
Semantic agents for location-aware service provisioning in mobile networks

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Agenda



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- ◆ Research motivation
- ◆ Semantic Web Vision
 - Semantic Web architecture
 - Web ontology languages
 - Semantic Web services
- ◆ Semantic agents
 - Semantic matchmaking
 - Approach for service provisioning in mobile networks
- ◆ Location-aware content delivery system
 - Requirements and usage scenarios
 - Architecture
 - Prototype implementation
- ◆ Conclusion

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Research motivation (1)



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- ◆ As the functionality of mobile devices grows, configuring and maintaining mobile applications becomes a complex and time-consuming task
 - E.g. enabling WAP, GPRS, MMS and data connectivity requires configuration of multiple settings
- ◆ Over-The-Air (OTA) provisioning
 - remote management of device settings and applications
 - operators can easily introduce new services and manage provisioned services

Research motivation (2)



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◆ *Problem:*

- users need to manually search for services on Web
- searching for Web services by *keywords* is not always successful
- existing Web services model
 - *not able* to dynamically discover the most appropriate service that meets user's requirements

◆ Semantic Web concept

- dynamic, heterogeneous, shared knowledge sources providing machine-understandable content (in a similar way as in WWW)
- Web of interactive, automated and intelligent services that communicate via Internet

Research motivation (3)



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- ◆ Intelligent software agents
 - able to dynamically discover, invoke, compose, and monitor Semantic Web services
- ◆ Idea: *semantic service matchmaking*
 - synergy of both *intelligent-agent* and *Semantic Web technologies*
 - meets the needs of users **and** service providers in the electronic market

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Semantic Web Vision



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- ◆ Most of today's content is human-understandable
- ◆ The *meaning* of data
 - has to be added to content and its formatting information
- ◆ *Metadata*
 - refers to data about data → the term *semantic*
- ◆ Tim Berners-Lee - the initiator of Semantic Web
 - Semantic Web will gradually evolve from the existing Web
 - adding the meaning of information - important role!
- ◆ The aim of Semantic Web:
 - to represent Web content in a machine-processable form
 - use intelligent techniques to take advantage of these representations

Semantic Web Vision - contd.



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◆ Knowledge management

■ *Metadata*

- identify and extract information from Web sources

■ *Ontology*

- *an explicit and formal specification of conceptualization*
- easily processed by computer and queried by user
- new knowledge can be derived using inference rules

■ *Logic*

- formal languages → expressing knowledge
- well-understood formal semantics → describing meaning of sentences
- automated reasoners → deduce conclusions

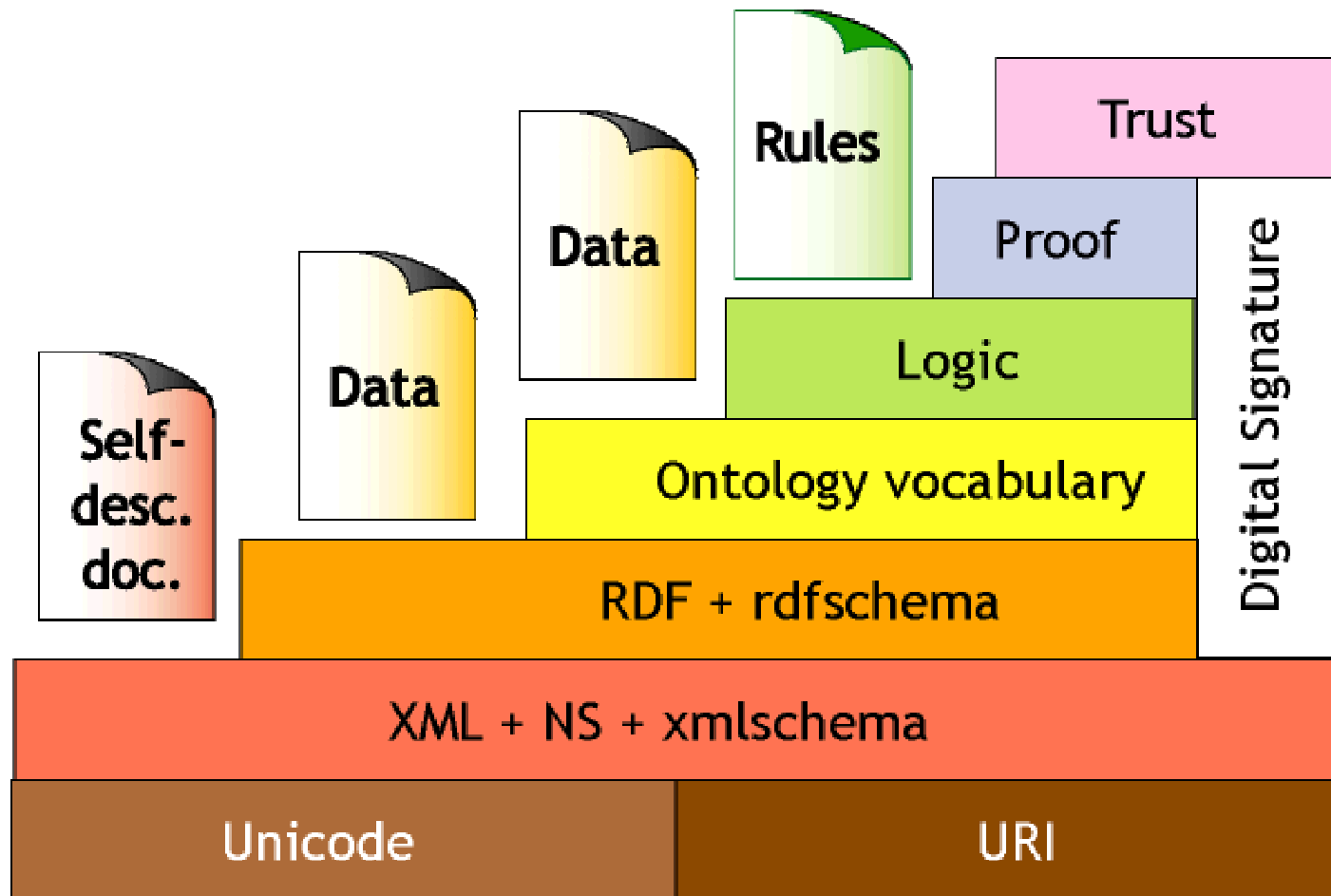
◆ Complex Semantic Web

- many small ontologies point to each other, developed by web users

Semantic Web architecture



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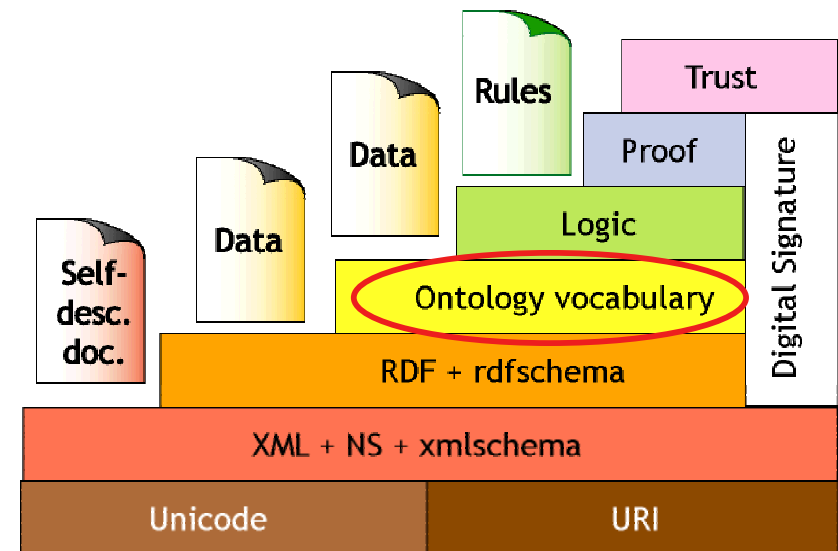


Web Ontology Languages



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- ◆ RDF (Resource Description Framework)
 - framework for describing and exchanging metadata on Web
- ◆ RDF Schema (RDFS)
 - specifies how to use RDF to describe RDF vocabularies
 - provides modelling primitives for expressing information on the Web
- ◆ OWL
 - introduced due to the limited expressivity of RDF and RDFS
 - DAML+OIL
 - created by a joint initiative of research groups from US and Europe
 - a starting point for W3C in defining OWL
 - richer expressiveness <-> efficient reasoning ???
 - three sublanguages: OWL Lite, OWL DL and OWL Full



Semantic Web Services



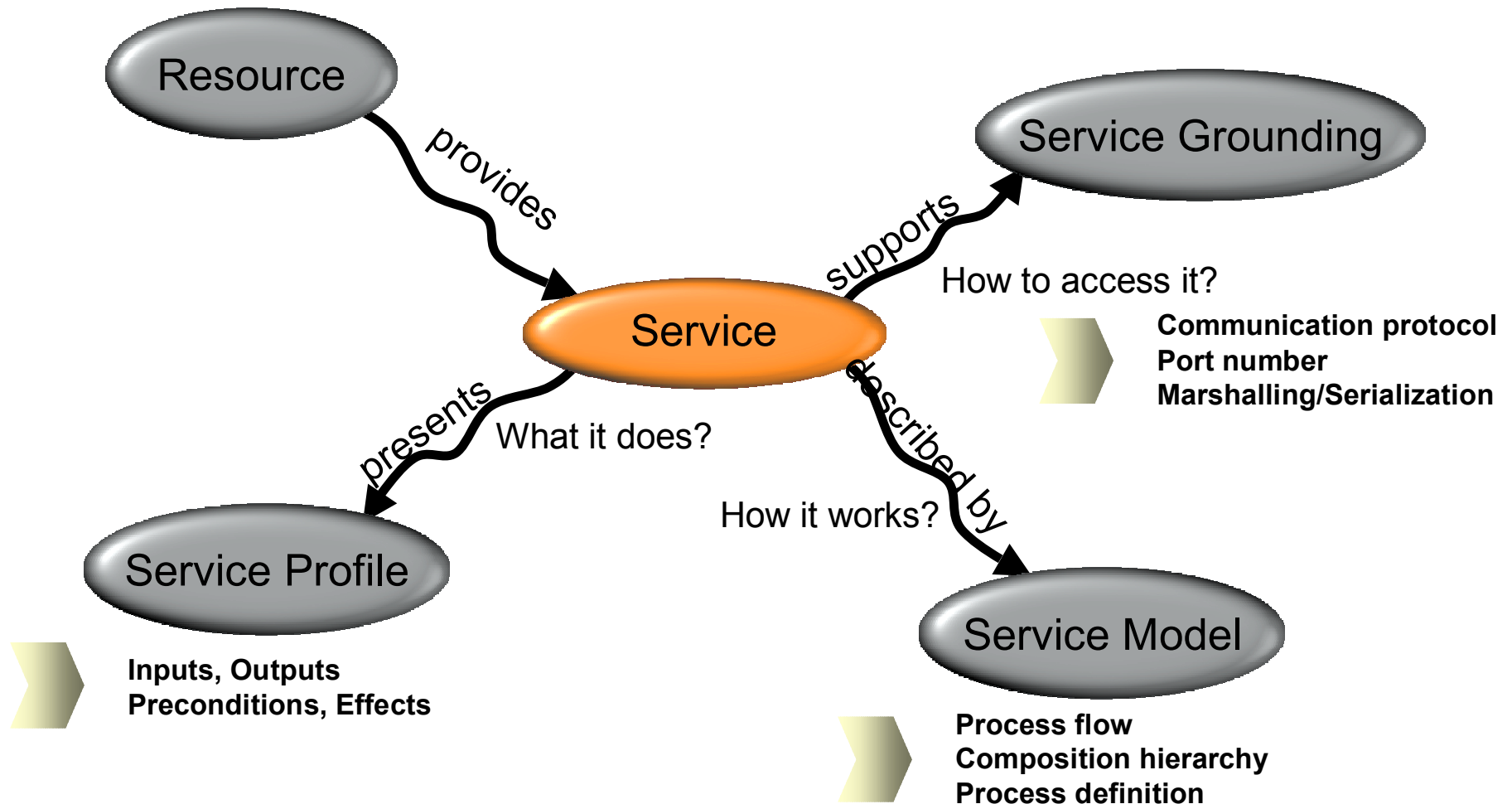
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- ◆ Intelligent, interactive, and automated services that interoperate through the Internet
 - perform tasks, provide information, transact business
 - important - conducting business faster and more efficiently!
- ◆ Existing Web services
 - discovered and invoked by human users
 - rapid growth of information and services on the Web
 - problem: finding the service that matches user's requirements
- ◆ OWL-S
 - OWL-based Service ontology
 - provides a core set of markup languages constructs for:
 - modelling Web services to be machine-interpretable
 - describing properties and capabilities of Web services

Semantic Web Services - OWL-S service ontology



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◆ Three types of processes:

- atomic
- simple
- composite

◆ Control constructs:

- Sequence
- Split
- Split+Join
- Choice
- Any Order
- If-Then-Else
- Iterate
- Repeat-While
- Repeat-Until

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 - **Semantic matchmaking**
 - **Approach for service provisioning in mobile networks (Demo)**
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- ◆ Agents
 - pieces of software that work autonomously and proactively
 - perform tasks on behalf of a user or other agent
- ◆ FIPA
 - an international non profit association of companies and organizations for producing standard specifications for agent technology
- ◆ Intelligent agents
 - incorporate some reasoning or planning
- ◆ Semantic agents
 - intelligent agents that run on the Web, performing complex tasks on behalf of their users
 - Semantic Web services will be discovered, invoked, composed and monitored automatically by semantic agents

- ◆ Terminology:

service requester
requested service

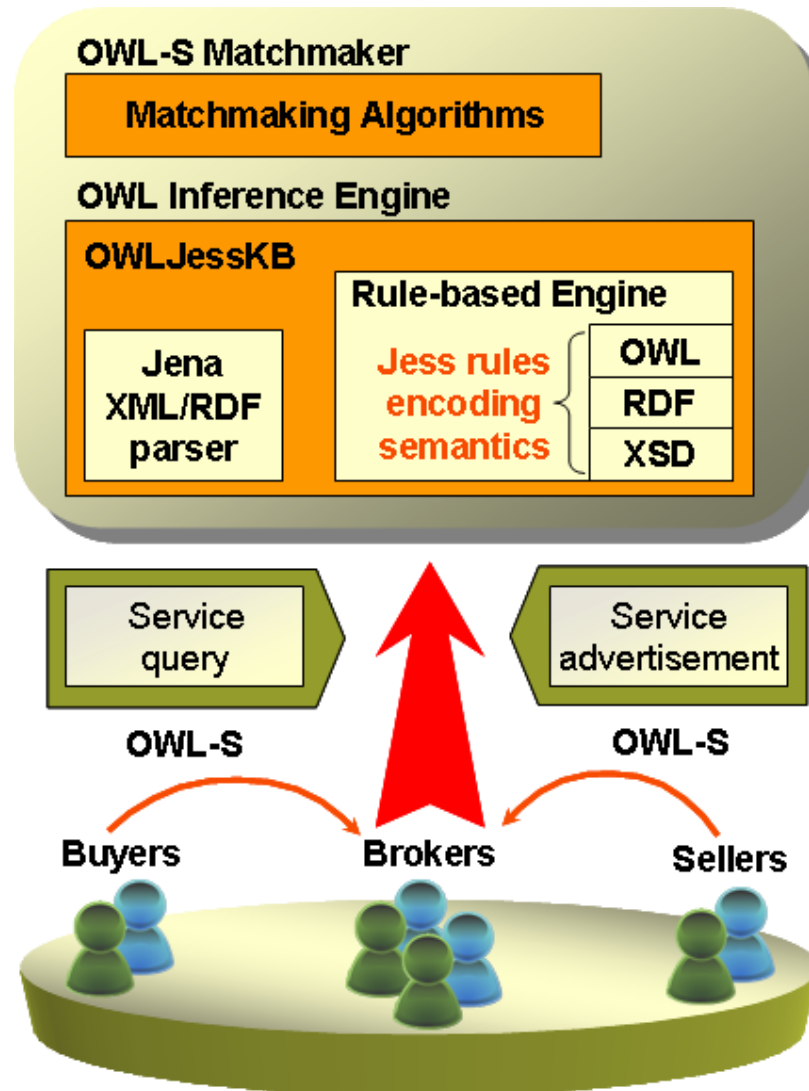
service provider
advertised service

- ◆ Semantically comparing advertised service(s) with the requested service
 - used to find a service that best meets user requirements
 - requires both services to be described in OWL-S
 - based on service process model
 - produces a matching degree (ranking result)

Semantic matchmaking - semantic agent components



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Semantic agents - Demo (1)



Service request

Select inputs:

- bookmarked landmark
- location on map
- landmark name input
- content topic

Select outputs:

- output landmark name
- geographical map
- current location
- location-aware content

Select target location:

- manually
- automatically



Second screen

Hello! ServiceOfferAgent
alan@161.53.19.119:1099/JADE is ready.

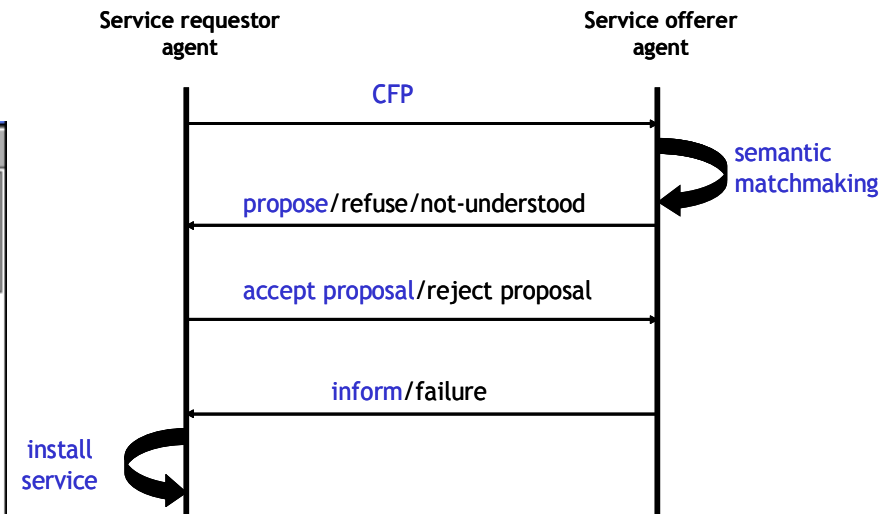
Agent alan: sent CFP!

Agent alisa: proposed
Location-aware content delivery

Agent alan: Accepting proposal
from responder
alisa@161.53.19.119:1099/JADE

Agent alan: received inform from
alisa

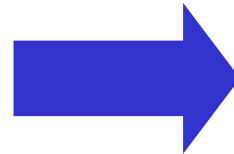
Agent alan: service path=
http://localhost/ota/midpclientprojec
t.jad



Semantic agents - Demo (2)



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Installed service

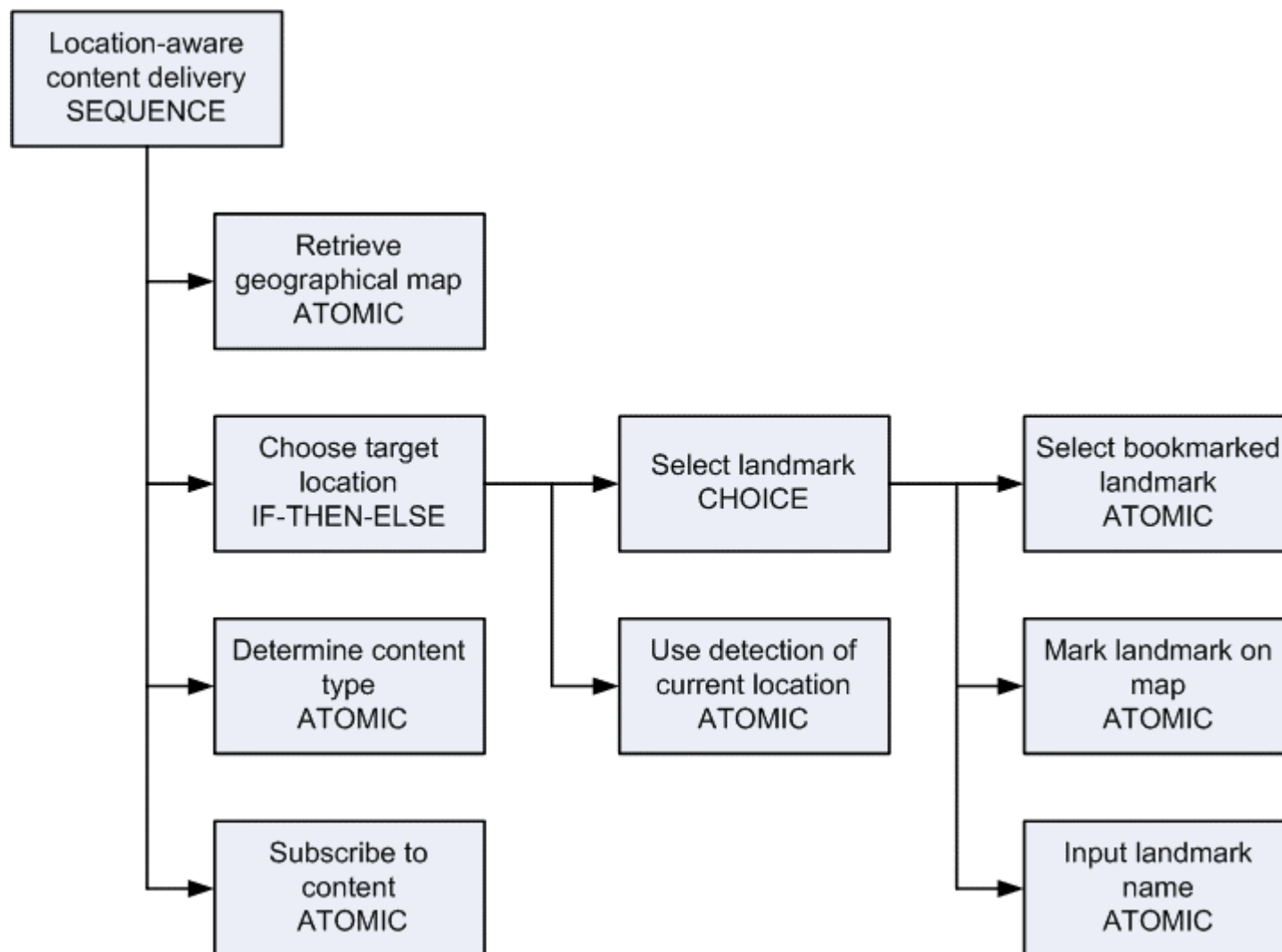


Demo - OWL-S advertisement of location-aware service



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Demo - Inputs and outputs for service advertisement



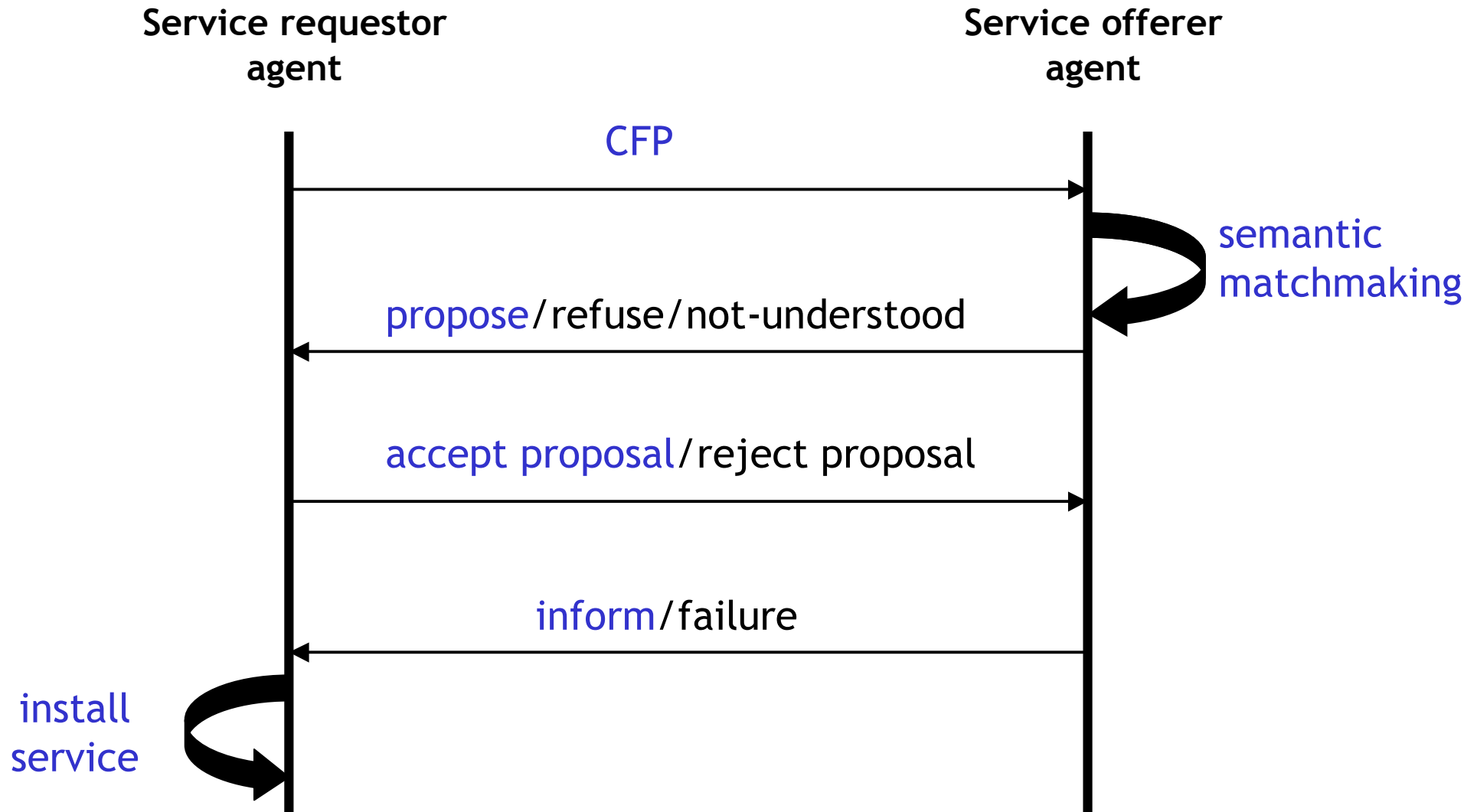
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Atomic Process	Inputs	Outputs
Retrieve geographical map		geographical map
Select bookmarked landmark	bookmarked landmark	landmark name
Mark landmark on map	location on map	landmark name
Input landmark name	landmark name	
Use detection of current location		current location
Determine content type	content type	
Subscribe to content		location-aware content

Demo - Agent interaction using FIPA Contract Net



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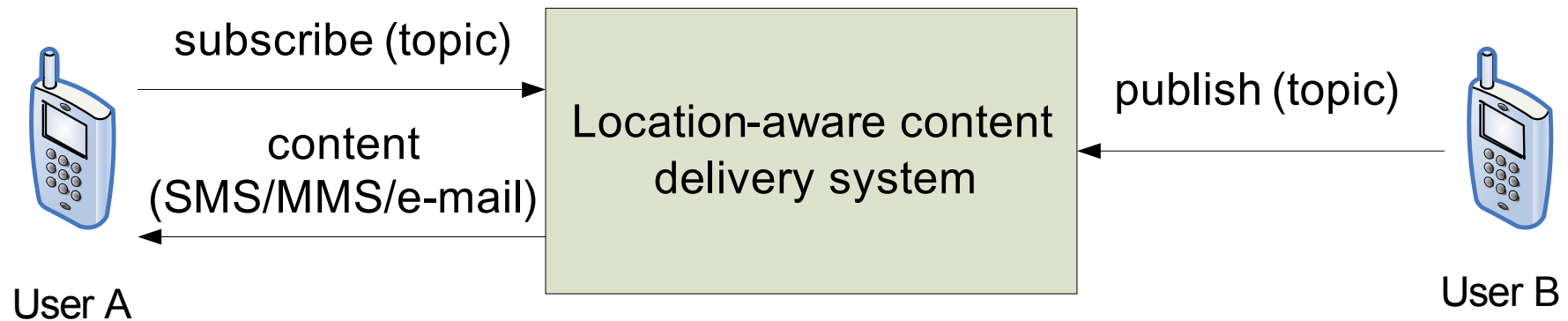
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Location-aware content delivery system



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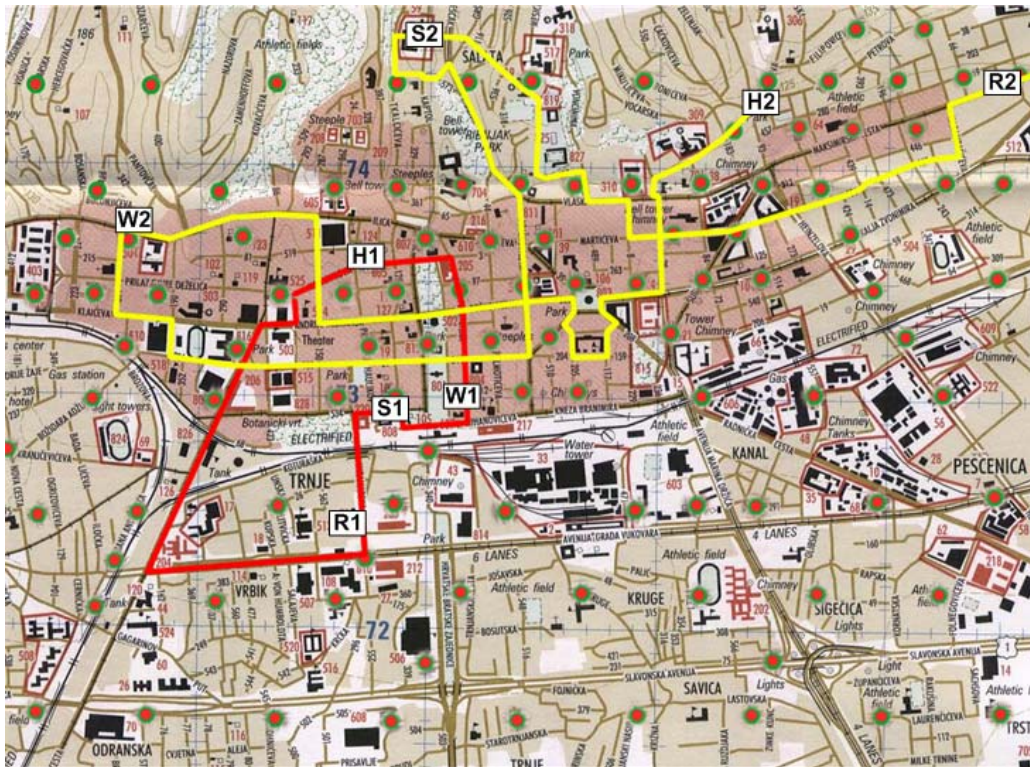


- ◆ Mobile location-based information service
- ◆ Delivers personalized content to mobile users
 - depending on user's current location, terminal, and preferences

Requirements and usage scenarios



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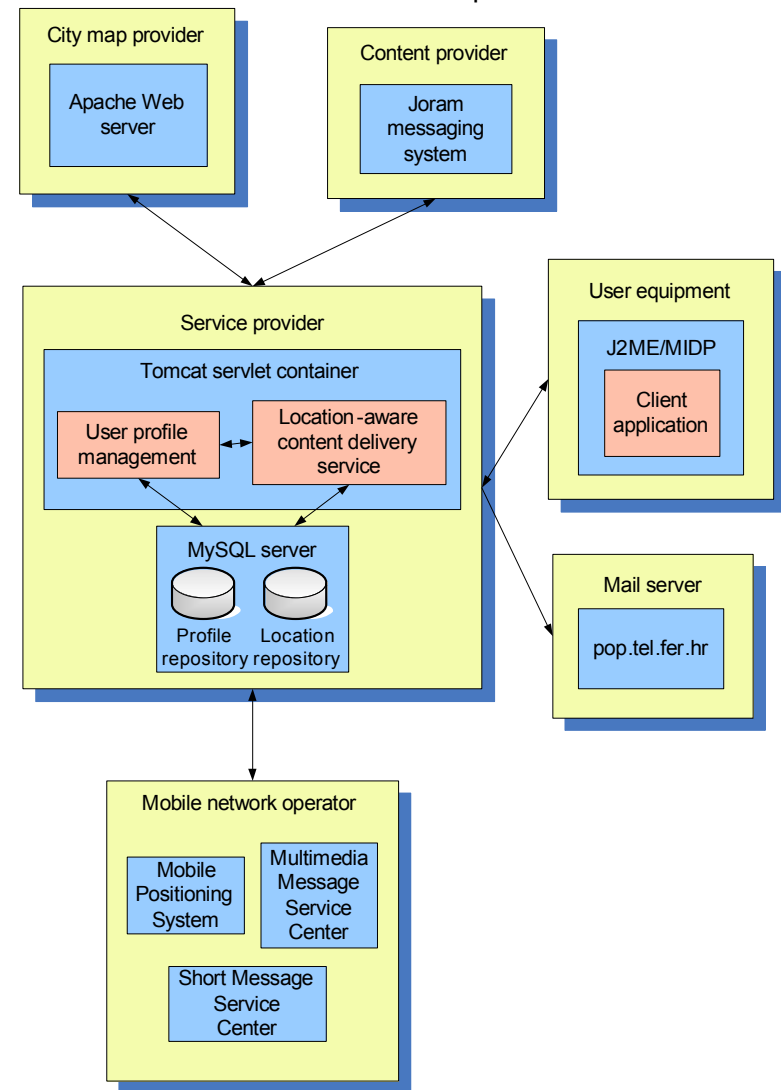
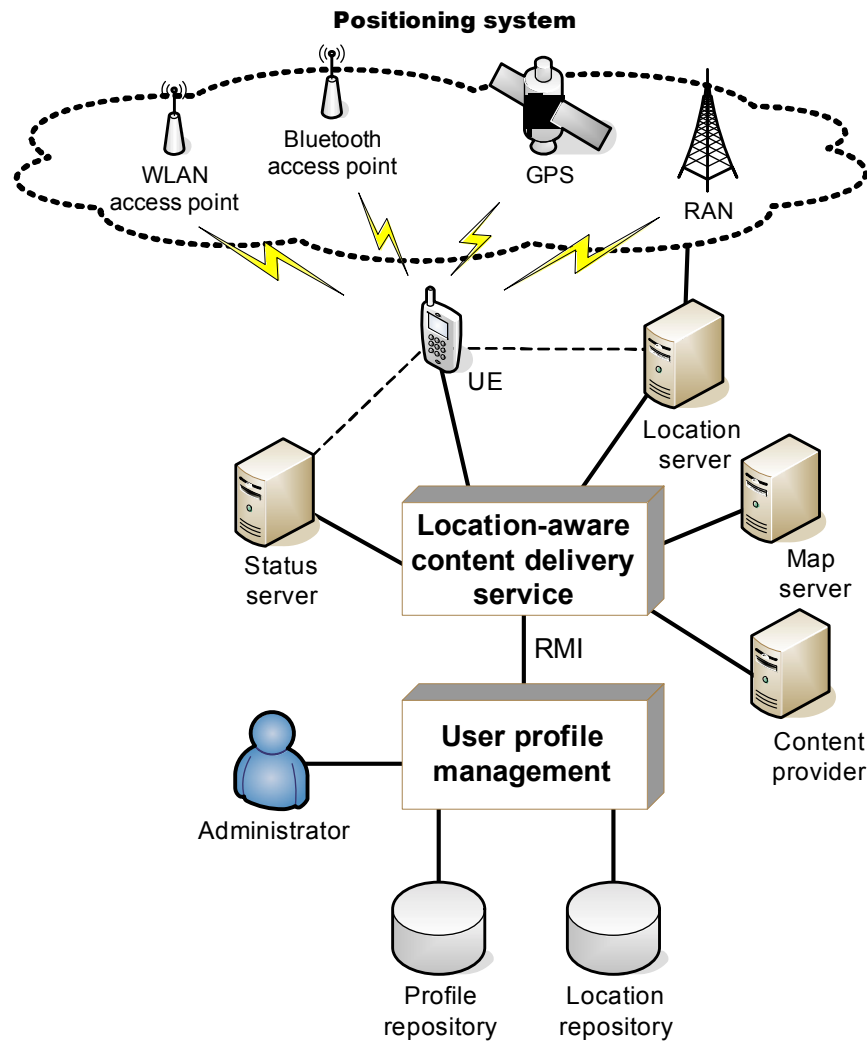


- ◆ Two users are simulated in Zagreb city area
- ◆ Set of landmarks:
 - Home_i
 - Work_i
 - Shopping_i
 - Recreation_i
- ◆ Subscription types:
 - non location-based
 - landmark-based
 - current location-based

System architecture and deployment



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Client application



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- ◆ Authentication (by both subscriber and publisher)

Login screen

Username

Password

Msisdn

Menu

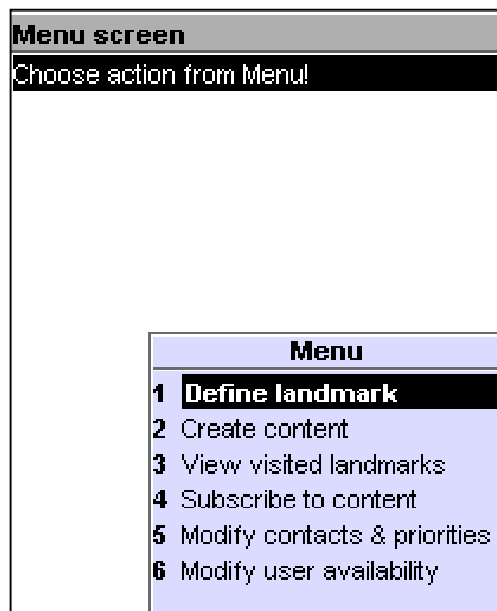
- 1 Start
- 2 Back



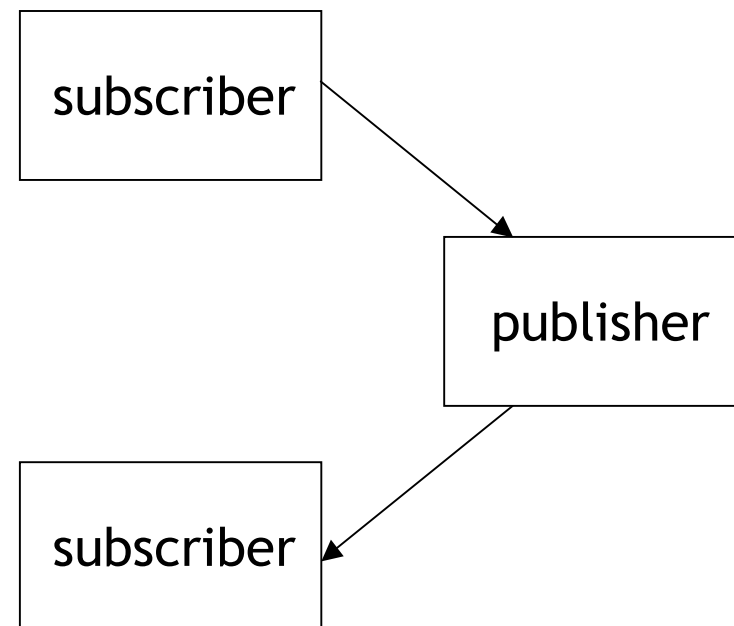
Notification Screen

Authorization succeeded!

◆ Menu options



Timeline

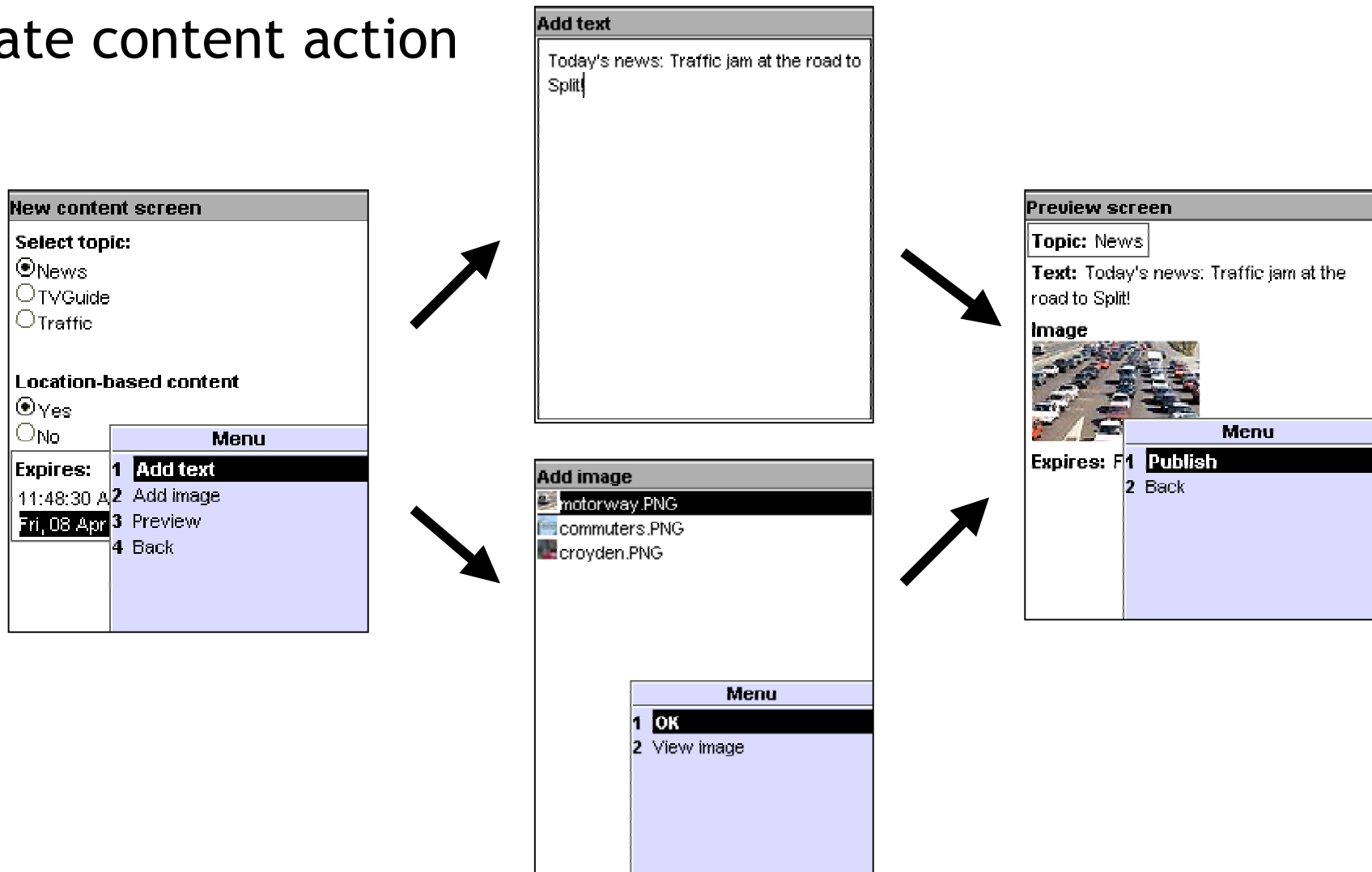


Client application - publisher



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◆ Create content action

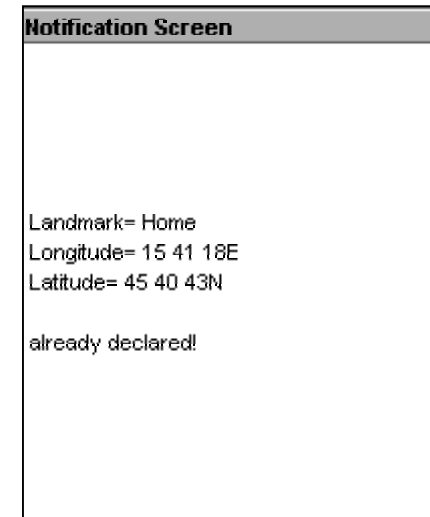
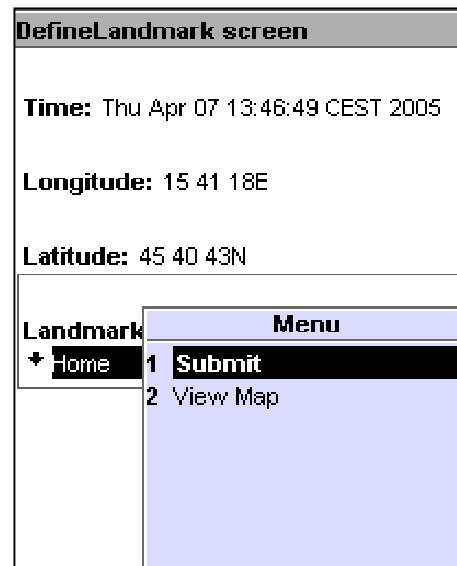
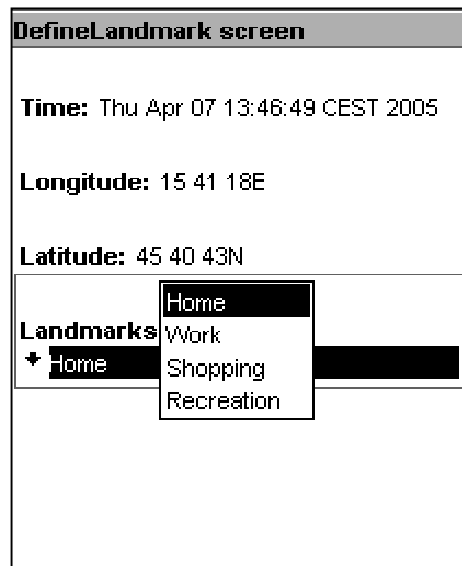


Client application - subscriber



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◆ Define landmark action

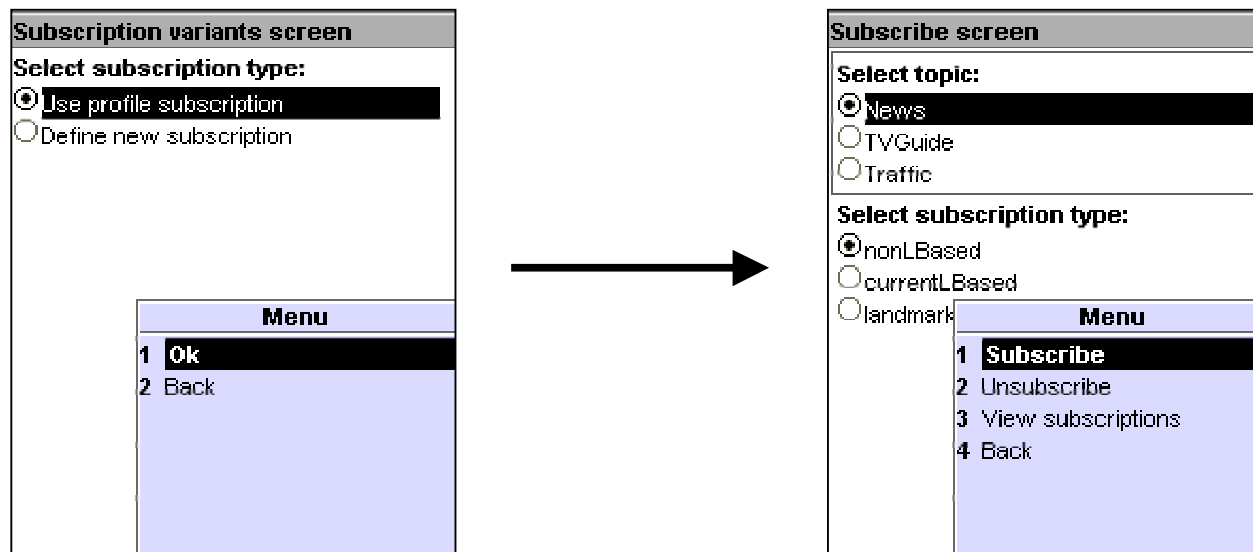


Client application - subscriber



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◆ Subscribe to content action

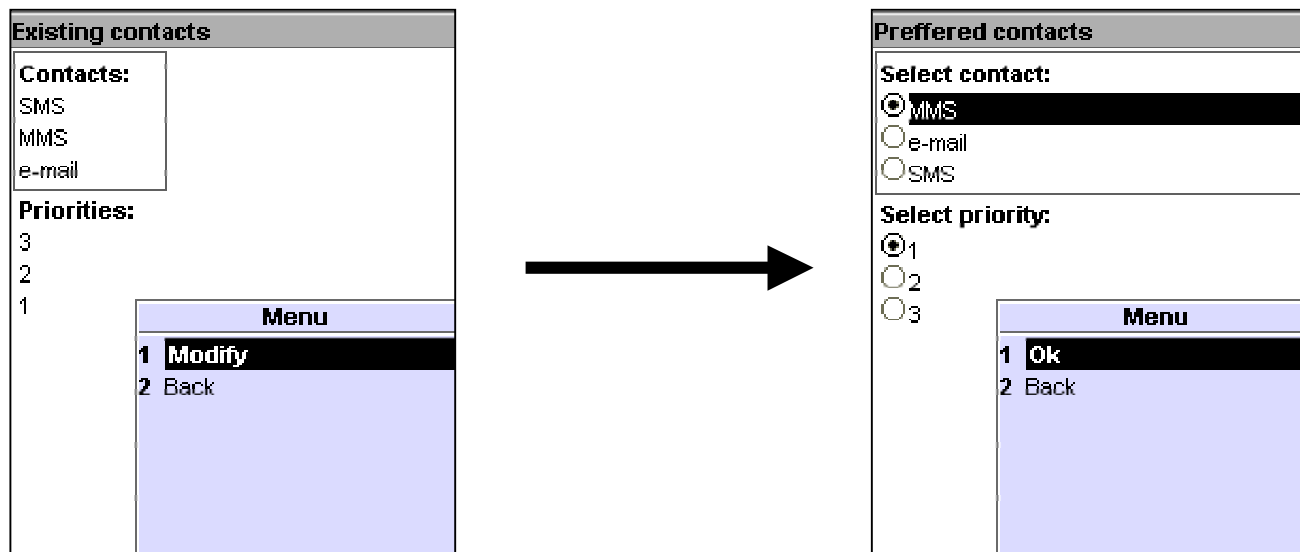


Client application - subscriber



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◆ Modify contacts & priorities action

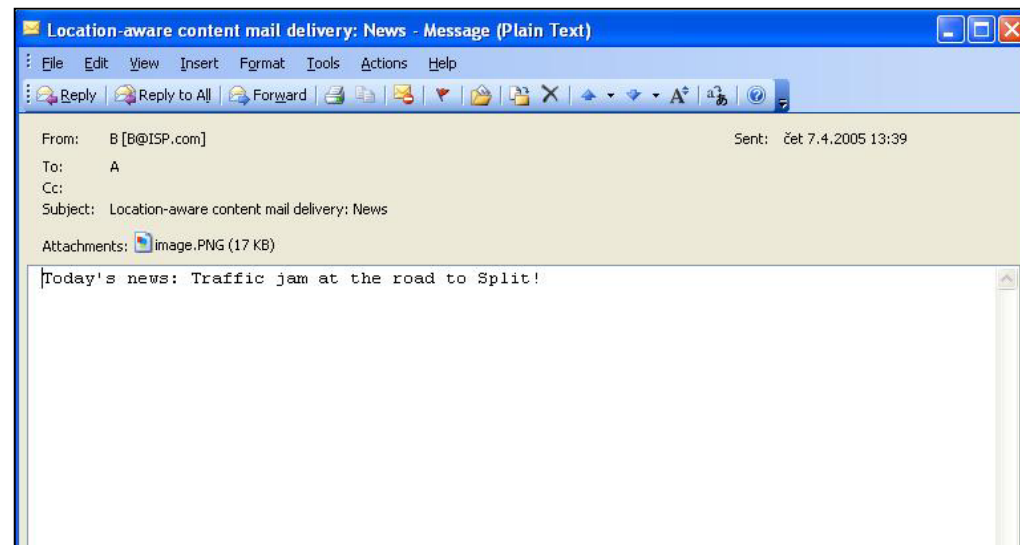


Client application - subscriber



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◆ Content delivery



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Conclusion



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- ◆ an approach for service provisioning in mobile networks using semantic agents is proposed
- ◆ location-aware content delivery system is presented
 - provisioning of client part - using semantic agents
 - provisioning of server part - using multi-agent system for remote software maintenance and execution
 - <http://agents.tel.fer.hr>
- ◆ Future work
 - use camera API for taking photos
 - improve user interface
 - utilize additional positioning technologies
 - scalability
 - add time component to the context

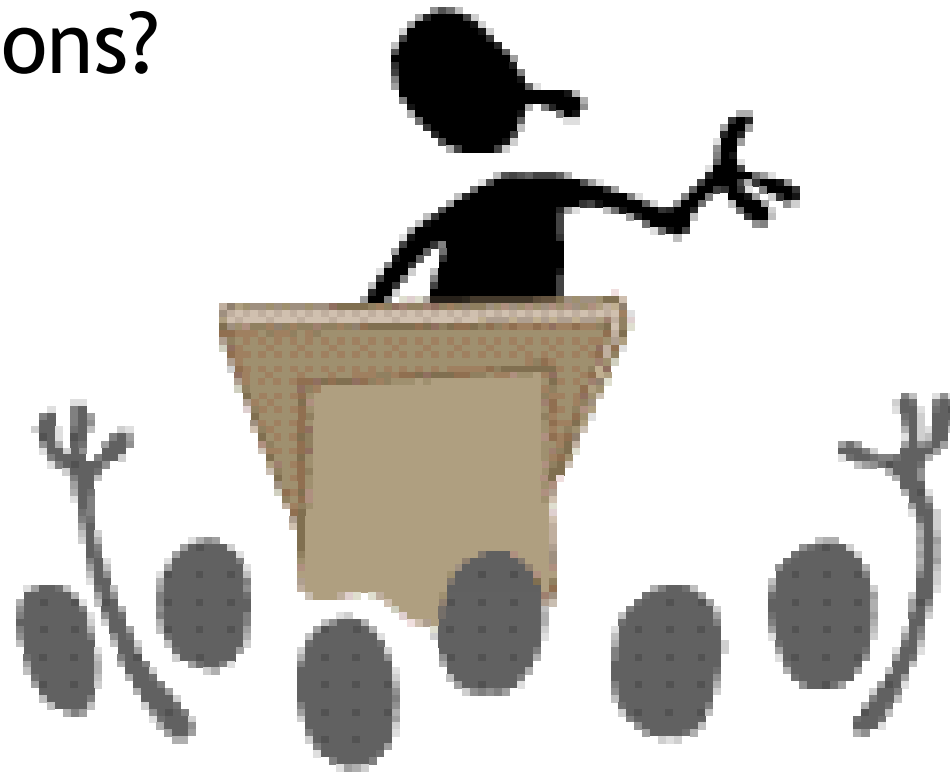
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Thank You!
Any Questions?



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