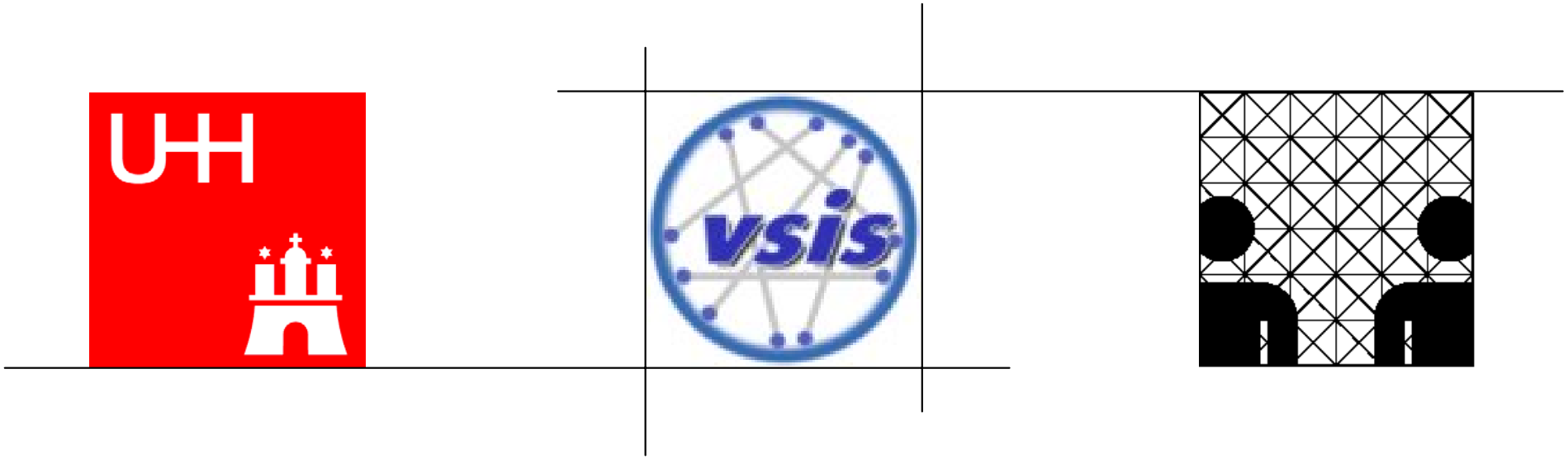

Unifying Agent and Component Concepts - Jadex Active Components

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Overview

- **Motivation for Active Components**
- Active Component Concepts
- Active Components Platform & Example
- Summary and Outlook

Requirements

- Building distributed systems is hard due to several inherent characteristics such as
  - Message communication
  - Concurrency
  - Non-functional aspects like scalability, fault tolerance

- Current technology trends further increase the demand for novel software technical concepts
  - Increased hardware concurrency
  - Delegation of tasks to computers
  - …

- We want the software paradigm to cope with most of the complexities
  - Exhibit different kinds of entity behavior
  - Having rich interaction styles
  - Can act on their own
  - Support non-functional characteristics

Paradigm Comparison (1)

Software agents:

- Autonomous, reactive, proactive, social, (mentalistic notions)
- Communication based on speech acts/protocols

Active objects (coming from actors):

- Objects that decouple caller from callee
- Method-based interaction

Software components:

- Passive but composable entities managed by an infrastructure
- Communication message and call-based

Paradigm Comparison (2)

Structure

- Support software engineering principles (hierarchical, modularization)
- Exhibit different kinds of entity behavior (internal architecture)

Interaction:

- Having rich interaction styles (message based, method call)

Execution:

- Can act on their own (autonomy)
- Support non-functional characteristics (management infrastructure)

	structure		**interaction**		**execution**	
	hierarchical	**internal architecture**	**message based**	**method call**	**autonomous**	**managed**
agents	partially	yes	yes	no	yes	partially
active objects	no	no	no	yes	yes	no
components	yes	no	yes	yes	no	yes

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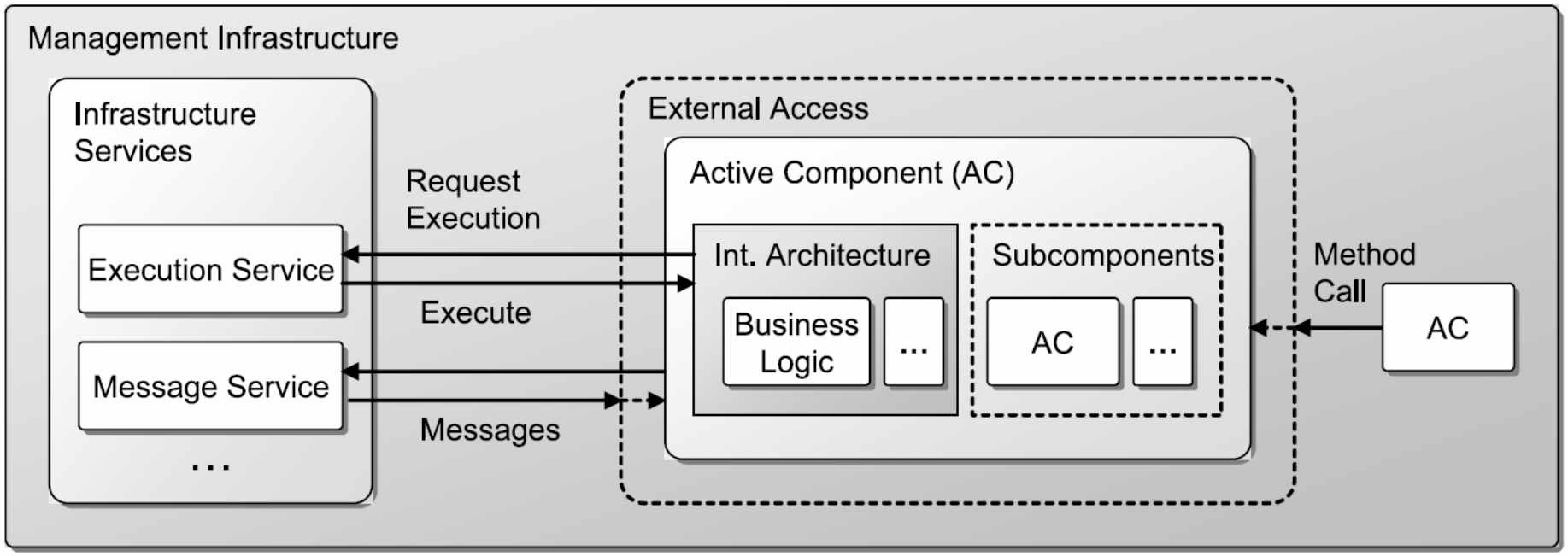
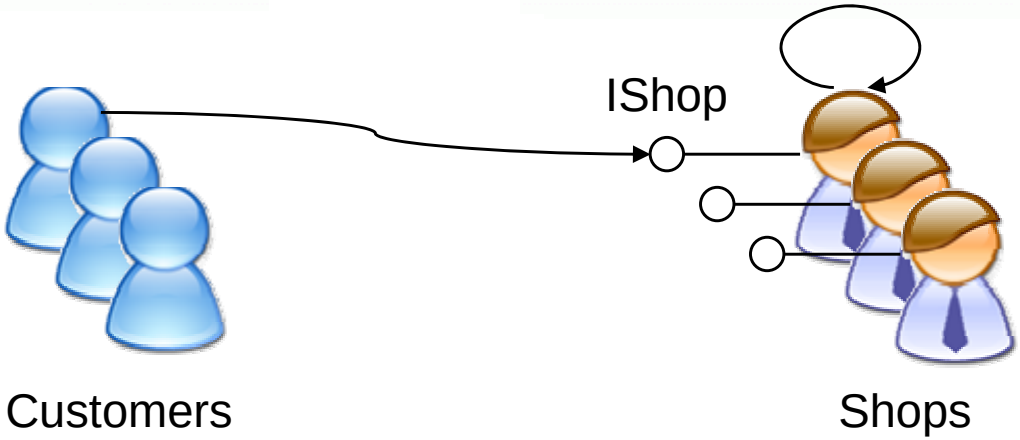
Active Component Foundations



Definition: "An active component is an autonomous, managed and possibly hierarchical software entity that is capable of interacting with other active components in different modes including message passing and method calls."

- Invocation styles like agents and active objects
- Rich behavior styles like agent architectures or workflows
- Management infrastructure and composability of components

Invocation Style: Shop Example



Scenario

- Shops have an inventory and offer items for certain prices
- Customers can search stores and buy items in them

System design

- Shops define an interface IShop that allows customers to get the catalog of offered items and buy them
- Customers search for IShop providers and use the interface to issue buy orders
- The call is decoupled at interface level and executed asychronously in the callee (external access)

Shop Example Interface

```
public interface IShop
{
    public String getName();

    public IFuture buyItem(String item, double price);

    public IFuture getCatalog();
}
```

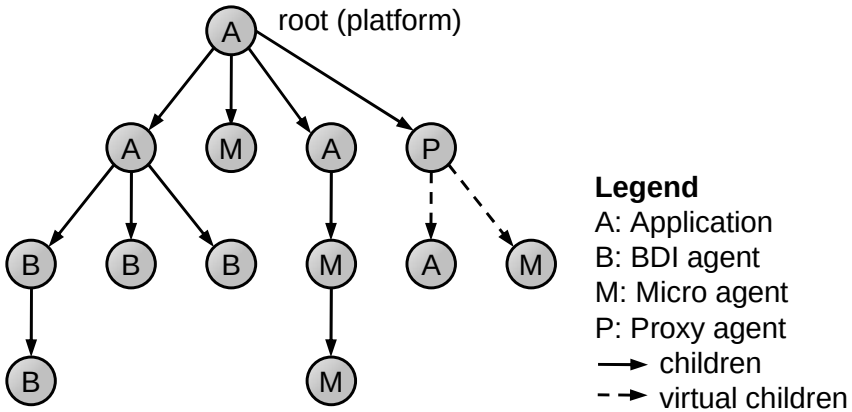
- Simple shop interface offers methods for getting the shop name, buying an item and getting the catalog
- getName() is allowed as it is considered as constant, i.e. the value will be cached
- IFuture represents a value that is immediately returned but may provide the result in future

Behavior Style: Internal Architecture

- Many different internal agent architectures exist
  - reactive (e.g. Subsumption, Tasks)
  - deliberative (e.g. IRMA)
  - hybrid (e.g. BDI)
- No one-fits-all solution
  - Simple architectures for simple problems
  - Complex architectures for complex problems
- Active components widen the spectrum
  - Agent architectures: BDI, Micro, (Task)
  - Workflow engines: BPMN, GPMN
  - Applications (management of components and non-component fuctionality)

Composability: Component Hierarchies

- Active components are contained in a tree-like structure, whereby the platform component is the root
- Typically this hierarchy reflects the creation relationships
  - A component can start another component as its subcomponent
  - The hierarchy does not enforce any policy on components
- Component hierarchy is helpful for
  - Applying commands on subtrees of components (e.g. terminating, suspending)
  - Including remote platforms using proxy components



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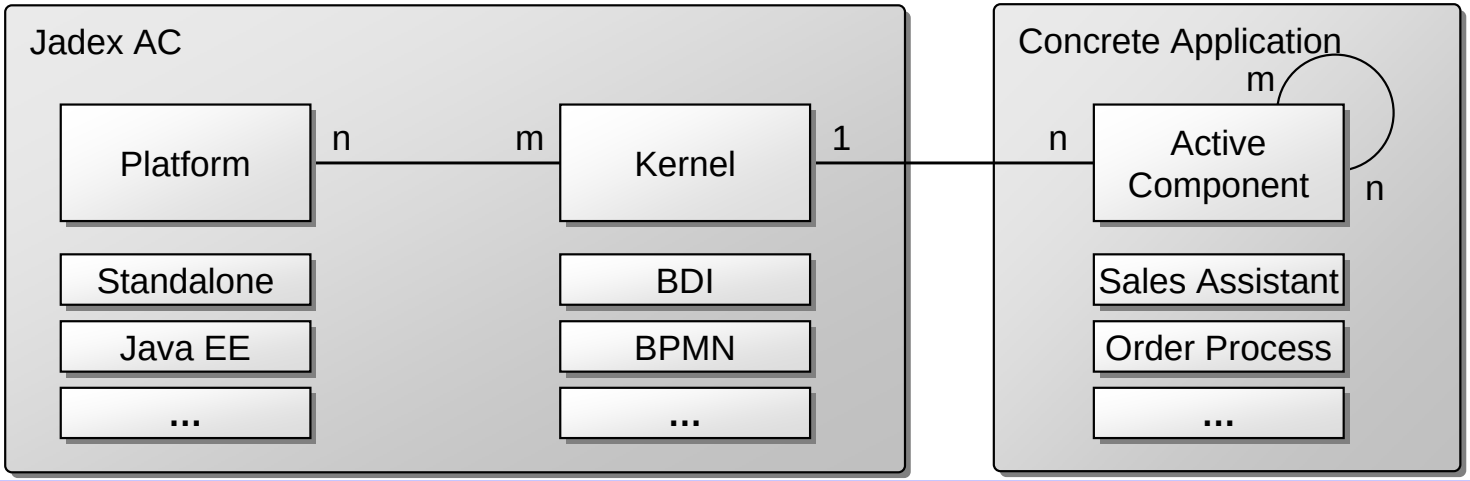
Jadex V2 Architecture Goals & Concepts

Design Goals:

- Platform can execute different kinds of components
- Component kernels should be enabled to run on different platforms
- Applications should be platform independent
- Applications should be composable from arbitrary component types (heterogeneous applications)

Platform: "A platform is the management infrastructure for components, which is responsible for their execution as well as for providing administration capabilities like a messaging system or a component service registry."

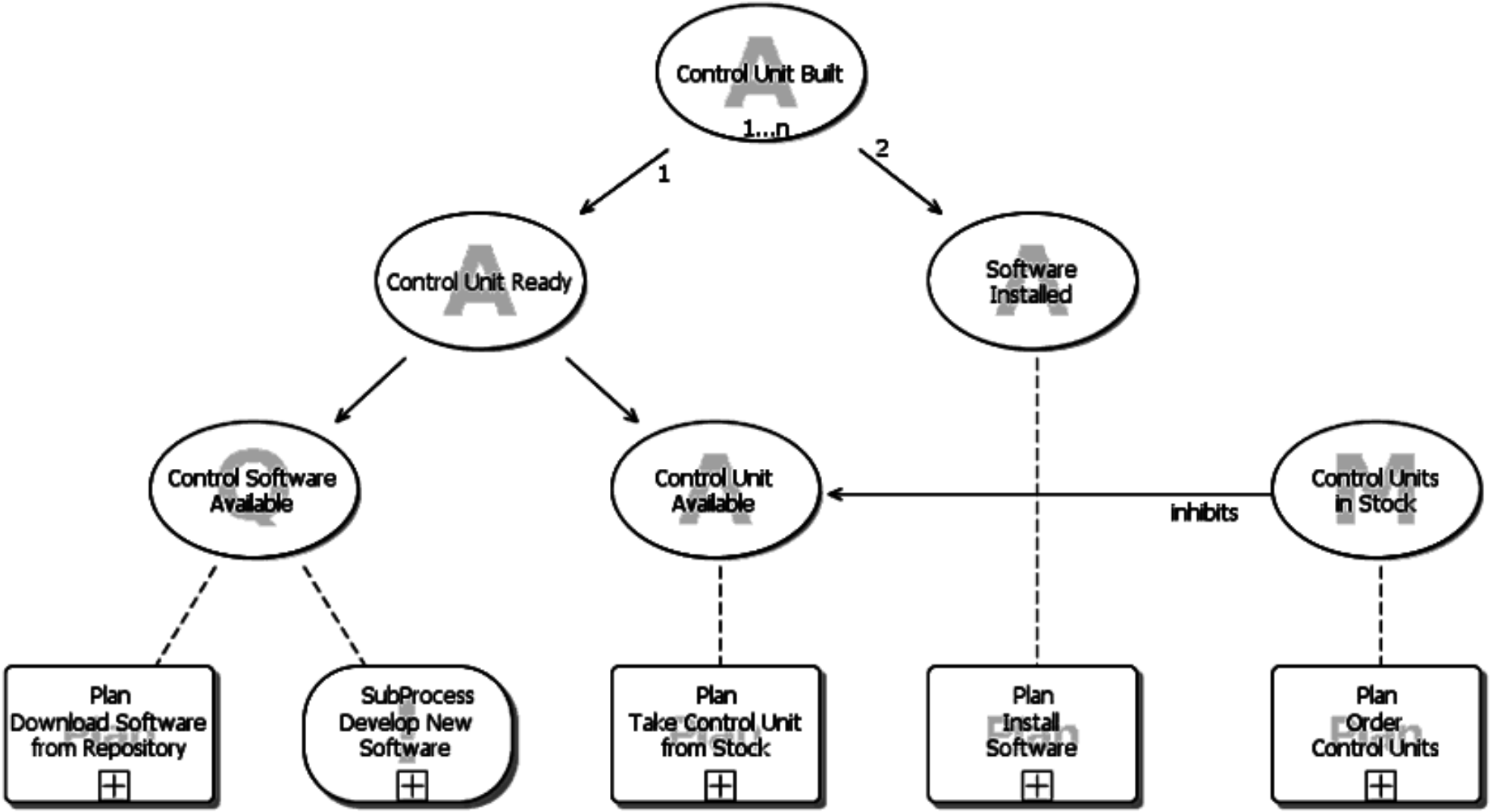
Kernel: "A kernel encapsulates the internal behavior definition of a specific active component type."



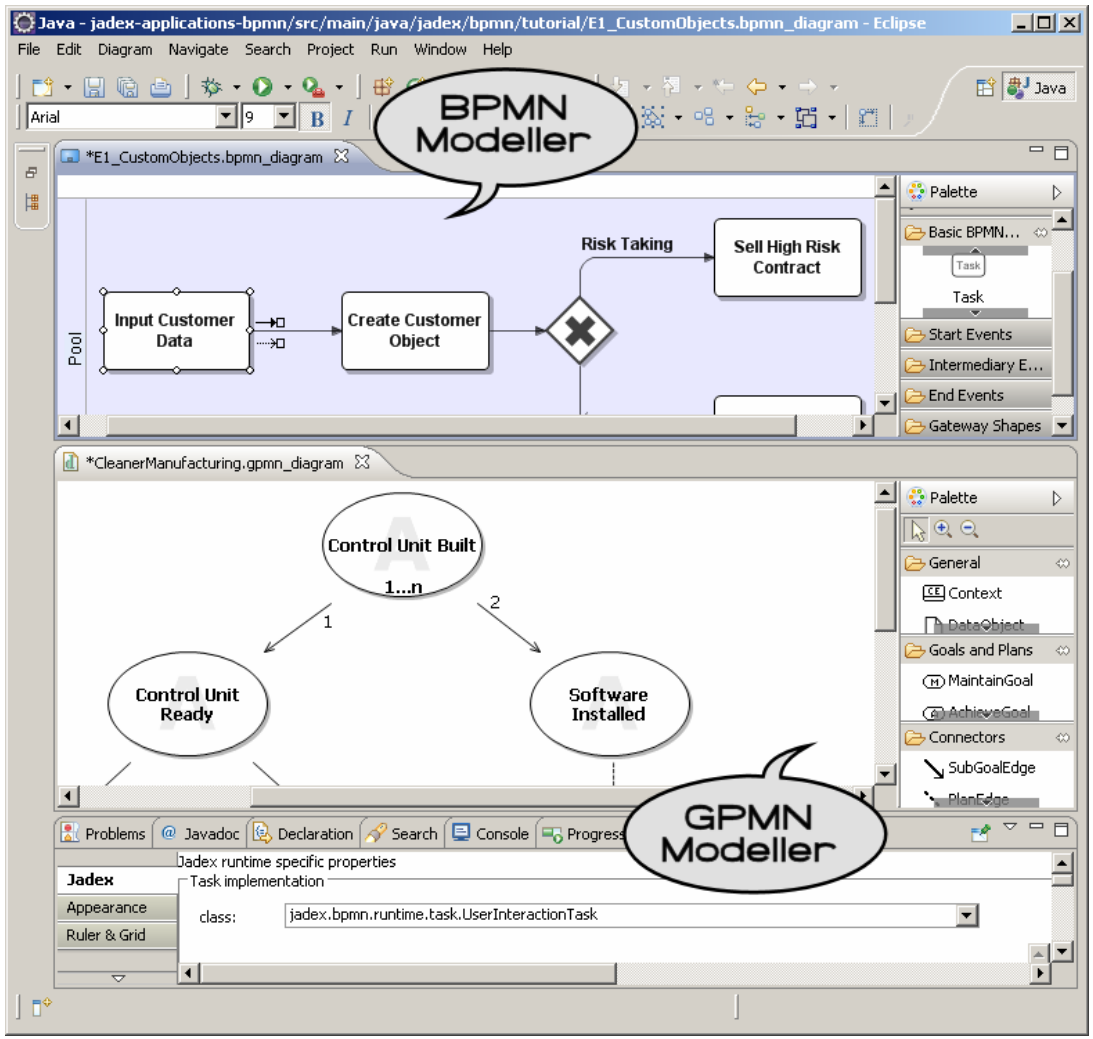
GPMN Workflows

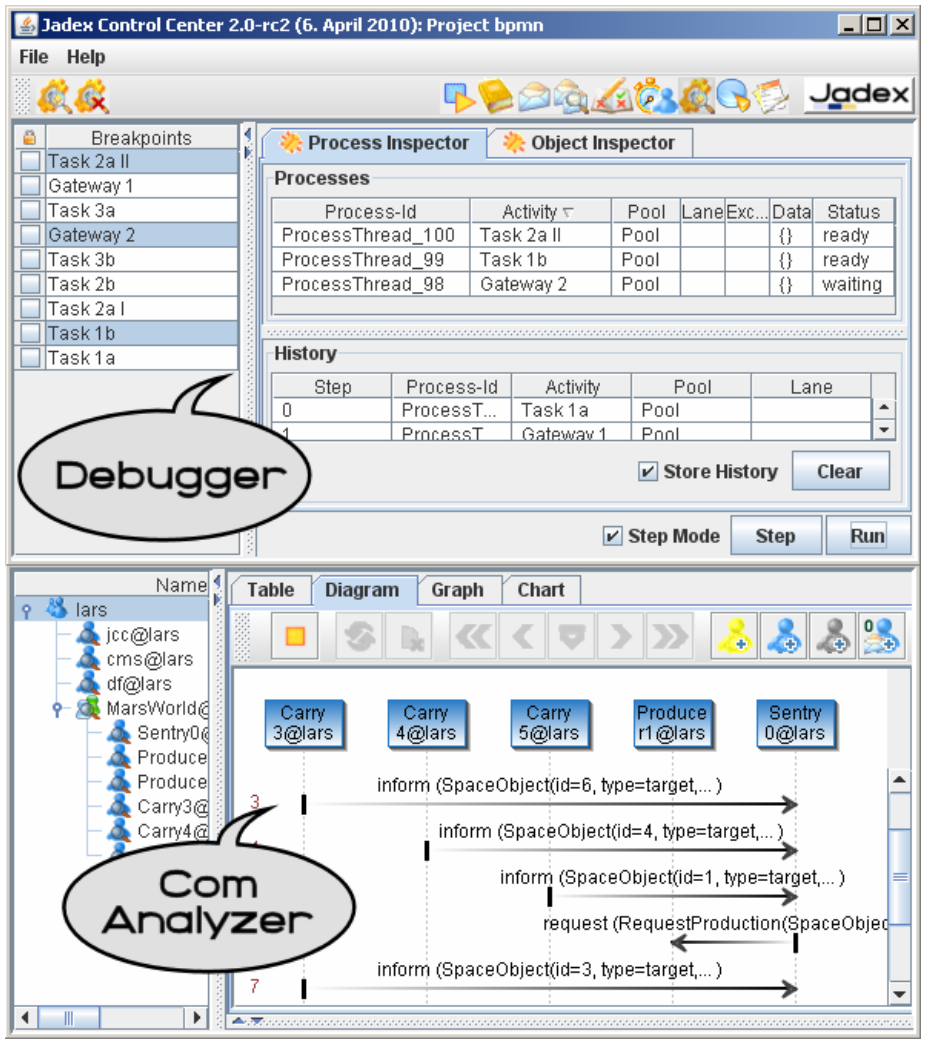
- GPMN = Goal Process Modeling Notation
- Is based on research of Daimler AG and currently topic of a technology transfer project between the University of Hamburg and Daimler AG
- Research focus is the development of flexible and agile workflow concepts by employing agent technology concepts
- GPMN workflows are executed via model transformation as normal BDI agents
- GPMN workflows can be modeled via an eclipse-based editor similar to the BPMN version
- Behavior concepts
  - GPMN workflows consist of a goal hierarchy
  - The leaves of this hierarchy are concrete BPMN plans

GPMN Workflow Example



Modeling and Runtime Tools





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Summary and Outlook

Active components as step beyond purely message-based agents aiming at easier pragmatic application construction

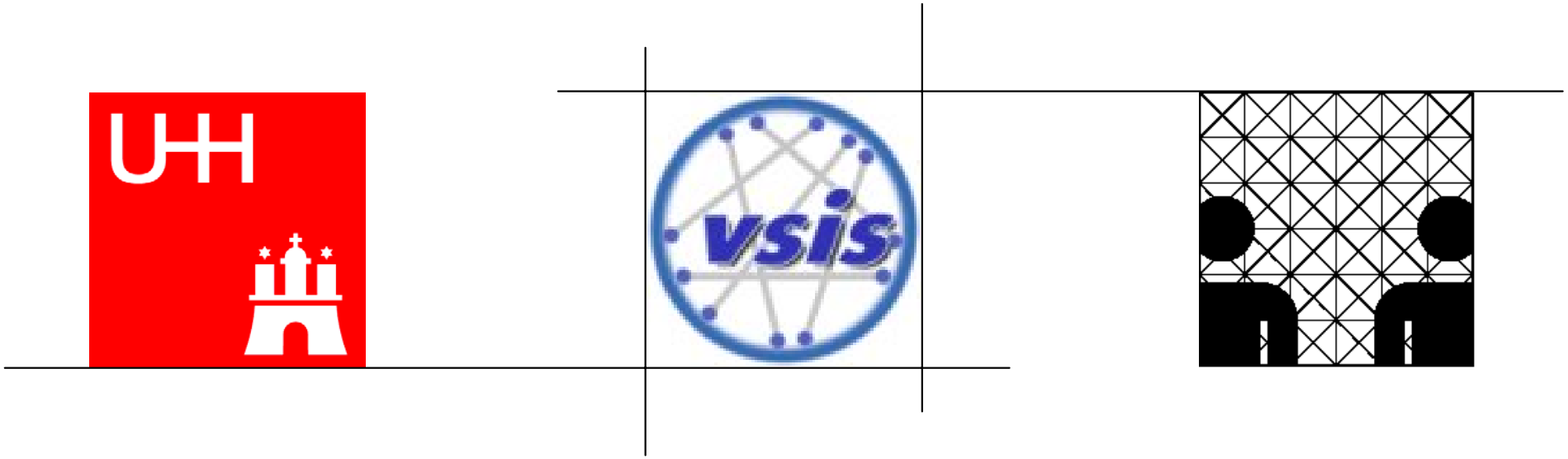
- Simplify agent concepts
- Enrich them with further concepts from active objects, and software components

Active components

- Support different invocation styles
- May be realized using different internal architectures
- Are hierarchical and managed entities

Jadex AC Platform with modeling and runtime tools:
http://jadex-agents.informatik.uni-hamburg.de

Future work: embracing concepts from the services area (SOA)



Thank You!

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