Toolchain - Introduction
Agent.Workbench + Eclipse + JADE

Agent Summer School - 15.07.2022

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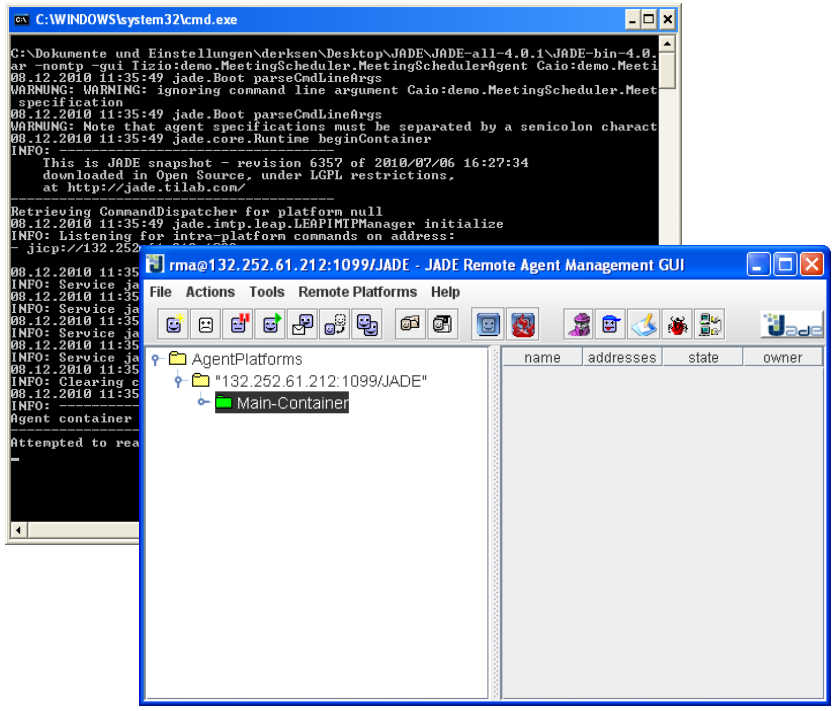
Outline

- **Agent.Workbench (Runtime Environment + Library)**
  - Why did we develop Agent.Workbench? (AWB)? What it is?
  - What can you do with AWB? - Some example agent systems
- **Eclipse (IDE - Integrated Development Environment for Java)**
  - Some basics for the usage (Perspectives, Projects & Target Platform)
  - Create your first Plug-in Project
- **JADE (Library + Agent Runtime Environment)**
  - Platform structure, Agent Life Cycle
  - Base Classes, Behaviours
  - Messaging, Interaction Protocols

Agent.Workbench

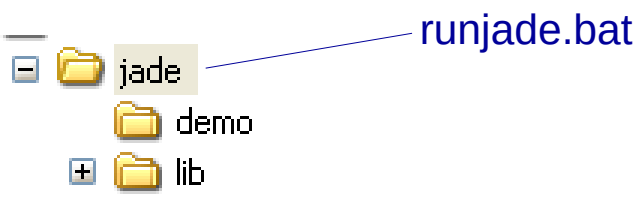
Why (Part 1): Starting JADE-Agents (the original approach)



Start using command line (an example):

java -classpath .;.\lib\jade.jar; .\lib\commons-codec\commons-codec-1.3.jar; jade.Boot -gui -services mas.service.SimulationService;jade.core.event.NotificationService;jade.core.mobility.AgentMobilityService;

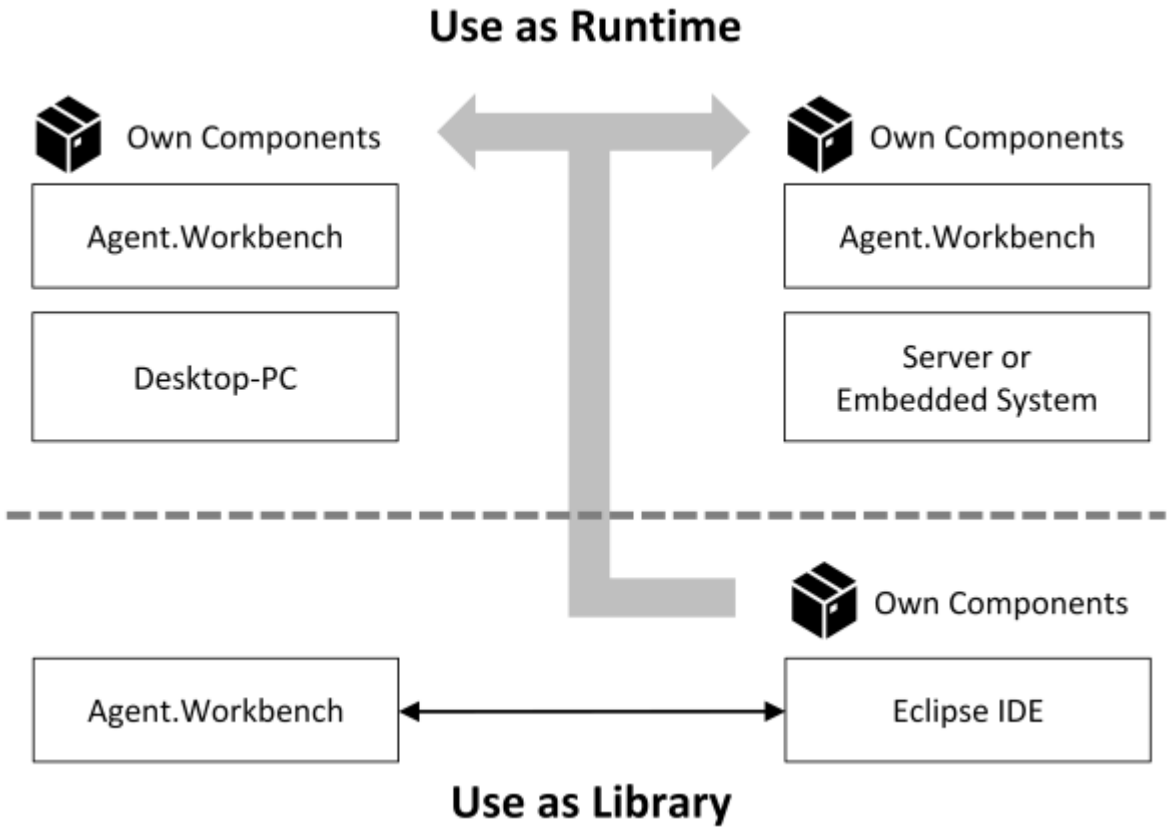
(„administratorsguide.pdf “, Page 4 ff.



Why (Part 2): Some things were missing

- **Development**
  - Beside the JADE library, what types of libraries are required (e.g. for database connections and other)?
  - How to have an extendible base for nearly any agent application?
- **Configuration**
  - How to easily configure the JADE agent platform?
  - How to visually configure agents?
- **Execution**
  - How to observe the agents and systems behaviour (especially on distributed systems)?
- **Shutdown**
  - How to proper shutdown an agent system (especially on distributed systems)?

What it is


Use as Runtime
Own Components
Agent.Workbench
Desktop-PC
Own Components
Agent.Workbench
Server or
Embedded System
Own Components
Agent.Workbench
Eclipse IDE
Use as Library

Structural Overview to Agent.Workbench

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Handling Agent Projects with different setups

Providing a shared environment for agents (e.g., in simulations)

Connect to Databases

Use & Provide REST-Services

Core	Environment Model	Databases	REST
JADE	JUNG	Hibernate	Jetty
OSHI	OSM	MariaDB	Jersey
JFreeChart		PostgresSQL	Jackson
		MariaDB	Swagger

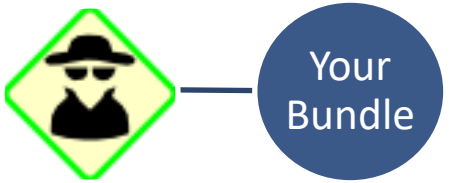
Customize the UI or extend AWB by writing:
- **OSGI-bundles with own agents**
- **an AWB - Plugin**
- **implement OSGI-Services**
- **connect to databases**
- **provide own REST-Services**
- **…**

Agent.Workbench
OSGI – Framework (Eclipse RCP)
Java
OS (Linux / Windows / Mac OS)

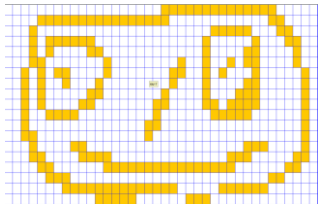
Have look on some example agent systems

- Ping-Pong: Observe the Messaging of two agents

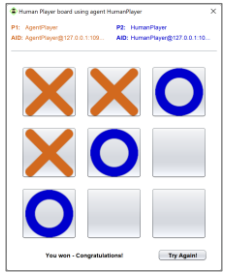
- Plugin-Example: Extend the AWB - UI



- Game of Life: A Cellular Automata Game



- Tic Tac Toe: The challenge of the day!



- Peak - Example: An electrical distribution grid with Energy-Agents

Some Links

- **Agent.Workbench on GitHub:**
  https://github.com/EnFlexIT/AgentWorkbench
- **Agent.Workbench on GitBook:**
  https://enflexit.gitbook.io/agent-workbench/
- **JADE: Java Agent DEvelopment Framework**
  https://jade.tilab.com

The Eclipse IDE for Enterprise Java and Web Developers

Have look to Eclipse

Some Links

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- **Define the Target Platform for development “… based on a AWB Installation”:**
  https://enflexit.gitbook.io/agent-workbench/development/basic-steps/define-a-target-platform/target-platform-based-on-awb-installation
- **Create an agent project:**
  https://enflexit.gitbook.io/agent-workbench/development/basic-steps/create-a-project-plugin
- **Starting AWB from Eclipse**
  https://enflexit.gitbook.io/agent-workbench/development/basic-steps/starting-awb-from-eclipse


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JADE
Java Agent DEvelopment Framework

Why (Part 2): Some things were missing

- **Development**
  - Beside the JADE library, what types of libraries are required (e.g. for database connections and other)?
  - How to have an extendible base for nearly any agent application?
- **Configuration**
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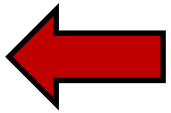
- **Execution** 
  - How to observe the agents and systems behaviour (especially on distributed systems)?
- **Shutdown**
  - How to proper shutdown an agent system (especially on distributed systems)?

The JADE – Platform Execution

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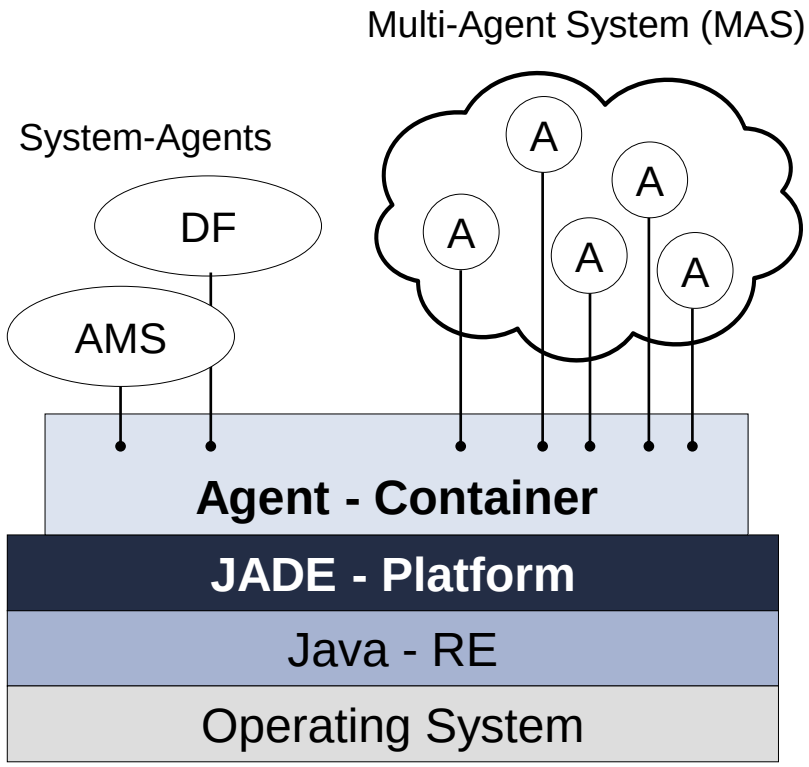
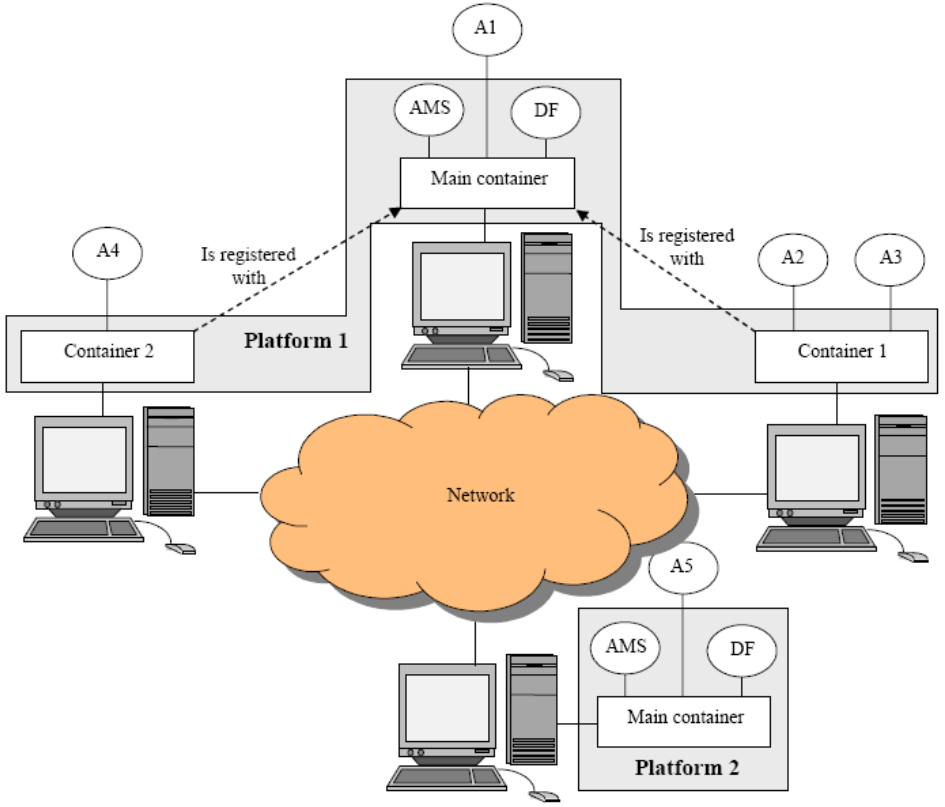
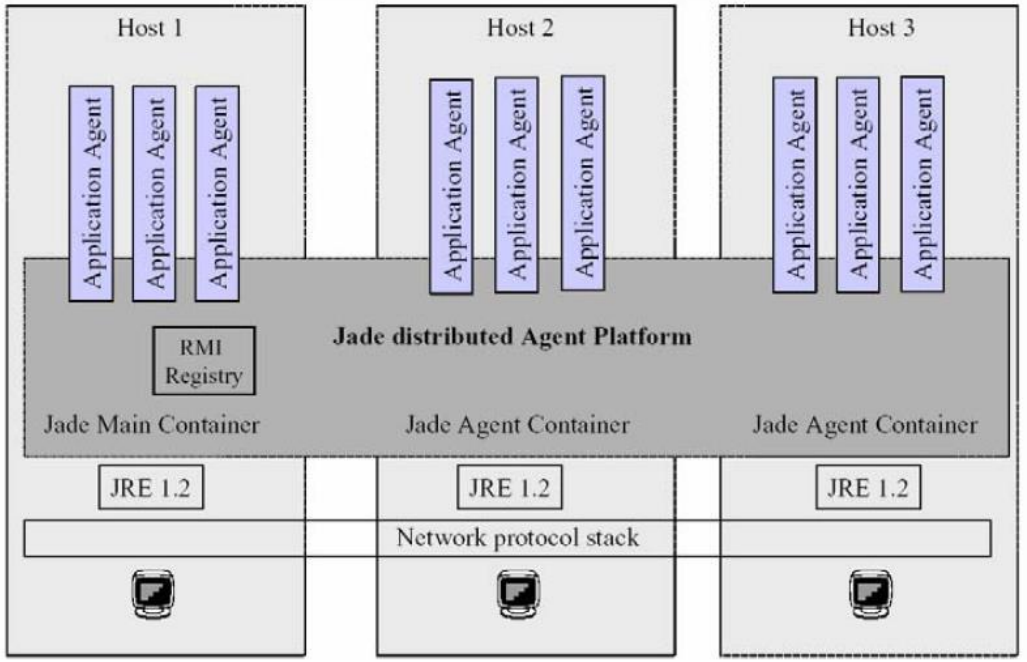
Platform and Container



Agent Distribution





JADE - System-Agenten

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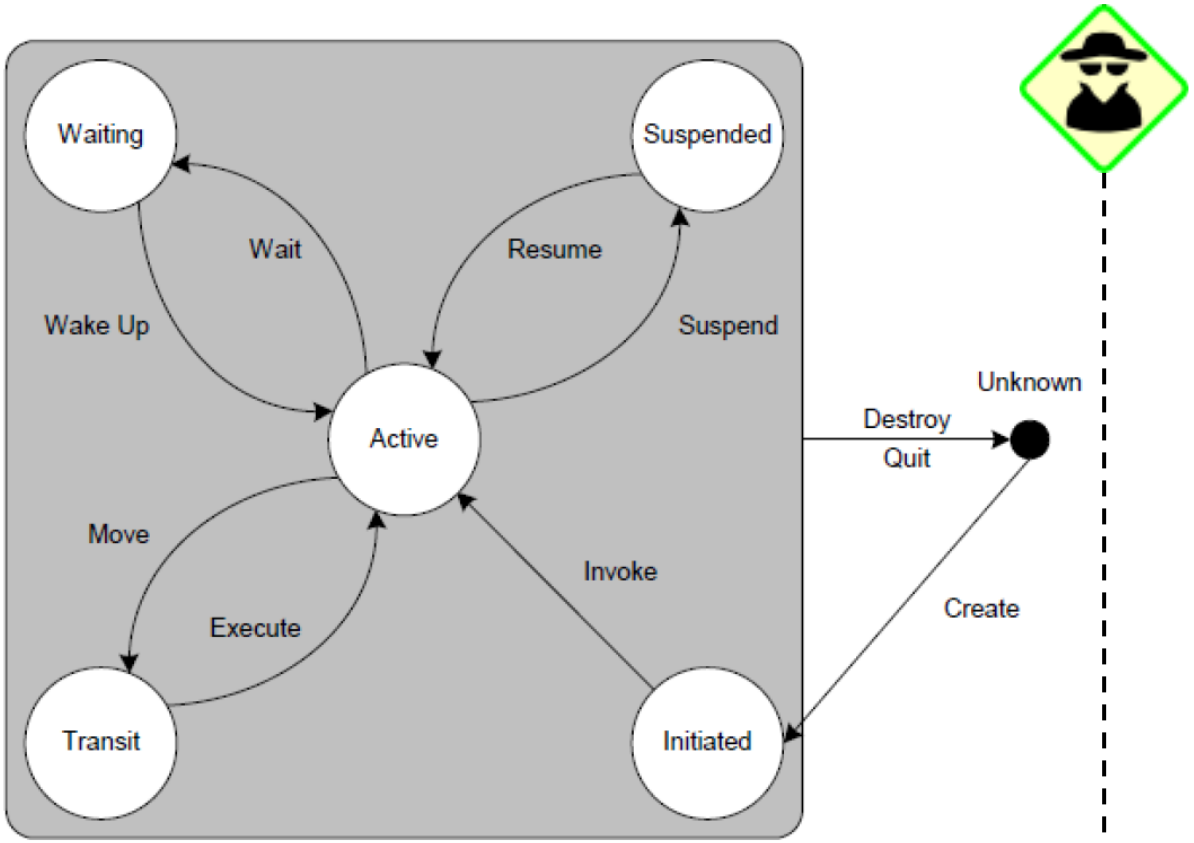
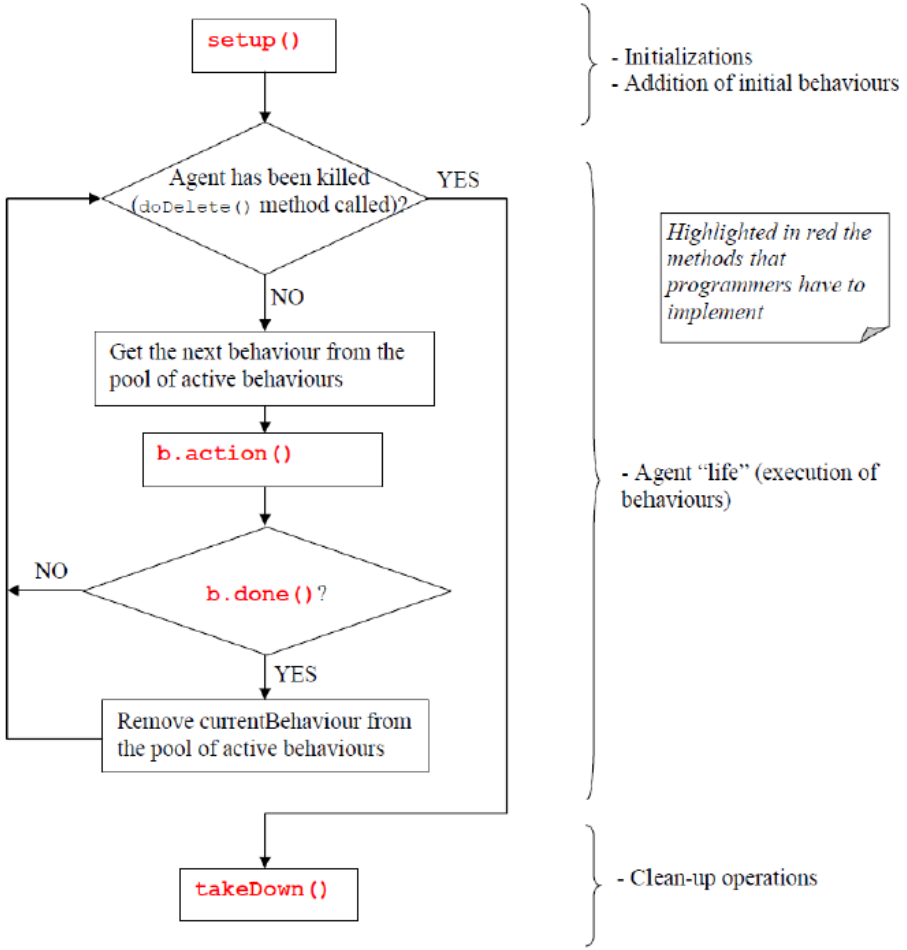
- **RMA (Remote Management Agent):** a graphical user interface for the platform management. Basically the RMA can be used to start further JADE tooling agents (described in the following).
- **Introspector:** an agent that allows to monitor an agents state (e.g., its life cycle state) with respect to currently available or executed behaviours
- **Sniffer:** represents an agent that allows to monitor message sending between agents. This will be presented similar to an UML sequence diagram. Very useful to observe communication between multiple agents!
- **Dummy Agent:** is a Debugging- and Test-Tool for ACL-Messages. Then usage of this agent enables to create and send ACL-Messages to specific agents.
- **Directory Facilitator (DF):** the DF and its graphical representation enables to monitor the “Yellow Pages Service that can be started as an additional JADE-Service
- **LogManager**: Enables to configure the log level of the internal Logging-System

An Agents Life Cycle



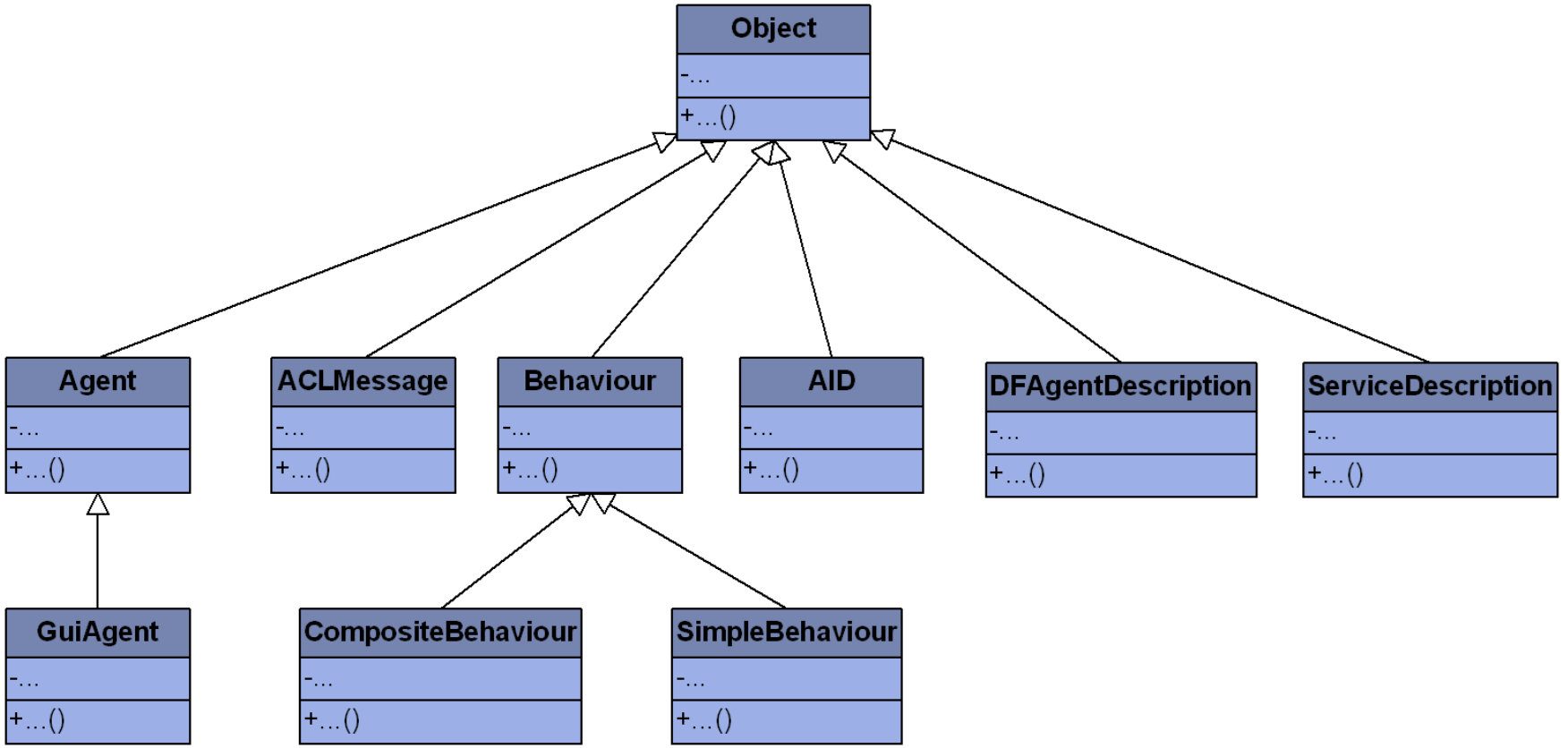


The beginning of an agent development

Creating a JADE agent is as simple as defining a class extending the `jade.core.Agent` class and implementing the `setup()` method as shown in the code below.

```
import jade.core.Agent;

public class BookBuyerAgent extends Agent {
  protected void setup() {
    // Printout a welcome message
    System.out.println("Hallo! Buyer-agent "+getAID().getName()+" is ready.");
  }
}
```

Some important JADE classes



A simple Agent example


```
import jade.core.Agent; import jade.core.behaviours.*;

public class Simple0 extends Agent {
    protected void setup() {
        addBehaviour( new B1( this ) );
    }
}

private class B1 extends SimpleBehaviour {
    private boolean finished = false;

    public B1(Agent agent) {
        super(agent);
    }

    public void action() {
        System.out.println( "Hello World! My name is "+ myAgent.getLocalName());
    }
    public boolean done() {
        return finished;
    }

} //End class B1
```

Behaviours and their execution

- One agent is a single Java-Thread in which the added behaviours are executed sequentially
- By adding a behaviour to an agent, the behaviour is placed in the agents internal behaviour queue.
- The agents internal scheduler takes care of the execution of that behaviours

- Side Note: It is possible to add / execute another Java-Thread for an agent by using so-called ***ThreadedBehaviour***. Consequently, an agent can also act as a manager of several parallel control processes

Behaviour Overview I

Primitive Behaviours

- **SimpleBehaviour:** an basic class that you can extend in various ways and which often turns out to be the best solution when other promising Behaviours are found to have some hidden quirks
- **CyclicBehaviour:** This behaviour stays active as long as its agent is alive and will be called repeatedly after every event. Quite useful to handle message reception.
  - **TickerBehaviour**: a cyclic behaviour which periodically executes some user-defined piece of code
- **OneShotBehaviour:** This behaviour executes ONCE and dies....
  Not really that useful since the *one* shot may be triggered at the wrong time.
  - **WakerBehaviour**: which executes some user code once at a specificized time
  - **ReceiverBehaviour**: which triggers when a given type of message is received (or a timeout expires).

Behaviour Overview II

Primitive Behaviours

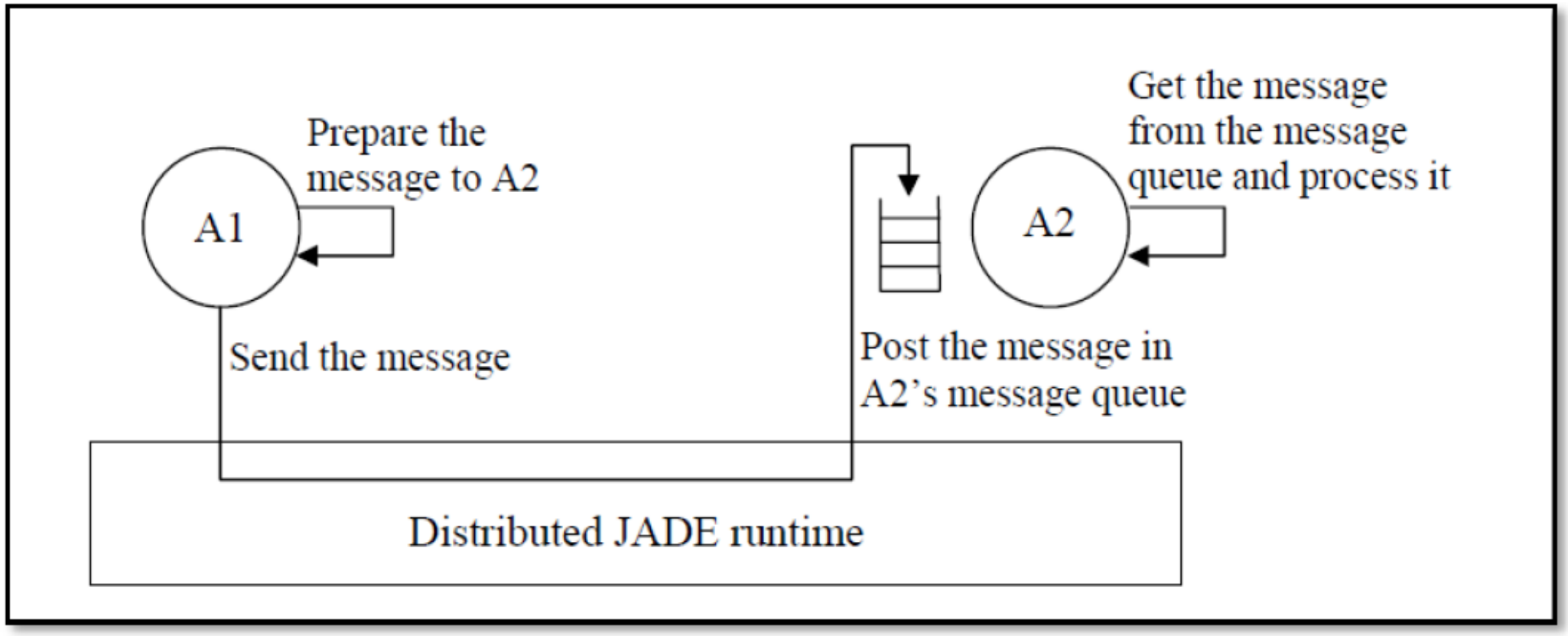
- **Note:** *TickerBehaviour*, *WakerBehaviour* and *ReceiverBehaviour* are conceptually subclasses of Cyclic and OneShot classes, but they are implemented as extensions of *SimpleBehaviour* and *Behaviour*

Composite Behaviours

- **ParallelBehaviour:** controls a set of children behaviours that execute in parallel. The important thing is the termination condition: we can specify that the group terminates when ALL children are done, N children are done or ANY child is done.

- **SequentialBehaviour:** this behaviour executes its children behaviours one after the other and terminates when the last child has ended.

Agent Communication



Send and receive Messages

Send a simple Message

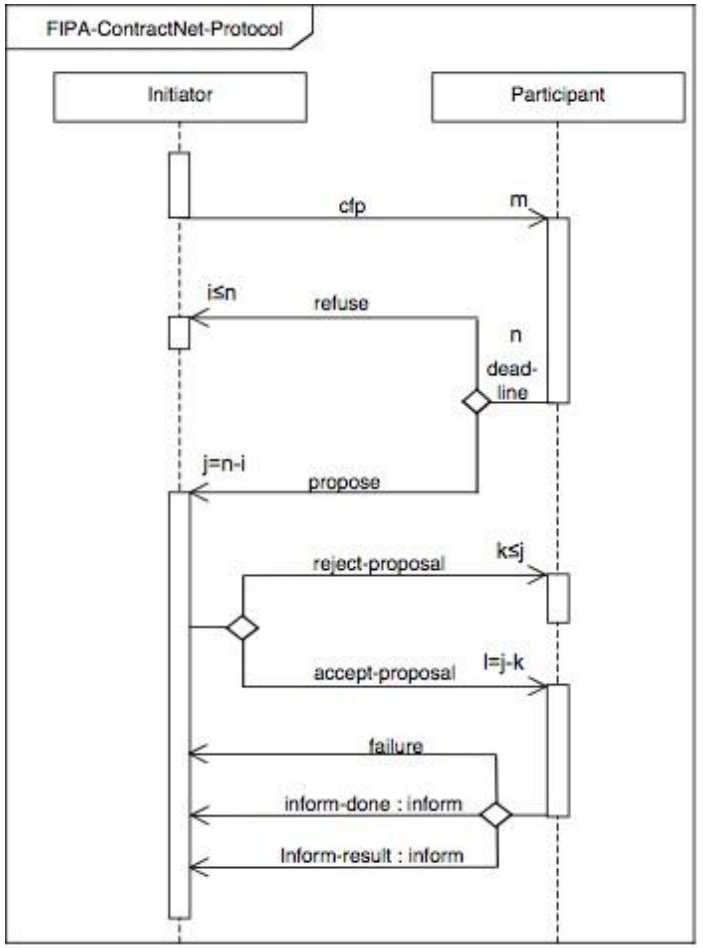
```
// --- Set receiver ------------------------------
AID receiver = new AID("pong", AID.ISLOCALNAME);

// --- Create simple message ---------------------
ACLMessage msg = new ACLMessage(ACLMessage.INFORM);
msg.setSender(myAgent.getAID());
msg.addReceiver(receiver);
msg.setContent("ping");
myAgent.send(msg);
```

see AWB - Ping Pong example on Github!

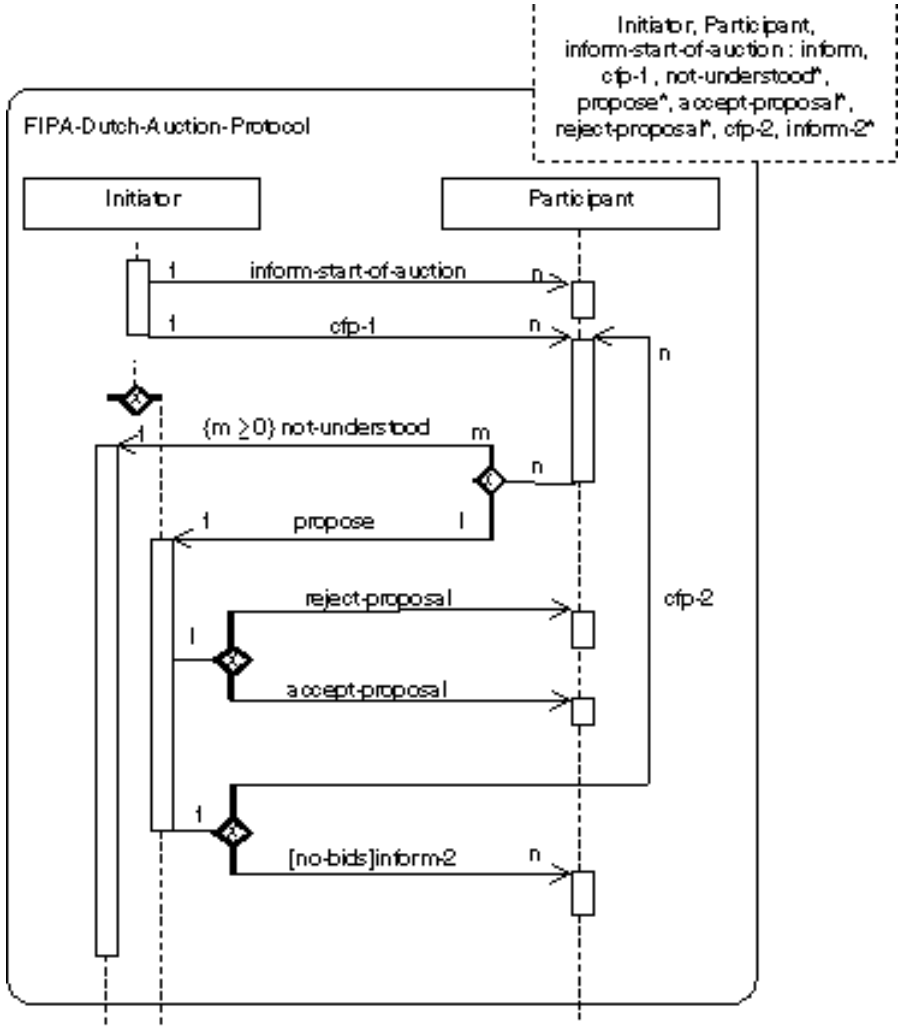
Receive a Message

```
class ReceiveBehaviour extends CyclicBehaviour {

  public void action() {

    ACLMessage msg = myAgent.receive();
    if (msg!=null) {
      // --- work on the delivered message -------
-
      => ...

    } else {
      // --- wait for the next incoming message --
-
      block();
    }
  }
}
```

Interaction Protocols available with JADE

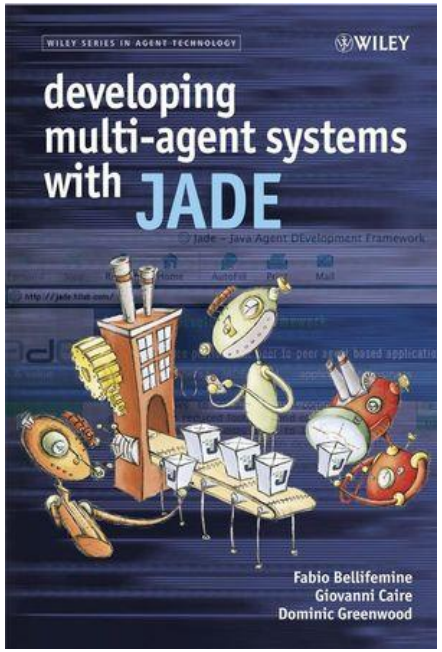


For further example protocols, see (old) FIPA - Site http://www.fipa.org



Some Links

- **JADE – Book**



- **JADE - Site:**
  https://jade.tilab.com/
- **FIPA - Site Create an agent project:**
  http://www.fipa.org
- **JADE - Repository on GitHub (by EnFlex.IT):**
  https://github.com/EnFlexIT/JADE

Thanks ! - Questions?

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