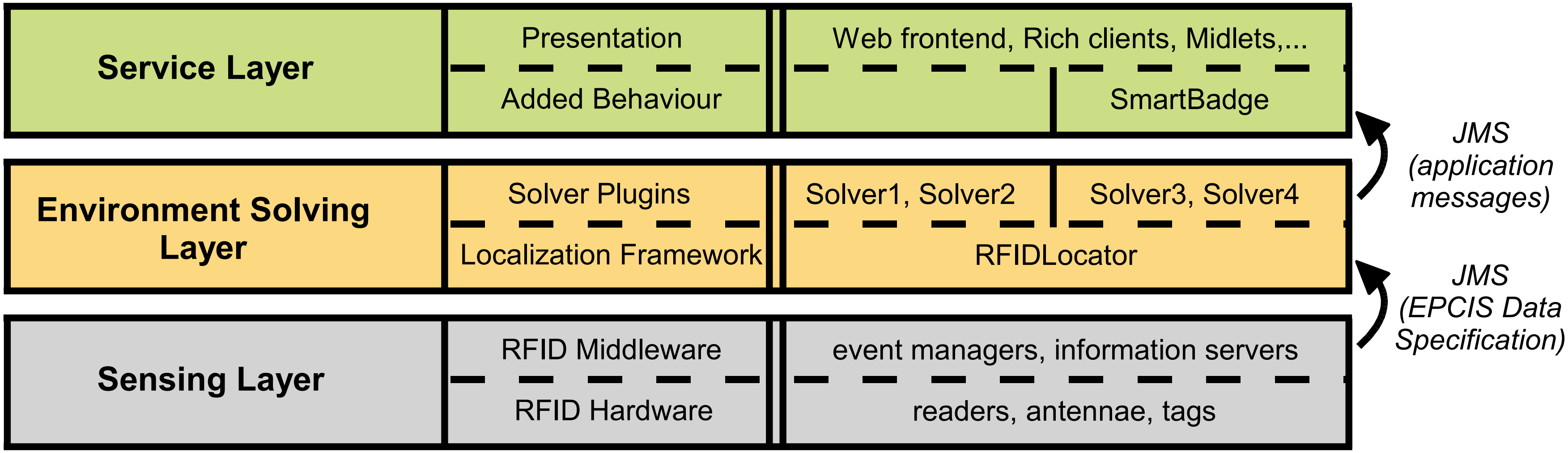
RFIDLocator: a Localization Framework

- The RFIDLocator is a localization framework.
- It was developed in the Software Engineering Group of the University of Fribourg in collaboration with Sun Microsystems Switzerland.
- It supports the development of spatially aware applications within a predefined area (e.g. a building)
- Example applications:
  - Tracking assets within a building
  - Inventory systems
  - Tracking patients within a hospital

RFID locator

The RFID Stack

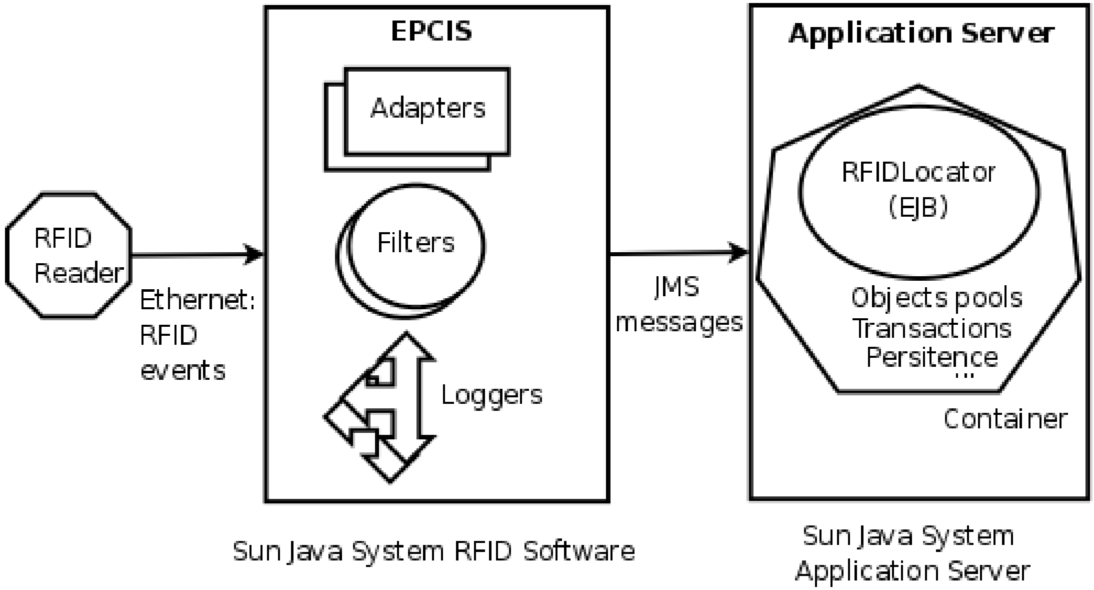


Service Layer	Presentation	Web frontend, Rich clients, Midlets,...
	Added Behaviour	SmartBadge
Environment Solving Layer	Solver Plugins	Solver1, Solver2 Solver3, Solver4
	Localization Framework	RFIDLocator
Sensing Layer	RFID Middleware	event managers, information servers
	RFID Hardware	readers, antennae, tags

JMS (application messages)

JMS (EPCIS Data Specification)

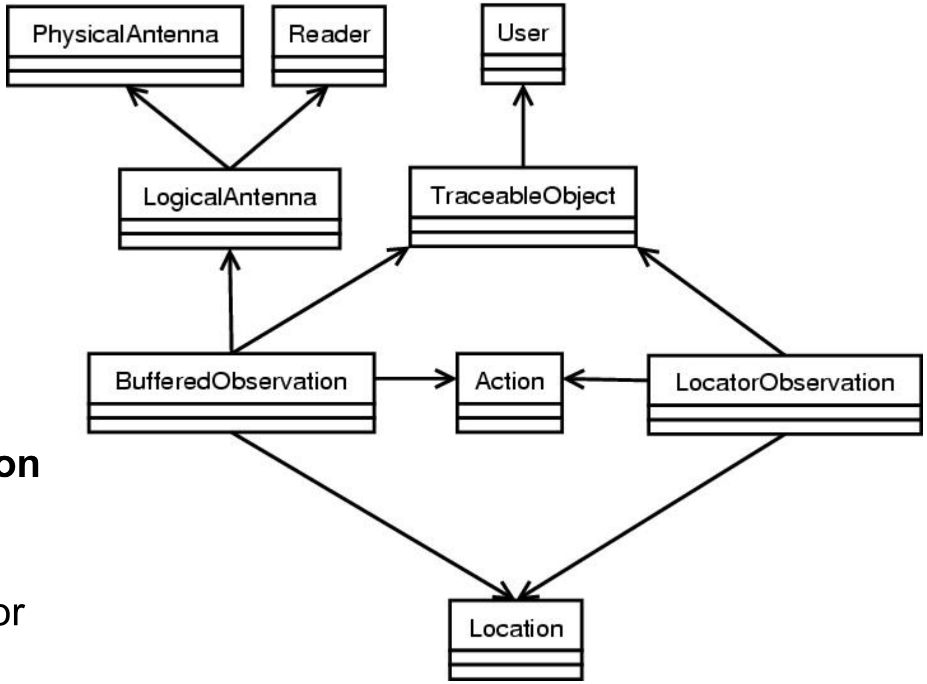
Global Software Architecture



- The RFIDLocator is a distributed Java Enterprise application, developed using the Enterprise JavaBeans specification.
- The application is deployed on the Sun Java System Application Server.
- The RFID middleware is the Sun Java System RFID Software.
- Besides the software choices, standard RFID hardware was chosen.

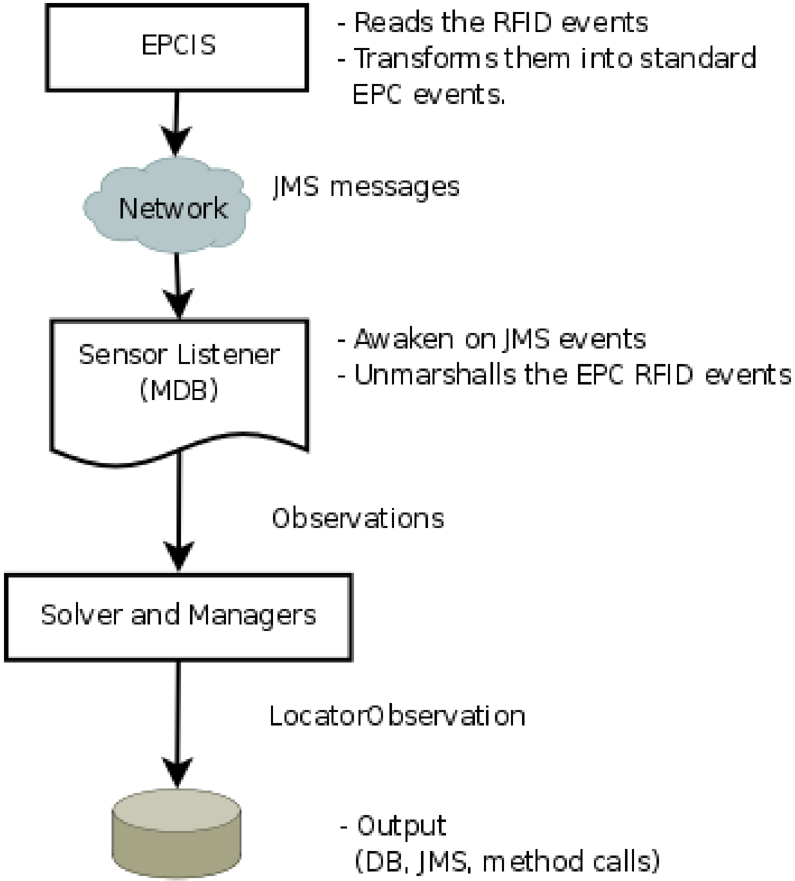
Object Model: The Actors

- **Reader**
  Models an RFID reader (aka Sensor)
- **PhysicalAntenna**
  A hardware component able to capture RFID events.
- **LogicalAntenna**
  Groups 1..n PhysicalAntennae.
- **TraceableObject**
  Models assets equipped with an RFID tag and traced by the application.
- **LocatorObservation** and **BufferedObservation**
  Results of an RFID event.
- **Action**
  Action assigned to the RFID events: either IN or OUT of the Location.
- **User**
  Models the users and administrators of the system.

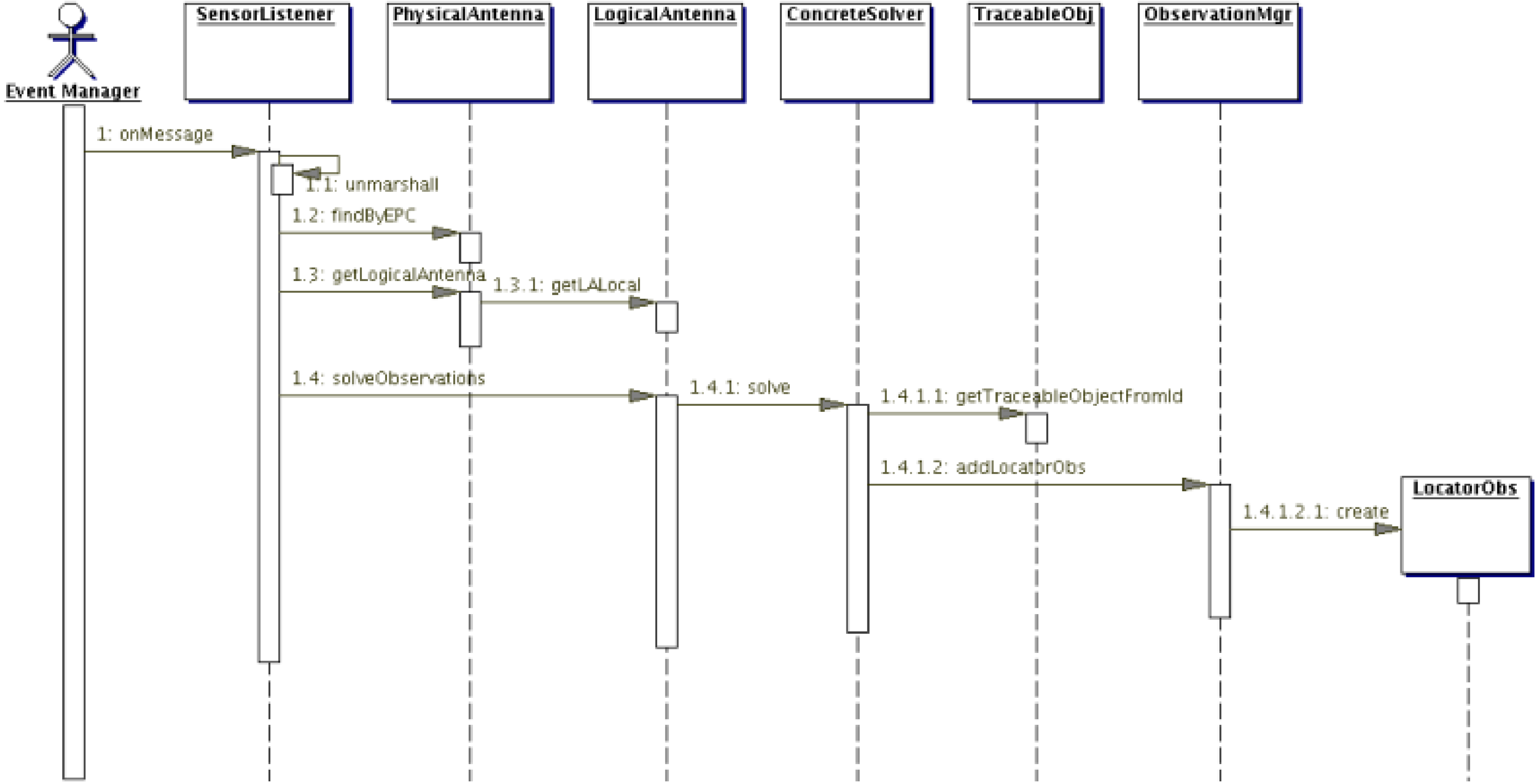


Services and Manager: The Core Classes

- The **SensorListenerMDB** is the integration point between the EPCIS and the RFIDLocator.
- The **Managers** are used to create, delete and manage the object model (actors).
- The **Solvers** are the algorithms of the framework. They decide whether an RFID event should be persisted as a business event (**LocatorObservation**).



Sequence Diagram of the Solving Process



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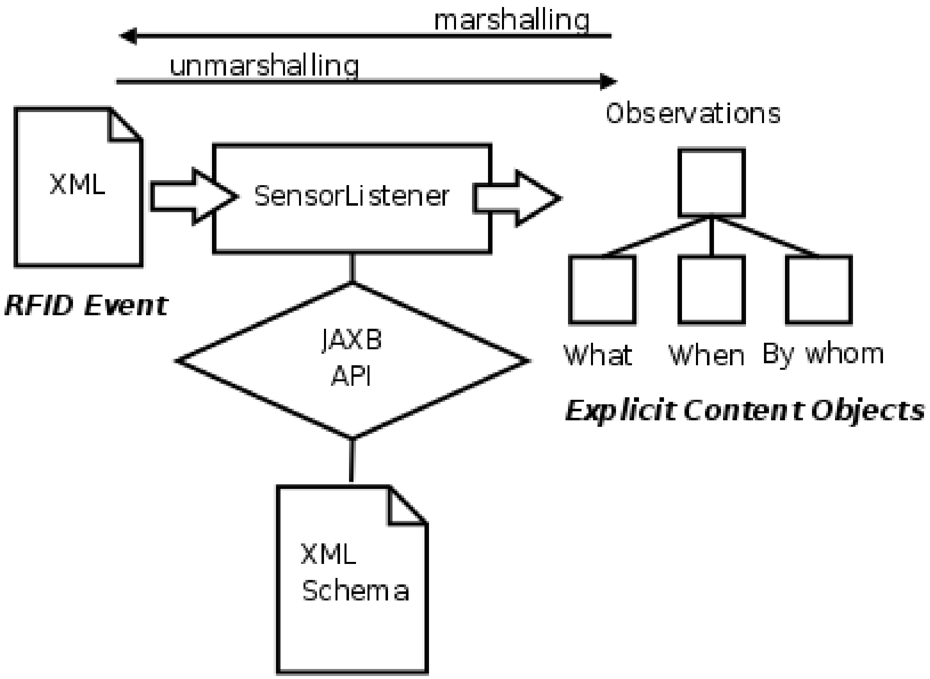
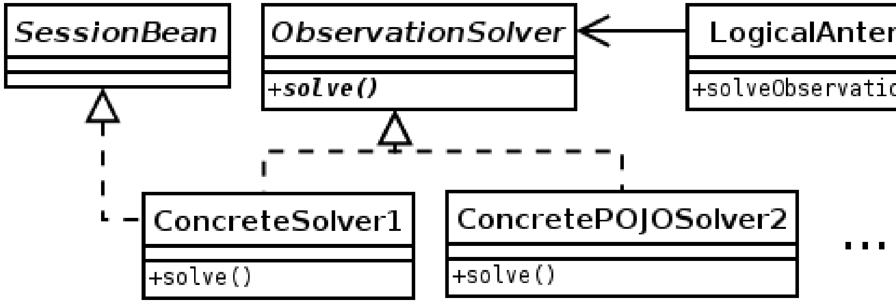
Adapting the Framework to a new Standard

- Using a tool based on JAXB and Ant, the RFIDLocator can accept any kind of XML-formalized RFID event.
- The XML schema of the formalism is used to generate explicit content objects that can be accessed in a “Object Oriented fashion”.
- The RFIDLocator only needs to be able to extract three information from these content objects:
  - *What* was observed (tag(s));
  - *When* it was observed (time);
  - *By whom* it was observed (antenna(e)).



Extending the Solving Logic



- To change the behavior of the core solving logic one only needs:
  - To program a new **Solver** using the provided interfaces and tools.
  - To have a **LogicalAntenna** referencing it.
- Using this simple but yet powerful scheme we can create **Solvers** to:
  - Aggregate RFID events (~business-level ALE).
  - Direct business events to different outputs (JMS queues, DB, log files, method calls, etc.)

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Using the Framework: the Smart Badge Project

SMARTBADGE

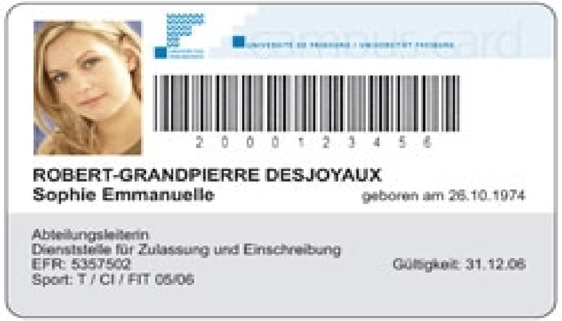
> The SmartBadge project is a multi-tier infrastructure offering contextual services to members of an institution:

- Each actor receives an RFID enabled card.
- RFID readers are installed at points of special interest and strategic places.
- The system delivers adapted content to users when they enter or pass by monitored places within the environment.

Use Cases

> Smart Badge on a University Campus:
  – RFID tags in students/staff ID cards.
  – Services:
    ➔ Adapted meal propositions sent per text.
    ➔ Lecture slides per email.
    ➔ Jobs/student union information.
    ➔ Monitoring attendees.

> Smart Badge at a Conference:
  – RFID tags on conference badges.
  – Services:
    ➔ Next talks matching profile.
    ➔ Updates, news, social events.
    ➔ Your conference log/blog.
    ➔ Monitoring attendees.



campus card

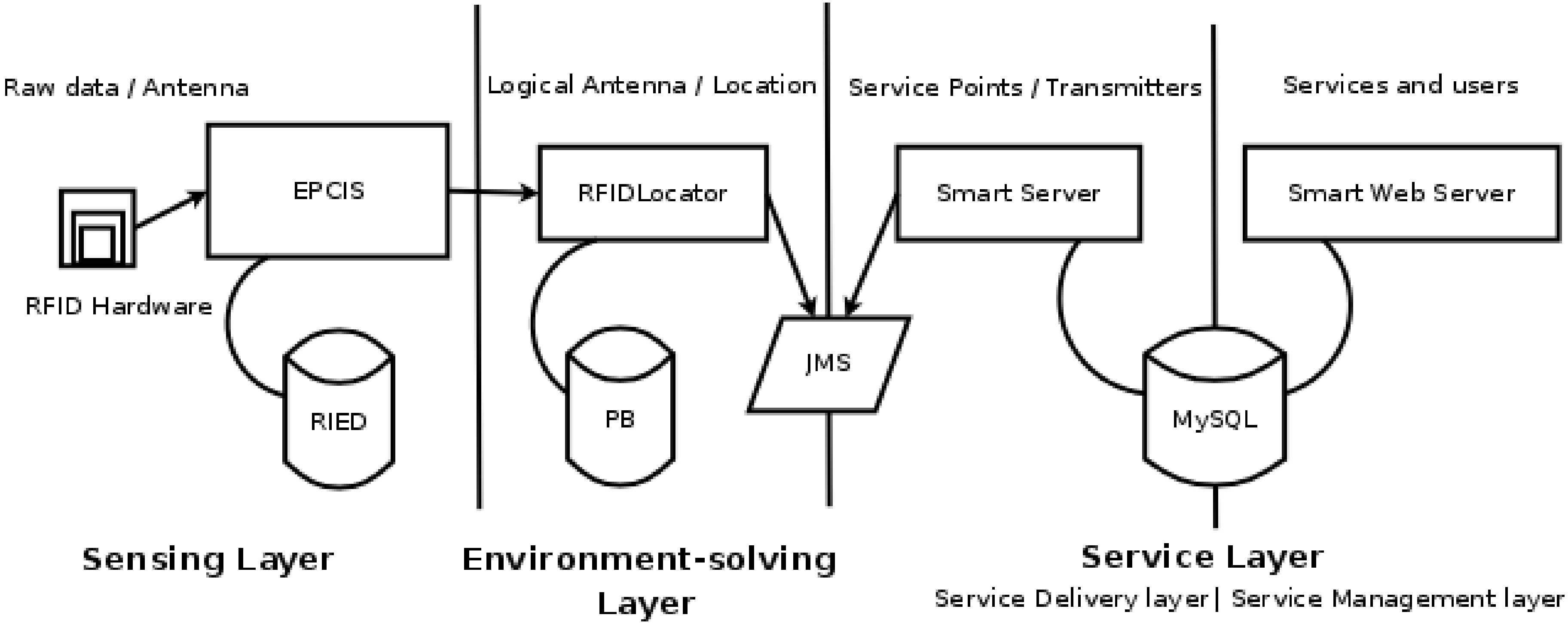
UNIVERSITÉ DE FRIBOURG / UNIVERSITÄT FREIBURG

2 0 0 0 1 2 3 4 5 6

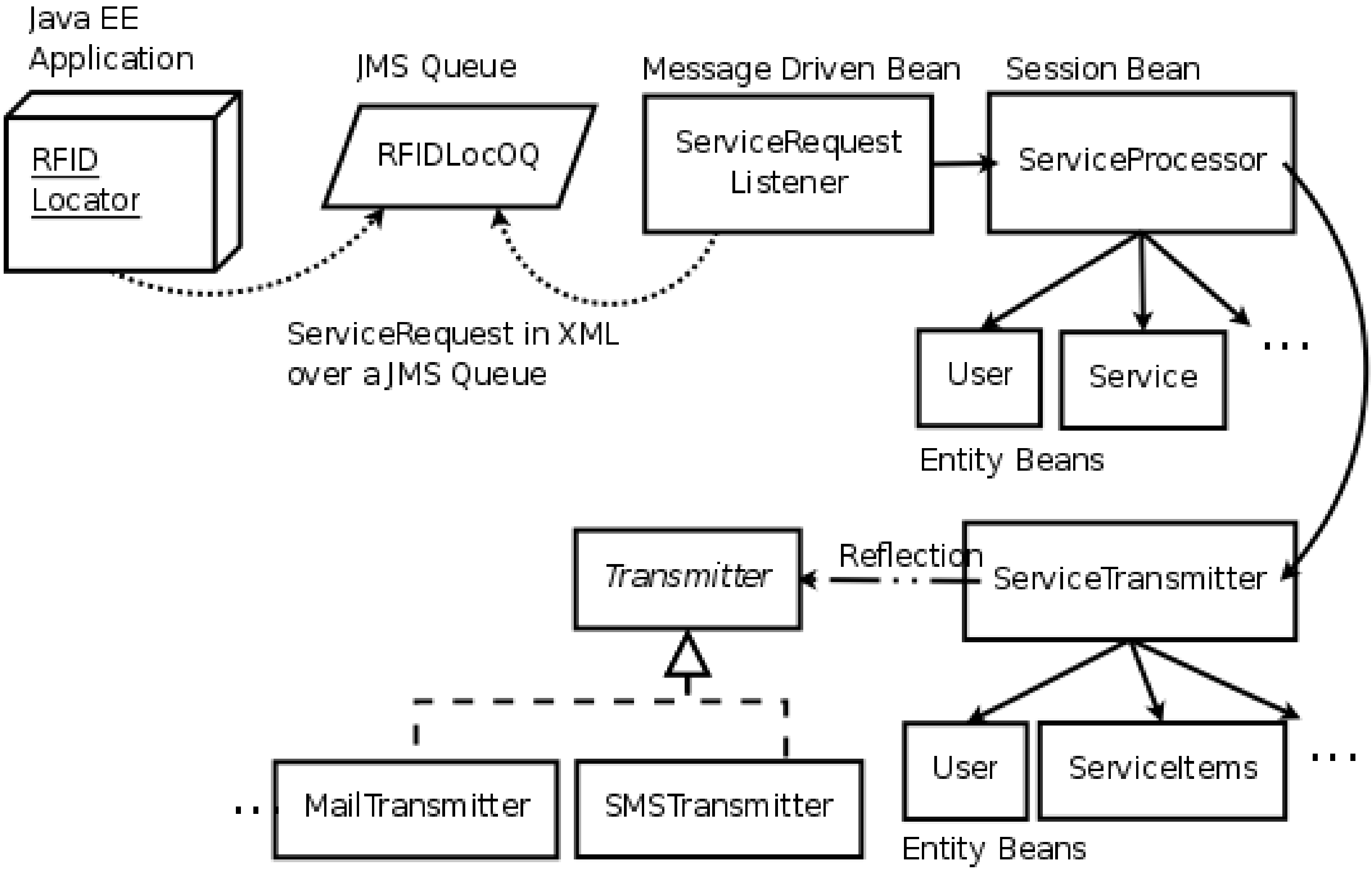
ROBERT-GRANDPIERRE DESJOYAUX
Sophie Emmanuelle geboren am 26.10.1974

Abteilungsleiterin
Dienststelle für Zulassung und Einschreibung
EFR: 5357502
Sport: T / CI / FIT 05/06
Gültigkeit: 31.12.06

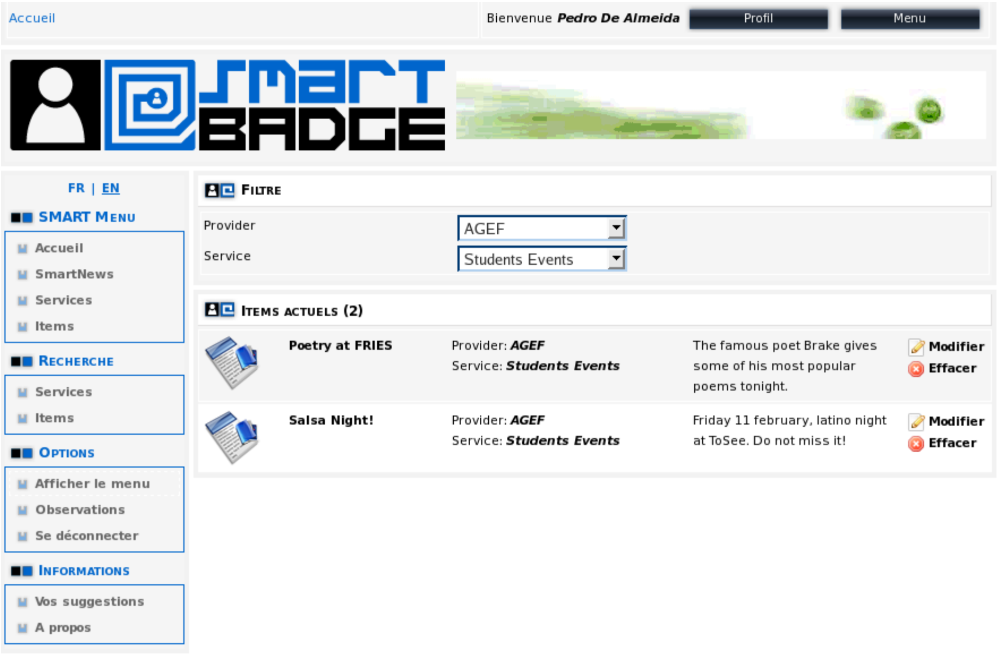
Architecture



Contextual Service Providing: Architecture



Managing Contextual Services



Accueil | Bienvenue *Pedro De Almeida* | Profil | Menu

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FILTRE

Provider: AGEF

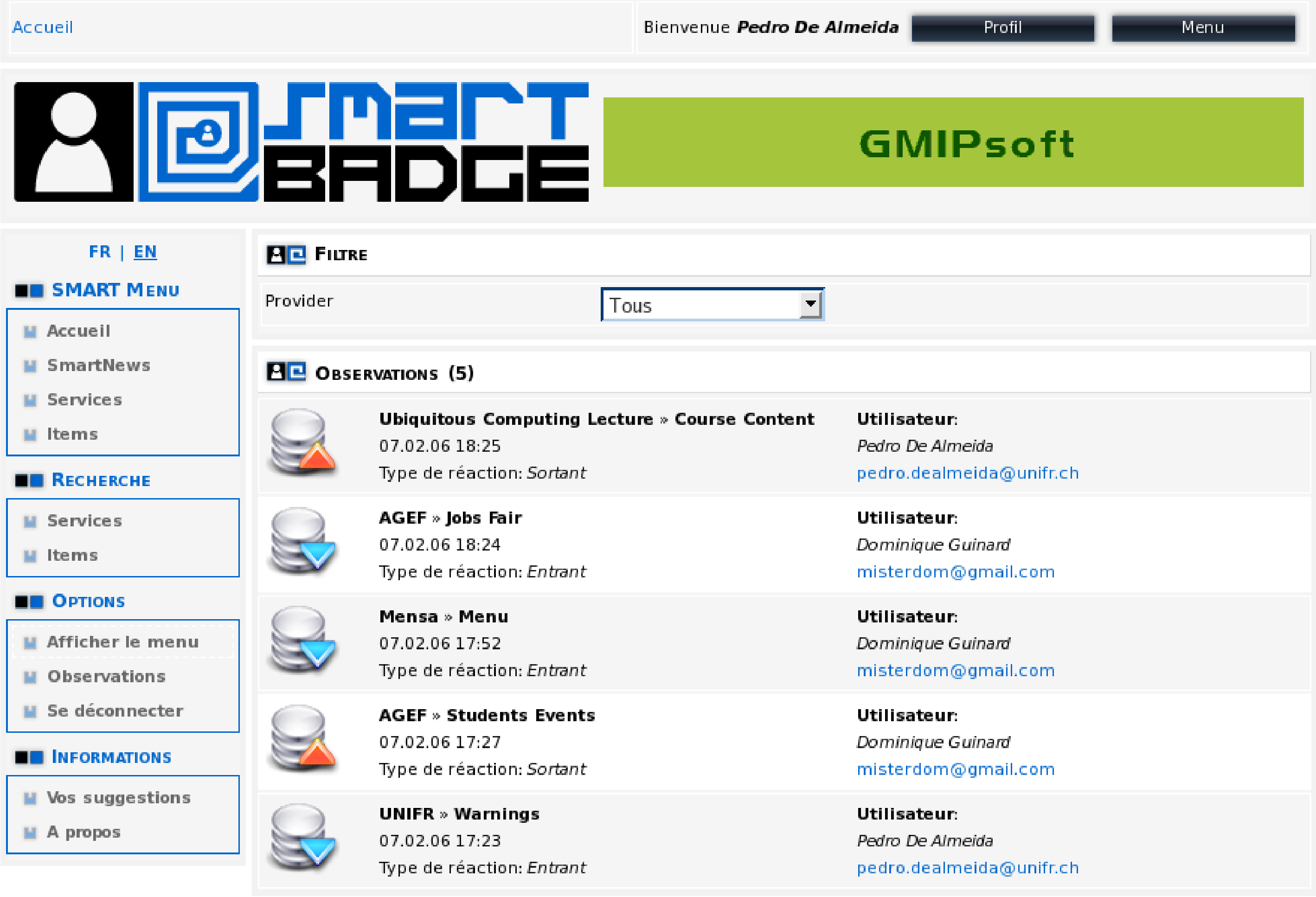
Service: Students Events

ITEMS ACTUELS (2)

Poetry at FRIES	Provider: *AGEF* Service: *Students Events*	The famous poet Brake gives some of his most popular poems tonight.	Modifier Effacer
Salsa Night!	Provider: *AGEF* Service: *Students Events*	Friday 11 february, latino night at ToSee. Do not miss it!	Modifier Effacer

- Smart Web Server
- Web front-end to manage services, service points and users.
- Users can access it to manage their profiles and preferences (e.g. diets, preferences for mobile device, affiliation, etc.)
- PHP & MySQL application

Managing Contextual Services



Accueil

Bienvenue ***Pedro De Almeida*** Profil Menu

SMART BADGE GMIPsoft

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SMART MENU

- Accueil
- SmartNews
- Services
- Items

RECHERCHE

- Services
- Items

OPTIONS

- Afficher le menu
- Observations
- Se déconnecter

INFORMATIONS

- Vos suggestions
- A propos

FILTRE

Provider: Tous

OBSERVATIONS (5)

Ubiquitous Computing Lecture » Course Content
07.02.06 18:25
Type de réaction: *Sortant*
Utilisateur:
Pedro De Almeida
pedro.dealmeida@unifr.ch

AGEF » Jobs Fair
07.02.06 18:24
Type de réaction: *Entrant*
Utilisateur:
Dominique Guinard
misterdom@gmail.com

Mensa » Menu
07.02.06 17:52
Type de réaction: *Entrant*
Utilisateur:
Dominique Guinard
misterdom@gmail.com

AGEF » Students Events
07.02.06 17:27
Type de réaction: *Sortant*
Utilisateur:
Dominique Guinard
misterdom@gmail.com

UNIFR » Warnings
07.02.06 17:23
Type de réaction: *Entrant*
Utilisateur:
Pedro De Almeida
pedro.dealmeida@unifr.ch

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Enhancements

- The RFIDLocator is a working prototype, not a fully-featured system.
- Making it available for commercial purposes would require:
  - A thinner granularity for the user management (roles, restricted access to the TraceableObjects, etc.).
  - A more complete administrative GUI (modifying the reader's configuration, etc...).
- Update to new standards and middleware.

Achievements

- Integration of various standards of the RFID field.
- Built a realistic distributed application involving many different hardware devices.
- Performing distributed application enabled by the use of Java Enterprise Framework and its EJB components:
  - scalable, robust, reliable, transaction control.
- The RFIDLocator framework has a clean, flexible and well documented software architecture:
  - Validated by the implementation of the SmartBadge.
  - Allowing further extends and uses of this open-source framework.

Future of RFID

- EPC Network standards presents a huge potential in term of cross organizations interoperability.
- Price/performance ratio is improving encouraging global adoption.
- Application domains do not cease to widen as technology evolves:
  - Cellular phones (Nokia, etc.) to include RFID readers for NFCs applications.
  - Underskin RFID implants for humans allow new use-cases.
- Privacy and security concerns should not be underestimated. They have to be solved at both technological and legal levels (e.g. EU e-privacy directive).

Resources

- RFIDLocator's official website: **http://diuf.unifr.ch/rfid**
  - Java API
  - Application source code and binaries (under GPL)
  - Documentation (under FDL)
  - Related publications
- Other URLs:
  - Department of Informatics of University of Fribourg
    `http://diuf.unifr.ch`
  - Software Engineering Group
    `http://diuf.unifr.ch/softeng`

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SAP® ETH

Software Engineering Group

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Haute Ecole d'Ingénierie et de Gestion
du Canton de Vaud