

Laboratory assignment

Component 1

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1 JADE Overview

JADE (Java Agent Development Framework) is a widely used software framework designed for developing multi-agent systems (MAS). It provides a powerful set of tools to build, deploy, and manage intelligent agents within a distributed environment [BPR01]. It is written in the Java programming language and offers a comprehensive platform for creating agent-based applications with built-in support for various essential agent functionalities [BPR01]. The framework was developed by the Telecommunications and Informatics Laboratory (Telcom Italia Lab) at the Department of Computer Science of the University of Parma, Italy [BEL00].

1.1 Programming language

JADE is developed in Java, which ensures portability and scalability across various platforms. Java's object-oriented design enables the creation of modular agents and provides a wide range of libraries for data management, networking, and concurrent programming. [BPR01].

1.2 Agent design

JADE supports designing agents that can act autonomously, make decisions, and communicate with other agents in the system [BPR01]. Every agent in JADE is an independent entity with its own lifecycle, behaviors, and properties [BPR01]. Agents may behave in different ways, which are implemented as classes and can be added or removed dynamically during their lifecycle [BPR01].

Agents can communicate and collaborate with other agents using message-based communication, which is a core feature of the framework [BEL00].

1.3 Concurrency and Parallel Execution

JADE has built-in features that allow agents to operate both concurrently and in parallel [BEL00]. Each agent has its own thread of execution, enabling the system to handle multiple agents at the same time [BEL00]. The framework efficiently manages the scheduling of agents, making real-time, distributed decision-making in multi-agent environments possible [BEL00].

JADE's Agent Platform ensures that each agent operates independently, while still being able to collaborate with other agents when necessary, making it suitable for highly dynamic and scalable environments [BPR01].

1.4 Agent Communication

JADE integrates a FIPA-compliant Agent Communication Language (ACL), which is a standard for inter-agent communication in MAS [Chi01]. Through ACL, agents can send and

receive messages that include requests, queries, responses, and other types of communication, making it possible for agents to share knowledge and coordinate their actions [Chi01].

In order to ensure reliable and asynchronous communication over a variety of transport protocols, such as TCP/IP, HTTP, and others, JADE provides a Message Transport Service that facilitates message exchange between agents [BPR01].

The framework includes support for ontologies (shared vocabularies) that allow agents to correctly interpret and understand messages [BPR01].

1.5 Agent Management

JADE has a robust agent management system that encapsulates services for agent creation, registration, and lifecycle management [BPR01]. The Agent Container serves as the execution environment for agents, while the Agent Platform manages multiple containers, enabling distributed execution of agents [BEL00].

By using JADE's Yellow Pages Service, agents can discover and locate other agents by their functionalities or capabilities, making it easier to find relevant agents for collaboration or providing services [BPR01].

1.6 Scalability and Distribution

JADE support executing agents in a distributed manner, allowing them to operate across multiple machines, which is suitable for large-scale agent-based systems [BPR01]. This distribution feature is made possible by the Platform Management System, which deploys agent and allows them to easily communicate across different platforms [BPR01].

Moreover, JADE provides mobility features, allowing agents to migrate between containers and devices, enhancing its adaptability to dynamic environments [BEL00].

References

- [BEL00] F BELLIFEMINE. An object-oriented framework to realize agent systems. *Proc. of WOA 2000*, pages 52–57, 2000.
- [BPR01] Fabio Bellifemine, Agostino Poggi, and Giovanni Rimassa. Developing multi-agent systems with jade. In *Intelligent Agents VII Agent Theories Architectures and Languages: 7th International Workshop, ATAL 2000 Boston, MA, USA, July 7–9, 2000 Proceedings 7*, pages 89–103. Springer, 2001.
- [Chi01] L Chiariglione. Fipa: Foundation for intelligent physical agents. *FIPA Board of Directors, Resolutions of the Osaka*, 2001.