ᔕ PLM 베스트 프랙티스 컨퍼런스 2012 ᔕ

인지 제조시스템
- Cognitive Manufacturing System -

June 21st, 2012

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LPE

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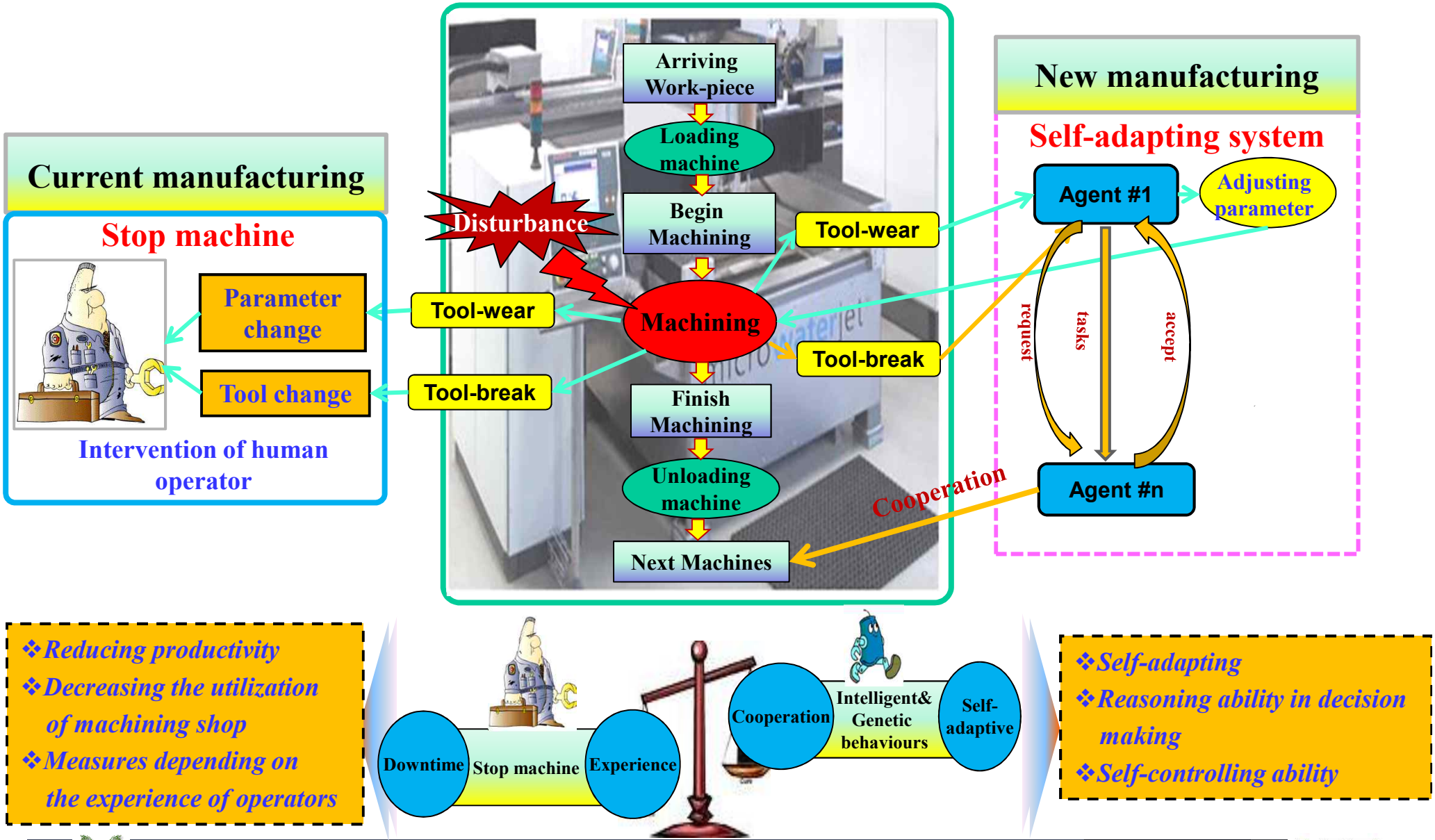
- Cognitive Manufacturing System -

Necessity for developing a new manufacturing concept

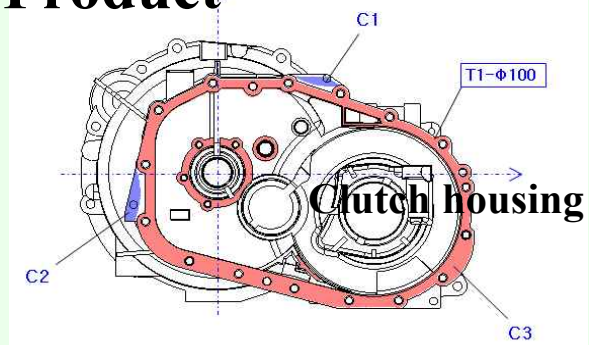


- *Reducing productivity*
- *Decreasing the utilization of machining shop*
- *Measures depending on the experience of operators*

- *Self-adapting*
- *Reasoning ability in decision making*
- *Self-controlling ability*

Analyzing current manufacturing in consideration of self adapting concept

Product

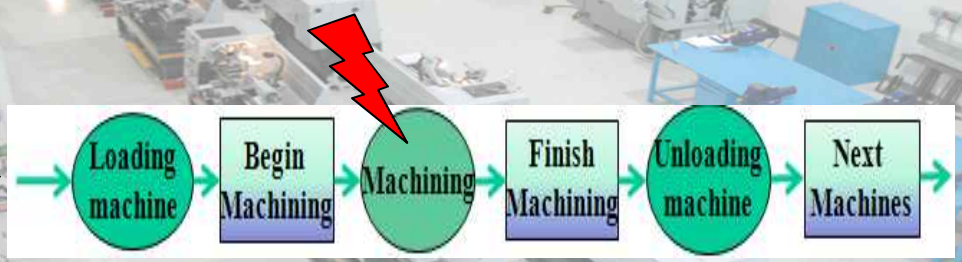


- Processing operations per product: 17
- Machines: 12

Machining Shop

Disturbance

- Downtime: 20-25% of total planned time



Clutch housing

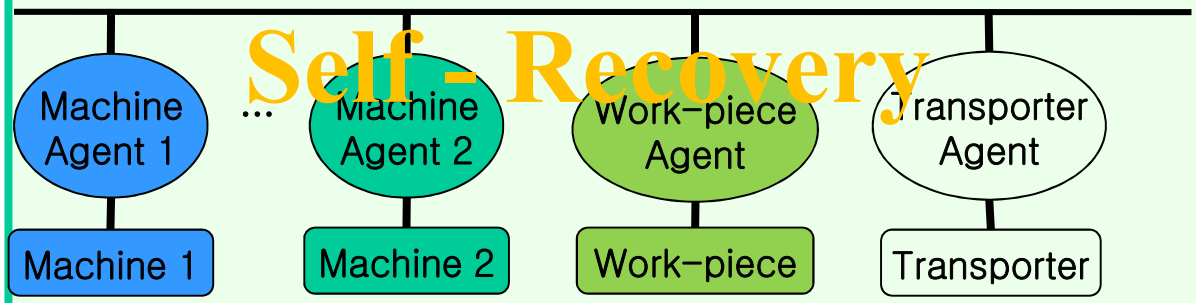
Recovery method

Current recovery method:

Stop the machining shop to repair and reset

- Centralized control system
- Rigid Control: Top-down problem solving
- Low scalability
- Low adaptability

Proposed method: Self-adaptive manufacturing system

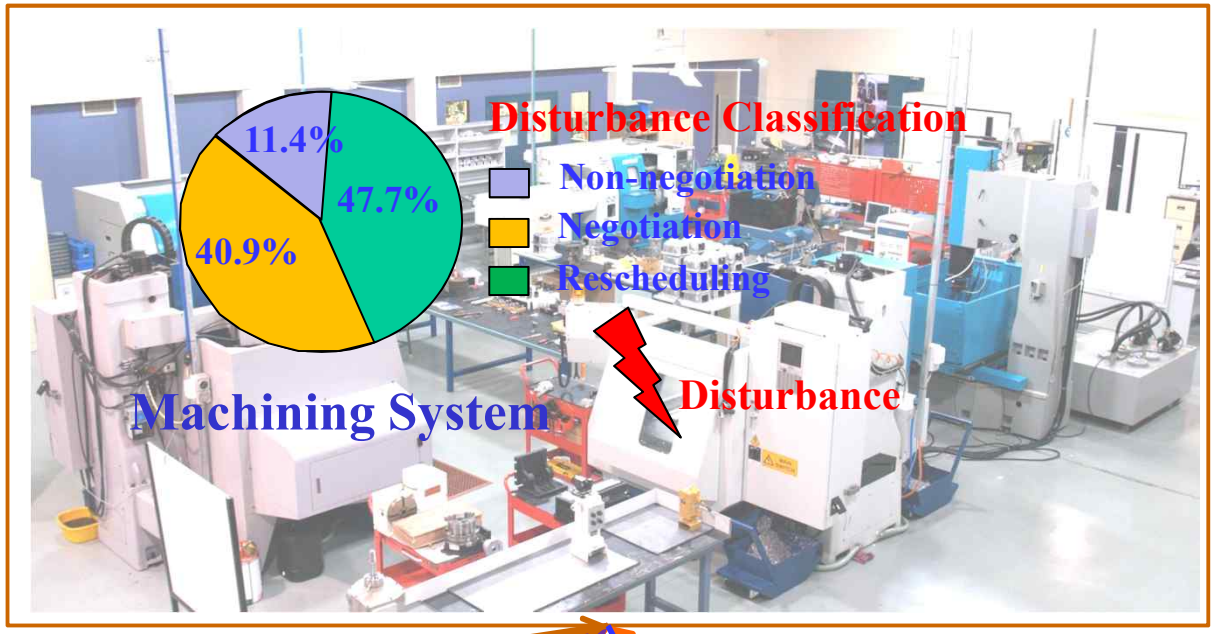


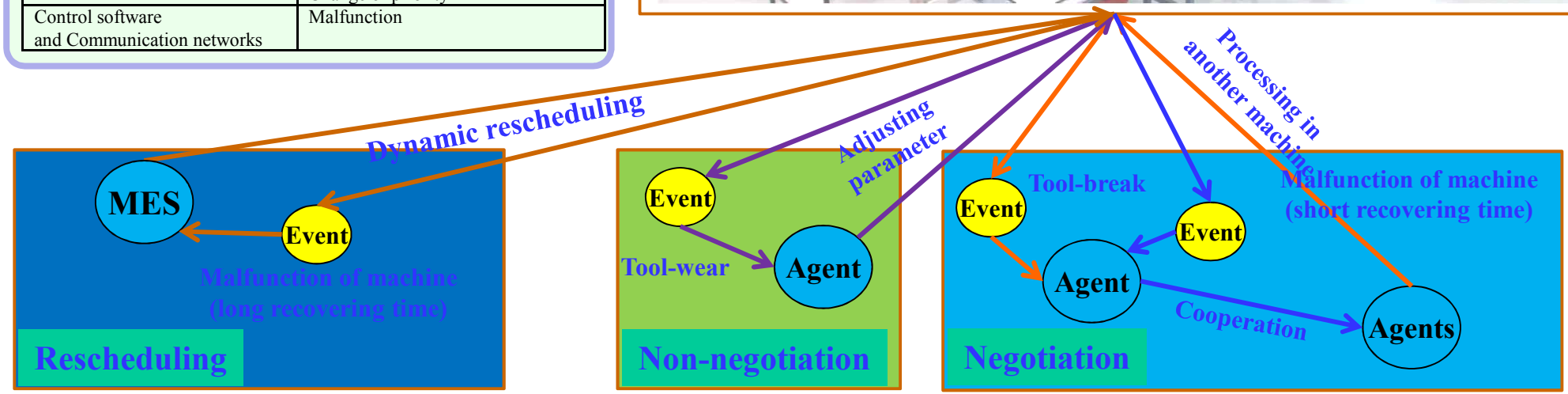
Disturbance Classification and Management methods

Disturbance Information

- Data collection time: 2006.08.31-2009.08.18
- Disturbance numbers: 685

Disturbance class	Type of disturbance
Related to resources	Machine breakdown
	Maintenance of machine
	Tool breakdown
	Tool wear
	Operator absenteeism
Related to orders	Unavailability of raw material
	Cancellation order
	Rework
	Arrival of a new job order
	Urgent job
	Delay in transport using material handling system
	Out sourcing
Related to measurement of data	Process time variation
	Variation of set-up times
	Change of priority
Control software and Communication networks	Malfunction



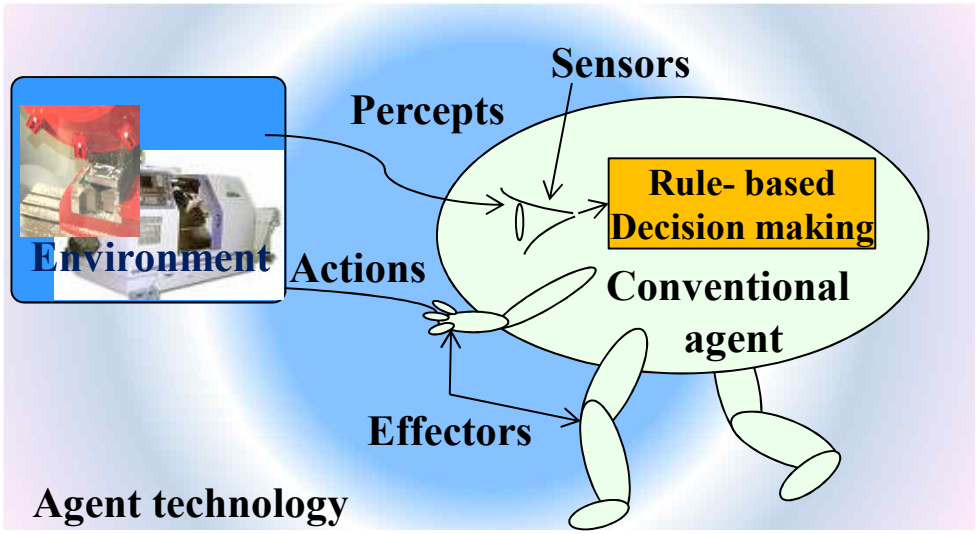


Rescheduling type:
Recovering time > 1 hour

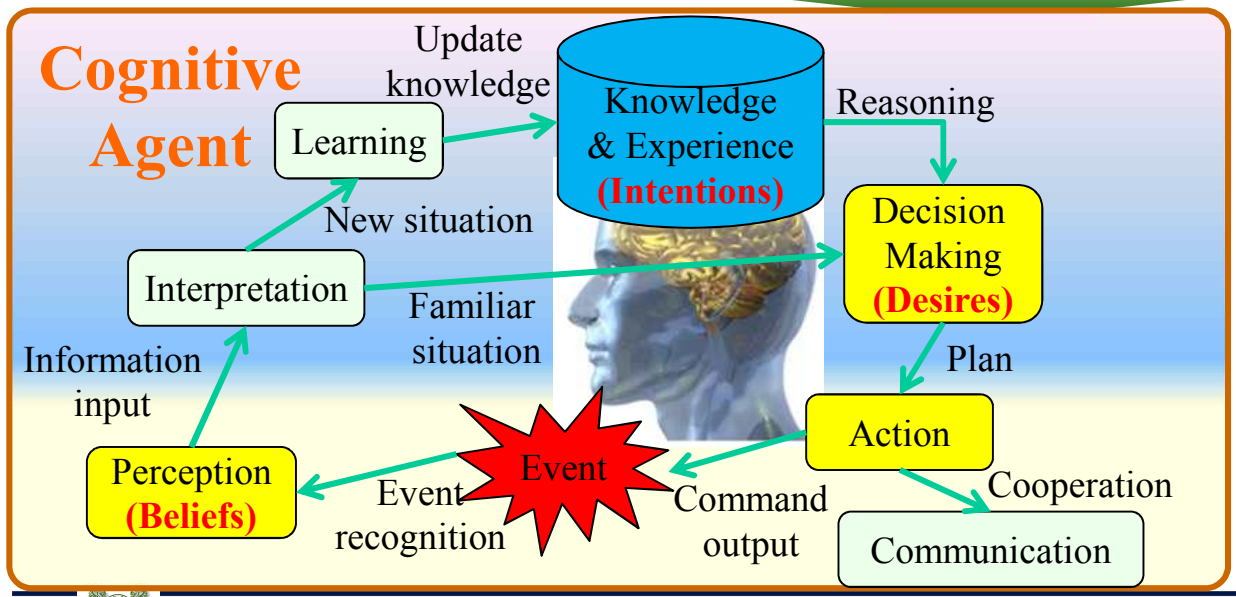
Non-Negotiation type:
Recovering time < 30 mins

Negotiation type:
30 mins < Recovering time < 1 hour

Concept of cognitive agent



Synthesis of agent and cognitive technologies



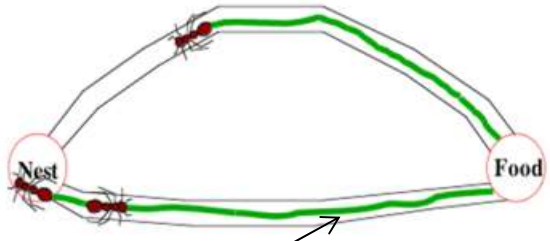
BDI Architecture

Beliefs
Grasping the information of the current states of an agent's environment

Desires
All the possible states of tasks that agent could carry out

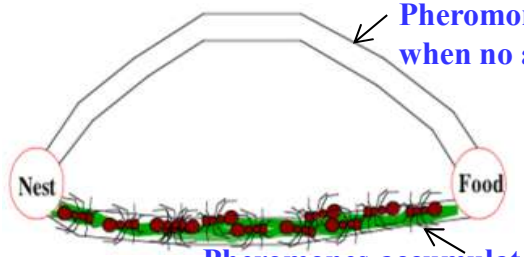
Intentions
The states of tasks that the agent has decided to work towards

Biology inspired strategy to adapt to disturbance



Ants lay pheromone on the trail when they moves food back to nest

Ant travel rule:
Each ant always try to chose the trail has higher pheromone concentration



Pheromones evaporate when no ant pass

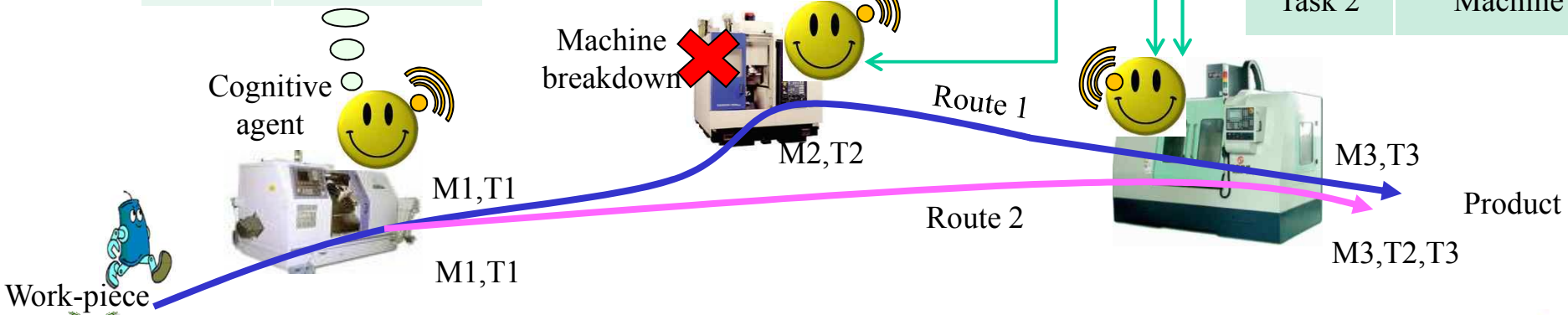
Pheromones accumulate with multiple ants using same path

From Natural to Manufacturing Systems

The machine with the shortest processing time for carrying out a specific operation will has the highest pheromone

Information Node	
Ability	**Pheromone**
Task 1	Pheromone value 1
Task 2	Pheromone value 2

Ability list	
Ability	**Machine tool**
Task1	Machine 1
Task 2	Machine 2
Task 3	Machine 3
Task 2	Machine 1
Task 2	Machine 3



Systematic procedure for developing a Self-Adaptive Manufacturing System (SAMS)

Product and Machining Shop

★Disturbance Classification
★Finding measures against the corresponding disturbances

Disturbance Analysis

Elementary technologies to develop a SAMS

★ Inspired Biology : Ant Colony Algorithm
★ Cognitive Agent

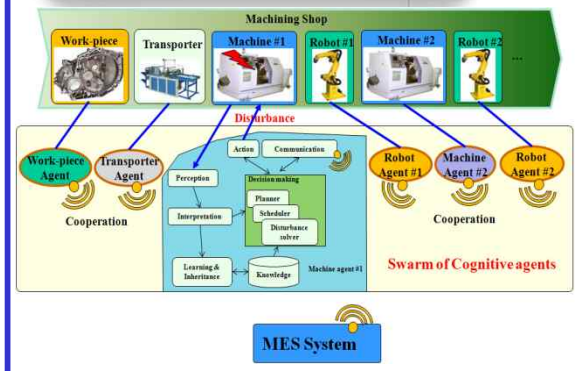
★Model of the machining shop based on functional agents
★Information Model of SAMS
★ Mechanism of SAMS for adapting to disturbance
★Algorithm for making decision of SAMS

Developing Architecture Of the machining shop based on Cognitive agents

Implementing the Test-bed of SAMS

★Architecture of the Test-bed
★Mechanism of the implemented SAMS for adapting to disturbances

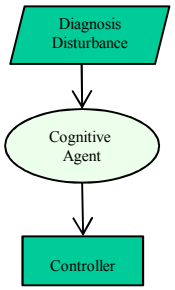
Model of SAMS



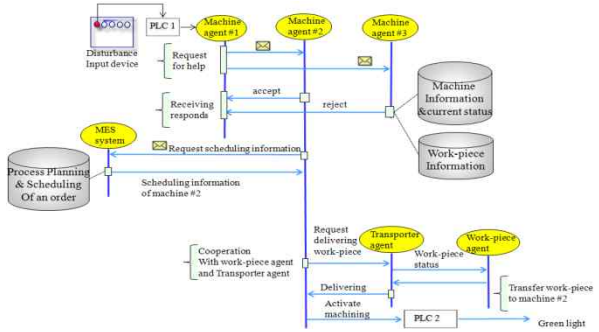
Test-bed

Strategies for overcoming disturbances

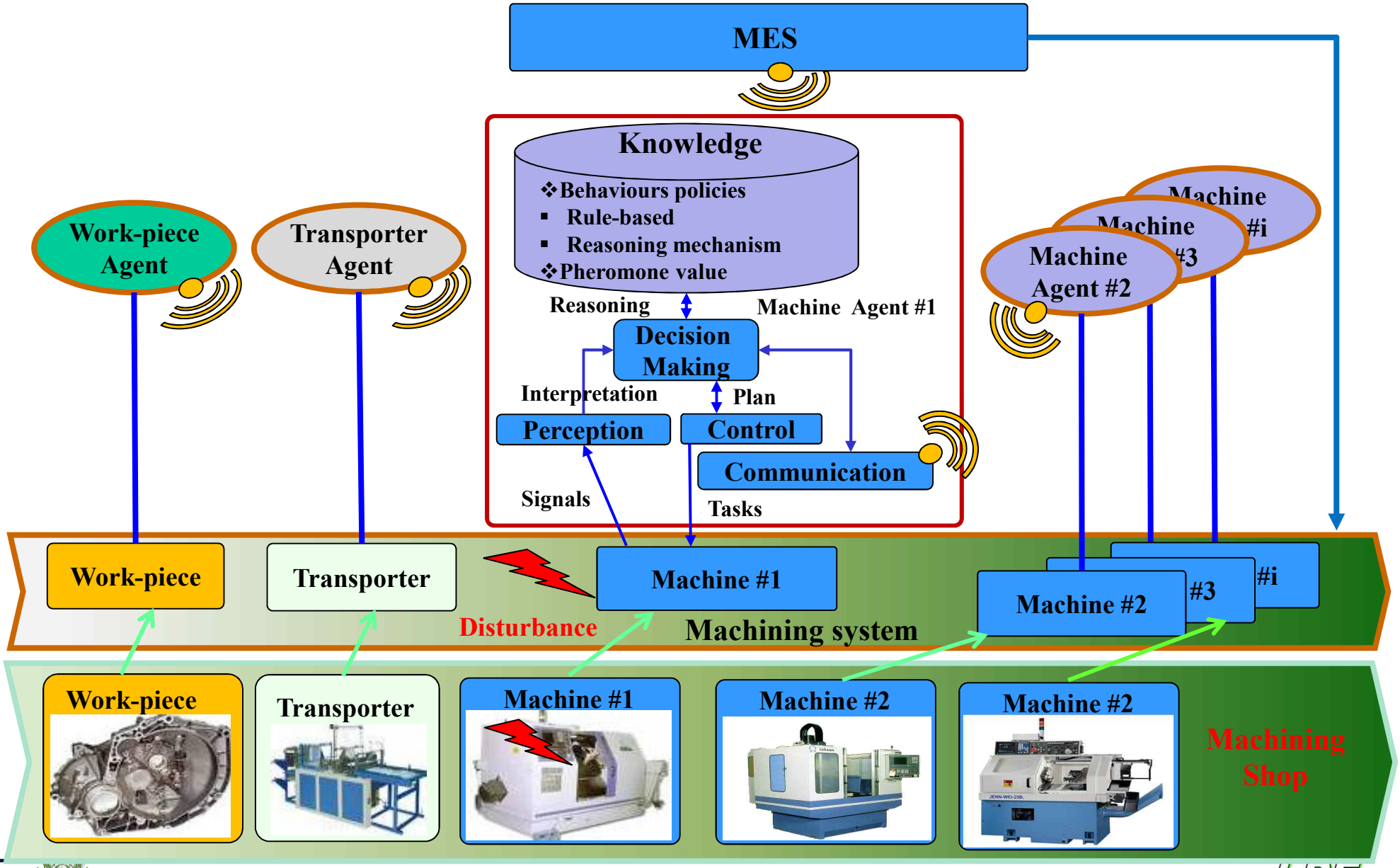
Non-negotiation



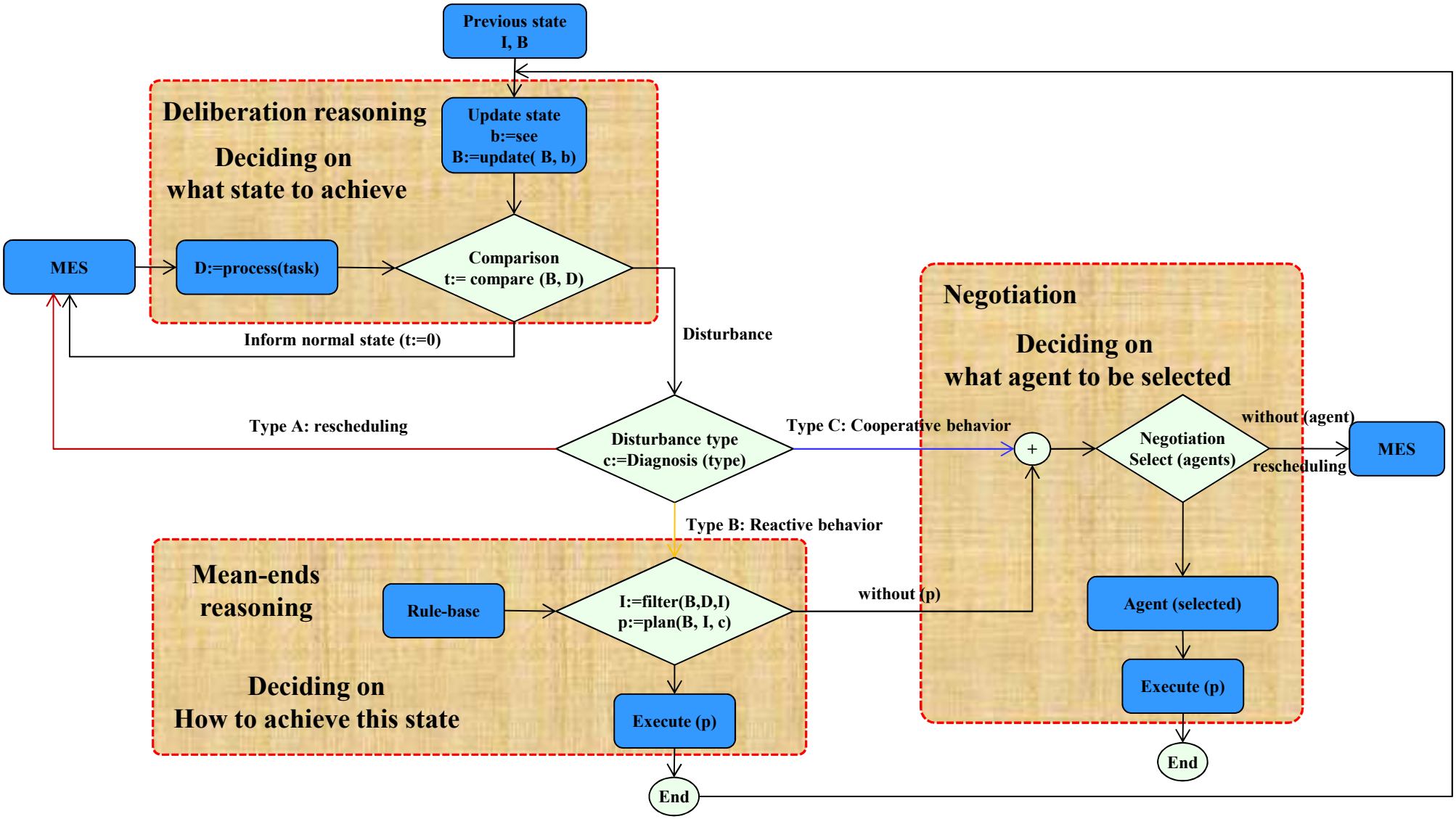
Negotiation



Concept of a self adapting manufacturing system



Cognitive agent based disturbance handling

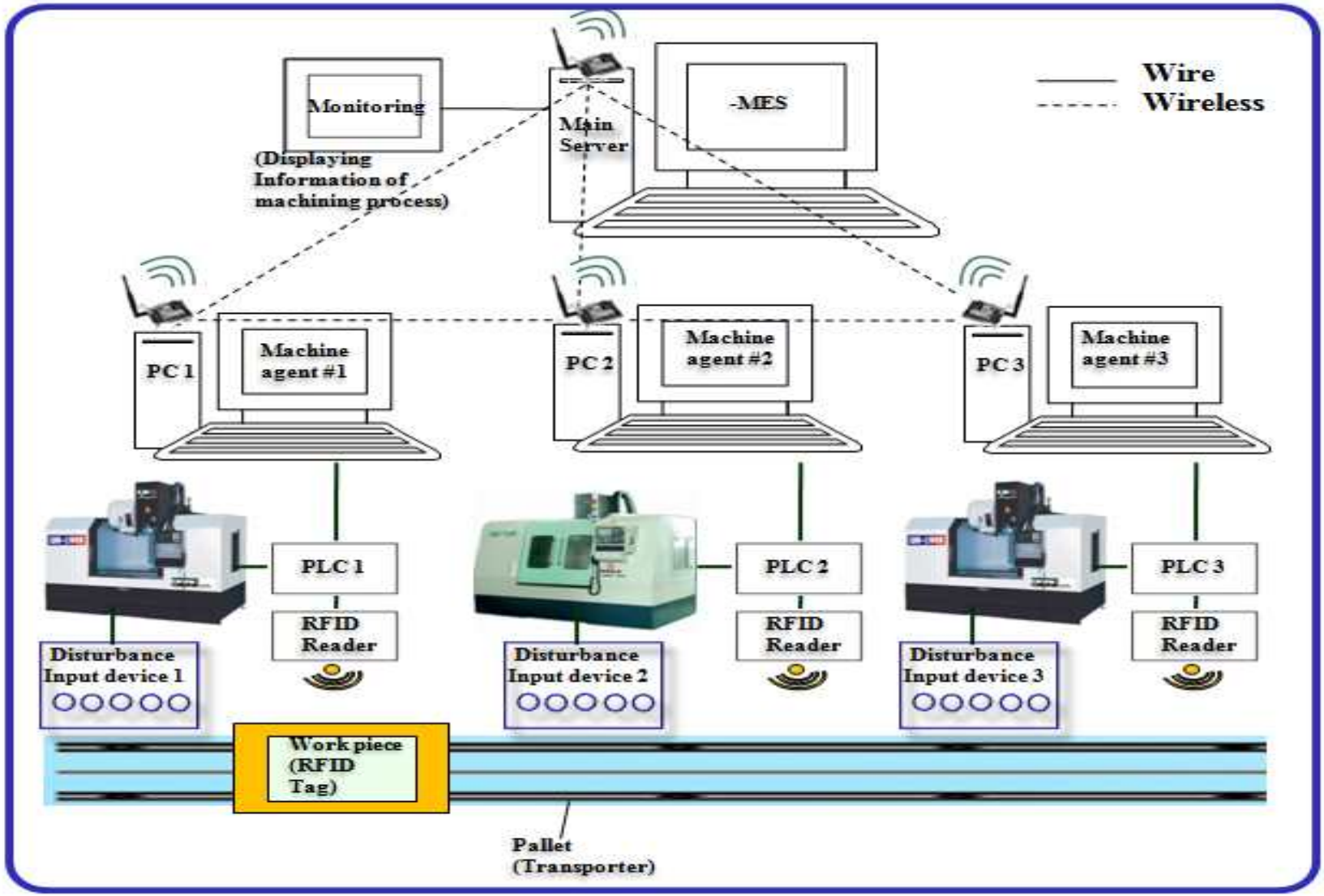


Implementing the Test-bed of SAMS

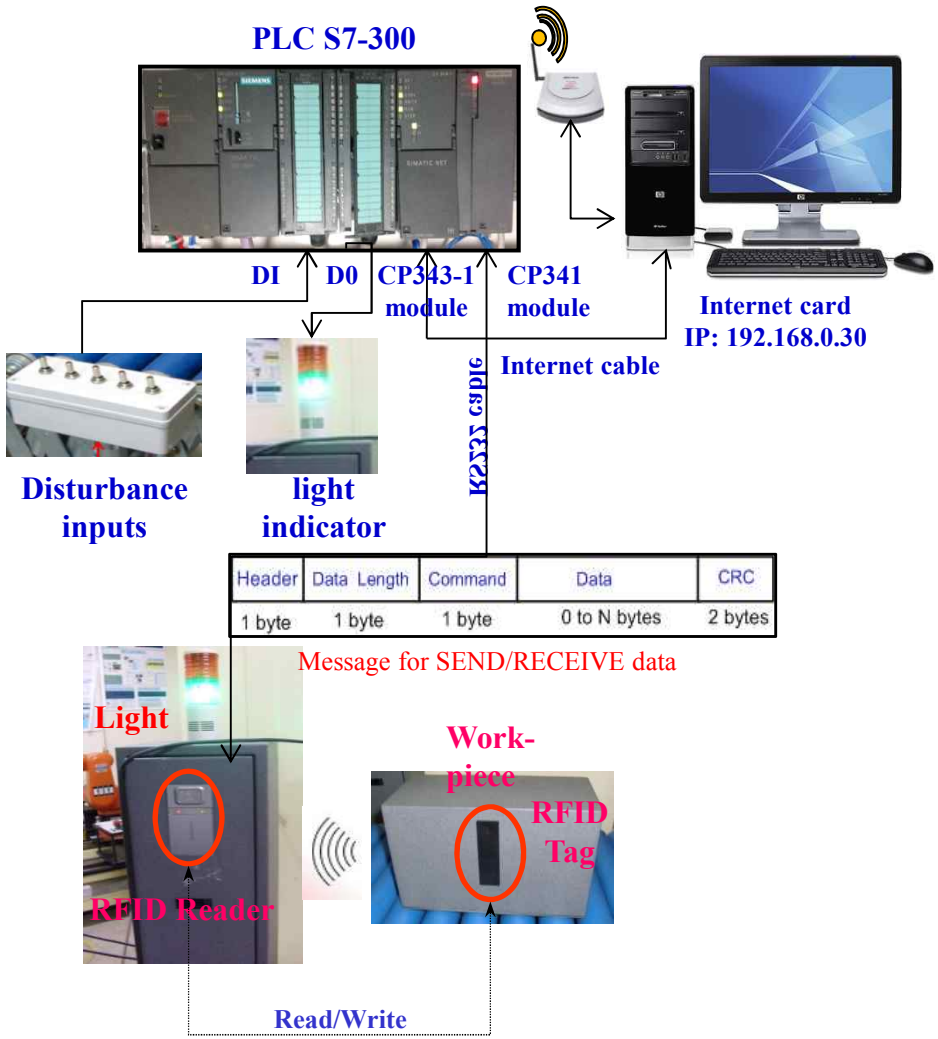
Working sequence for implementing the SAMS

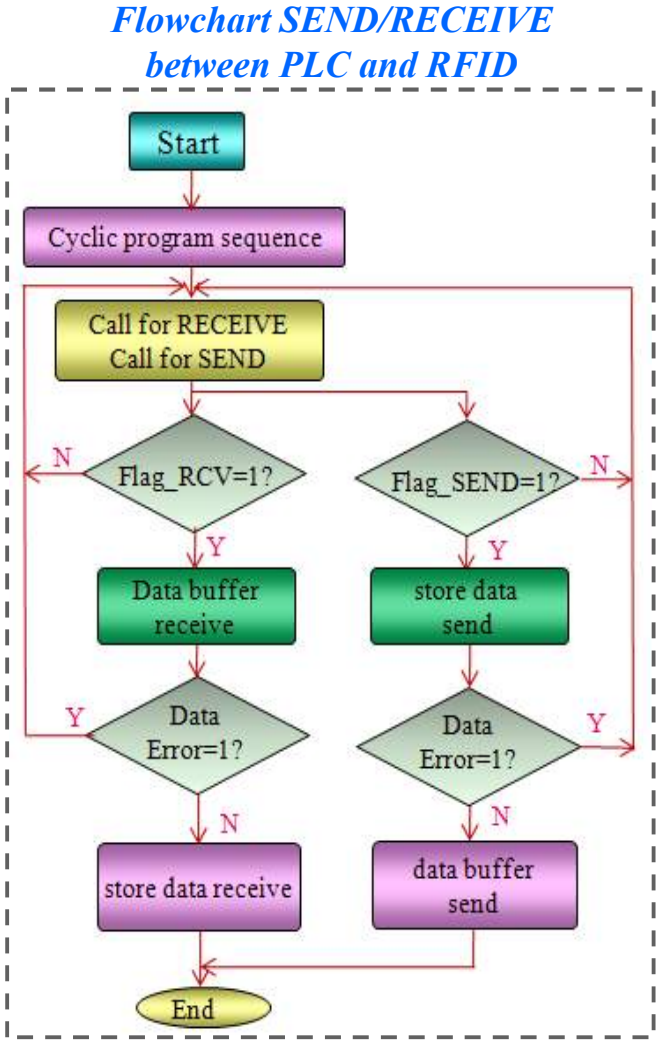
- Hardware architecture of SAMS
- Software architecture of SAMS
- Developing the database of SAMS
- Non-negotiation mechanism of SAMS
- Negotiation mechanism of SAMS
- Demonstration of SAMS
- Evaluation of SAMS

Hardware architecture of SAMS on the test-bed

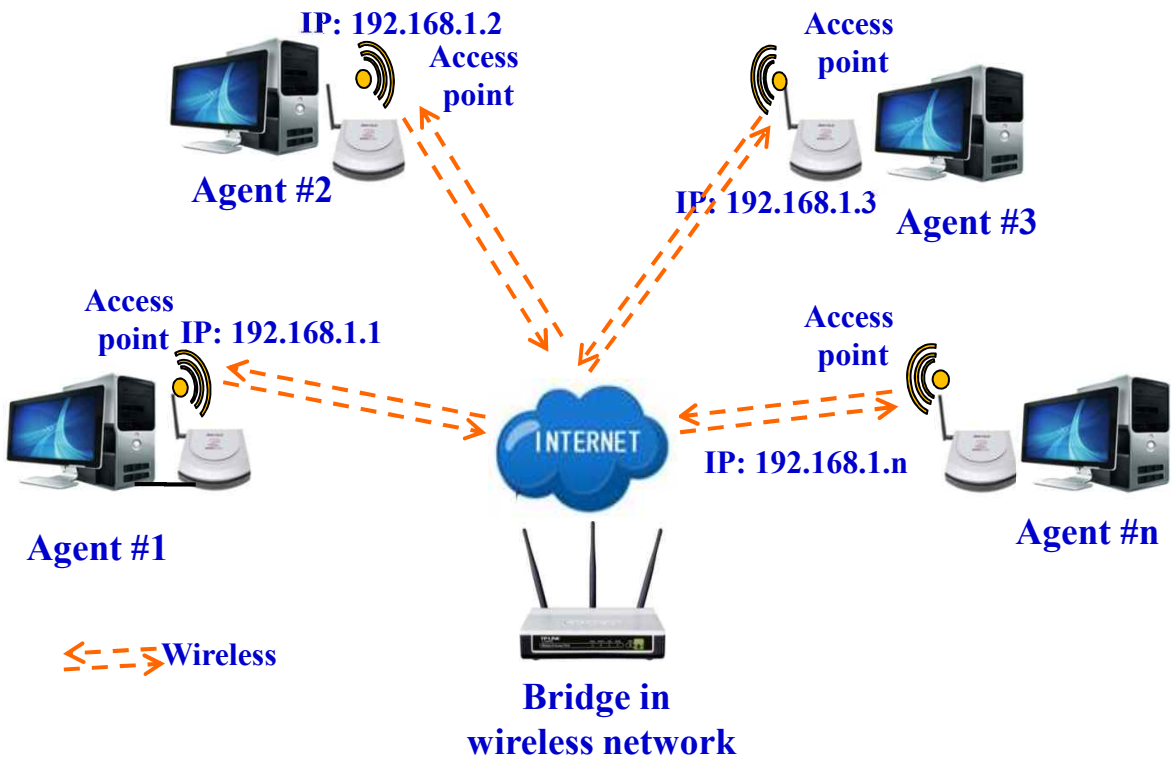


The communication of wire network between the devices in SAMS



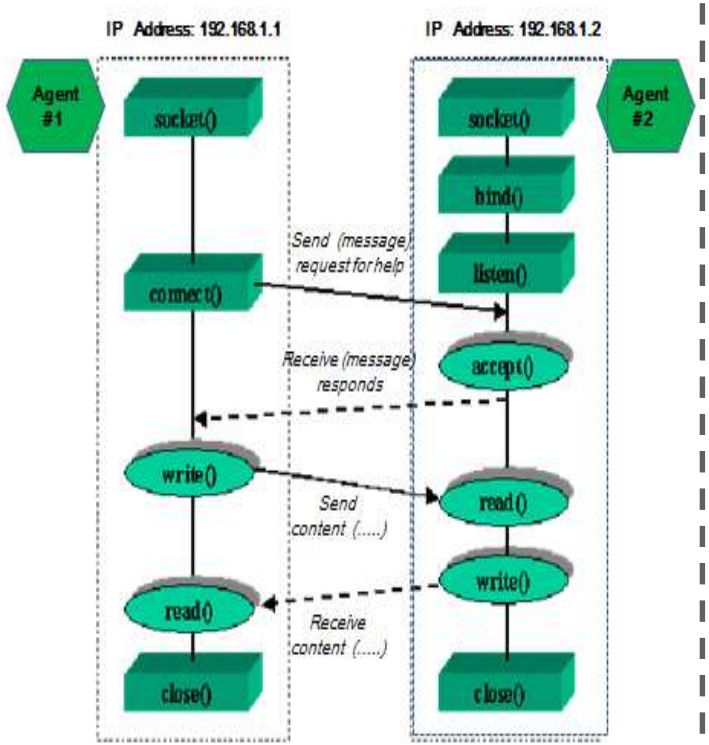


The communication of wireless network between agents in SAMS

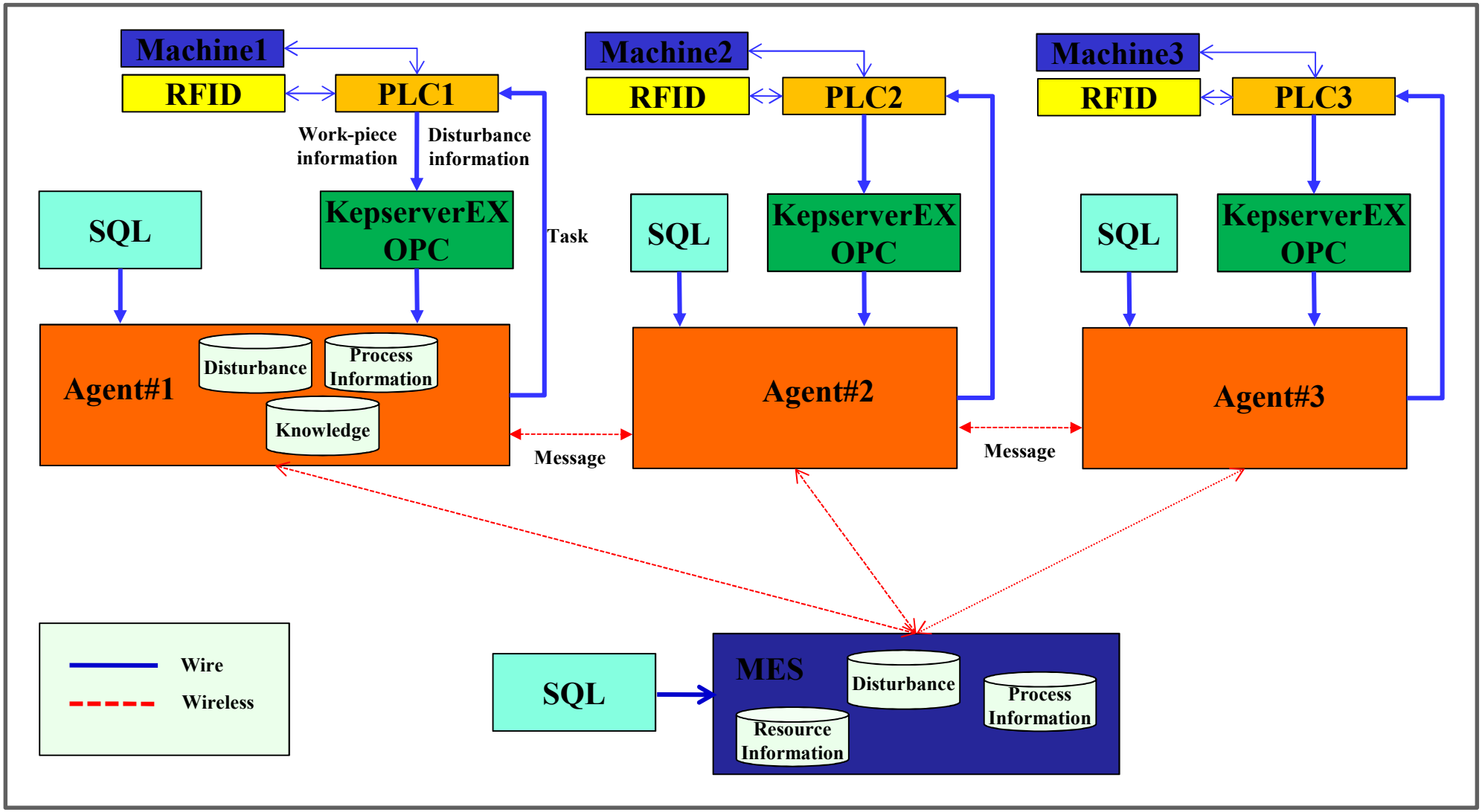


The communication bridge has function of the signal amplifier, and is a middleware node in the communication wireless network.

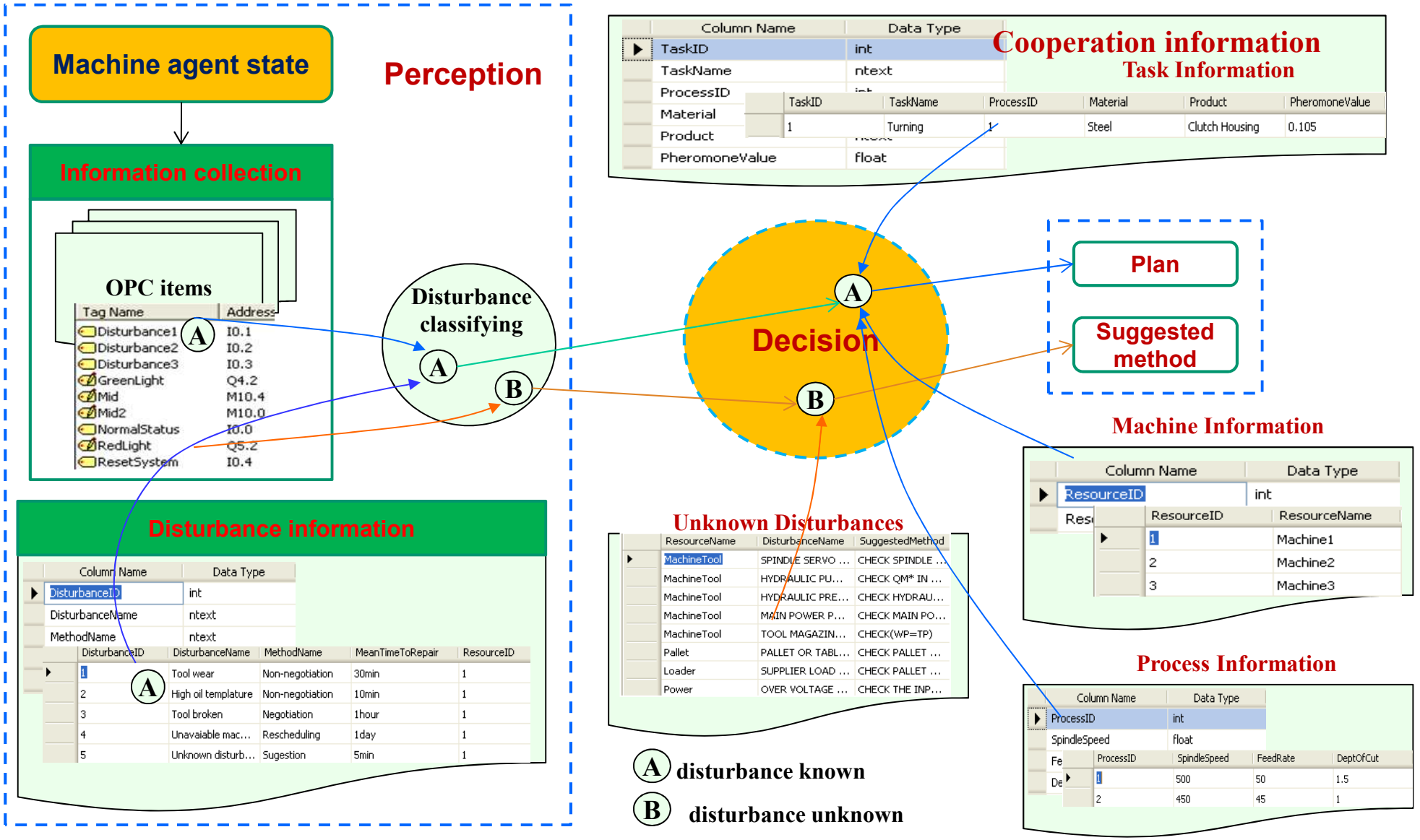
The communication mechanism between agents in the AMS



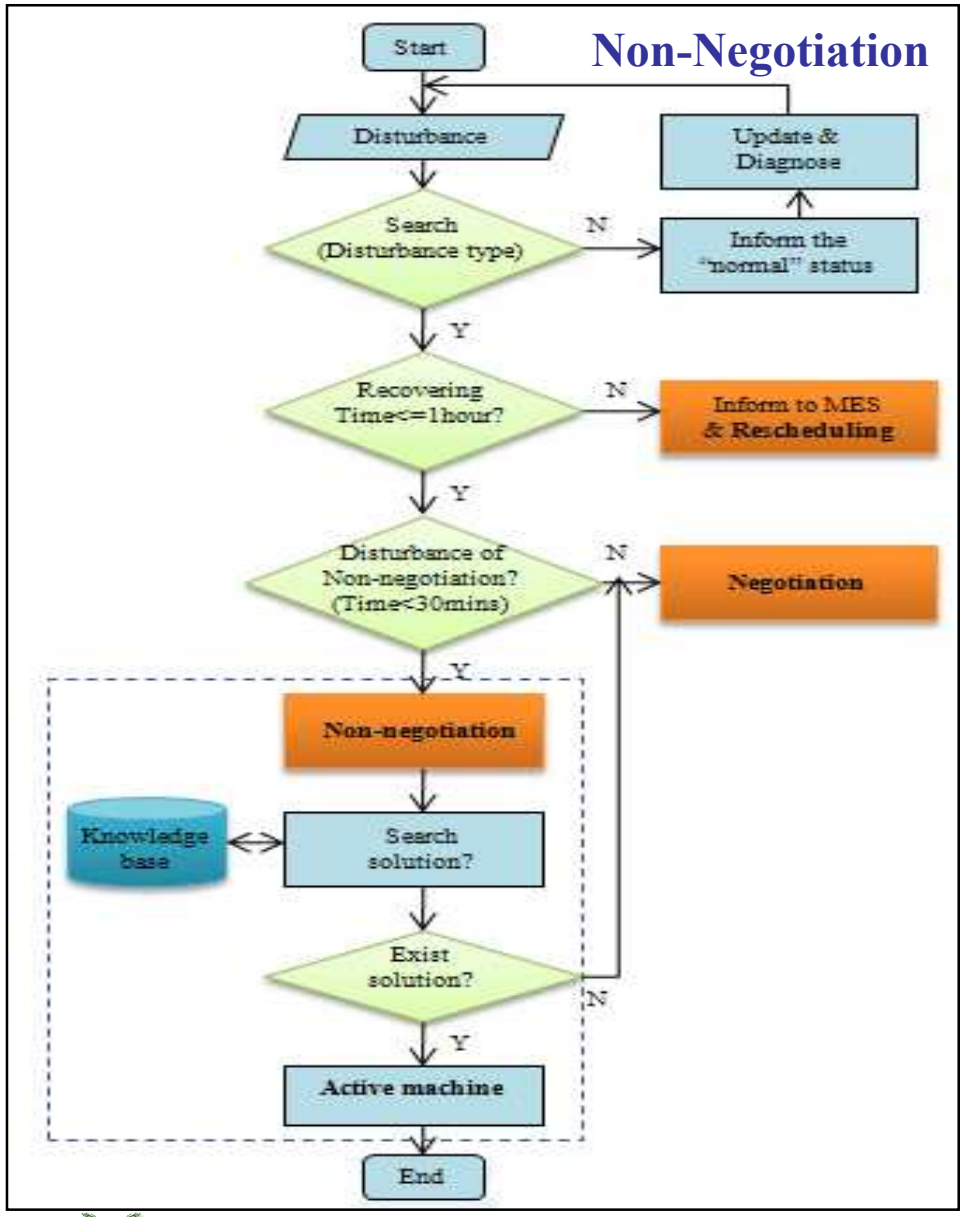
Software architecture of SAMS

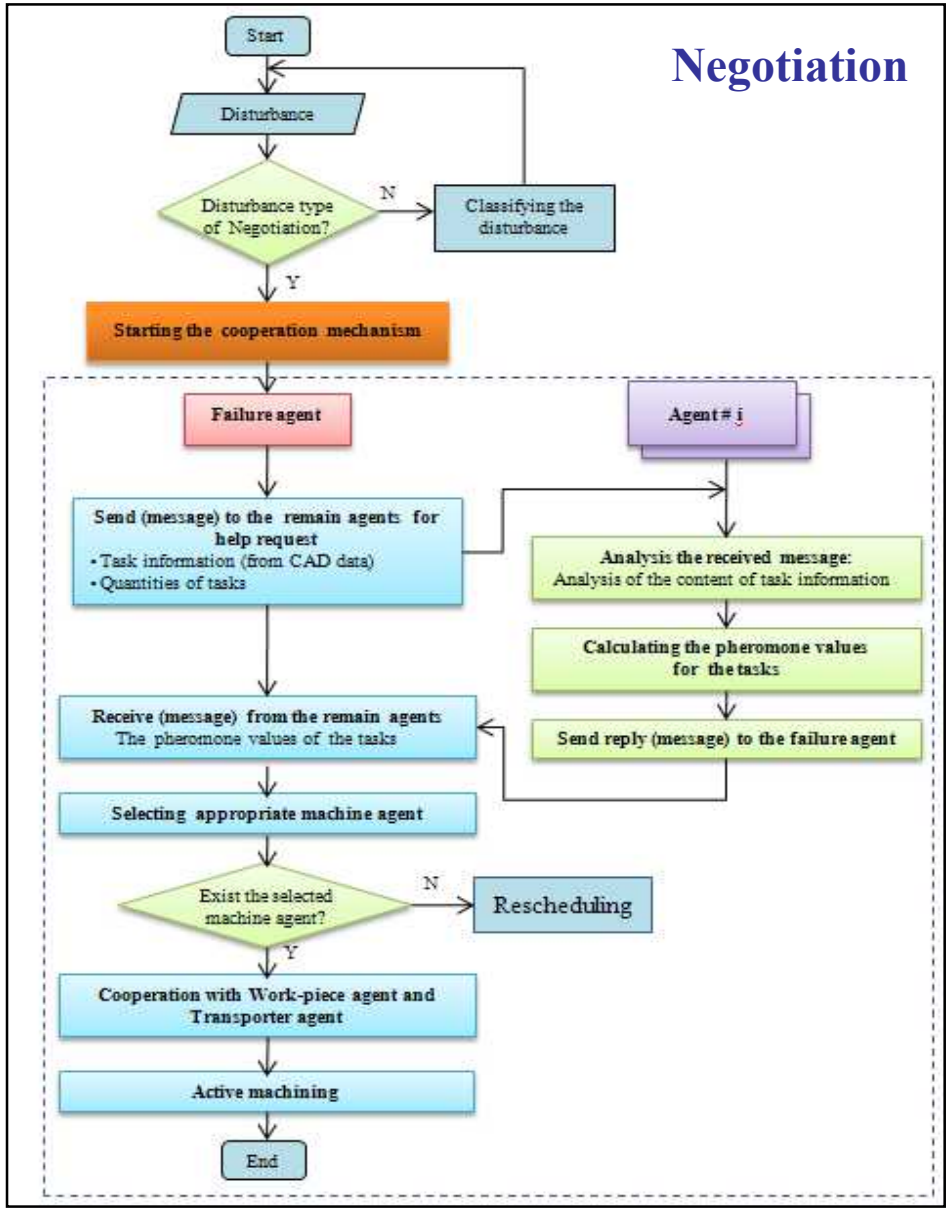


Database design and analysis

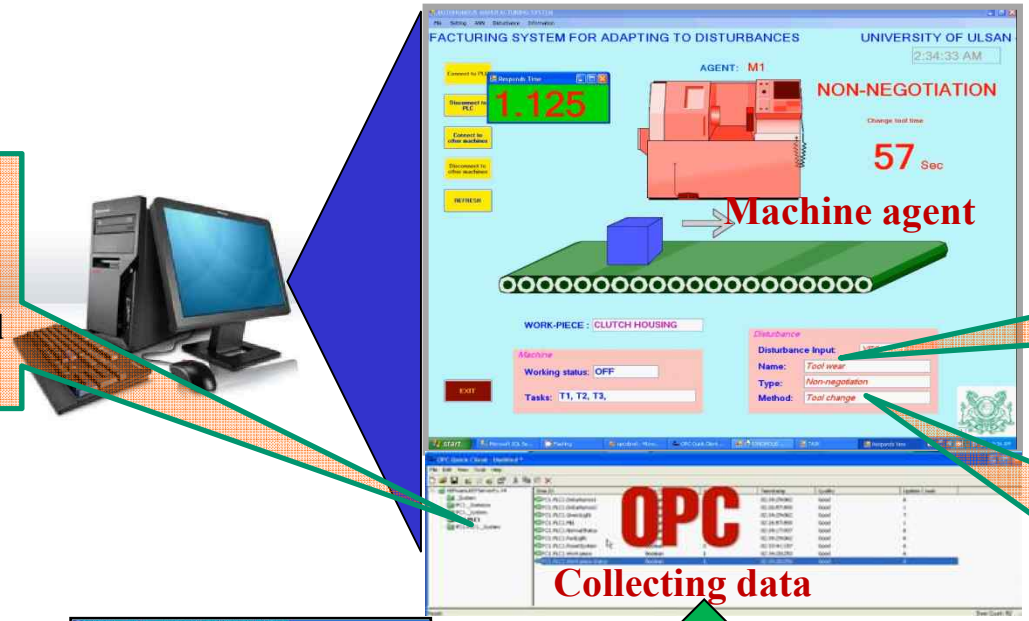


Algorithm for making decision of SAMS





Reaction of the system in the case of non-negotiation



3 OPC protocol is used for communicating between PLC and agent

4 Agent diagnoses the disturbance type

5 In case of the disturbance belongs to the non-negotiation type, agent generates a new plan and sends the command to PLC

2 PLC 1 sends the signal to agent

1 Input disturbance shown by turning on the red light (alarm) at PLC 1

6 The system overcomes the disturbance shown by turning on the green light at PLC 1

Demonstration for non-negotiation mechanism

Reaction of the system in the case of negotiation

5 Agents establish the wireless network to server

MES

Registering network

6 Agent negotiation

4 Agent diagnoses the disturbance belonging to the negotiation type

Agent 1

NEGOTIATION

Agent 2

7 An appropriate agent is selected for carrying out the job of the failure machine

3 Collecting data

OPC

(Selected agent)
Agent 3

OPC

2 PLC 1 sends the signal to agent

PLC 1

1 Input disturbance shown by turning on the red light (alarm) at PLC 1

8 The system overcomes the disturbance shown by turning on the green light at PLC 2

PLC 2

Demonstration for negotiation mechanism

Conclusion

Summary

- The cognitive agent technology and the biology inspired strategy are applied to the SAMS
- Disturbances and corresponding management methods in the machining shop of a clutch housing are analyzed
- Developing a SAMS to autonomously overcome these disturbances
- Implementing a test-bed to demonstrate the functionalities of SAMS.

Benefits

- This method could replace the traditional method that has been intervened by human operator
- It has the functionalities of intelligent behaviour such as self-adapting, self-controlling, and reasoning ability in decision making
- Increasing the productivity and reducing downtime in the product line.

Future work

- Implementing self-evolution mechanism for solving the new disturbance to be happened

Thank you for your attention.