EVROPSKÁ UNIE
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MINISTERSTVO ŠKOLSTVÍ, MLÁDEŽE A TĚLOVÝCHOVY
OP Vzdělávání pro konkurenceschopnost
2007-13
VYSOKÉ UČENÍ TECHNICKÉ V BRNĚ
INVESTICE DO ROZVOJE VZDĚLÁVÁNÍ

Agent platforms

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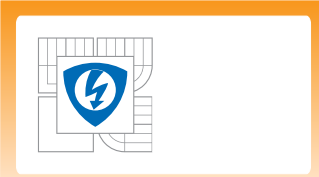
March 22, 2010

Tato prezentace je spolufinancována Evropským sociálním fondem a státním rozpočtemČeské republiky.



Outline

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Multi-agent systems
Agent platforms
FIPA specifications
Communication
Mobile agents
Security services
Platform overview

- Multi-agent systems
- Agent applications
- Multi-agent platforms - basic features
- FIPA specifications
- Communication
- Agent mobility
- Security issues
- Overview of agent platforms

Outline

Multi-agent systems

Multi-agent systems

Examples of agent applications

Agent platforms

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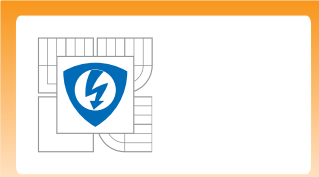
Platform overview

Multi-agent systems



Multi-agent systems

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- Software agents which interact to achieve a common goal
- Heterogeneous agents
- Different execution environments - PCs, embedded systems, industrial control systems
- Message-based interaction between agents

Examples of agent applications

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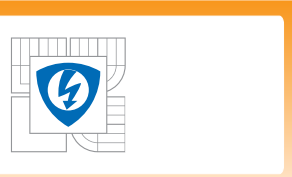
- User Interface Agents
  - Personal Assistants
  - Health-care Assistants
- Information Management Systems
  - Resource Discovery Agent
  - Travel Assistants
- Business Applications
  - Energy management
  - Logistics
  - Supply chain management
  - Traffic control management



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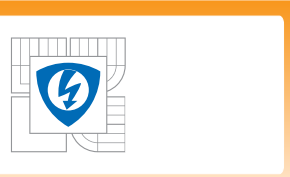
Agent platforms



Multi-agent platforms

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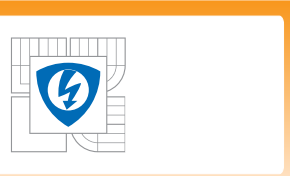
Basic features

- Simplify and speed-up a development process
- Ensure safe and efficient execution environment
- Allow seamless interaction between individual agents

Various levels of provided services

- Toolkits for creating agent applications (UML-like tools), model-driven approaches
- Agent programming languages, interpreters
- Full platforms - self-contained systems that provide runtime libraries, APIs for developers



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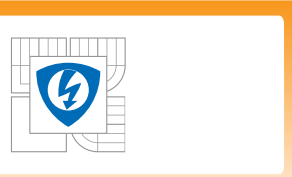
From software development point of view

- Middleware which provides developers with execution environment and programming API
- Agent life-cycle management
- Communication infrastructure
- Set of basic services which can be utilized by agents residing on platform (like service discovery)
- Security and mobility services
- Monitoring and logging components
- Additional optional modules - advanced reasoning, machine learning, interaction protocols



Interaction schemes

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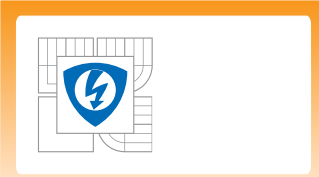
From the point of view of interaction among agents we distinguish:

- Open systems
  - Interaction among various types of agents from different developers
  - Common understanding of messages is necessary - specification of message structure
  - May act as self-interested and try to harm others/whole system - security issues
  - Strong emphasis on interoperability
- Closed systems



Interaction schemes - closed systems

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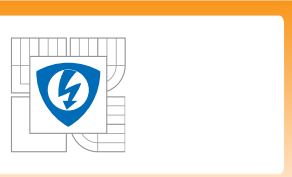
- Closed systems
  - Interact with a predefined set of agents known to the developer in advance
  - Proprietary data formats can be used
  - Interoperability can be sacrificed for the sake of performance optimizations



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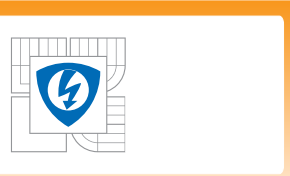
FIPA specifications



FIPA specifications

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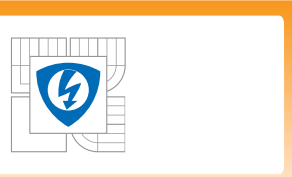
Foundation for Intelligent Physical Agents - FIPA

- Founded to create specification that will ensure interoperability among agents
- Complete set of specifications from different categories:
  - agent communication
  - agent transport
  - agent management
  - abstract architecture and applications
- Most significant for agent interoperability is agent communication



FIPA specifications

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In order to be FIPA compliant, concrete architectural specifications must have certain properties

- Mechanisms for agent registration
- Agent/service discovery service
- Inter-agent message transfer

Defined by FIPA Abstract Architecture specification Together provide support for:

- concurrent execution of agents - multiple agents running in parallel on the same host
- distributed execution of agents - agents distributed over multiple physical hosts

Agent interoperability

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- Software created by different developers and at different times works together in seamless manner
- Limitations of current software interoperability
  - Lack of the ability to communicate definitions, theorems and assumptions
  - No general way of resolving inconsistencies in the use of syntax and vocabulary
- ACL by Genesereth and Fikes, 1992 - three cornerstones
  1. Vocabularies (ontologies)
  2. Knowledge Interchange Format (KIF)
  3. Knowledge Query Manipulation Language (KQML)

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Communication

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Categories of requirements for an ACL

- Form - it should be declarative, syntactically simple and easily readable
- Content - a distinction between the languages that express communicative acts and the language that conveys the content of the message
- Semantics - should exhibit properties expected of the semantics of any other language
- Implementation - efficient, provide a good fit with existing software, hide the details of lower layers

Agent communication language

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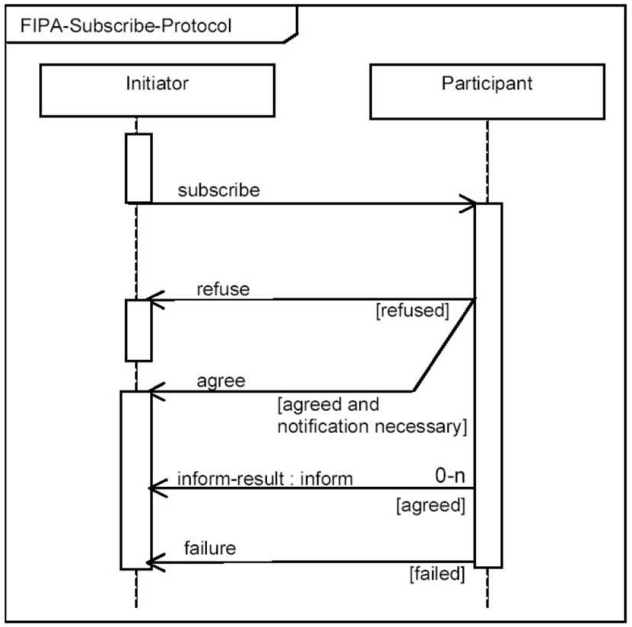
- Networking - support all important aspects of modern networking technology, independent of transport mechanism
- Environment - it must cope with heterogeneity and dynamism
- Reliability - support reliable and secure agent communication



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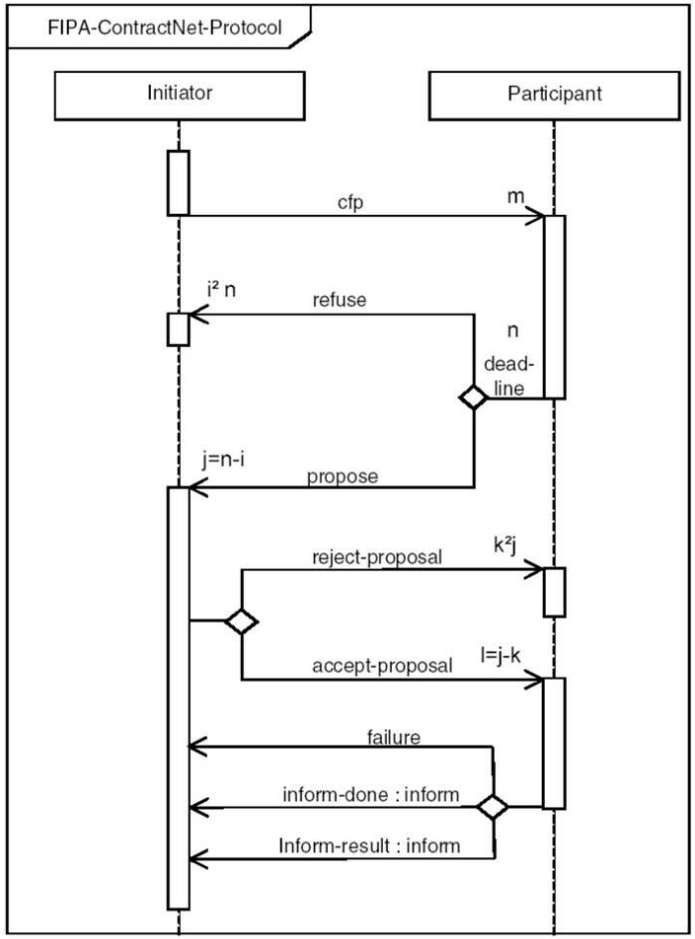

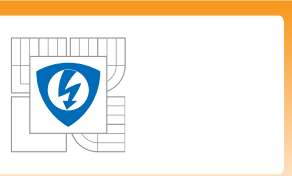

Communication between agents

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- Agents communicate by exchanging messages which represent speech acts (INFORM, QUERY, etc.)
- Messages are encoded in an agent communication language
- Messages include indication of the type of communicative act, names of sender and receivers, content of the message itself
- Content of the message is specified by ontology
- Unicast, multicast, broadcast messages
- Message is delivered via message transport

FIPA management reference model

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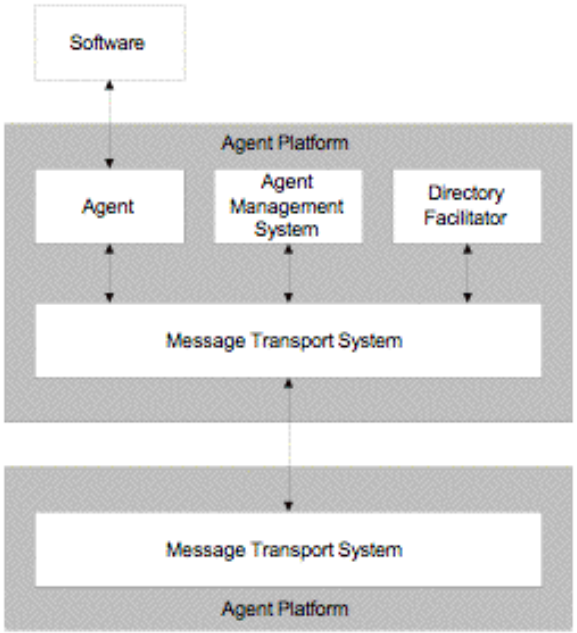
Provides normative framework within which FIPA-compliant agents exist and operate.

It establishes the logical reference model for creation, registration, location, communication, migration and retirement of agents.



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Basic components of the reference model are:

- Agent platform provides physical infrastructure in which agents can be deployed, it can be viewed as a kernel responsible for thread, socket and memory management
- Agent is computational process that implements the autonomous, communicating functionality of an application
- Agent must have an identification which is unique within the agent universe
- Agent Management System is mandatory component, it maintains a directory of agent identifiers and transport addresses
- Directory facilitator is optional component, it provides yellow pages services
- Message transport is responsible for physical message delivery, each agent must be registered at message transport

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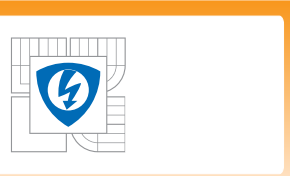

Mobile agents

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Mobile agents are characterized by code mobility

- Mobile agents travel to places, where they perform tasks on behalf of a user
- Reason why to travel - insufficient computational power, unreliable communication, remote data source
- Security issues
- Mobility vs. cloning, stand-in agents

Types of agent mobility

- Strong mobility - mobility of code, data and execution state, transparent for the computational process, requires support from the OS and execution environment
- Weak mobility - only the code and data are transferred, intentional mobility

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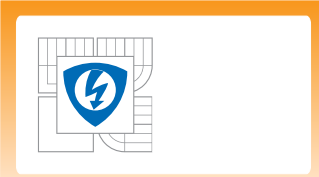
Problems with agent mobility

- Various operating systems, programming languages, agent platforms
- Security features - permissions, authorities, access control
- Necessity to transfer all required data, libraries
- Interaction with message transport system - new communication address, delivery of messages received by old message transport



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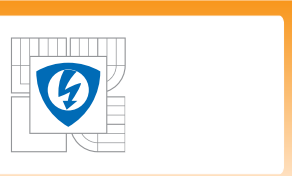

Security

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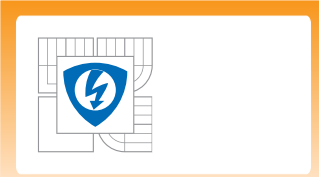
Important aspect especially in the case of open systems

- Thread-safe agent execution model which holds rest of the system harmless against agent failure
- Communication security
  - message encryption/signing
  - security certificates with public/private keys
- Trust and reputation models to create a set of trustful collaborators in open systems
- Protect private knowledge of individual agents



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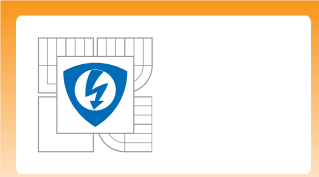
Overview of agent platforms
AGLOBE agent platform

Platform overview



Overview of agent platforms

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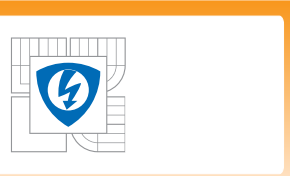
- In total more that 150 agent platforms and toolkits, most of them obsolete or discontinued
- Provided under an open source license
  - JADE
  - AGLOBE
  - Cougaar
- Commercial platforms
  - Jack
  - LS/TS
  - Cybele



AGLOBE agent platform

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AGLOBE agent platform

Developed at ATG, CVUT Prague

- Strong focus on distributed simulations
- Scalability, high number of fully autonomous agents, lightweight infrastructure
- Agent migration, persistence, communication inaccessibility
- Library management
- Java-based, required JDK 6
- Available on http://agents.felk.cvut.cz/aglobe