

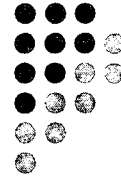
# Context Awareness in Ubiquitous Computing

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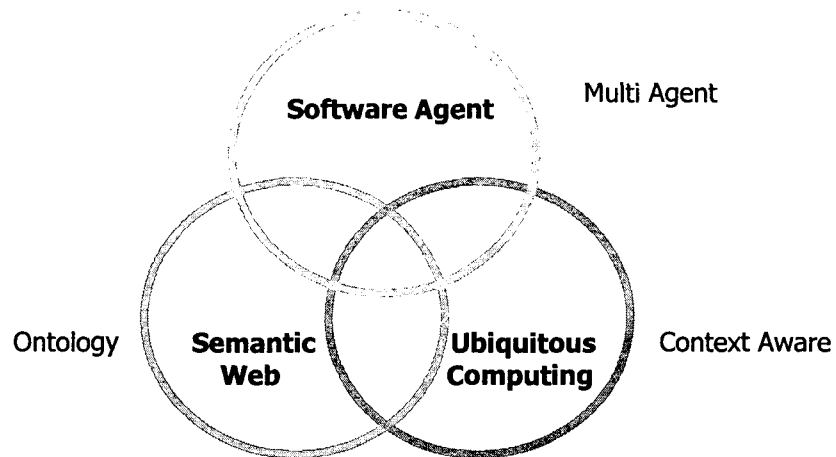
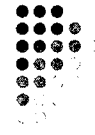
## Talk Outline

- Contexts
- Ontology
- Context Awareness
- Context Aware uT Agents
- Summary



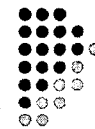
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## Research Scope



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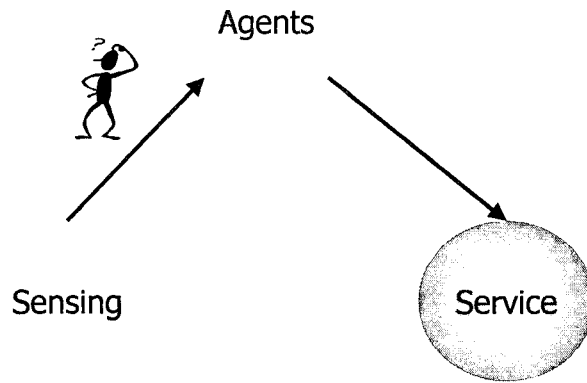
## Contexts



- Any information that can be used to characterize the situation of entities that are considered relevant to the interaction between a user and an application, including the user and the application themselves.

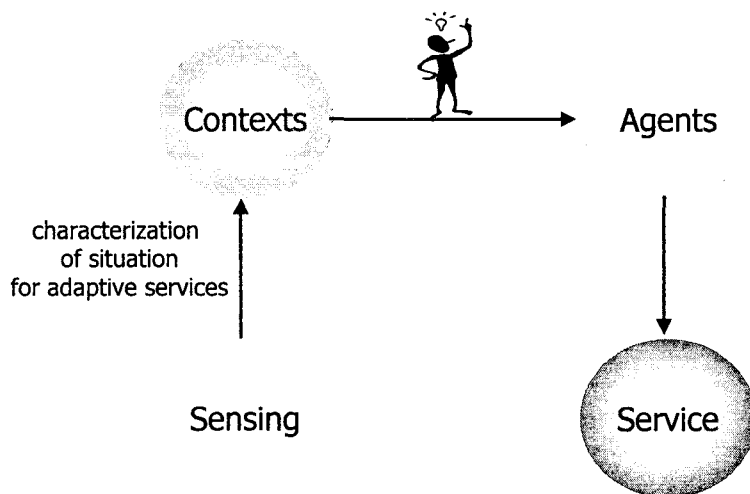
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## Why Contexts?



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## Why Contexts?



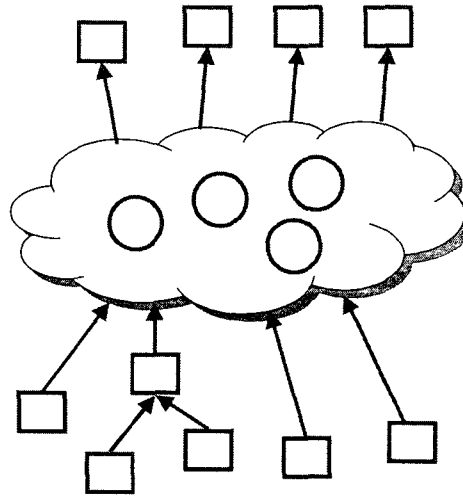
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## Contexts

uT Applications  
and Devices

Contexts

uT Sensors



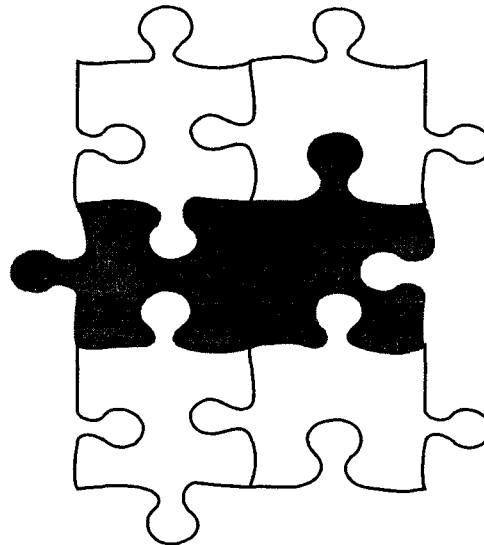
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## Context as An Interface

uT Applications  
and Devices

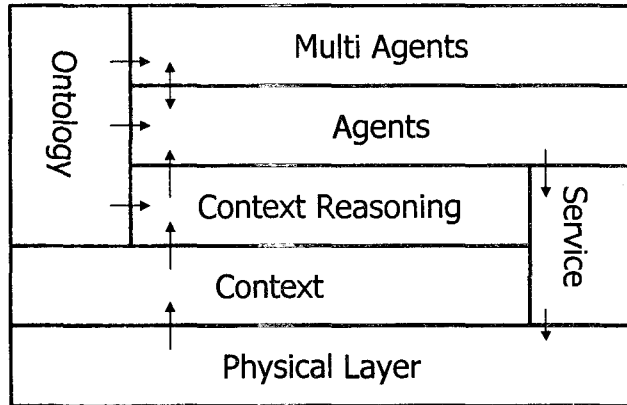
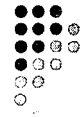
Contexts

uT Sensors

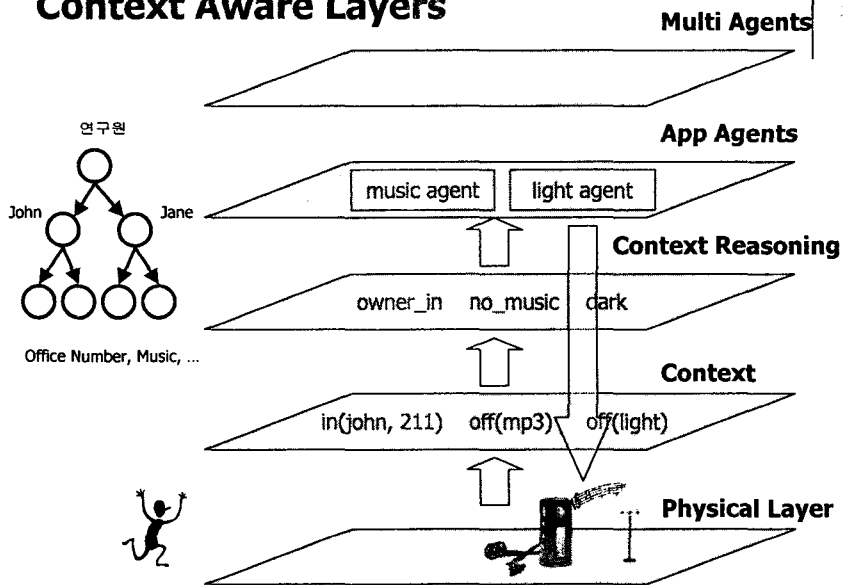
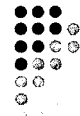


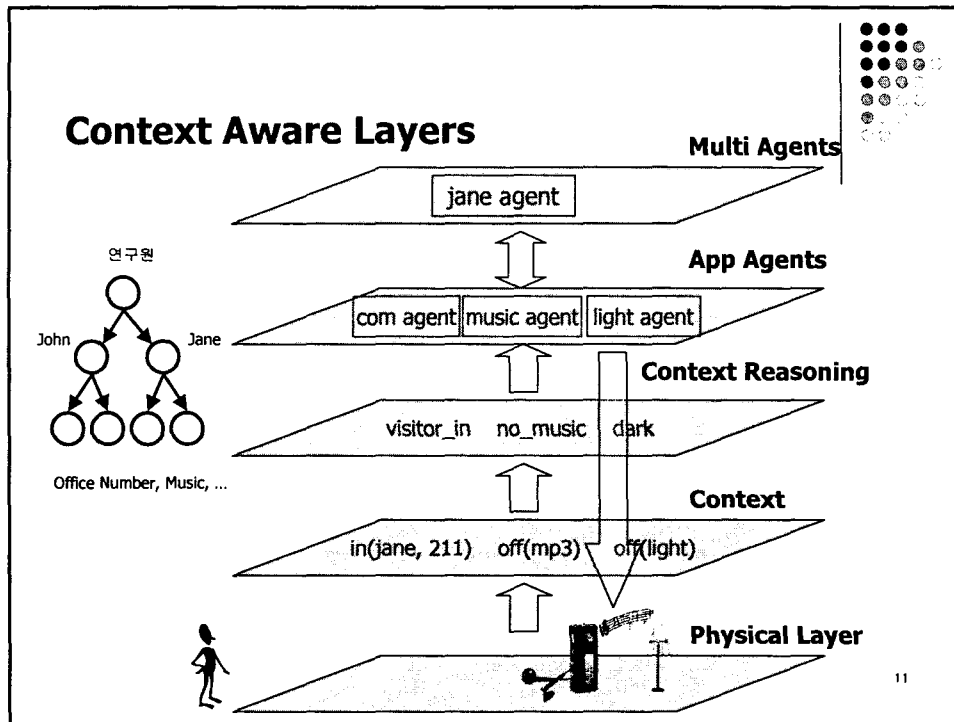
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# Context Awareness



# Context Aware Layers





- ## Ontology
- Approximate conceptualization of a domain by a formal language and vocabulary
  - Application's view of the worlds in terms of interrelated concepts
    - Define all of the concepts in a taxonomic hierarchy
    - Define the properties and relationships
  - Provides a means for software agents to reason about contextual information
  - Semantic interoperability
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## Why Ontologies in Ubiquitous Computing?

- Enabling knowledge sharing
  - A common ontology enables knowledge sharing
- Modeling contextual knowledge
  - Explicit and declarative model
- Reasoning contextual knowledge
  - Well defined declarative ontologies allows agents to reason about contextual information

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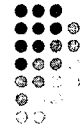


## Use of Ontology

- A key to realization of vision of ubiquitous computing
  - Computer systems are seamlessly integrated into our everyday life, anticipating our needs and providing relevant services and information to us in an anytime-and-anywhere fashion.
- Shared ontology can help independently developed systems to share knowledge and interoperate.
- Coupling with inference engine, ontology is used by ubiquitous system to reason about relations in and the meanings of the described information.

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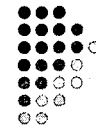
## Ontologies in Ubiquitous Computing



- Context ontology
  - Describe contextual information
  - Used to infer new context information
- Service ontology
  - A taxonomy of the services

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## Context Ontology



- The ontology describes a set of terms for describing context knowledge.
- Sharing
  - Context ontology allows agents to share a common understanding of the information
- Reasoning
  - reason about additional information that us beyond what is already known

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## Examples

- Physical contexts
  - Location, time
- Environmental contexts
  - Light and sound level, weather
- Device contexts
  - Mp3 player and songs in it, beam projectors
- Personal contexts
  - Health, mood, schedule, activity
- Social contexts
  - Group activity, social relationship
- etc, like system contexts

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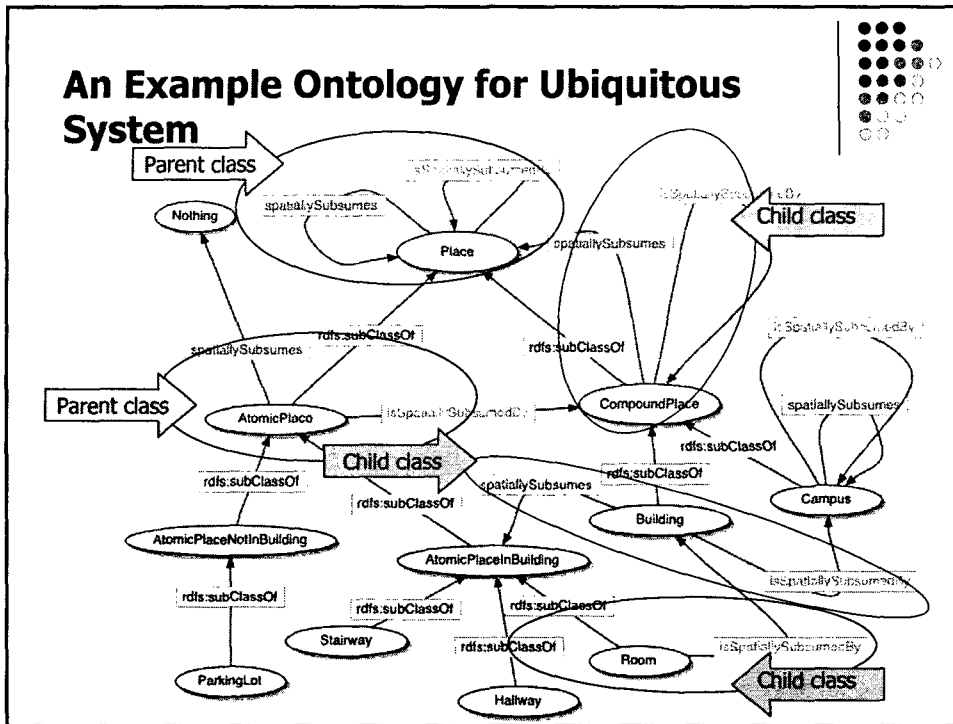


## Representation of Ontology

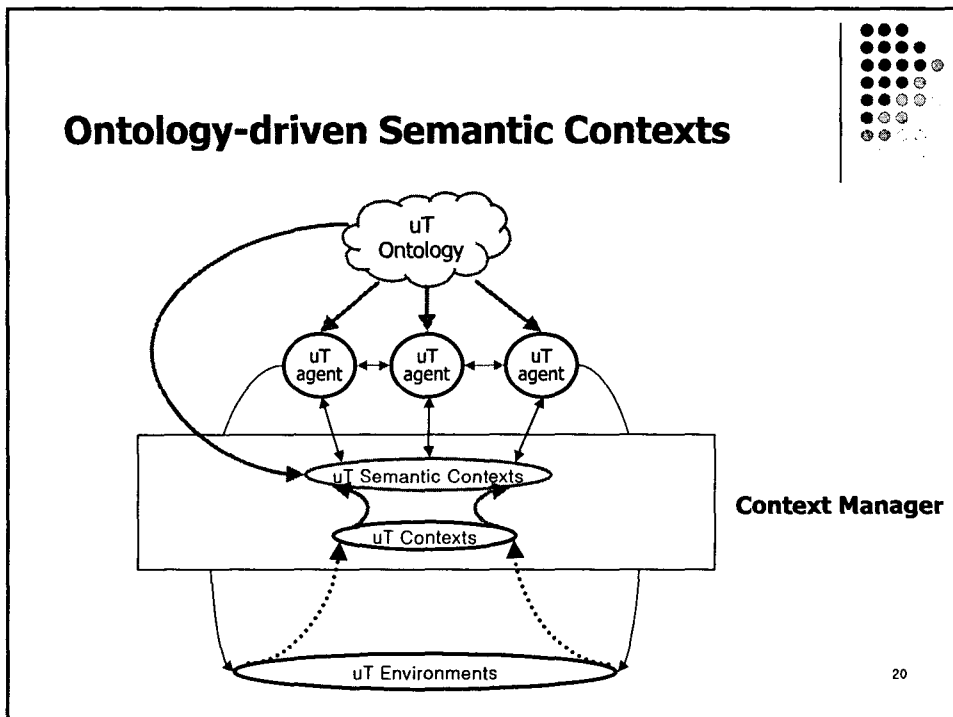
- OWL(Web Ontology Language)
  - Contextual ontology
  - Related Works
    - CoBrA, Prof. Tim Finin at UMBC
    - GAIA, Prof. Roy Campbell at UIUC
- OWL-S
  - Service ontology

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## An Example Ontology for Ubiquitous System



## Ontology-driven Semantic Contexts

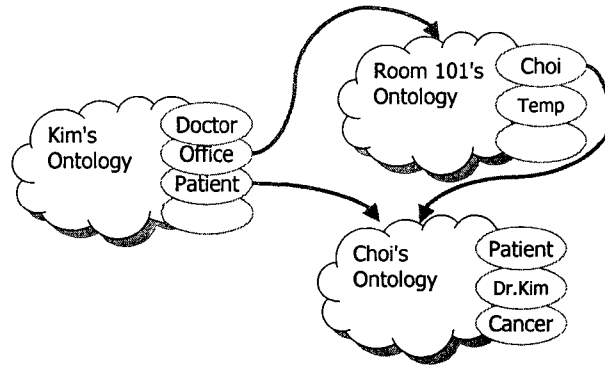


## Why Ontology in Context Generation?

Semantic  
Context

Kim enters his office to consult his patient Choi  
who suffers from cancer.

Ontology  
Reasoning



Contexts

enter(Kim, Room101)



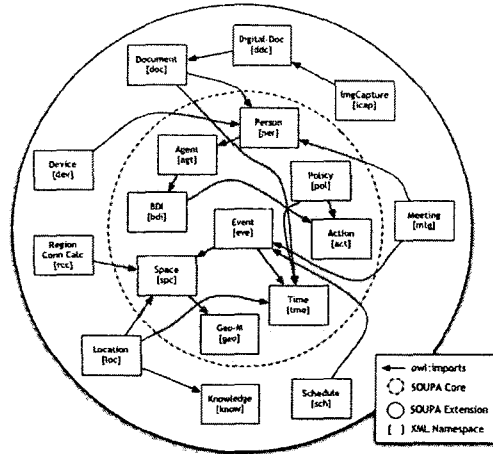
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## uT Ontology

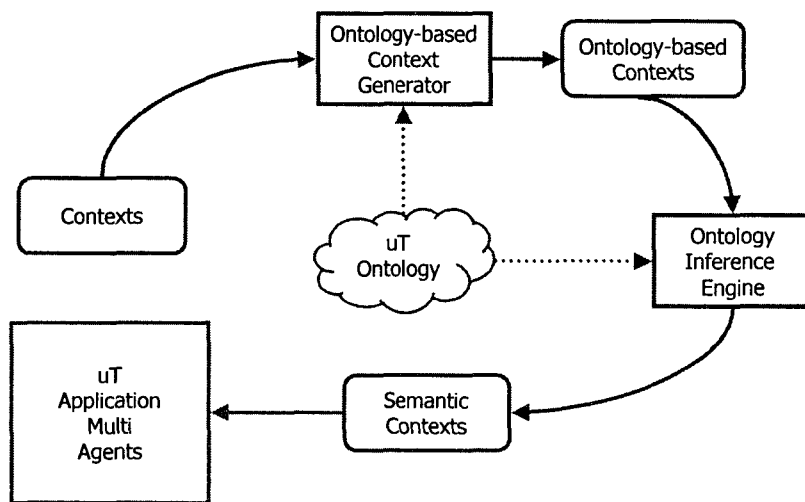
- Ontology representation
  - OWL(Web Ontology Language)
  - Protégé 2000
- SOUPA(Standard Ontology for Ubiquitous and Pervasive Applications)
  - A set of ontologies for supporting pervasive and ubiquitous computing applications.
  - SOUPA Core and SOUPA Extension
- uT Generic ontology
  - Time
  - Space
  - Person
- Application ontology
  - Well being application

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# SOUPA Ontology



# Semantic Contexts Architecture

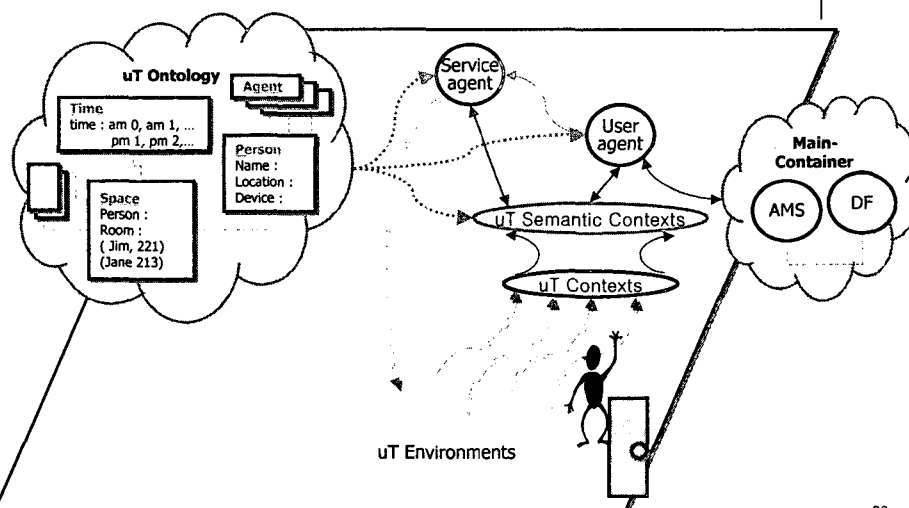


## uT Agent

- JADE 기반의 agent
- Inference engine
  - JESS
  - Agent specific knowledge base
- Ontology
  - OWL
- Communication
  - OWL-based JADE communication

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## uT Agents & Ontology



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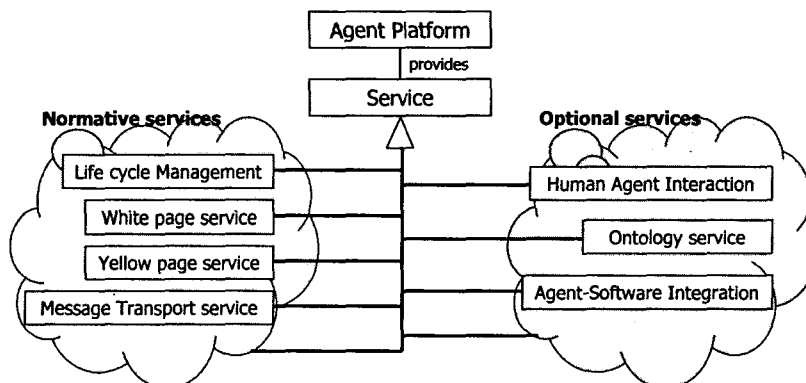
## JADE

- FIPA multi agent framework
- Agent Management System
  - White page
- Directory Facilitator
  - Yellow page
- Agent Communication Channel

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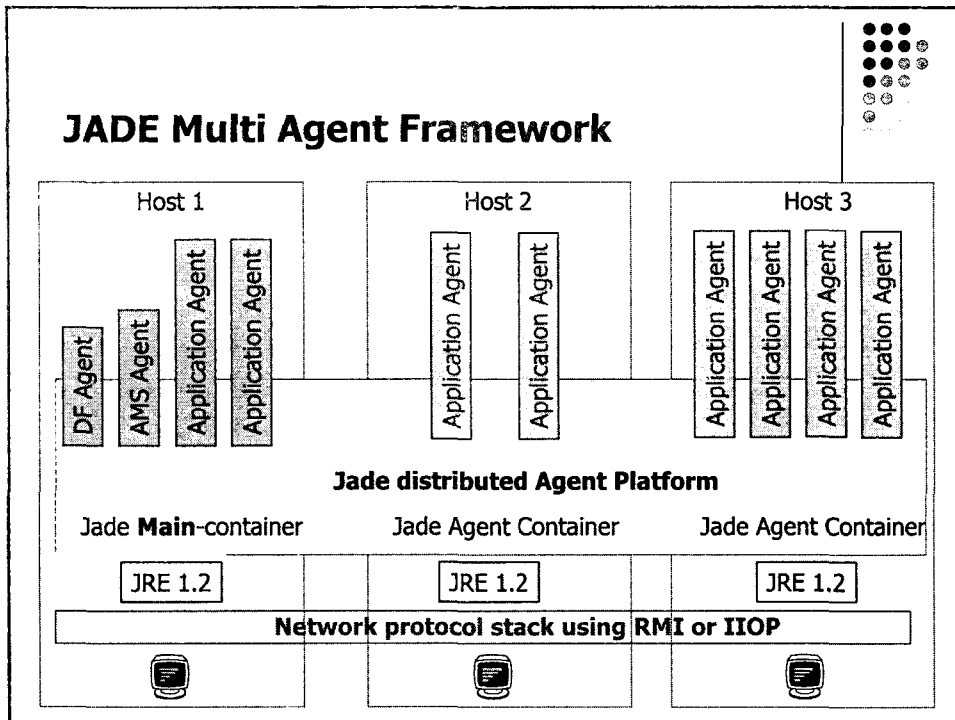
## Conceptual Model of JADE

Conceptual model of an Agent Platform

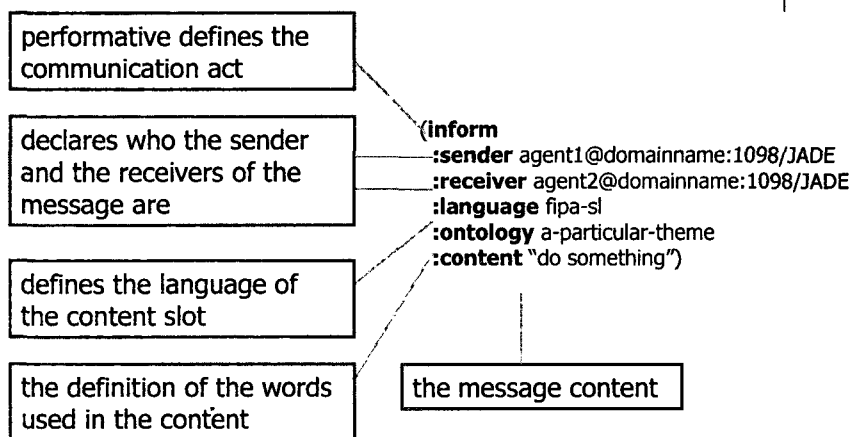


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## JADE Multi Agent Framework



## Agent Communication Msg



\*note: there are other message slots not mentioned.

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## Communication Act

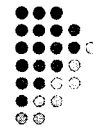


- FIFA Message type

- ACCEPT-PROPOSAL
- AGREE
- CFP
- CONFIRM
- DISCONFIRM
- FAILURE
- INFORM
- INFORM-IF
- INFORM-REF
- NOT-UNDERSTOOD
- PROPOSE
- QUERY-IF
- QUERY-REF
- REFUSE
- REFUSE-PROPOSAL
- REJECT
- REJECT –PROPOSAL
- REQUEST
- REQUEST-WHEN
- REQUEST-WHenever
- SUBSCRIBE
- PROXY
- PROPAGATE

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## JADE and OWL



- FIPA does not support OWL parser for ACL.
- In a near future, FIPA will support.

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## OWL-based ACL

(inform

**:sender** agent1@domainname:1098/JADE

**:receiver** agent2@domainname:1098/JADE

**:language** OWL

**:ontology** a-particular-theme

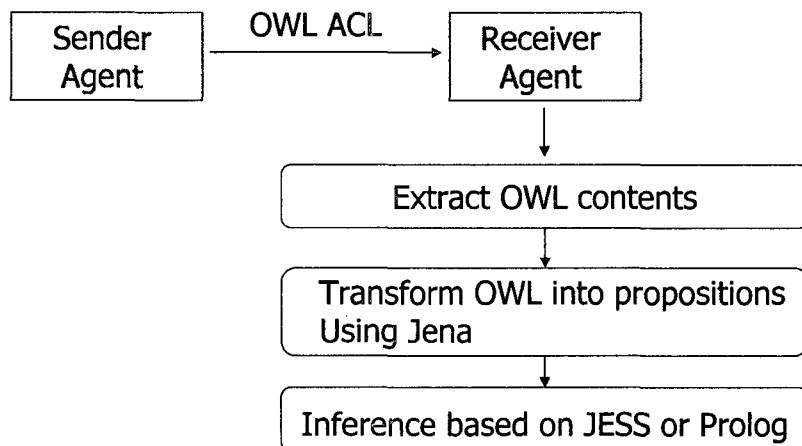
**:content** "

```
<?xml version='1.0'?> ")
<rdf:RDF xmlns='http://ailab.ssu.ac.kr/ontology/ubiProject/ontologies#' ">
  xmlns:rdf='http://www.w3.org/1999/02/22-rdf-syntax-ns#' ">
  xmlns:rdfs='http://www.w3.org/2000/01/rdf-schema#' ">
  xmlns:owl='http://www.w3.org/2002/07/owl#' ">
  xmlns:fipaowl='http://taga.umbc.edu/fipaowl#' ">
  xml:base='http://ailab.ssu.ac.kr/ontology/ubiProject/ontologies#' ">")

  <Person rdf:ID='park'>") <hasName>Young-Taek </hasName>") </Person> ")
  <Schedule rdf:ID='park'>")
  <byPerson><owl:Thing rdf:ID='Young-Tack ' /></byPerson> ")
  <duringTime rdf:resource='pm 2' /> ")
  <hasContent rdf:resource='#Agent System' /> ")
  </Schedule>")
</rdf:RDF>") "
```

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## OWL ACL Inference



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## Summary

- uT ontologies can enable context awareness to represent more rich information.
- Ontologies enable uT agents to reason about dynamic contexts.
- Multi agents can use ontologies to communicate between agents.