10th Central and Eastern European Software Engineering Conference in Russia - CEE-SECR 2014



October 23 - 25, Moscow

Service Formalism and Architectural Abstractions for Smart Space Applications

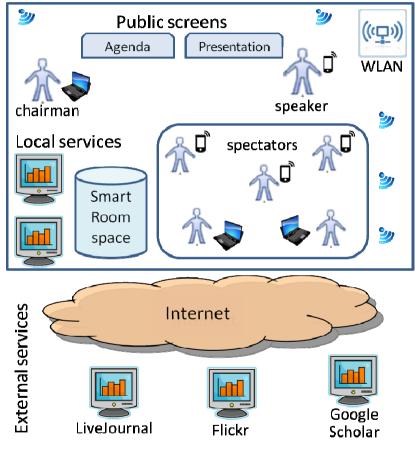
Dmitry G. Korzun Petrozavodsk State University

The Problem

- Ubiquitous Computing
 - Smart Environments
 - Multi-agent systems
- Internet of Things (IoT)
 - Ubiquitous connectivity
 - Smart objects
- Smart space: A localized IoT-aware service-oriented computing environment with a shared view on resources

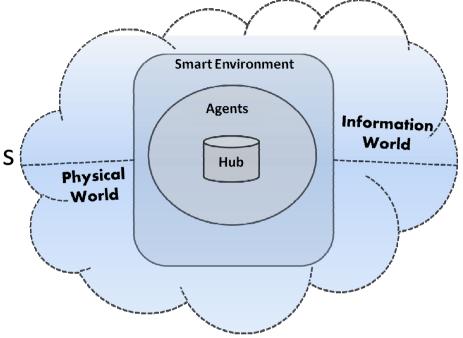
Dmitry Korzun: Development of Smart Space Applications

SmartRoom System (example):



Smart Spaces

- Multiple data sources:
 - Physical and Information worlds
 - Users generate content
 - Derived information
- Inhabitants: Software agents, e.g., IoT smart objects



- Hub selectively encompasses the data sources (virtualization)
- Global IoT is divided into spaces (e.g., processors of Big Data)
 - Dmitry Korzun: Development of Smart Space Applications

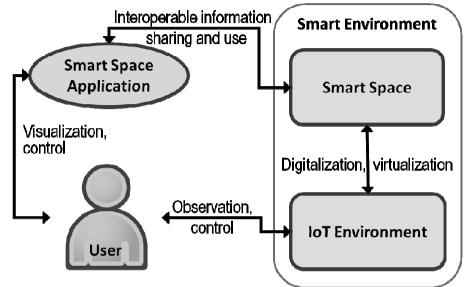
Enabler Models and Technologies

- Blackboard model: interaction by information sharing
- Semantic Web (knowledge-driven support):
 - RDF model for machine-interpretable data representation
 - OWL ontology for model-driven programming
 - Reasoning over "linked data" (SPARQL)
- Publish/Subscribe model: event-driven programming
- Smart-M3 platform: open source for research prototyping

Dmitry Korzun: Development of Smart Space Applications

Smart Space Application (SSA)

- Distributed system of agents hosted in IoT environment
- Smart properties of SSA:



- Understanding the situation where the application is used and by whom
- 2. Interpreting the semantics of shared information
- 3. Tolerating uncertainty at development and run time
- Dmitry Korzun: Development of Smart Space Applications

24.10.2014

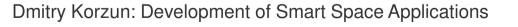
SSA Services

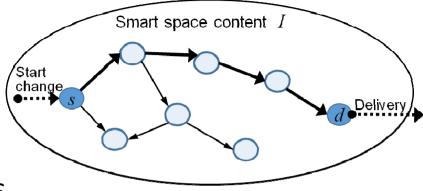
- SSA acquires knowledge about the environment and its users to provide them with services using the best-suit resources from all kinds of participants
- Agent is a Knowledge Processor (KP) over shared content /
- Service development: in terms of scenarios with knowledge reasoning acts
- Control flow: initiated from the user side and completed at a point where the user perceives the service
 - Dmitry Korzun: Development of Smart Space Applications

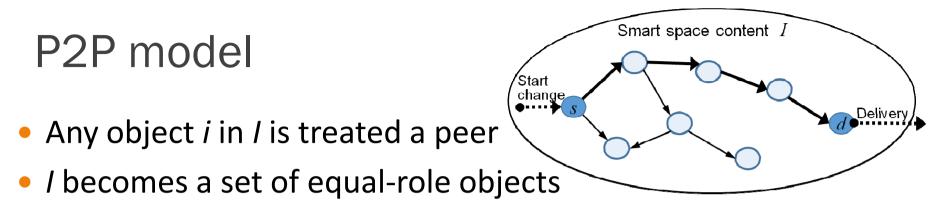
Service Formalism

- Service:
 - knowledge reasoning over I
 - Delivering the result to the users
- Entities of the shared content I are virtualization:
 - Objects of the physical and information worlds
 - Agents and their related information
- P2P-like structure of *I*, including application data (shared), world entities (physical and information), and agents (KPs)









- Objects: active entities and subject to information changes
- Interaction: links between objects
 - Ontological (data representation)
 - Meditorial (result of actions)
- Service construction: a flow of information changes, $s \rightarrow * d$

Dmitry Korzun: Development of Smart Space Applications

Architectural Abstractions

- Whole app.logic = sum of concurrent activities of KPs
- KP is responsible for links $i \rightarrow j$ of service $s \rightarrow * d$

Type	Description
P-C	Producer-Consumer pattern. KP _P publishes infor-
	mation into I . KP _C queries this information and
	reacts.
Pipe	KP_0, KP_1, \ldots, KP_n form a kind of supply chain
	(linear) with source KP_0 and destination KP_n .
	The P-C abstraction is a particular case for $n = 1$.
Tree	Some KPs induce reaction of more than one other
	KPs. A kind of one-to-many synchronization with
	epidemic-style dissemination of changes in I .
Flow	Cyclic supply chains are possible. The KPs are or-
	ganized in iterative processing flow when the same
	KP is activated multiple times.

- Event-driven programming, e.g., persistent semantic query
- Rule-based programming,
- P2P-like routing, e.g., cyclic routing
 - Dmitry Korzun: Development of Smart Space Applications

24.10.2014

Conclusion

This study is a part of project 14.574.21.0060 (RFMEFI57414X0060) of Federal Target Program "Research and development on priority directions of scientific-technological complex of Russia for 2014-2020"

- Terminology:
 - Smart space and Smart environment
 - Smart space application and services
- Formalization for SSA design
 - Service as a path in the P2P-like network of virtualized objects
 - Architectural abstractions for agents (knowledge processors) that construct and deliver services

dkorzun@cs.karelia.ru

