



OWL-based location Ontology for context-aware services

AIMS'04 (UbiComp) – September 7, 2004

Artificial Intelligence in Mobile Systems

Thibaud Flury, Gilles Privat, Fano Ramparany

France Telecom R&D - Grenoble

The present document contains information that remains the property of France Telecom. The recipient's acceptance of this document implies his or her acknowledgement of the confidential nature of its contents and his or her obligation not to reproduce, transmit to a third party, disclose or use for commercial purposes any of its contents whatsoever without France Telecom's prior written agreement.

OWL-based location ontology for context-aware services

- ▶ **Location and Ubiquitous Computing**
 - ▶ Software Services and Physical Devices
 - ▶ From location technologies to context-aware services
 - ▶ Semantic Web and Ontologies
- ▶ **A Location Ontology**
 - ▶ Unifying heterogeneous location information
 - ▶ From generic location models to concepts and relations
 - ▶ Instantiate the Ontology with a basic example
- ▶ **Location Ontology and Location Service**
 - ▶ The ontology as a knowledge base
 - ▶ Reasoning with Inference Rules
 - ▶ A Location Service



Location and Ubiquitous Computing



- ▶ **Software Services and Physical Objects**
 - ▶ Services in a *Service Oriented Architecture (SOA)*
 - Services located in the **network** can cooperate
 - ▶ Embedded Devices in the tangible world
 - Smart objects located in **physical space**
 - ▶ Using location to bridge the gap
 - Software Services within Smart Objects
 - *The object offers physical affordance in the mundane world*
 - *The object offers informational service in information world*
 - Location information as an input for context-aware service
 - Location information as a common denominator



Software Services and Physical Devices

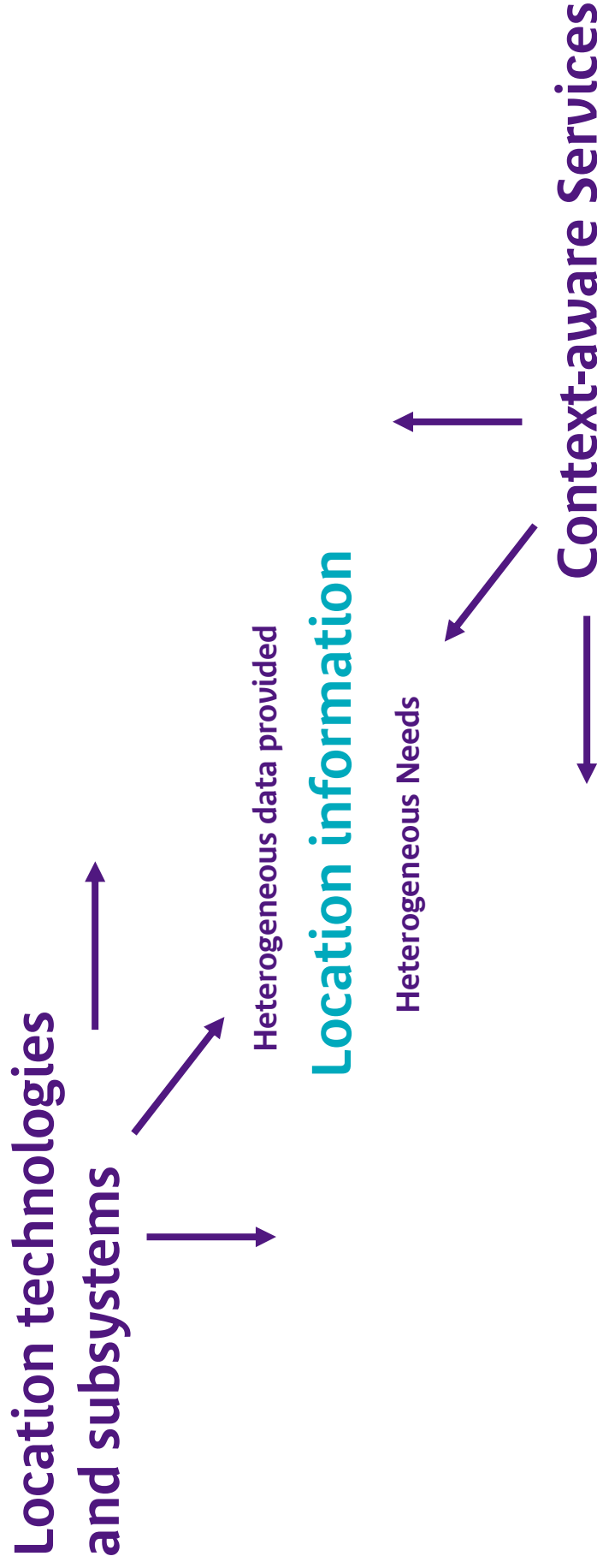
➤ "Where is the nearest printer?" Classical example



- Locate the service in the network (send data to print)
 - *IP address: 191.23.12.45*
 - *Programmatic Handle using RMI, RPC, ...*
 - *URL: service:printer://perre.sta.fr:515 (SLP)*
 - *An advertised services in a SOA: Jini, UPnP, ...*
 - ...
- Locate the device in physical space (retrieve the printed document)
 - *Geographical position: lat 05°43'37", long 45°11'16", elev 212 m*
 - *Into room B103*
 - *First floor, end of corridor, second door on the left*
 - *Inside Peter's office*
 - ...



▶ From location technologies to context-aware services





- ▶ **Semantic Web and Ontologies**
 - ▶ The web actually contains data for *human*
 - ▶ The semantic web aims to explain these data *to machines*
 - ▶ Two distinct entities may share knowledge
 - Using ontology bridging and information crossing
 - ▶ A well-suited mean to characterize *location information*
 - A way to have heterogeneous entities (location technologies and clients applications understand each other and cooperate)

A Location Ontology



Unifying heterogeneous location information

- Defining an ontology for location information
 - Independent from any particular technology or need
 - Extensible to integrate seamlessly new technologies and answer to new needs
 - Generic enough to be crossed with domain specific ontologies

A Location Ontology



Unifying heterogeneous location information

- Our method
 - 1° Find common denominators
 - *Location Information gathered in general categories*
 - 2° Characterize the underlying models
 - 3° Formalize the general concepts and relations
 - 4° Link the distincts models
 - *Integrate the models using inheritance/specialization mechanisms*
 - *Using abstraction levels (From techno-driven to human interpretation of space)*
 - *New concepts and relations between concepts belonging to distinct models*

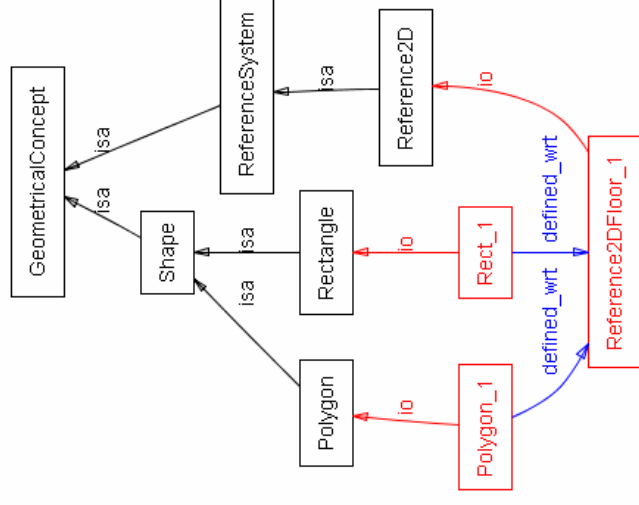
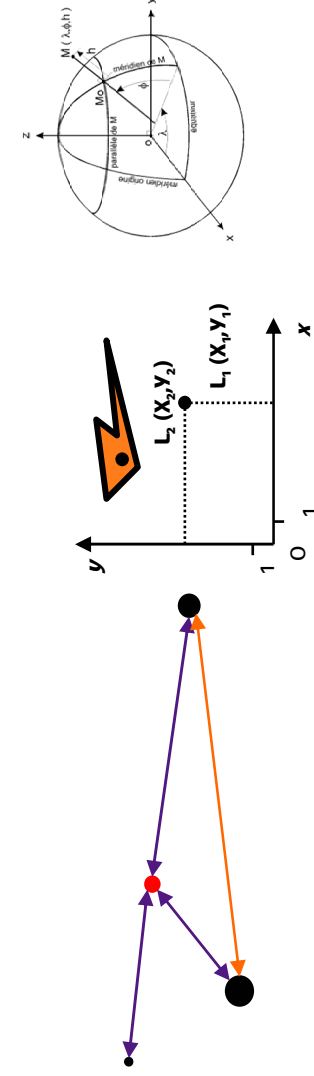
(confidential)

A Location Ontology



▶ From generic location models to concepts and relations

- ▶ Geometric models
 - Distance, angle, position, orientation ...
 - Geometric Transformations
- Geometric abstraction of Shape
- Coordinate Reference System

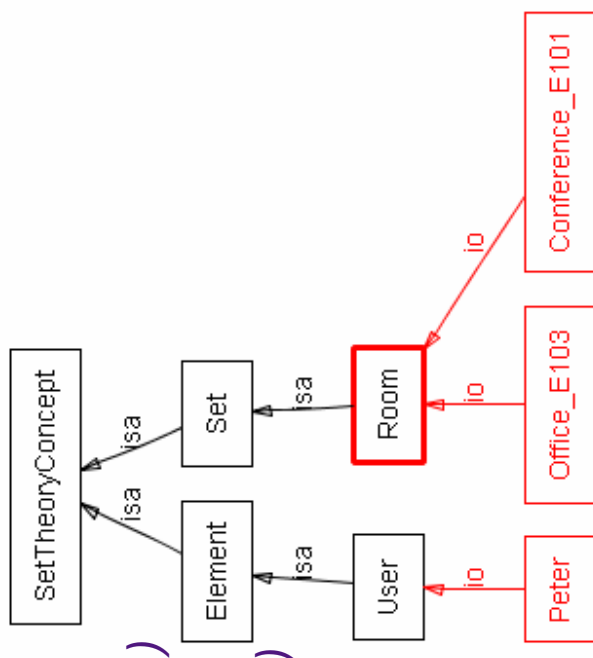
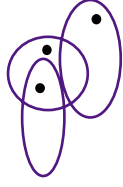
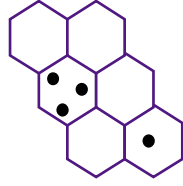


A Location Ontology



▶ From generic location models to concepts and relations

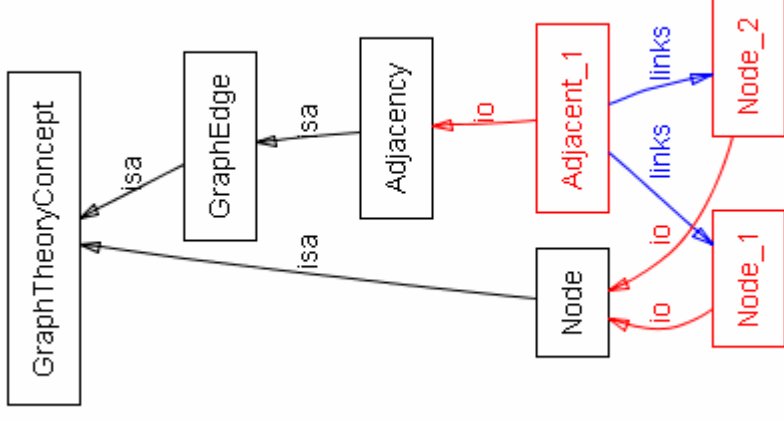
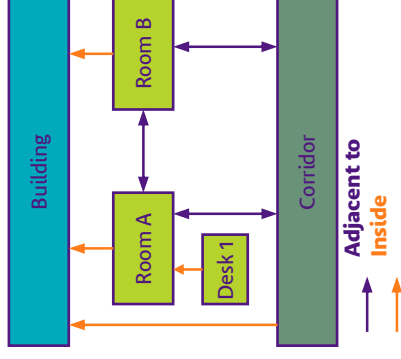
- ▶ Set-theoretic models
 - Presence of an *Element* within a *Set*
 - Set based operations (*Union, intersection ...*)
 - Set Relationships (*disjoint, containment ...*)



A Location Ontology



- ▶ From generic location models to concepts and relations
 - ▶ Graph-based models
 - *Node* linked by *GraphEdges* (un-oriented *Edges*, or oriented *Arcs*)

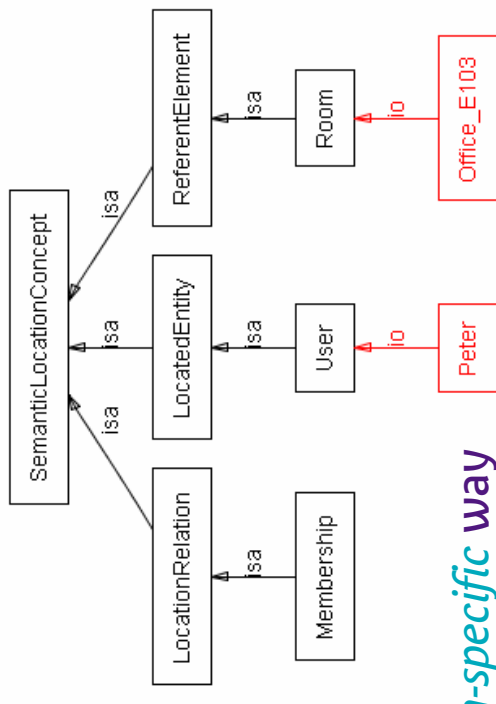


A Location Ontology

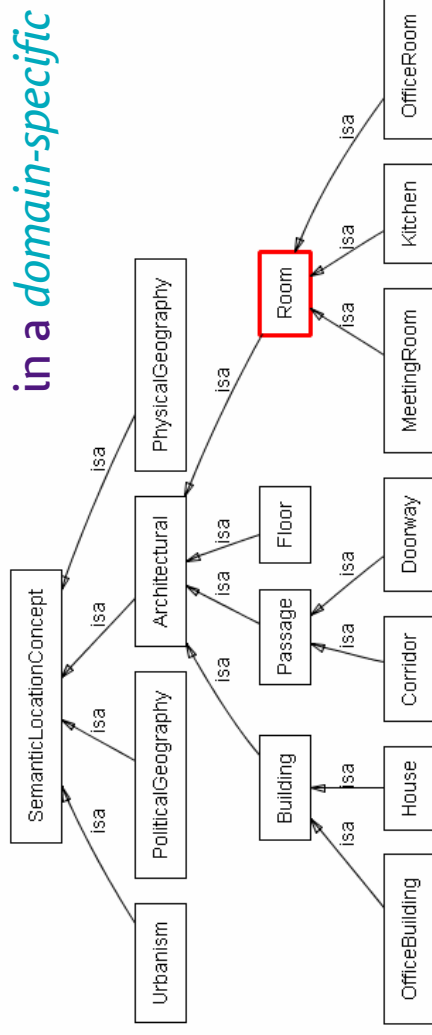


► From generic location models to concepts and relations

- Semantic models
 - A *Located Entity* share a *Location Relation* with a *Referent Element*



- Location concepts re-defined in a *domain-specific way*

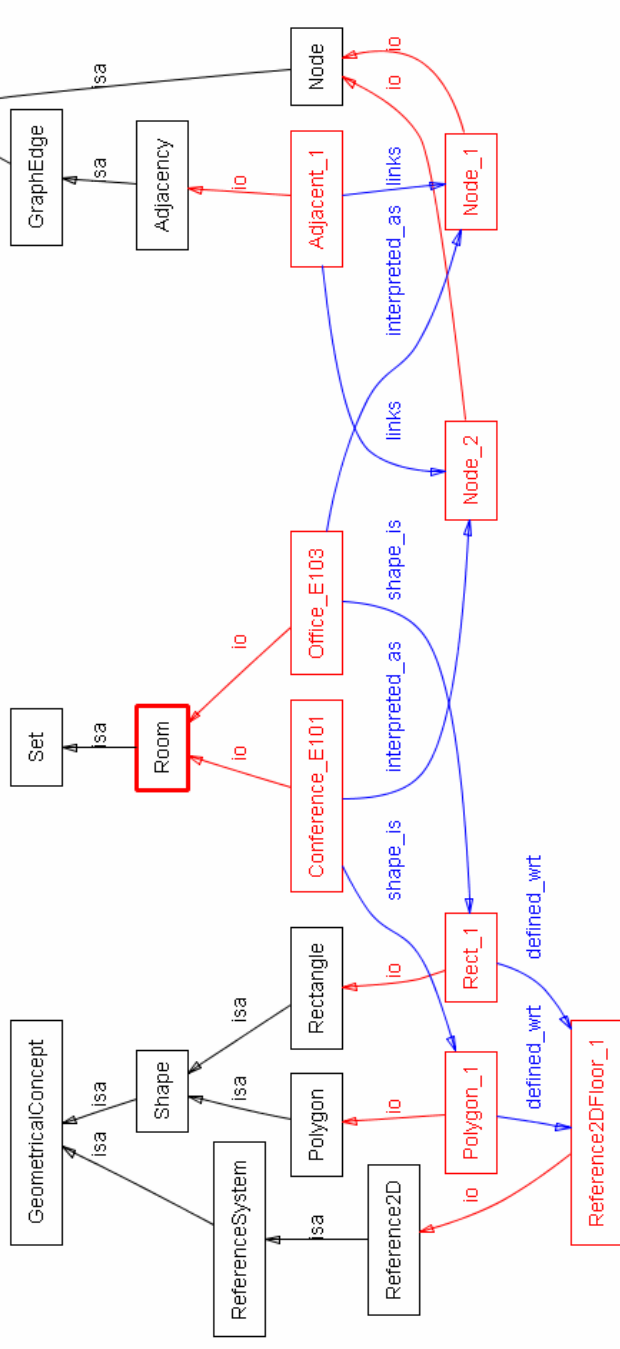


A Location Ontology



▶ Instanciate the Ontology with a basic example

- ▶ The instance draws natural relations between heterogeneous models



Location Ontology and Location Service



The Ontology as a (flat) knowledge base

- A kind of repository for
 - Collecting data from numerous sources
 - Store, handle the persistency and the causal validity of information
 - A mean to query for explicitly stored information

Location Ontology and Location Service

▶ Reasoning with Inference Rules

- ▶ Process to automate the reuse of location information
- ▶ Reasoning used when data is collected
 - *Interpret* location information from the raw data collected
 - *Check* the information or *aggregate* it with other sources
- ▶ Reasoning to satisfy the needs of client applications
 - Understand and *answer location queries*
(when the result is not explicitly store in the knowledge base)
 - *generate events* with complex conditions



Location Ontology and Location Service

A Location Service

- The goal: A software system to manage location information
- Integrate dynamically specific representation of space implicitly or explicitly defined according to location technologies or client applications
- Provided as a basic functionality in a *Service Oriented Architecture*

