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Agent Base Approach for Intelligent Distribution Control Systems

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Agent Base Approach for Intelligent Distribution Control Systems

Abstract

Agent –Base technology

Abstract

Global competition and rapidly **changing customer requirements** are forcing major changes in the production styles ,planning , services , configuration of manufacturing organizations and many other areas.

Recently, agents and multi-agent systems are becoming a new way to analyze, design and implement complex (software) systems ,Specifically, when the design problem is distributed in nature, the development of a solution may benefit from an agent-based approach.

In this presentation , we give a brief of some related projects in this area.

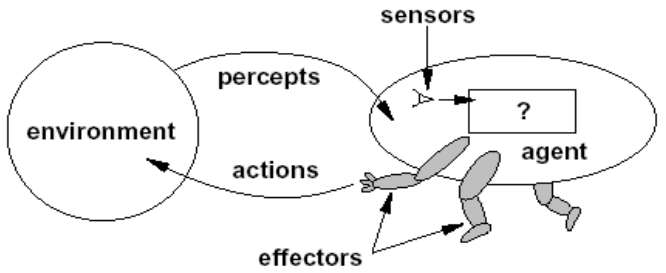
Main

Introduction and Concept definition

What is an Agent,Intelligent Agents, Software Agent?

Agent

An agent is a **computer system** capable of autonomous (capable of acting independently, exhibiting control over their internal state) action in some environment in order to meet its design objectives.

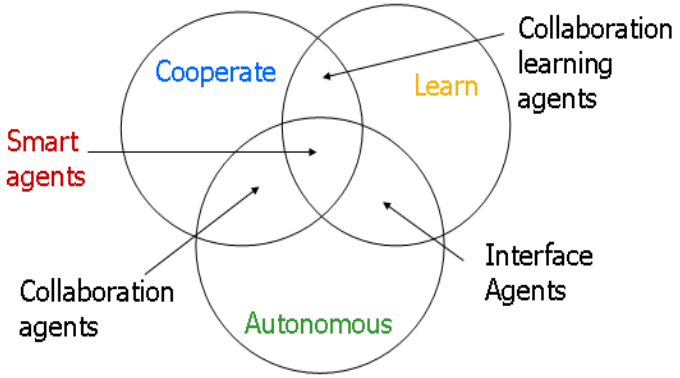


Intelligent Agents

An intelligent agent is a **computer system** capable of **flexible** autonomous action in some environment

ability to adapt
- problem-solving-rules or algorithms

ability to learn
- trial-and-error
- example and generalization



Based on Nwanna's primary attribute dimension

Software agent

Software agent is a **functional software** module that is able to execute some predefined class of external tasks and has an autonomy during these tasks realization.

Introduction and Concept definition

What is an Agent-oriented Programming, Autonomous Agent, Agent-Base programming, Intelligent Agent in Artificent Intelligent?

Agent-Oriented Programming	An approach to **building agents**, which proposes programming them in terms of mentalistic notions such as beliefs, desire and intentions. [M.Wooldridge, 1995].
Agent-Based Programming	An approach to **the building software** systems **using various agent frames** as basic functional components of the designed system architecture (so called **MAS architecture**).
Autonomous agent	An autonomous agent is a system situated within and a part of an environment that senses that environment and acts in it, over time, in pursuit of its own agenda and so as to effect what it senses in the future. [Franklin and Graesser, 1995]
Intelligent Agents in AI	In the artificial intelligence sense of the term, there are multiple types of agents and sub-agents. • Physical Agents • Temporal Agents It is possible to group agents into **five classes** based on **their degree of perceived intelligence** and capability: **simple reflex agents;** **model-based reflex agents;** **goal-based agents;** **utility-based agents;** **learning agents.**

Introduction and Concept definition

Intelligent Agents in Artificial Intelligence?

Intelligent agents in Artificial Intelligence

1. Simple reflex agents

Simple reflex agents acts only on the basis of the **current percept**. The agent function is based on the condition-action rule:**if condition then action.**

2. Model-based reflex agents

Model-based agents can handle **partially observable environments**. Its current state is stored inside the agent maintaining some kind of structure which describes the part of the world which cannot be seen.This additional information completes the **"World View"** model.

3. Goal-based agents

Goal-based agents are model-based agents which store information **regarding situations that are desirable**.

4. Utility-based agents

Goal-based agents **only distinguish between goal states and non-goal states**. It is possible to define a measure of how desirable a particular state is. This measure can be obtained through the use of a utility function which maps a state to a measure of the utility of the state.

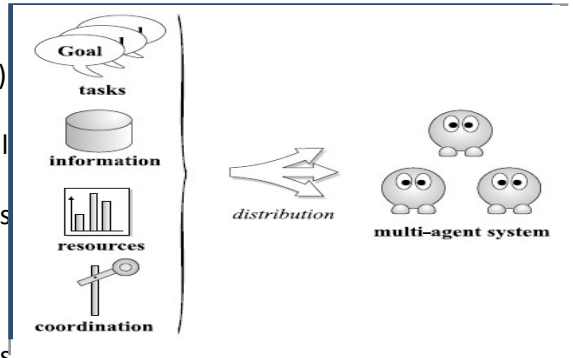
5. Learning agents

In some literature IAs are also referred to as **autonomous intelligent agents, which means they act independently, and will learn and adapt .** According to Nikola Kasabov

Introduction and Concept definition

What is main differences between Agent and Object and ES, Modes of Agency, Inter-Agent Communication?

Main differences Agents and Objects	**Agents are autonomous**- decide for themselves **Agents are smart** - flexible (reactive, pro-active, social) behavior **Agents are active**- at least one thread of active control
Main differences Agents and Expert Systems	**Agents situated in an environment:** **Agents act** **Some real-time (typically process control) expert systems are agents**
Inter-agent Communication	**Effective communication requires:** **Shared knowledge** of syntax **Shared understanding** of semantics and pragmatics
Modes of interaction	**Independence** (no interaction) **Simple collaboration** (compatible goals, sufficient resources, insufficient skills) **Obstruction** (incompatible goals, insufficient resources, sufficient skill **Coordinated collaboration** (compatible goals, insufficient resources, insufficient skills **Pure individual competition** (incompatible goals, sufficient resources, sufficient skills) **Pure collective competition** (incompatible goals, sufficient resources, insufficient skills, **Individual conflict over resources** (incompatible goals, insufficient resources, sufficient skills) **Collective conflict over resources** (incompatible goals, insufficient resources, insufficient skills)



Overview MAS technology

Overview MAS technology

What is MAS, Potential and Challenge of Multi agent systems?

Multi agents systems

n artificial intelligence research, agent-based systems technology has been hailed as a new paradigm for conceptualizing, designing, and implementing software systems.

multi-agent system is a **group of agents that interact to solve problems that are beyond the individual capabilities** . Multi-agent system design is more complicated than a single agent design. It presents many new cooperation issues. This presents us…

ask allocation: how to assign responsibility to a single agent?

esolving Conflicts: How to resolve conflicting knowledge, actions and goals among agents

Potential of Multi agents systems

- **Open information systems will contain multiple autonomous agents** or agents acting on behalf of autonomous users or entities
- **Solution of complex problems require the services of multiple agents with diverse capabilities.**
- **Multi-agent systems can support distributed collaborative problem solving** by agent collections.
- **Multi-agent systems support a modular,** extensible approach to design of complex information systems

Challenge Multi agents systems

How can multi agent systems generate useful behaviors?
Inter-agent communication (of knowledge, intentions, beliefs)
Inter-agent collaboration (e.g., through negotiation among self-interested rational agents)
Coordination and control in multi-agent systems

Overview MAS technology

What is Multi agent software, Conventional Software?

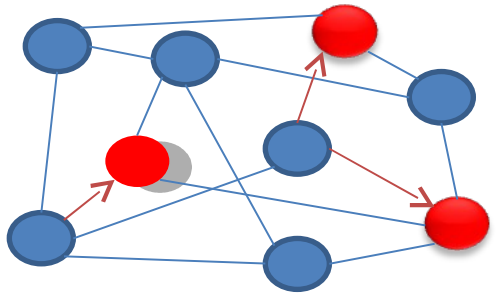
Why MAS Are Different?

In general agent-oriented programming is the next step of object-oriented programming (OOP), which integrates achievements of last decades in **artificial intelligence**, **parallel computing** and **telecommunications.**
Comparing with objects in OOP,

Multi-Agent Software

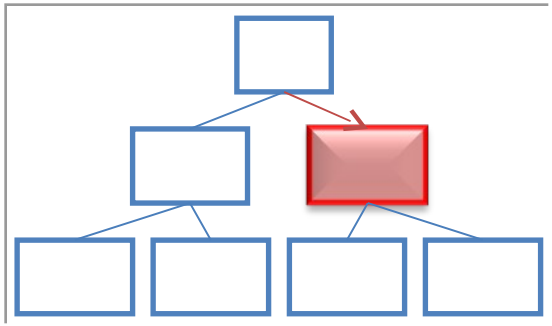
t is a self-organized network of agents (software objects) constantly working in parallel building or revising links. No one knows which agent will call which – it depends.

very agent is autonomous and struggles to achieve its own goal.



Conventional Software

t is the example of a large program which calls subprograms (methods) sequentially one by one Even with progress of object-oriented programming (OOP) ,there is still pre-organized structure of source code lines which give direct instructions to computer what to do, when and how.



Overview MAS technology

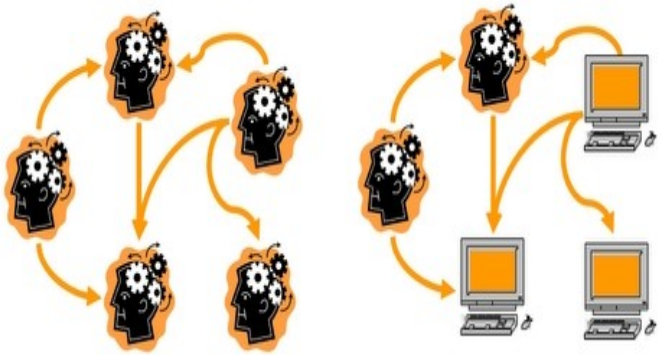
Advanced Agent Technologies supporting decision making in complex domains

Multi agent System Applications- Trust and Reputation

Advanced Agent Technologies supporting decision making in complex domains

Improving Robustness and Fault Tolerance by Assessing the Trustworthiness of Information and Sources As decision-makers, **software agents** construct **beliefs** about **themselves**, **others**, and **the environment**.

These beliefs form the basis for decisions and actions.



MAS supporting decision making in complex domains

Overview MAS technology

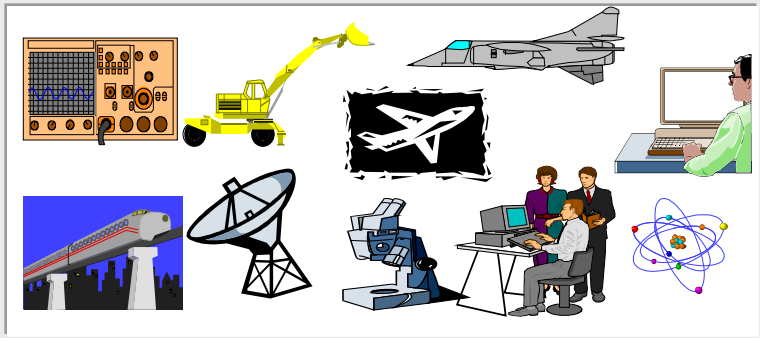
What is Multi agents organization and application?

The beauty of Multi-agent software!

-Total control -Large networks of small agents -Parallel processing -Negotiation	- Evolution -Thriving on complexity -Conditions for development	-Distributed decisions -Knowledge-driven -Self-organization -Stability -Attempts to reduce complexity

Application Multi agents systems

Aircraft maintenance
Electronic-government services
Military defining
Wireless collaboration and communications
Military logistics planning
Supply-chain management
Joint mission planning
Financial portfolio management
many other areas



Application of distributed agent-based systems

often categorized as Distributed Artificial Intelligence (DAI) or Multi-Agent Systems (MAS), provide **decision support and operation control** in **complex domains.**

Agent base Approach in Social Service

Samara Region Social Services

Multi Agent System Applications- Social Services

3.1.Introduction ,Problem, Solution

This section presents **multi-agent system for social services** based on **social passport** and **smart cards** of citizens. It describes developed approach based on agents and ontologies , architecture of the system and its specific features. It is shown that application of **multi-agent technology** can bring **high value** and **clear benefits** for clients in full scale regional e-government systems.

Problem: This is a serious problem for social services of **each region which give support to their citizens**.

Solution: To solve problem, They have developed a multi-agent system application that the citizens can access the system via the Internet, Internet-kiosks which last version includes services of a cash-machine .

Samara Region Social Services

Multi agent System Applications- Social Services

3.2. ONTOLOGIES, SOCIAL PASSPORTS AND SMART CARDS OF CITIZEN

Today a citizen of Samara Region has the right **to obtain** a **social smart card** free of charge. It is called “smart”. The smart card becomes the **key to access** those data bases. Part of the provided data is obligatory and needs to be confirmed with originals of certain documents (e.g., passport number, etc.)

Obviously it is very unlikely that all these data will be accumulated in **one data base**. Instead at this stage They use **ontologies** to **integrate information** about a person. Their **ontology of social sphere**, defined in the form of **semantic networks**, acts as a **metadata** and contains data about location of different information on a certain person and its format.

Agent base approach in Social Services

Samara Region Social Services

Multi agent System Applications- Social Services

3.3. MULTI-AGENT SYSTEM OF SOCIAL SERVICES

for implementation of modern **e-Government** concepts. The agents uninterruptedly work for the good of a man, ensuring his or her social support, taking care of his or her health and education, work and security, culture and sports.

- **Agent of a person** -acts for and on behalf of a **person**,
- **Agent of a social law** - the agent of a law **scans citizens** social passports and finds out **relevant law**
- **Agent of a social officer** –Its task is to **find citizens** who **require social support**
- **Agent of a social organization** -acts for and on behalf of an organization officer

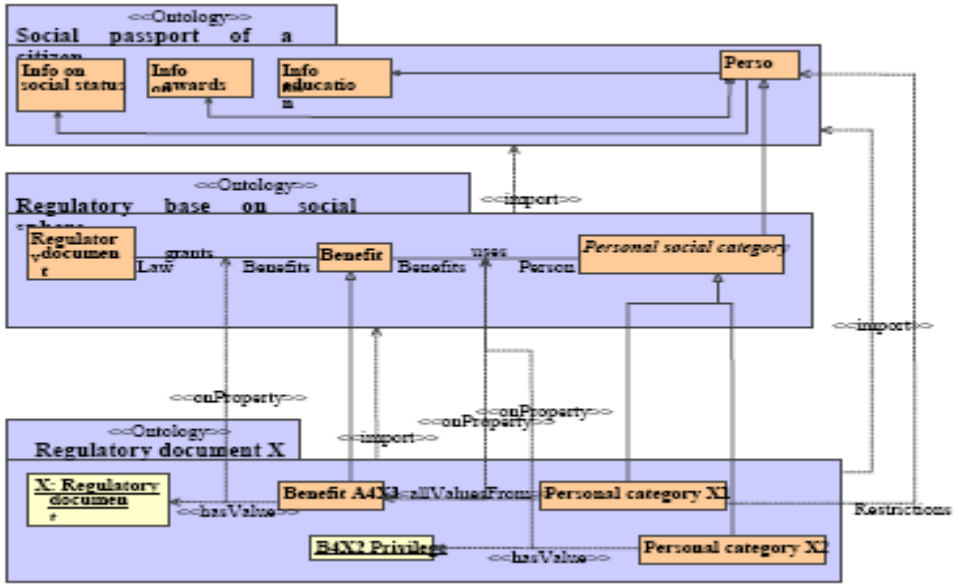
Samara Region Social Services

Multi agent System Applications- Social Services

3.4. REAL TIME KNOWLEDGE BASE

In their work system **users and software agents** may use **ontology-oriented knowledge bases**. modern methods of ontology representation as the **mostly wide-spread**, **well specified and open for extension.** Figure shows a simplified ontological model for representation of laws in social sphere.

Schematic model of representation of a social law



Samara Region Social Services

Multi agent System Applications- Social Services

3.4. REAL TIME KNOWLEDGE BASE

The **OWL standard** defines the format of ontology representation in the form of an **XML** file based on **RDFS scheme**.

As an example let's use regional law №122-GD "On governmental support of citizens with children". It defines several **benefits for families** with **3 or more children**, including "30% discount from **public utilities fee**".

```
<owl:Class
rdf:ID="30_percent_discount_for
_public_utilities ">
<!—- Restriction defining the
document which provides
benefits (defined directly without
a link) -->
<rdfs:subClassOf>
<owl:Restriction>
<owl:onProperty
rdf:resource="http://www.kg.ru/l
awsBase.owl#byLaws"/>
<owl:hasValue>
<laws:Regulatory_document
rdf:ID="Statute_122-GD">
<rdfs:comment
rdf:datatype="http://www.w3.or
g/2001/XMLSchema#string"
>STATUTE №122-GD " On
governmental support of citizens
with children
"</rdfs:comment>
</laws:Regulatory_document>
</owl:hasValue>
</owl:Restriction>
</rdfs:subClassOf>
<rdfs:subClassOf
rdf:resource="http://www.kg.ru/l
awsBase.owl#Public_utilities"/>
<!—- Restriction on categories of
citizens who use the benefit
(defined by a link to the class,
defined later) -->
<rdfs:subClassOf>
<owl:Restriction>
<owl:allValuesFrom>
<owl:Class
rdf:ID="Families_with_3_or_more
_children"/>
</owl:allValuesFrom>
<owl:onProperty
rdf:resource="http://www.kg.ru/l
awsBase.owl#forCategories"/>
</owl:Restriction>
</rdfs:subClassOf>
<rdfs:comment
rdf:datatype="http://www.w3.org
/2001/XMLSchema#string"
>30% discount from statute-
established public utilities
fee</rdfs:comment> </owl:Class>
```

Agent base approach in Social Services

Samara Region Social Services

Multi agent System Applications- Social Services

3.4. REAL TIME KNOWLEDGE BASE

In conclusion we'd like to mention that **such descriptions** on the **internal level** may be used by **agents**, but are also accessible to the public for navigation and browsing in a friendly visual interface of an internet kiosk.

SUPREMA Internet kiosk

SUPREMA User Interface

Samara Region Social Services

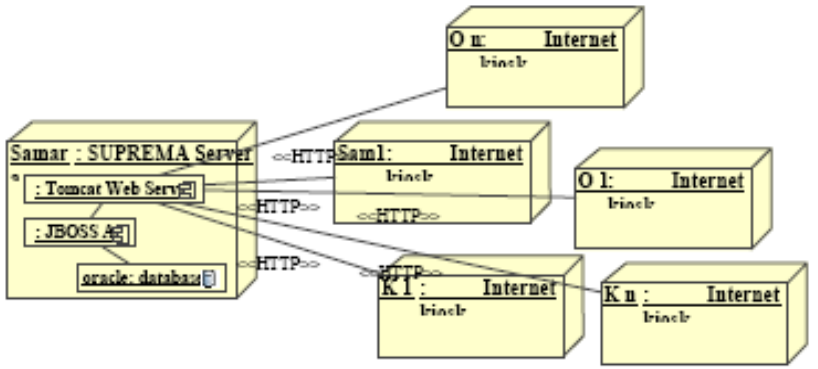
Multi agent System Applications- Social Services

3.5. TECHNICAL ARCHITECTURE

The software was developed on **three-level architecture** with the use of **J2EE** technologies which allow creating platform-independent applications, including:

- **subsystem** of personal interaction with citizens with the use of **internet kiosks**;
- **subsystem** of decision making support for **social sphere ministries**, namely Ministry of Social Protection, Public Health, Culture and Education;
- **Internet portal for integration of social sphere resources**, which are organizations, authorized by the above-mentioned ministries.

All data bases were also located on **one server**, which contained information on approximately 1.5 mln. people.



Original SUPREMA architecture

Agent base approach in Social Services

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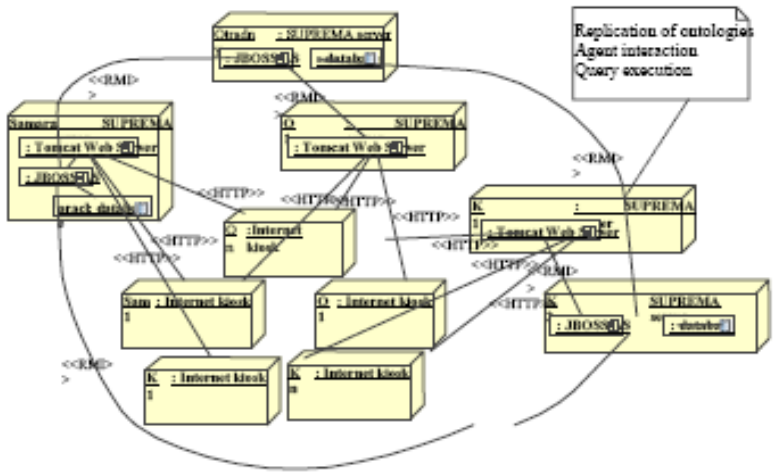
3.5. TECHNICAL ARCHITECTURE

with the development of the system a **new goal** was set: to create **a distributed P2P system architecture** capabilities of transparent user **access** to all nodes of the system from **any geographic location**.

the system is organized as SOA which has nested nodes, but all of them, being autonomous parts of the system in the whole.



Distributed SUPREMA architecture

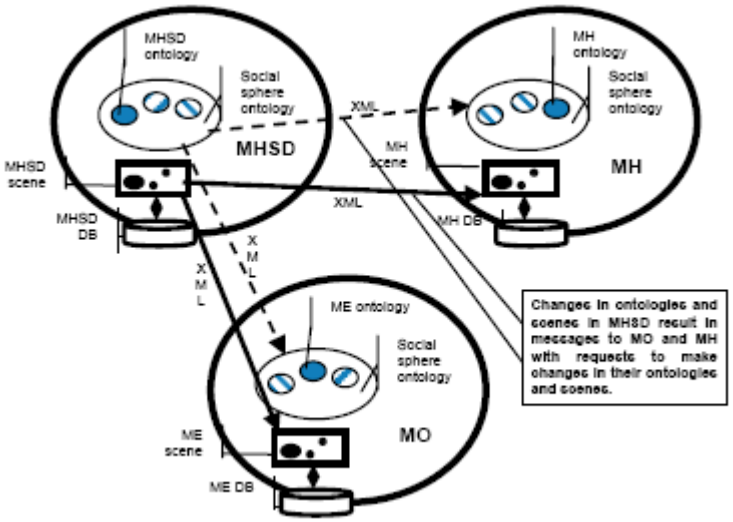
Samara Region Social Services

Multi agent System Applications- Social Services

3.5. TECHNICAL ARCHITECTURE

The **most important step** to construction of the distributed network was creation of a single repository of all ontologies. , which is **replicated** and **updated** on all servers and ensures common knowledge for each remote server.

This step **illustrates** structure of a fully distributed system, being developed now, which includes **Ministry of Humanitarian** and **Social Development**,…



Fully distributed system architecture

Samara Region Social Services

Multi agent System Applications- Social Services

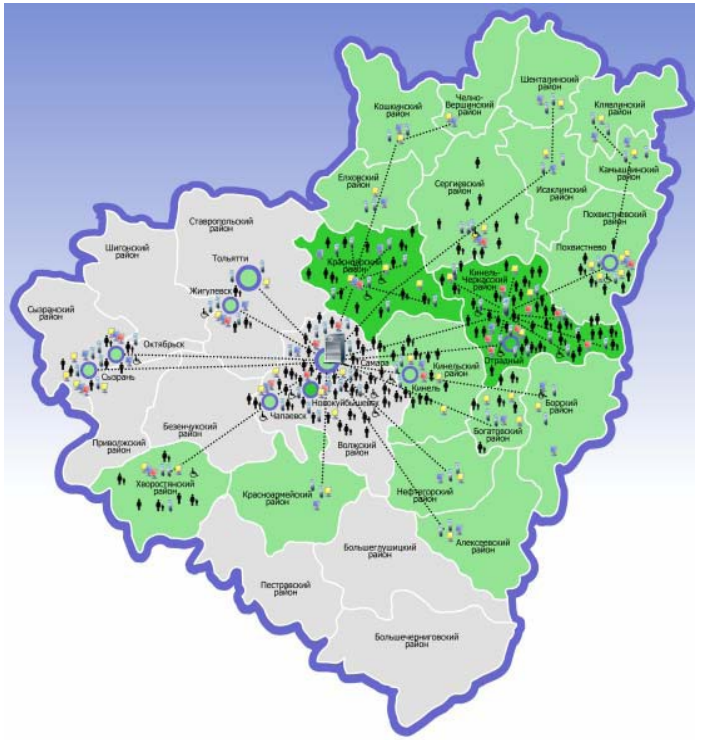
3.6. KEY STAGES OF PROJECT

With the pilot system (2001) at the first stage the Samara Region Administration became the winner of "Electronic Russia", a **national-wide projects contest**.

The second stage(2003 – 2005) developed its own specialized software on a large scale .

At present time the third stage of the system creation is being completed .

State of deployment of SUPREMA in Samara region



Samara Region Social Services

Multi agent System Applications- Social Services

3.7. NEXT STEPS

- The system development in new domains of the social sphere:

- System development in new social spheres: **healthcare, civil registry office**, **public utilities, education, culture**, etc.;
- **Integration of social passport with medical insurance certificate**, patronymic certificate, etc;
- Transfer of social payments and a **possibility to use** these money in supermarkets, for other expenses;

- To develop a toolkit, architecture and functionality of the system:

- Transfer to a fully distributed SOA system architecture with P2P interaction of servers;
- Electronic protocol of interactions between ministries, organizations and citizens;
- **extension of agents functionality** which pro-actively to implement a wider range of citizens' **demands and needs**;
- creation of multi-user, distributed ontologies and solving problems of their collaborative building and using.

Agent base approach in manufacturaient Control

Agent Base Approach for Intelligent Distribution Control

Manufacturing Control Problem

Manufacturing Planning, Scheduling and Control

Planning is the **process of selecting and sequencing activities** such that **they achieve one or more goals** and satisfy a set of domain constraints.

Scheduling is the **process of selecting among alternative plans** and **assigning resources and times to the set of activities** in the plan.

Manufacturing scheduling is a difficult problem, particularly when it takes place in an open, dynamic environment. A task can take **more time than anticipated or less time than anticipated**, and tasks can arrive **early or late**.

for manufacturing systems, the scheduling and **control** problem has been widely studied in the literature by various methods: **heuristics, constraint propagation techniques**, **simulated annealing**, **Taboo search**, **genetic algorithms, neural networks, etc.**

Agent technology has recently been used in attempts to resolve this problem.

Agent Base Approach for Intelligent Distribution Control

Manufacturing Control Problem

Manufacturing Planning, Scheduling and Control

Agents and controllers- Comparing agents and controllers

This comparing becomes important **when developing an agent-based method for solving control problems**. Several similarities and differences between these two concepts can be noticed.

Similarities

- **Objective:**

Both a controller and agent have objectives that determine their behavior**. a controller resembles a reactive agent.**

- **Situatedness:**

Both an agent and a controller **interact with some "surrounding"** by sensing and acting.

Differences

- Pro-active:

A controller is usually designed to **operate continuously during the whole operating time** of a control system.

An agent, however, decides whether **it wants to gets operational and produce actions**. It might not produce actions

during the whole operating time of the system.

- Thread of control :

Matters related to the thread of control are a major concern in MAS, whereas this is generally not addressed during

the design of controllers.

Agent Base Approach for Intelligent Distribution Control

Manufacturing Control Problem

Manufacturing Planning, Scheduling and Control - Agents in control engineering

Agents are not (yet) common in control engineering.

- The field of multi-agent systems **is relatively new**.
- Control theory has a strong mathematical foundation, whereas the field of multi-agent system mainly is focused on abstract descriptions of system . **Still there are examples in which a MAS has been used in control engineering .**

6. An applications is described by **Mac-Leod & Stothert .** They describe the problem of controlling a mine refrigeration system. **to model the refrigeration system as a cooperating multi-agent system and results in a planning mechanism that launches specialized agents to suit operating conditions and operator demand**." The application of MacLeod and & Stothert clearly is of the kind **"constructing a control system by using agents".**

- **Lygeros, Godbole and Sastry** describe an application which could be described as "**constructing controllers as architectures of agents".** They consider problems **that consist of a large number of agents and that have to make efficient use of a scarce resource**.

- **MacKenzie** describes an agent-based method for **designing controllers for (mobile) robots**. This method is based on the **behavior-based robotics paradigm.** he defines an **"assemblage agent".** An assemblage agent is a society of coordinated agents and can be part of some other assemblage agent.

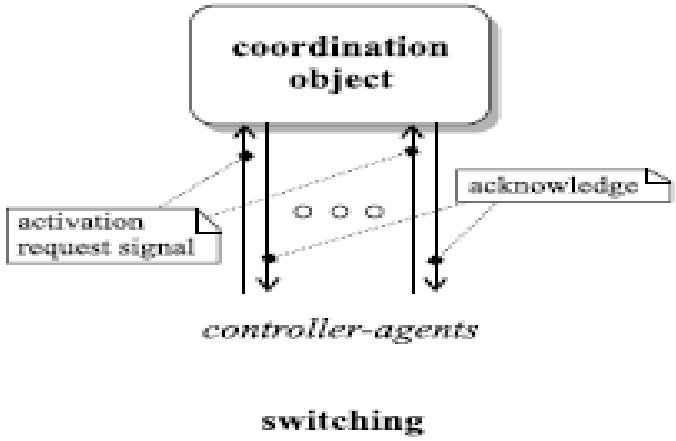
Agent Base Approach for Intelligent Distribution Control

Manufacturing Control Problem

Manufacturing Planning, Scheduling and Control

Controller-agent

Multi-controllers consist of several locally operating controllers.
A **controller-agent** is a largely autonomous, locally operating controller that consists of a control algorithm (in the form of an update and a calculate function).



Agent Base Approach for Intelligent Distribution Control

We found some application using agent-based design method for multi controller systems . The table presents a summary of these Applications.

JASS 2008	Group Name	Main Characteristics
1	Assen,Van Breemen & De Vries	Design and implementation of an intelligent room thermostat
2	K¨upers	Design and (partial) implementation of a safeguard module for an industrial manipulator
3	De Kruif	Design and implementation of a controller for the double beam experimental setup ,
4	Balkema,Boer, Dertien et	Design and implementation of a behavior-based controller for the autonomous mobile robot Arty
5	Jansen, Lubek & Seters	Controller design and implementation for a placement module of the Fast Component Mounter ,
6	Van Breemen & DeVries	Design and simulation of the water vessel problem,
7	Van Breemen, De Vries & Striper	Modeling of the manufacturing process of corrugated cardboard process ,
8	Striper	Design and simulation of a controller for the manufacturing process of corrugated cardboard

Agent Base Approach for Intelligent Distribution Control

Manufacturing Control Problem

Manufacturing Planning, Scheduling and Control

Manufacturing control relates to **strategies** and algorithms for operating a manufacturing plant.

The manufacturing control problem can be considered at two levels: **low- and high-level**
low-level, the individual manufacturing resources **are to be controlled to deliver** unit-processes expected by the high-level control functions.
High-level manufacturing control is concerned with **coordinating the available manufacturing resources** to make the **desired numbers of types of products.**

In agent-based manufacturing systems, agent technology is usually applied to high-level manufacturing control, but can also be applied at the lower level (Brennan et al 1997; Wang et al 1998).

Shaw may have been **the first** to propose using **agents in manufacturing scheduling** and **factory control.**
He proposed that a **manufacturing cell could subcontract work to other cells** through a bidding mechanism (Shaw and Whinston 1983).

YAMS (Yet Another Manufacturing System) (Parunak 1987) was another of the earliest agent-based manufacturing systems, wherein **each factory** and **factory component** is represented as an **agent**. **Each agent has a collection of plans, representing its capabilities.**

Agent Base Approach for Intelligent Distribution Control

We found some projects using agent technology for manufacturing planning, scheduling and execution control ,The table presents a summary of these projects.

JASS 2008	Project Name and domain	Group Name Main Characteristics
1	AARIA (Manufacturing Scheduling & Control)	Parunak et al ITI, U of Cincinnati Using autonomous agents to represent physical entities, processes and operations
2	AMACOIA Flexible assembly lines design	Sprumont & Muller U. of Neuchatel Using simulated annealing to search problem space
3	ARMOSE Robotics	Overgaard et al Odense U Each joint of a robot is modeled as an agent
4	I-Control Manufacturing system control	Brennan et al 1997, Wang et al U of Calgary Partial Dynamic Control Hierarchy (PDCH); Using agents to model IEC-1499 Functional Blocks
5	MASCADA Manufacturing Scheduling & Control	Bruckner et al Daimler-Benz AG, KULeuven Emergent Behavior in Manufacturing Control; Proactive Disturbance Handling; Hot Pluggable Agents
6	Sensible Agents Manufacturing intelligent control system	Barber et al U of Texas at Austin Implemented as CORBA objects communicating through ILU object environment

Agent Base Approach for Intelligent Distribution Control

Manufacturing Control Problem

For the demand of large scaled and complex control systems in industry process, we define project to put forward a general framework of agent-based distributed intelligent control systems (ADICS), which combines the natural distribution of distributed control systems , and constructs a multi-agent system (MAS) by taking agents as intelligent controllers.

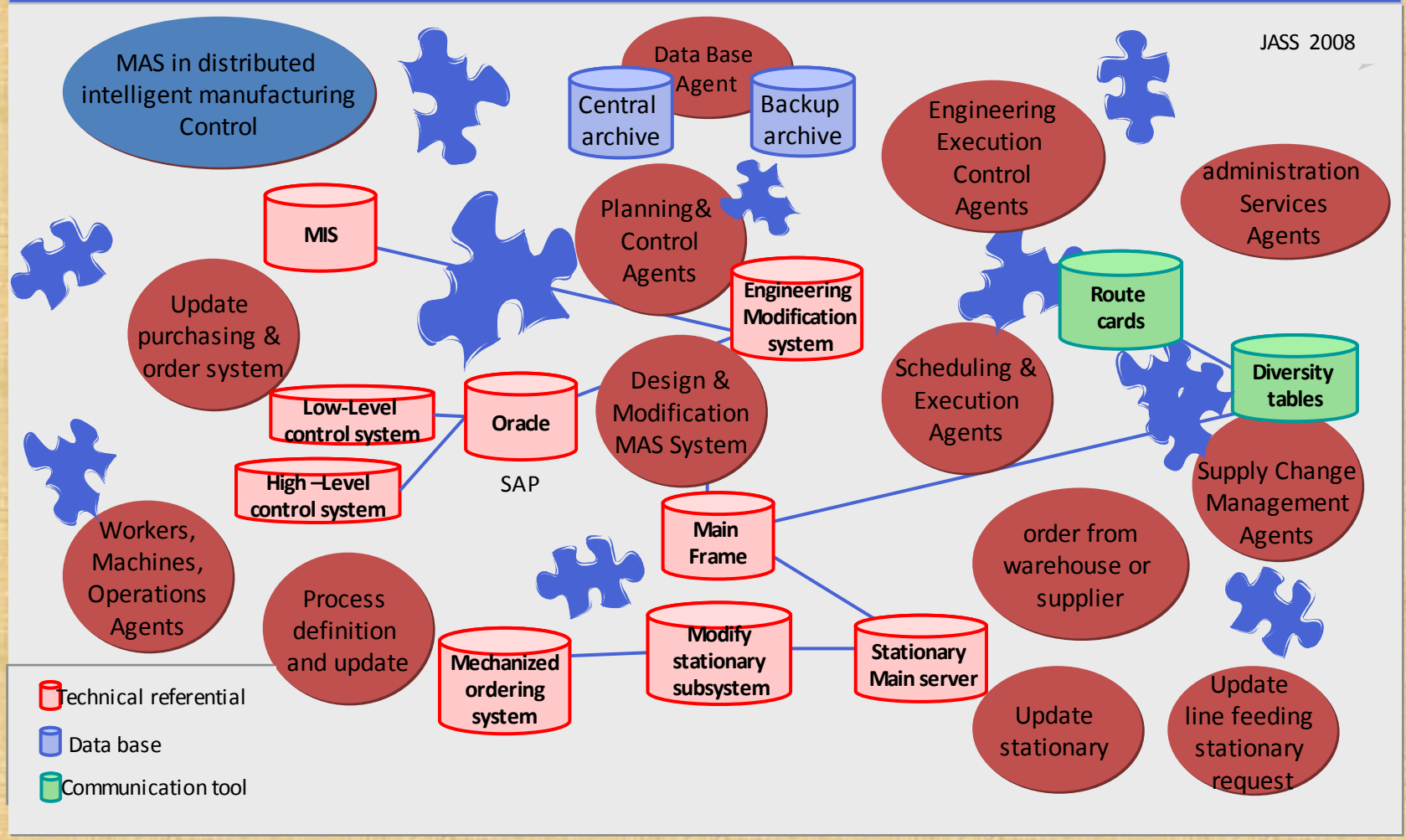
In distributed intelligent manufacturing systems, agents can be used to

- **Encapsulate existing software systems to resolve legacy problems and integrate manufacturing enterprises**
- **Represent manufacturing resources**
- **Model special services in manufacturing systems,**
- **Incorporate a whole scheduler or planner and control**

Agent base approach in manufacturing control

ILLUSTRATIVE

Modification system is supported by MAS in distributed intelligent environment via networks and IT systems…



Conclusion

Conclusion

Agent Base Approach for Intelligent Distribution Control Systems – **Prospects**

Currently, there is an interest from both **industry and universities into design methods for embedded systems**. The main focus is **co-design** of both **software and hardware aspects of a systems**. Often, these embedded systems are complex systems, as they consist of multiple functional components on both the software and hardware level.

The concept of an agent should be used more in these design methods.

Conclusion

Suggestions for research

Suggestions for future research- Framework-related

The most exist agent-based framework is aimed at developing **discrete-time controllers** that run on **single processors.** In order to have a more general framework, the following options for future research are suggested:

- **Discrete-event system approach**

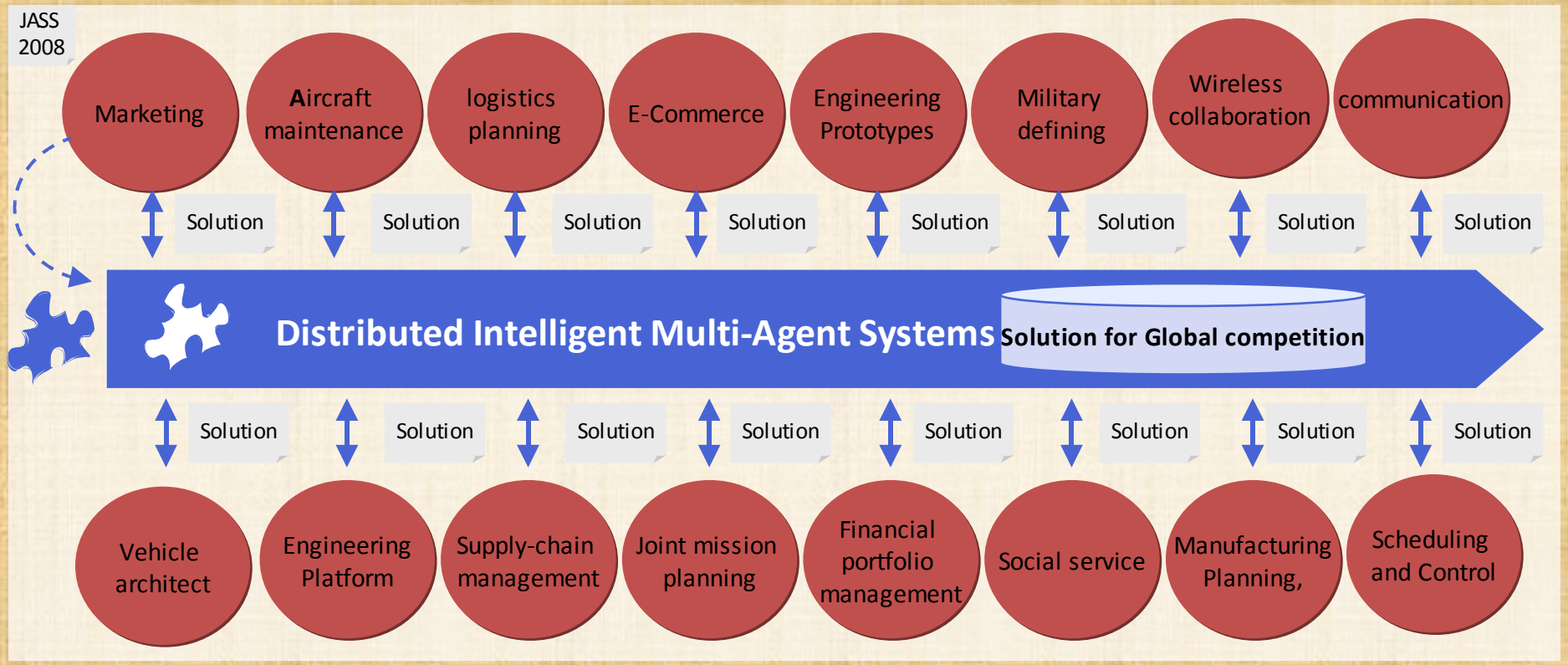
control systems may contain sensors and actuators that operate on an **event-driven basis**.
In order to build such control systems, a discrete time approach is not sufficient, or even feasible.
A discrete-event system approach may provide the theoretical basis for developing a design framework in which both periodic and a periodic components can be specified.

- **Heterogeneous hardware**

To avoid the difficulties of a multiple (heterogeneous) processor system typically **exist framework run on a single processor .A multiple processor system requires the distribution of the software components over the processors.**

Conclusion

The ideal Agent base system is a new Global Competition solution in dynamic environment.



Conclusion

Agent Base Approach for Intelligent Distribution Control Systems

Overall conclusion

The agent-based design **helps the designer to solve complex control problems**, by **offering** concepts to **structure the problem** and to **organize the solution**.

It is essential to create a control system for the economical operation.

We discussed that **Intelligent Multi-Agent Theory** can create an intelligent control system for **Dynamic environment.**

New intelligent control systems **are very different from previous control approaches**. It combines **optimized computation** with **automatic control** and introduces a multi-agent, intelligent control system to improve **total efficiency**.

In new **intelligent distribution control system agent base system** , **agents with different objectives** all **work together** with mutual coordination and consultation **to improve operations** .

Combining multi-agent theory and optimization to create a more intelligent control system will **greatly improve efficiency**, **increasing the Reliability** of Control Systems with Agent Technology and **reduce the operating costs**.

References

1	Introduction and Concept definition
2	Overview MAS technology
3	Agent base approach in Social Services
4	Agent base approach in manufacturing control
5	Conclusion
References	

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Thank you for attention!
Спасибо за внимание!
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