INTELLIGENT AGENT BASED MICRO GRID CONTROL

Presented by

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INTRODUCTION

- The increase in the demand for electricity and the increase in frequency of natural hazards.

- A blackout occurred in August 2003 when 50 million residents of U.S. and Canada were left without electricity services.

- Bigger power plants to micro grid concept.

- Modern communications and control technologies makes system reliable.

Micro grid Overview

Fig.1. Micro grid model

Micro grid overview

- Micro grid can provide an efficient way to integrate distributed energy resources(DER) and loads.
- Micro grid can achieve a flexible way for distributed energy resources to connect and disconnect as they like.
- Micro grid can independently operate in islanding mode when outage occurs.
- Current trends of control techniques of power systems are towards an automated agent technology.

AGENT PARADIGM AND ARCHITECTURE OF MULTI-AGENT SYSTEM

- Agent Oriented Programming (AOP) is a concept of artificial intelligence with distributed systems.

- According to Wooldridge

  "An agent is a computer system that is situated in some environment, and that is capable of taking autonomous action in this environment in order to meet its design objectives".

- Characteristics of an agent
  - Autonomy
  - Reactivity
  - Proactiveness
  - Social ability

AGENT PARADIGM AND ARCHITECTURE OF MULTI-AGENT SYSTEM

- FIPA Agent Communication Language are based on speech act theory. (inform, propose, agree)
- Ontology
  - Concept Schema
  - Predicate Schema
  - Agent Action Schema
- Agent Building Toolkits
  - ✓JADE
  - ZEUS
  - JAFMAS

AGENT PARADIGM AND ARCHITECTURE OF MULTI-AGENT SYSTEM

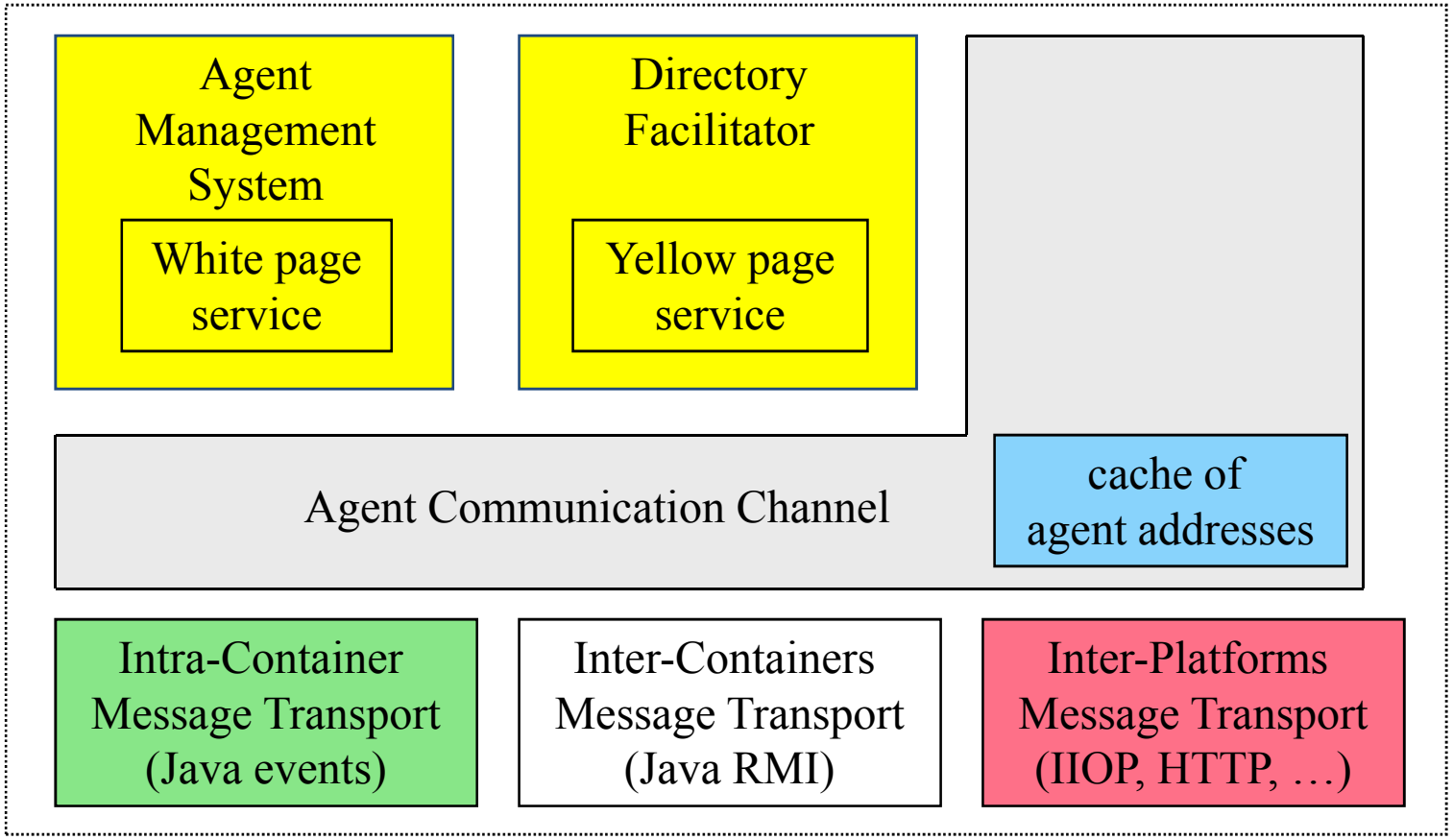


Fig.2. Internal architecture of JADE

DESIGN AND IMPLEMENTATION OF MULTI-AGENT SYSTEM

Agent Specifications and Responsibilities

- *Control agent*

  - Accept incoming registration
  - Respond to registrations
  - Monitor system voltage
  - Update subscribers
  - Interpret main grid state
  - Store information

DESIGN AND IMPLEMENTATION OF MULTI-AGENT SYSTEM

Agent Specifications and Responsibilities

- DER agent
  - Register with the control agent
  - Communicate with other user or DER agents
  - Sense and react to the external measurements
  - Update the user on current progress
- User agent
- Server agent

DESIGN AND IMPLEMENTATION OF MULTI- AGENT SYSTEM

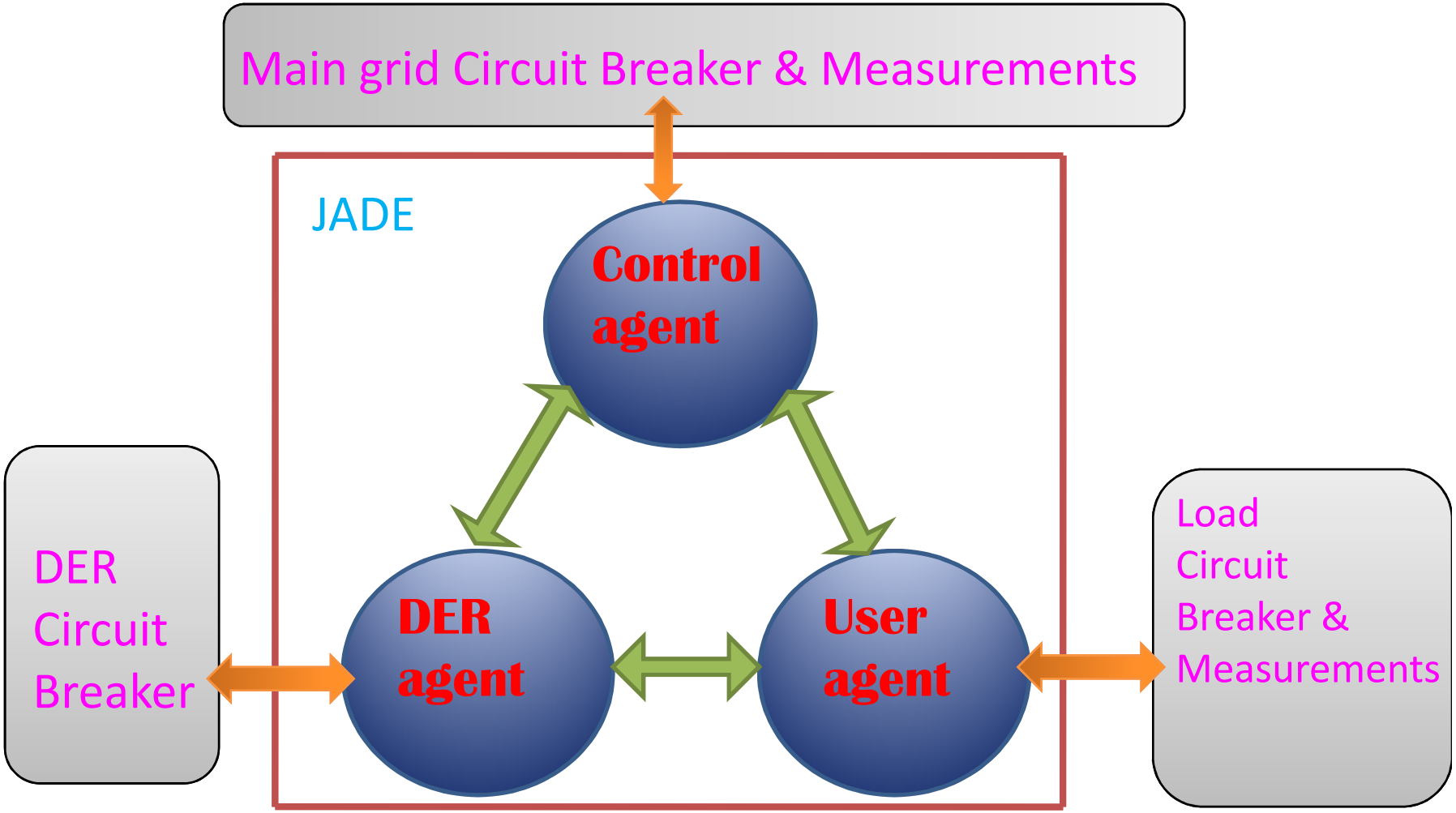


Fig.3. Interaction diagram of Multi-agent system

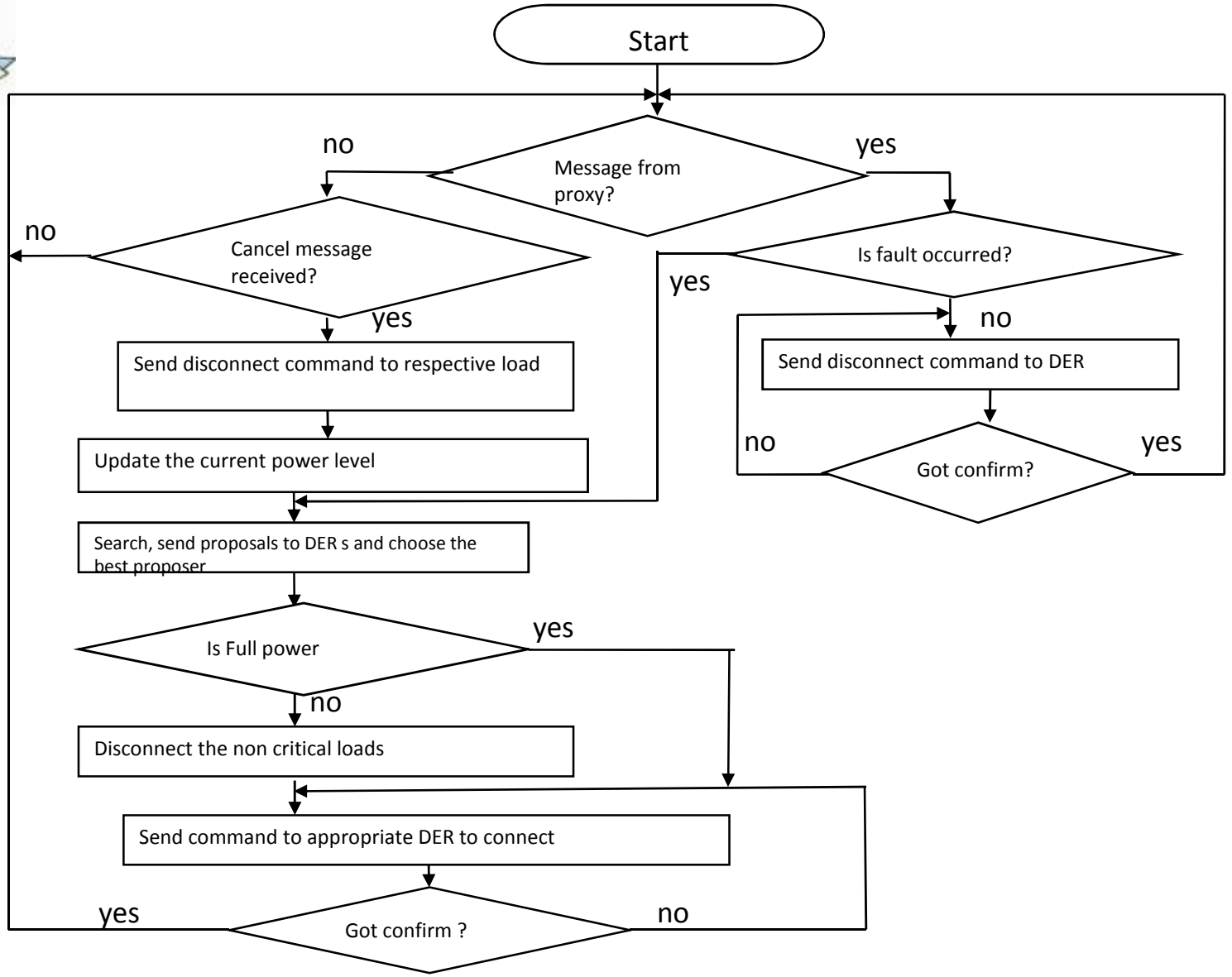


Fig.4.Flow chart of control agent (contract net interaction)

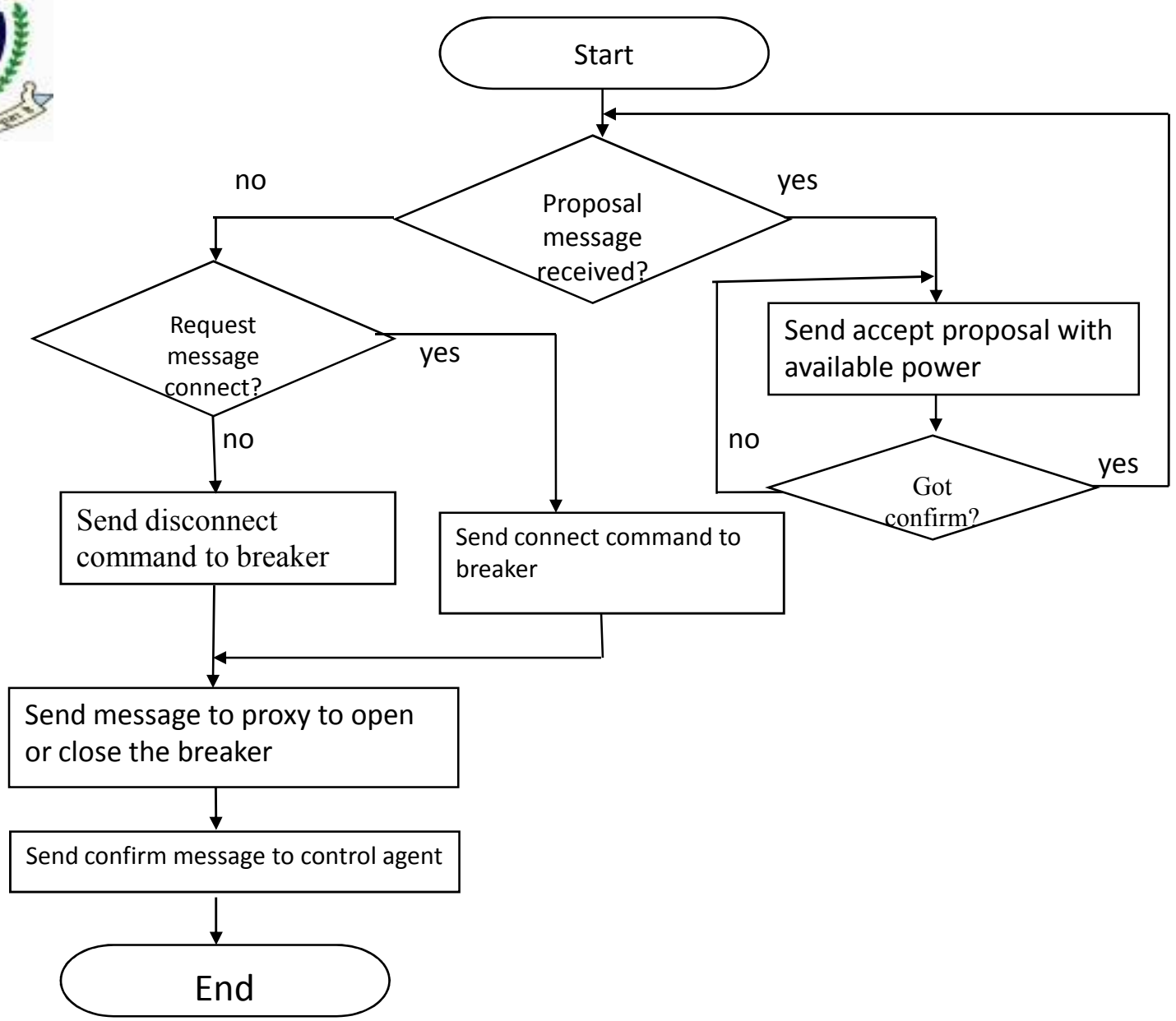


Fig.5. Flow chart of DER agent

IMPLEMENTATION OF INTELLIGENT MICRO GRID

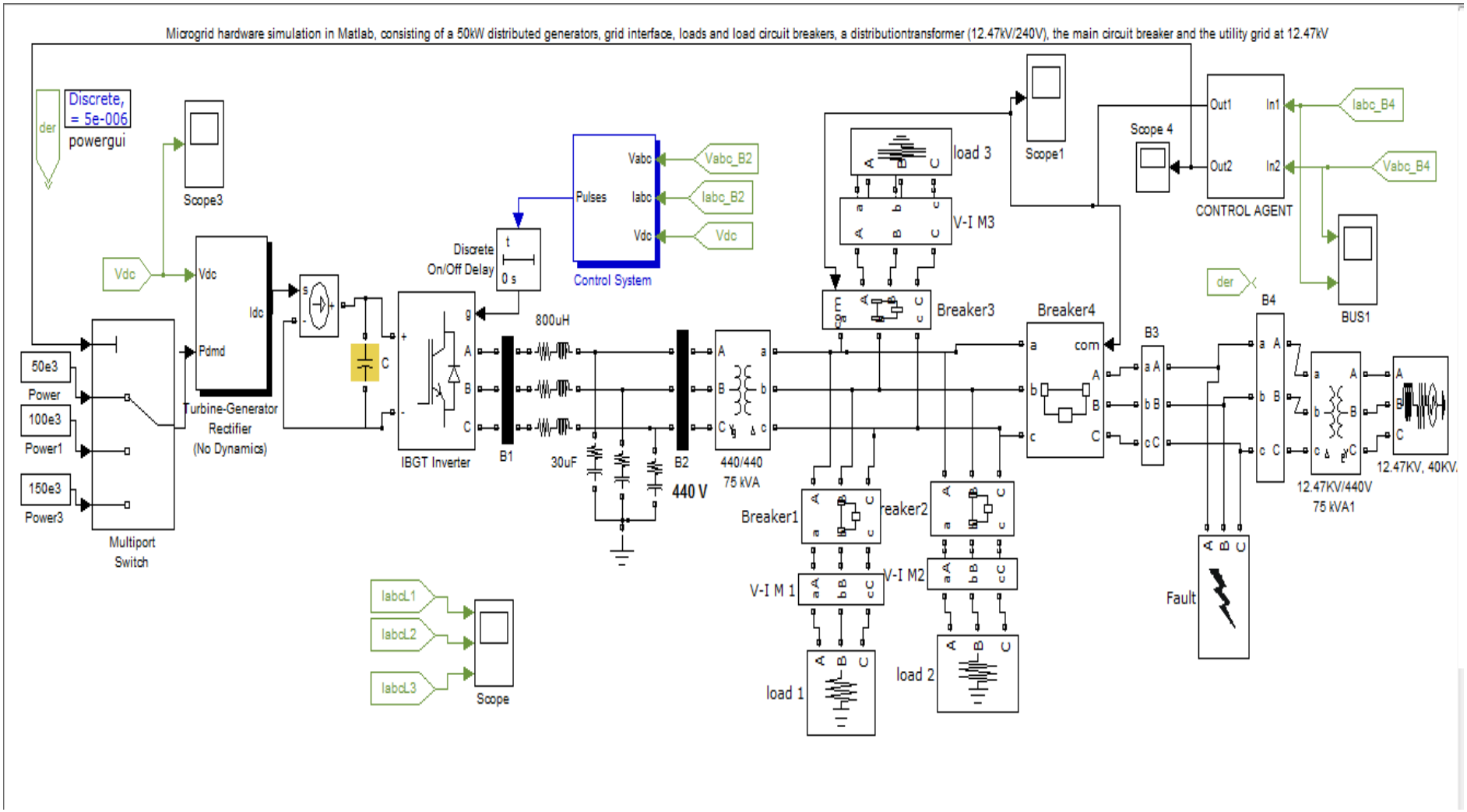


Fig 6. Matlab hardware simulation model of Micro grid

IMPLEMENTATION OF INTELLIGENT MICRO GRID

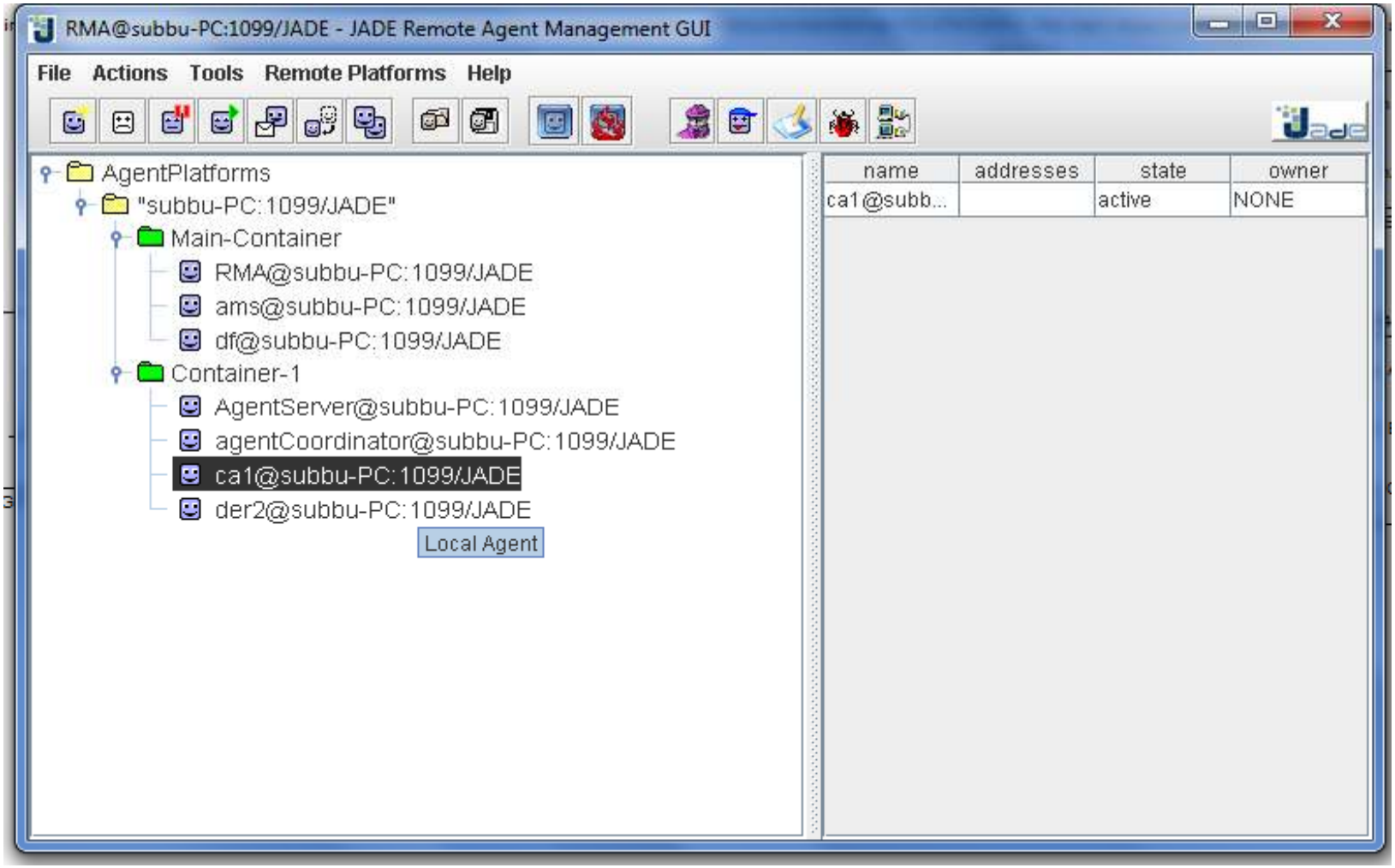


Fig 7. graphical user interface of JADE

IMPLEMENTATION OF INTELLIGENT MICRO GRID

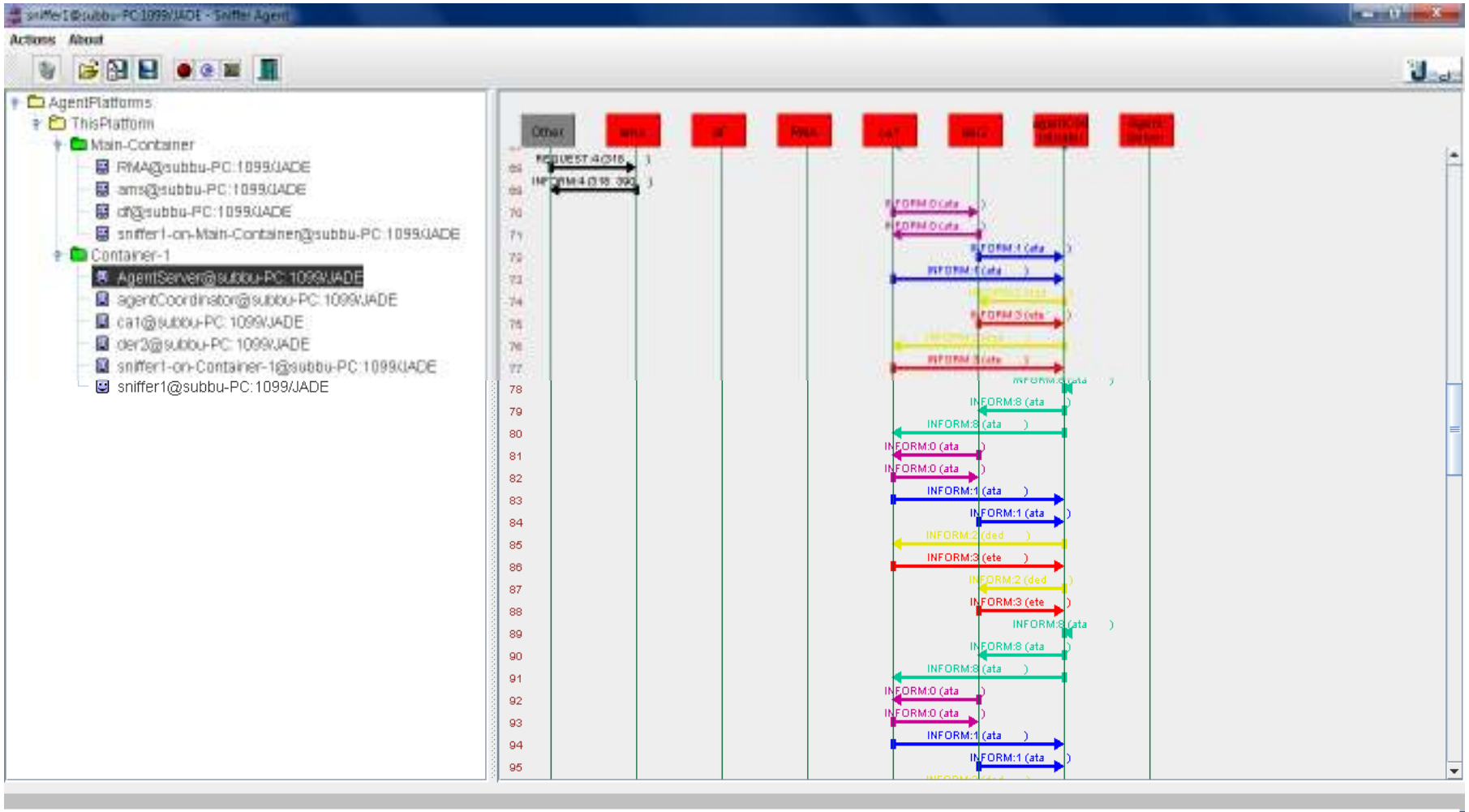


Fig 8. sniffer agent (message communication)

COMMUNICATION INTERFACE

- MACSim has a client-server architecture.

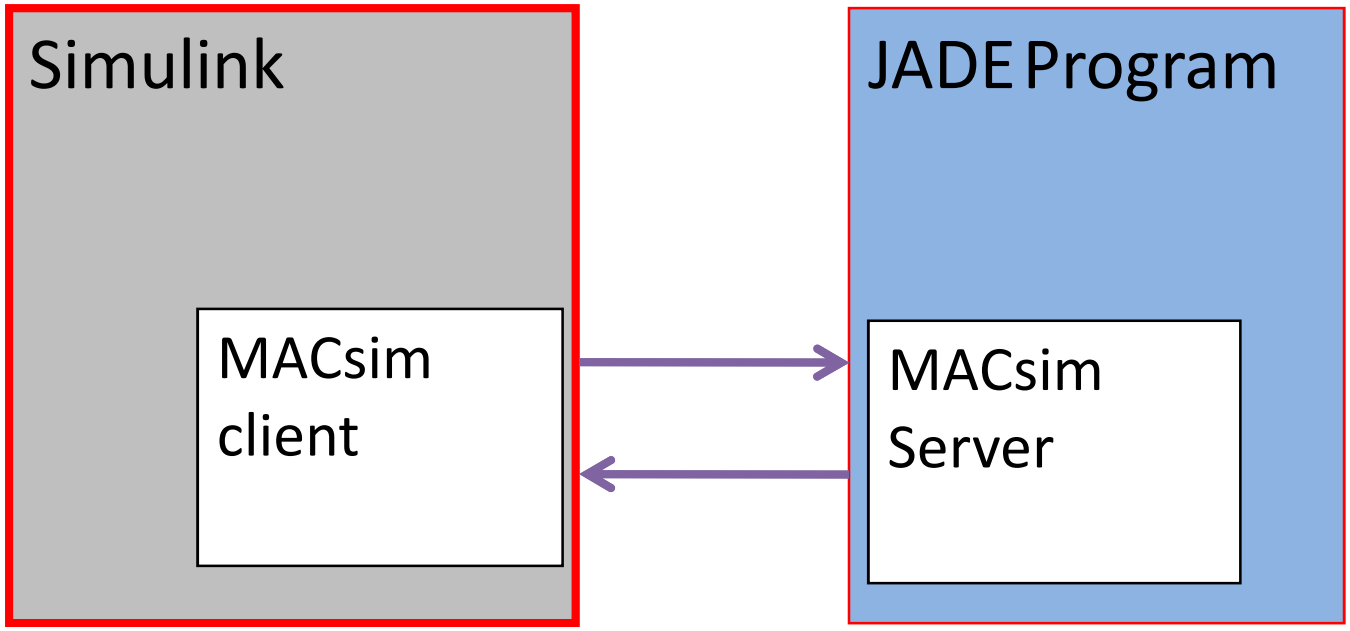


Fig9. Structure of MACsim

COMMUNICATION INTERFACE

- Agent environment

  Responsibility for passing any data between the two programs.

- Agent task force

  Agents, their behaviours and goals

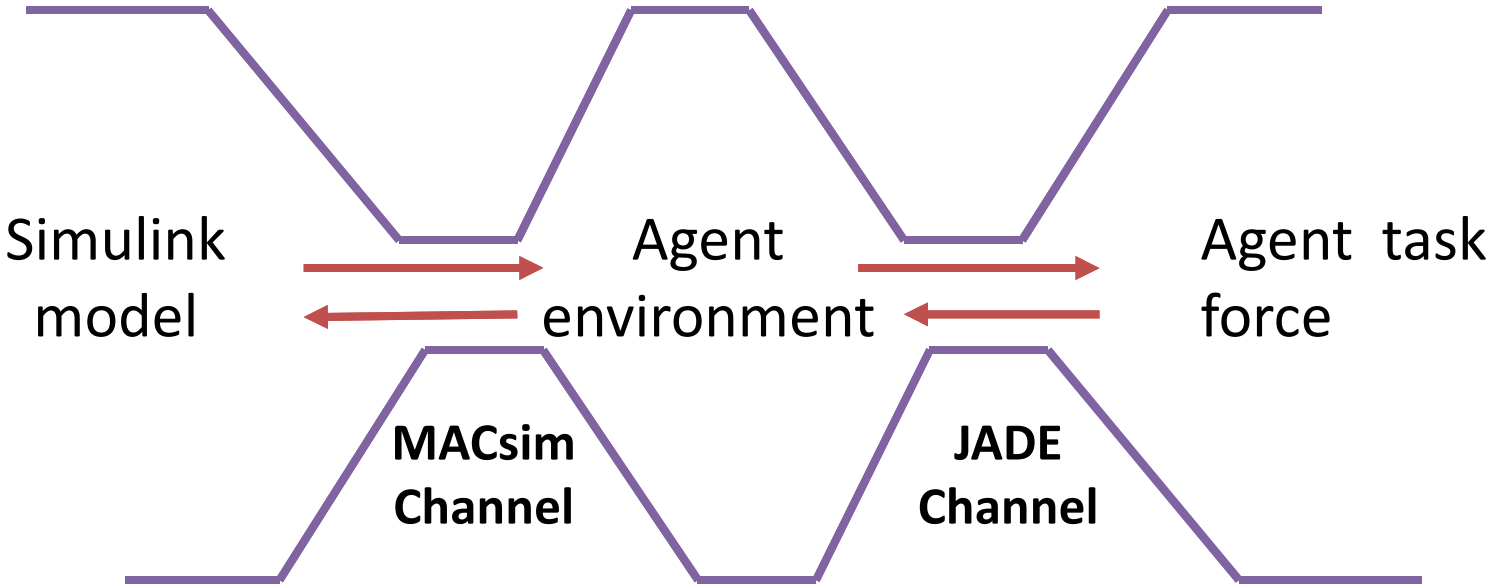


Fig10. Outline of the complete communication

RESULTS AND DISCUSSIONS

Three phase to ground fault between : 0.04-0.08sec

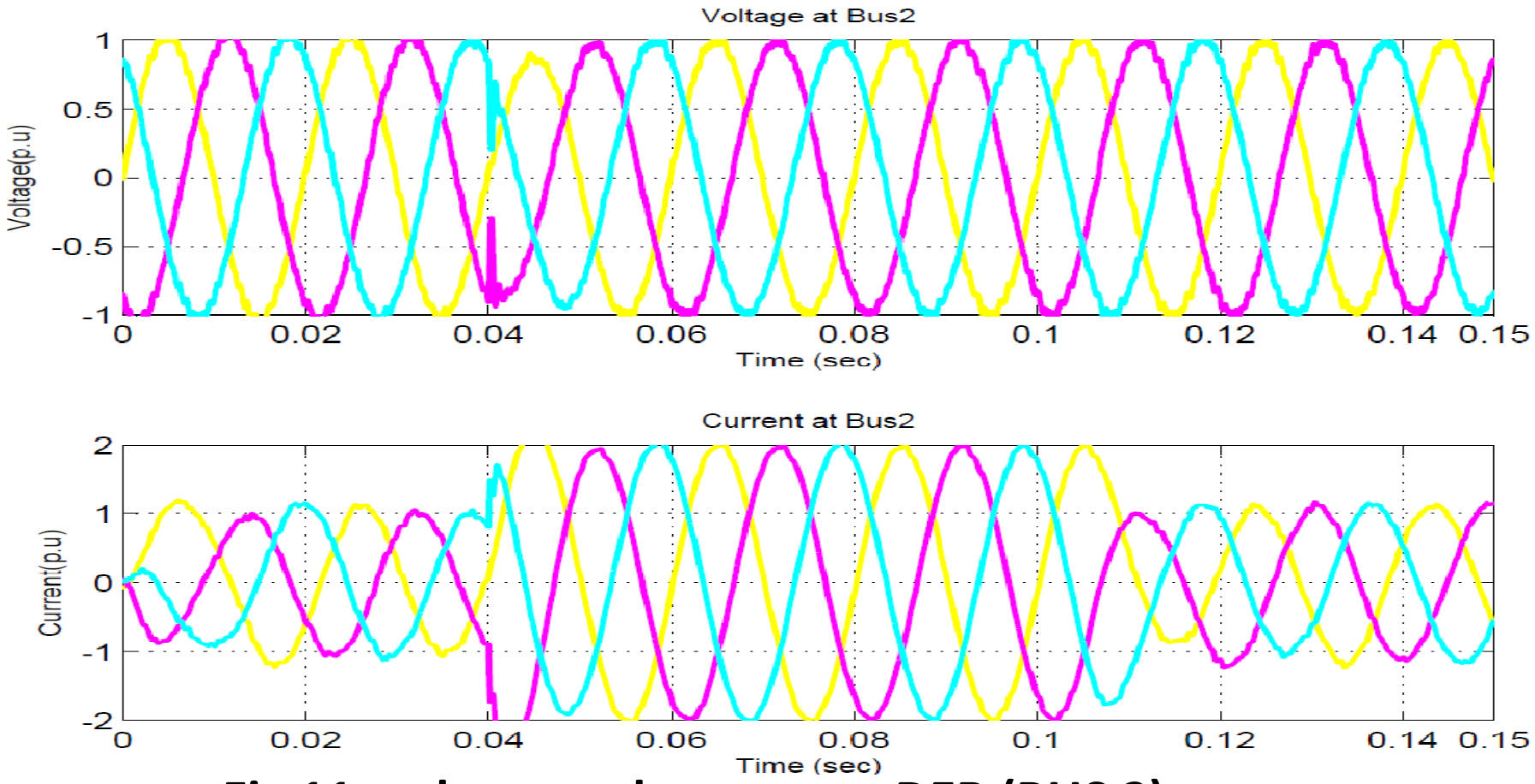


Fig 11. voltage and current at DER (BUS 2)

RESULTS AND DISCUSSIONS

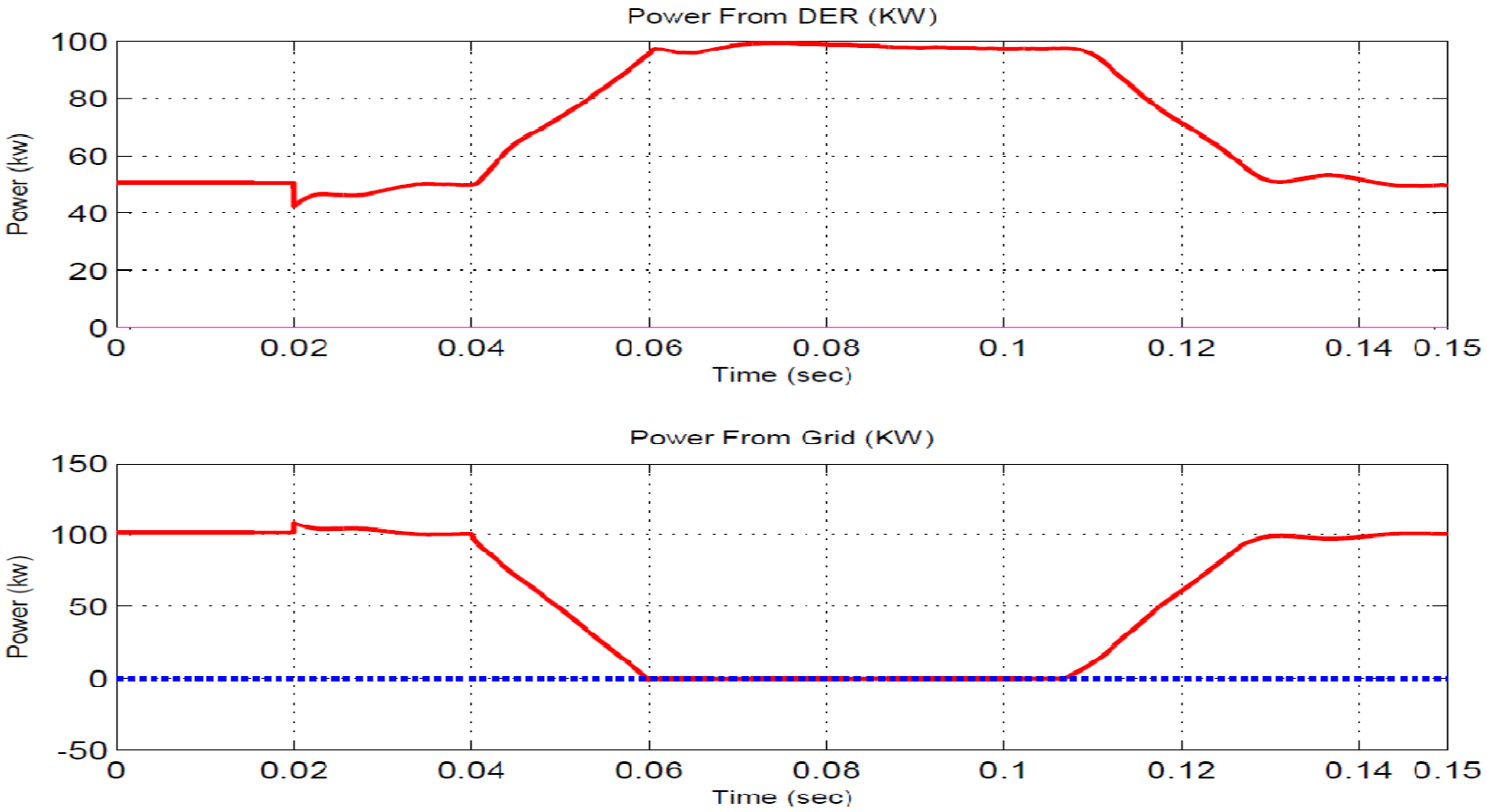
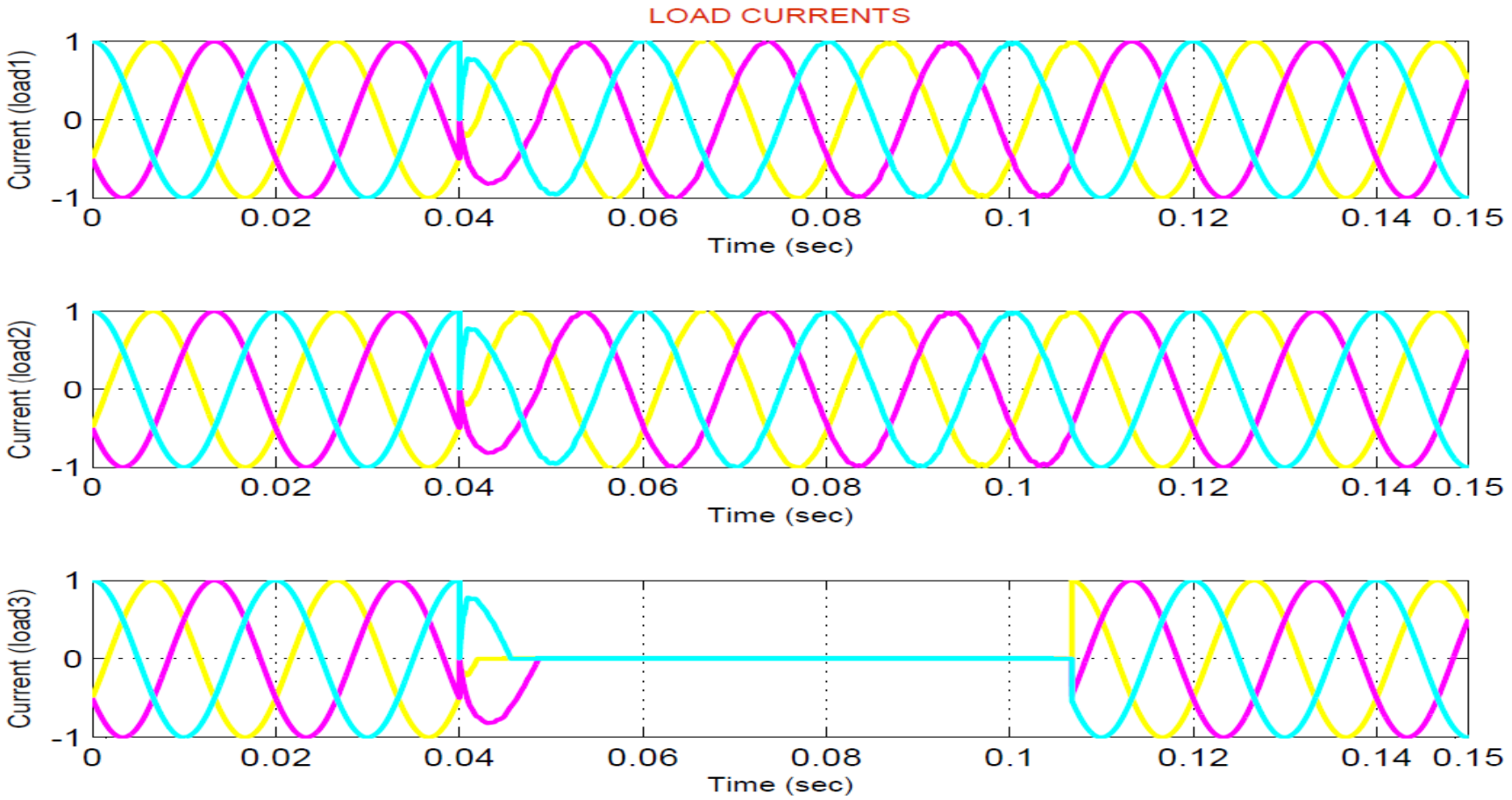


Fig 12. Power delivered by DER and Main grid

RESULTS AND DISCUSSIONS

I drawn by critical loads



I drawn by non-critical loads

Fig 13. Current drawn by critical and non-critical loads

RESULTS AND DISCUSSIONS

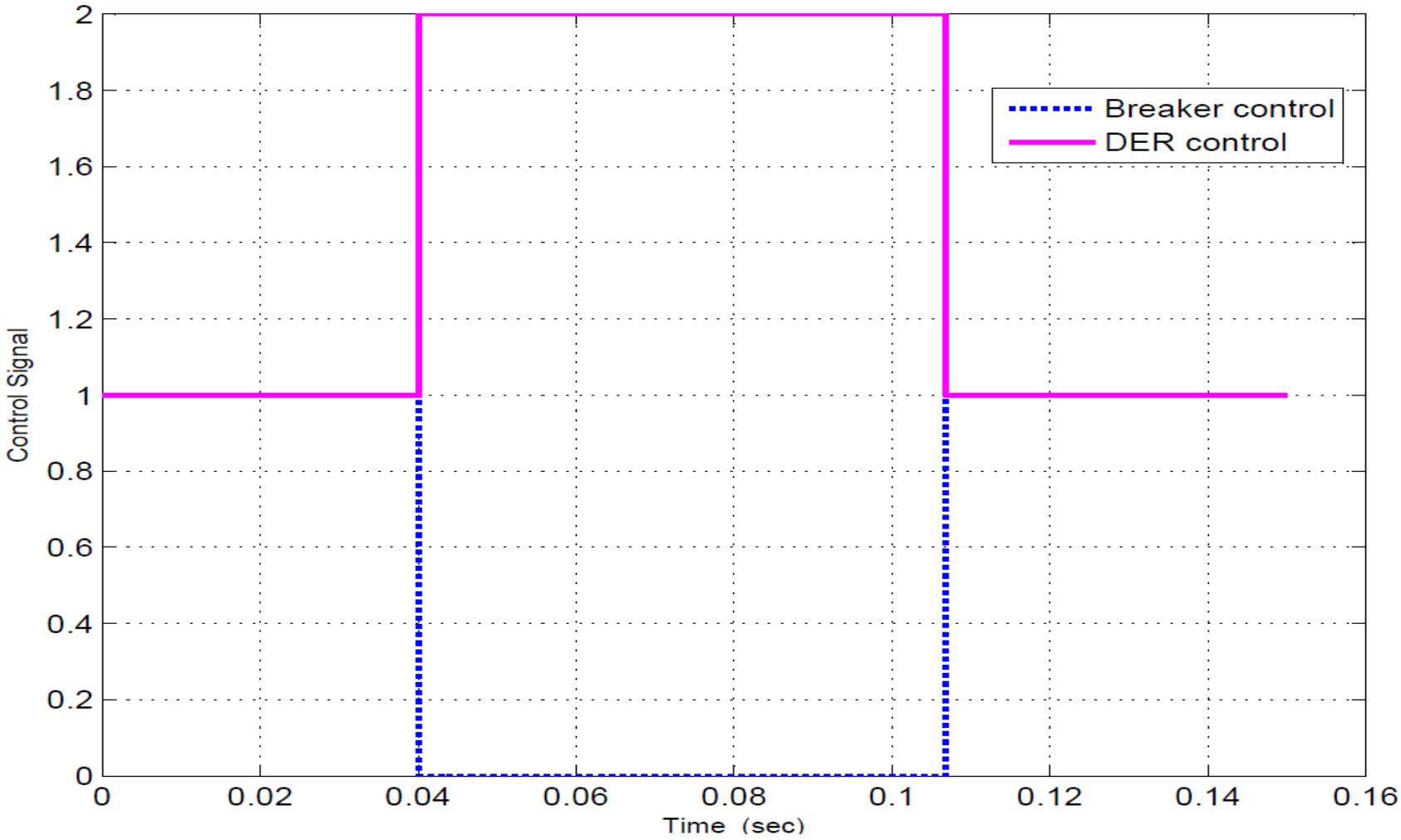


Fig 14. Control Signals given by JADE agents

ANALYSIS OF MICRO GRID FOR SINGLE FAULT SCENARIO

TIME (SEC)	0.02	0.039	0.041	0.045	0.05	0.06	0.08	0.10	0.12	0.14	0.15
VOLTAGE AT BUS2 (P.U)	1.0	1.0	0.87	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
POWER FROM DER(KW)	42	50	51	64	73	96	99	97.5	70	52	50
POWER FROM MAINGRID (KW)	106	100	92	71	48	0	0	0	62	98	100
STATUS OF LOAD C.B 1	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON
STATUS OF LOAD C.B 2	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON
STATUS OF LOAD C.B 3	ON	ON	OFF	OFF	OFF	OFF	OFF	OFF	ON	ON	ON
STATUS OF MAINGRID C.B	ON	ON	OFF	OFF	OFF	OFF	OFF	OFF	ON	ON	ON

CONCLUSION

- Simulink model of the micro grid has been developed.
- Multi-agent system has been developed for a micro grid containing control agent, DER agent and load agent in JADE.
- Micro grid is efficiently controlled by Control, DER and User agents in JADE.

FUTURE SCOPE

- This work can be extended to larger power systems .
- Prioritization of loads based on offering prices to DER can be further implemented.
- Decision making of agents can be further improved by considering the dynamic conditions of the equipment in the grid.

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Thank you!