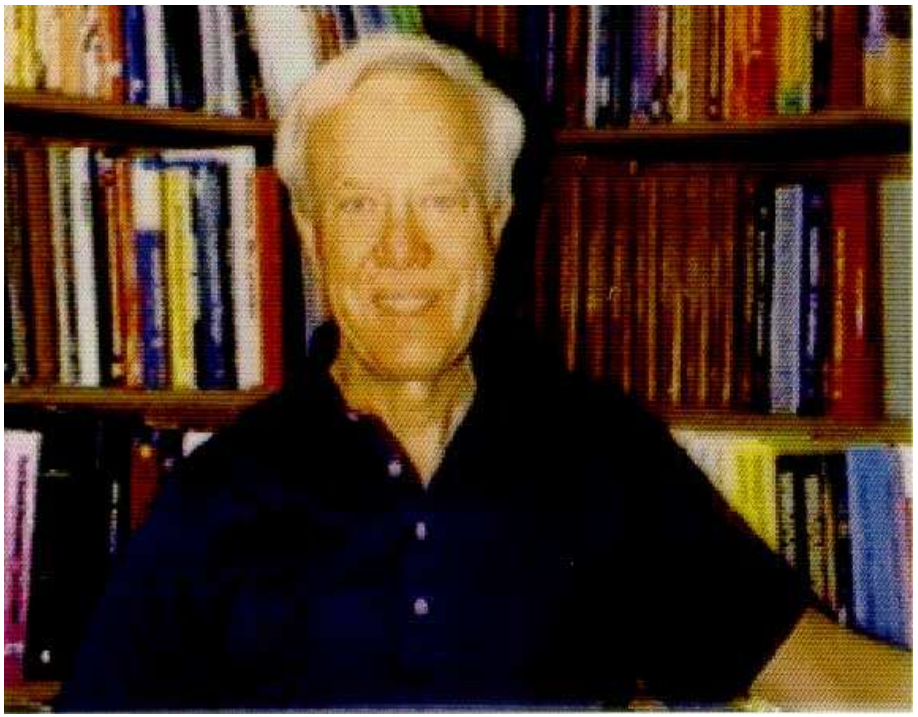


AI and computer science have already set about trying to fill … niches, and that is a worthy, if never-ending, pursuit.

But the biggest prize, I think, is for the creation of an artificial intelligence as flexible as the biological ones: that will win it.

Ignore the naysayers; go for it!

Nils J. Nilsson ***The Eye on the Prize***

Chapter I
Four Basic Topics in AI

Content

Chapter 1 - Four Basic Topics:

1.1 COOPERATION: Intelligent Agents

1.1.1 Agent Architecture

1.1.2 Multiagent Systems


1.1.1 Agent Architecture

Definition: What is an Agent?

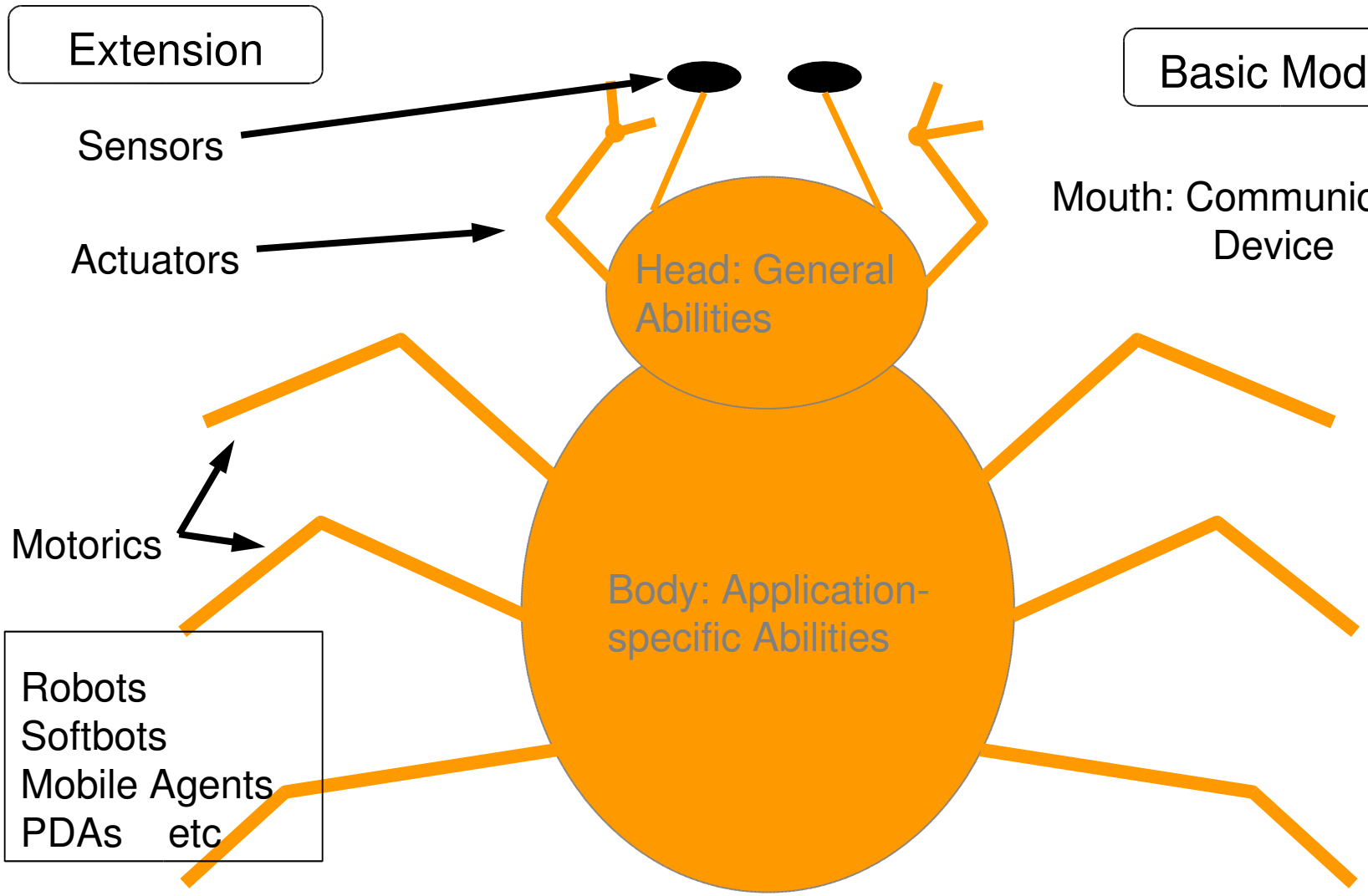
- Rao, Georgeff (91); Russell, Norvig (95)

- Wooldrige, Jennings:
  - *Autonomy*
  - *Reactivity*
  - *Pro-activity*
  - *Communication and Social Organization*

Properties of Agents (Jennings/Wooldrige)

Weak Notion of Agency	Stronger Notion of Agency	Other Properties
Autonomy	Knowledge/Belief	Rational
Social Ability	Intentions	Truthful ?
Reactivity	Desires/Goals	Benevolent
Pro-Activeness	Obligations	Mobile
		Emotions

The Agent Architecture: A Model



AIMA code

The code for each topic is devided into four directories:

- *agents:* code defining agent types and programs
- *algorithms:* code for the methods used by the agent programs
- *environments:* code defining environment types, simulations
- *domains:* problem types and instances for input to algorithms

AIMA code - Example

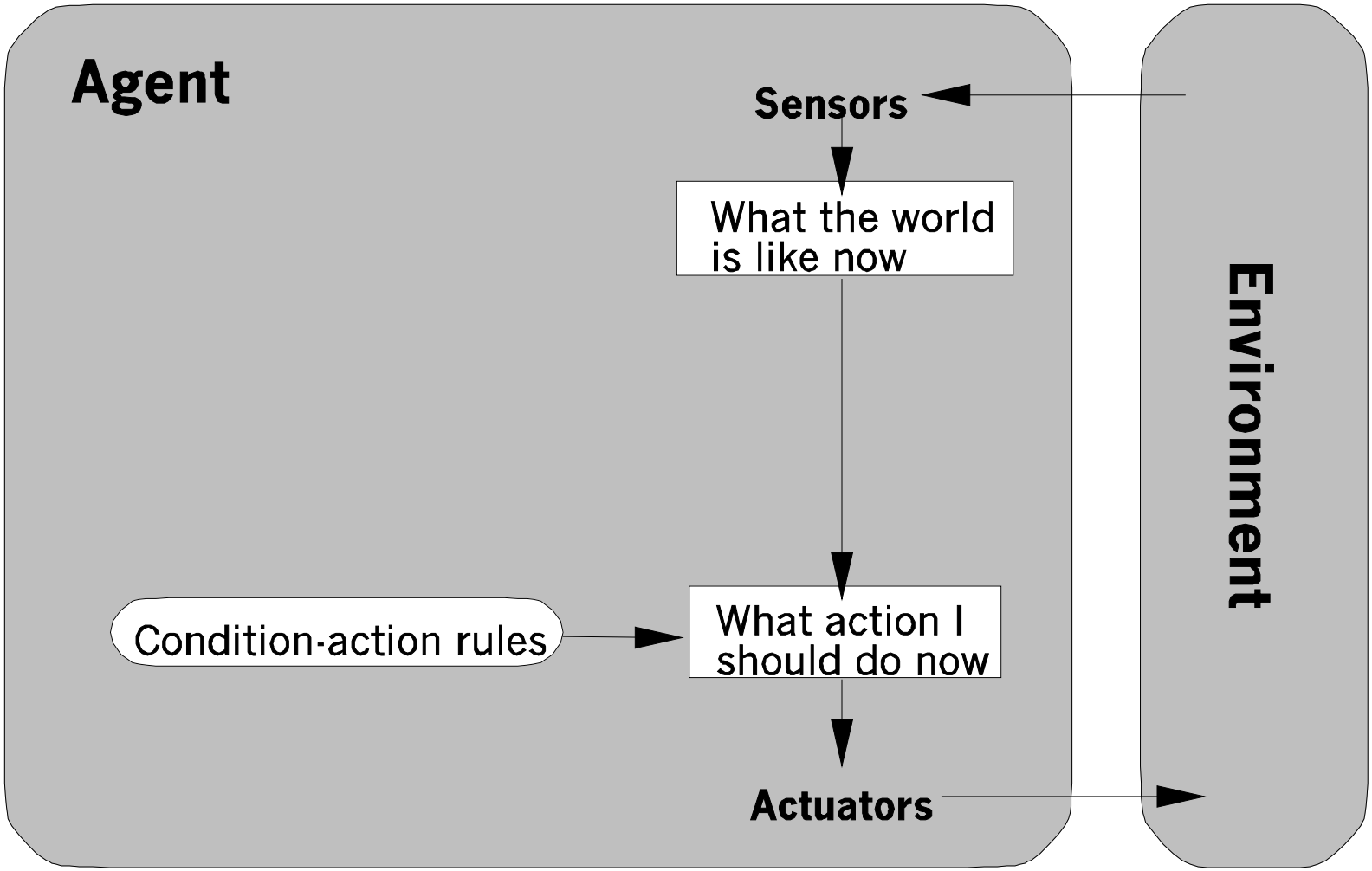
```
(setq joe (make-agent
        :name joe
        :body (make agent-body)
        :program (make-dumb-agent-program)))


(defun make-dumb-agent-program ()
  (let ((memory nil))
  #'(lambda (percept)
        (push percept memory)
        'no-op)))
```

Skeleton of an agent

```
function SKELETON-AGENT (percept) returns action
    static: memory, the agent's memory of the
            world
    memory ← UPDATE-MEMORY (memory, percept)
    action ← CHOOSE-BEST-ACTION (memory)
    memory ← UPDATE-MEMORY (memory, action)
    return action
```

TYPE 1: Simple Reflex Agents



Schema of a simple reflex agent

```
function SIMPLE-REFLEX-AGENT (percept)
    returns  action
    static:  rules, a set of condition action
             rules
    state ← INTERPRET-INPUT (percept)
    rule ←  RULE-MATCH (state, rules)
    action ←RULE-ACTION (rule)
    return action
```

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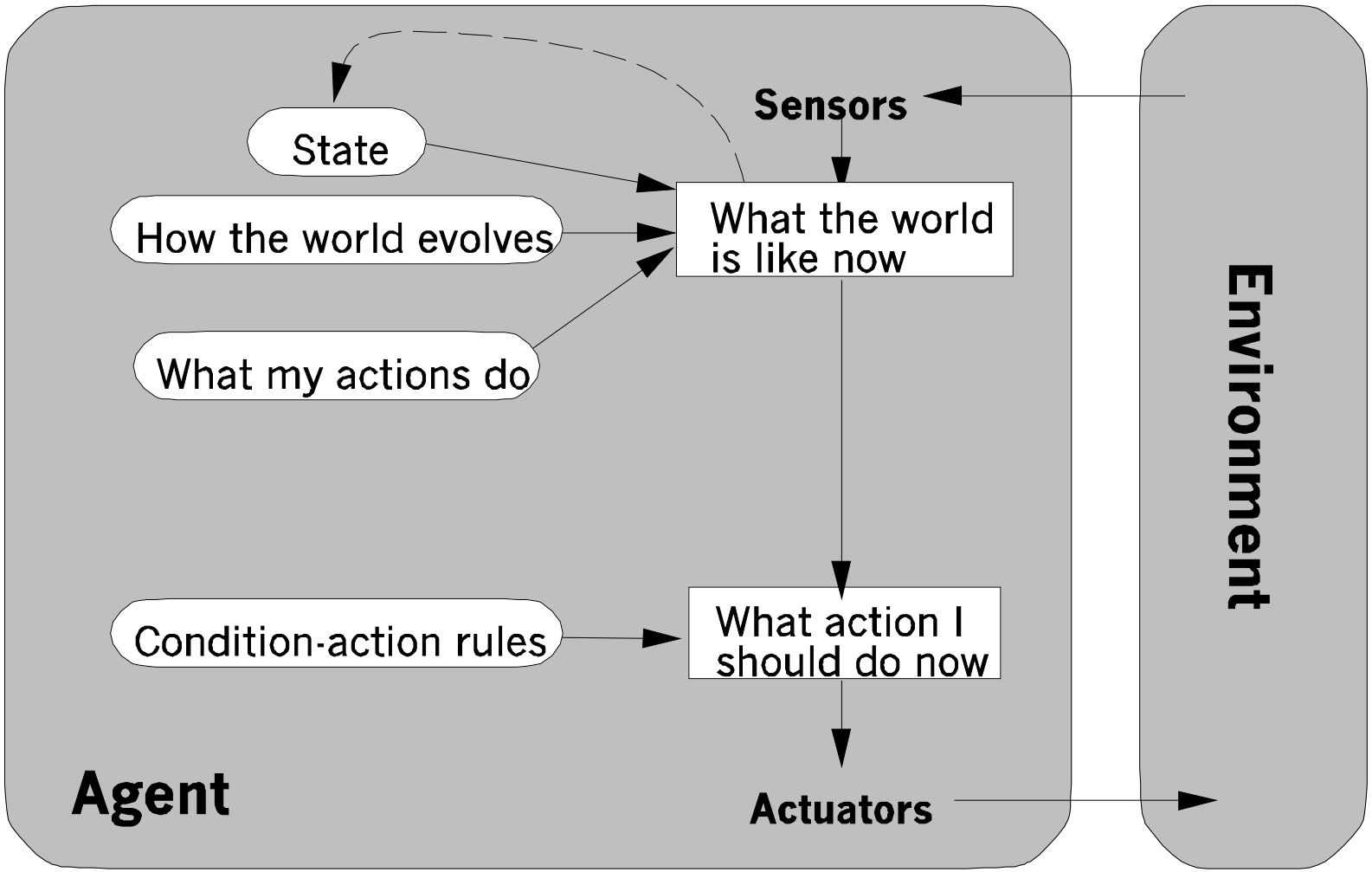
TYPE 2: State-based Agents

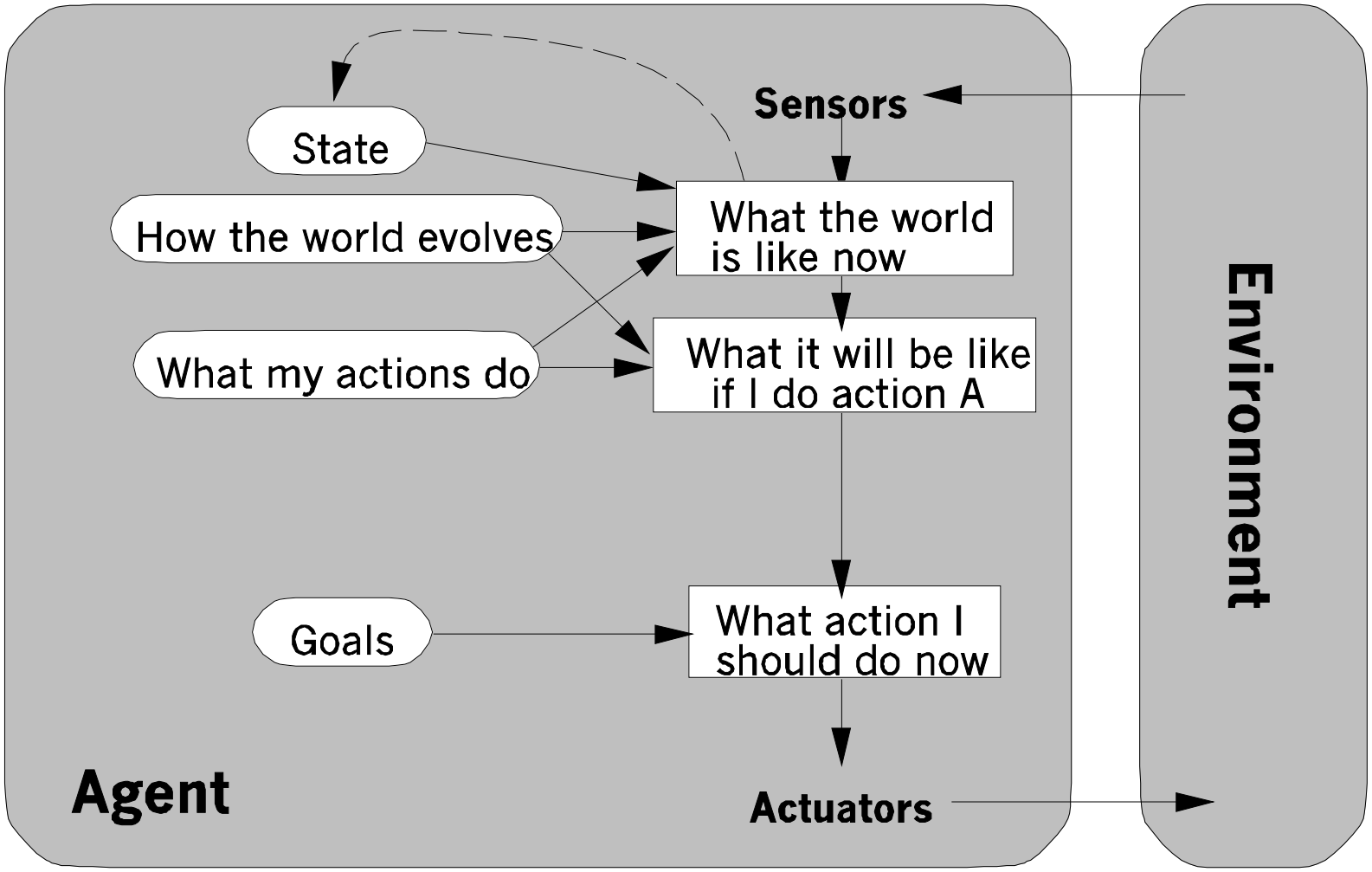


Schema of a Reflex Agent with State

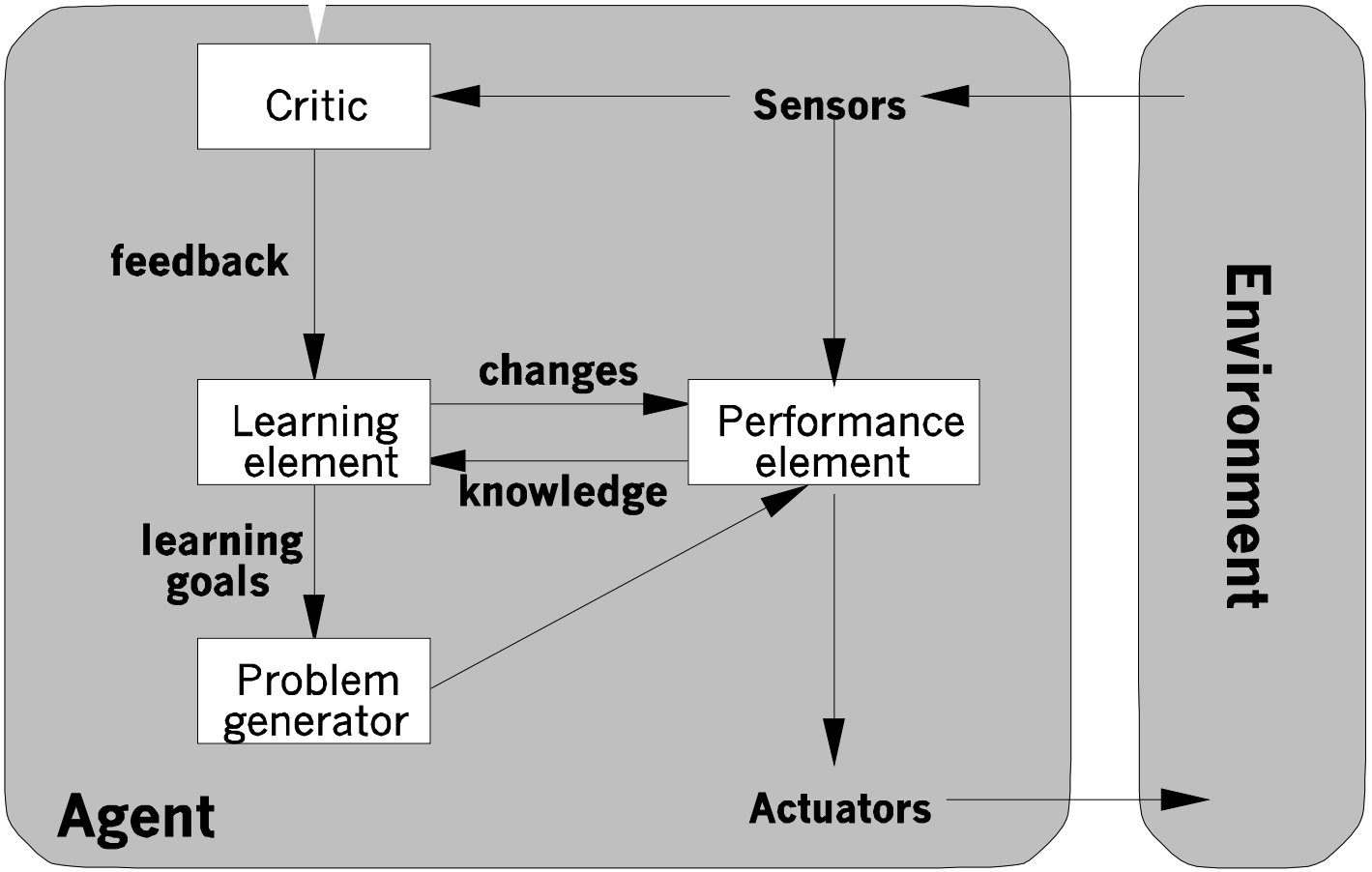
(state ≈ internal representation of the world)

```
function REFLEX-AGENT-WITH-STATE (percept)
    returns  action
    static:  rules, a set of condition action
             rules
    state ← UPDATE-STATE (state, percept)
    rule ←   RULE-MATCH (state, rules)
    action ←RULE-ACTION [rule]
    state ← UPDATE-STATE (state, action)
    return action
```

TYPE 3: Goal-based Agents



TYPE 4: Learning Agents/Utility based Agents



Classification of Agents

Utility-based Agents/Learning Agents:Type 4

Goal-based Agents: Type 3

State-based Agents:Type 2

Simple Reflex Agents: Type1

TYPE 5:

Consciousness

?

Nilsson, Russel & Norvig

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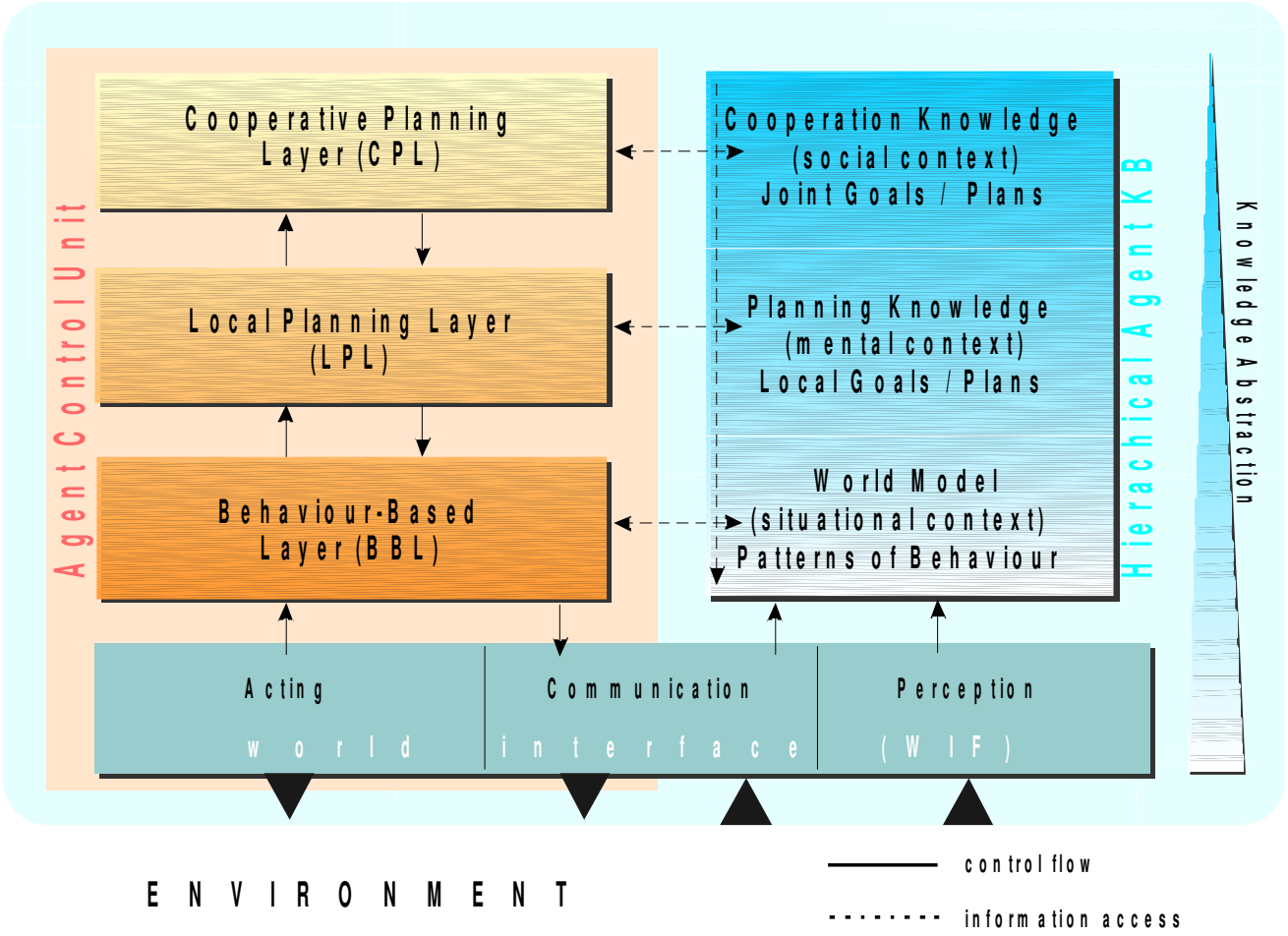
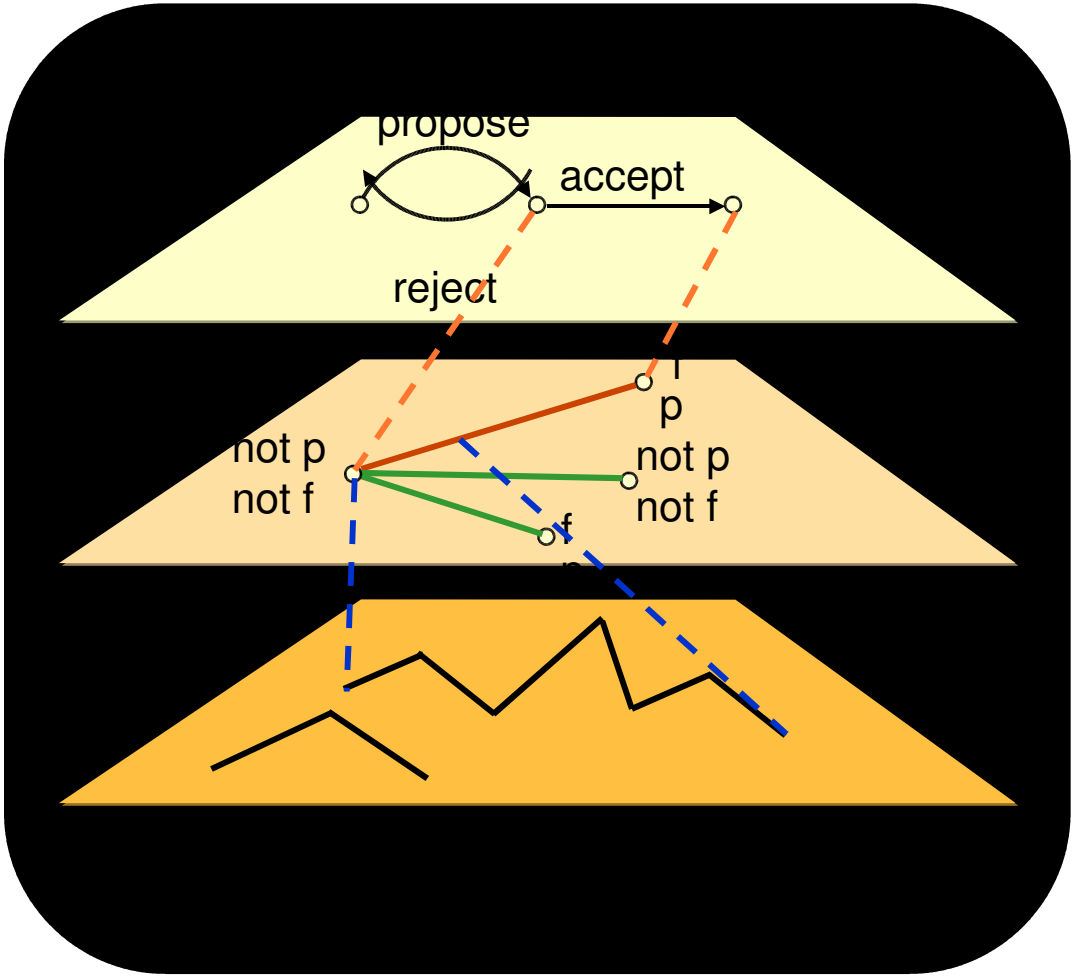
The Agent Architecture InteRRaP



Intuitive View of the InteRRaP Agent Architecture

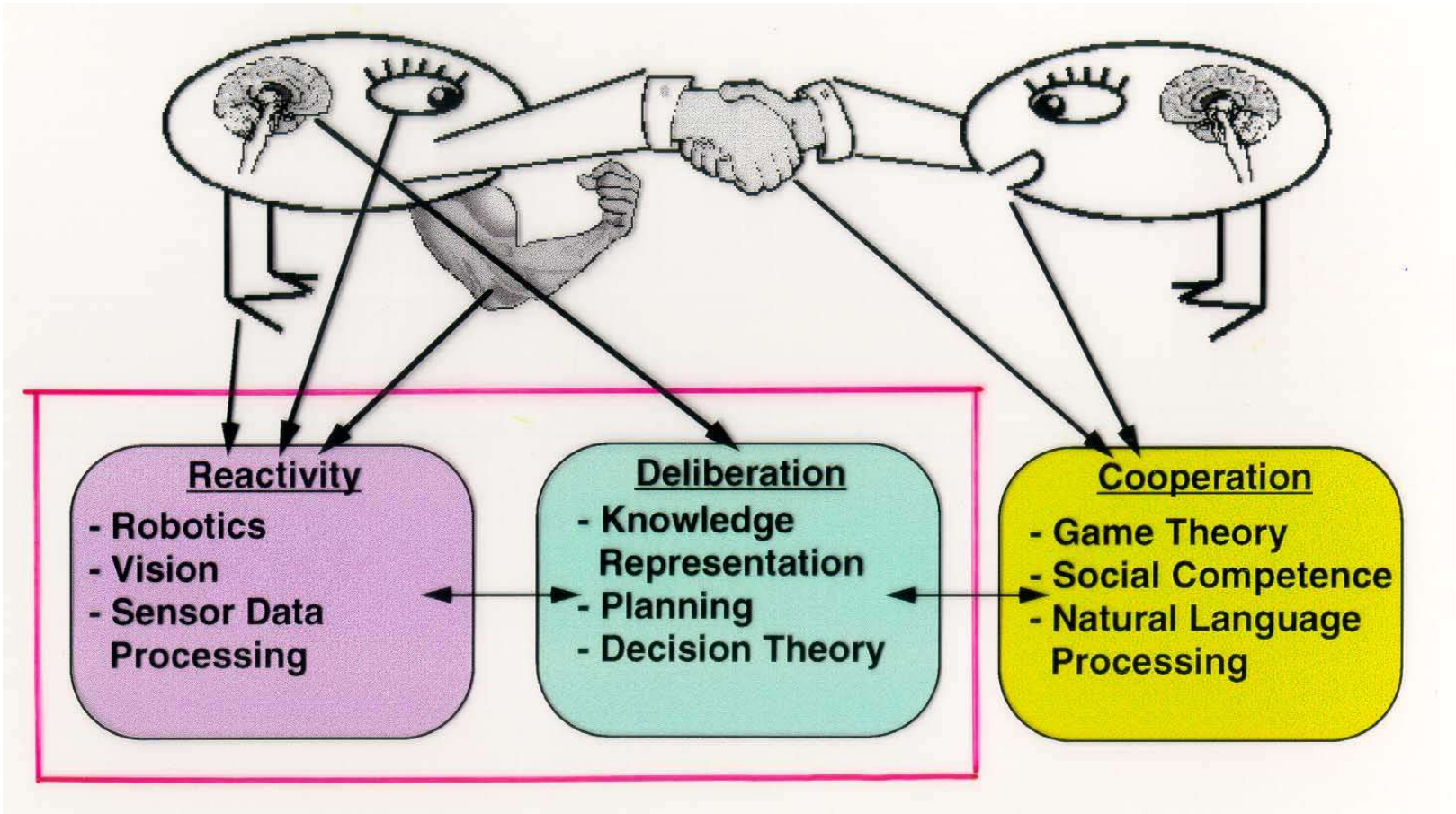


Cooperative Planning Layer

Local Planning Layer

Behaviour-Based Layer

DISTRIBUTED ARTIFICIAL INTELLIGENCE



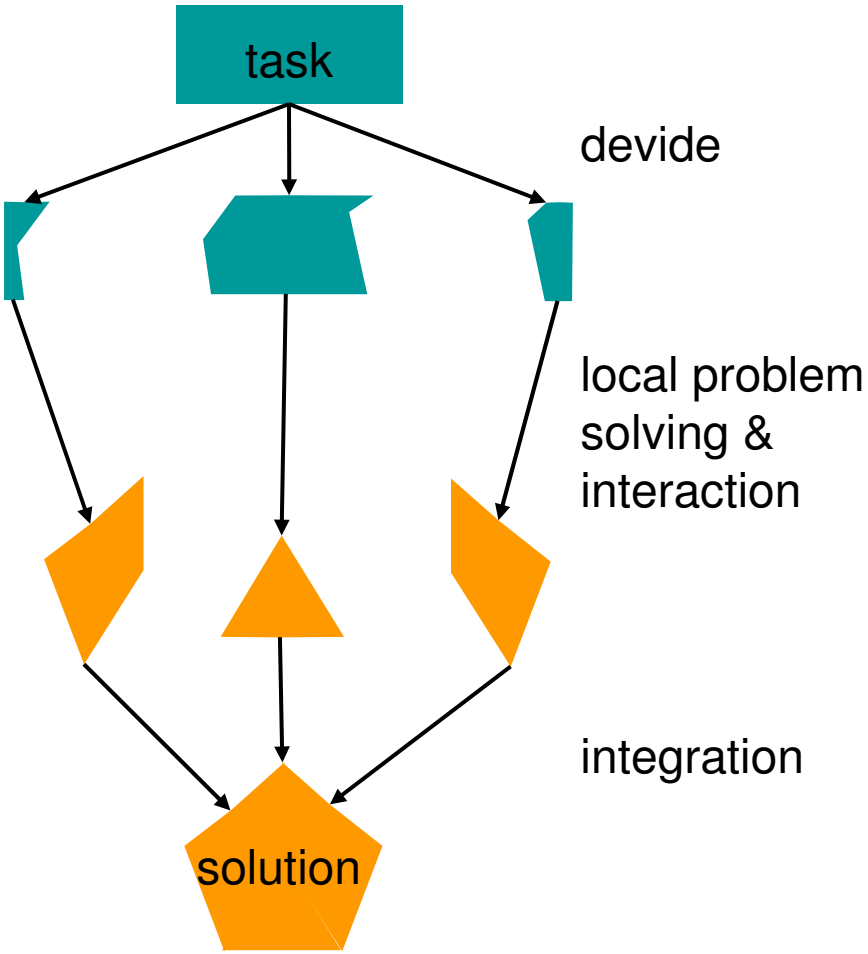
DAI integrates many AI topics


1.1.2 Multiagent Systems

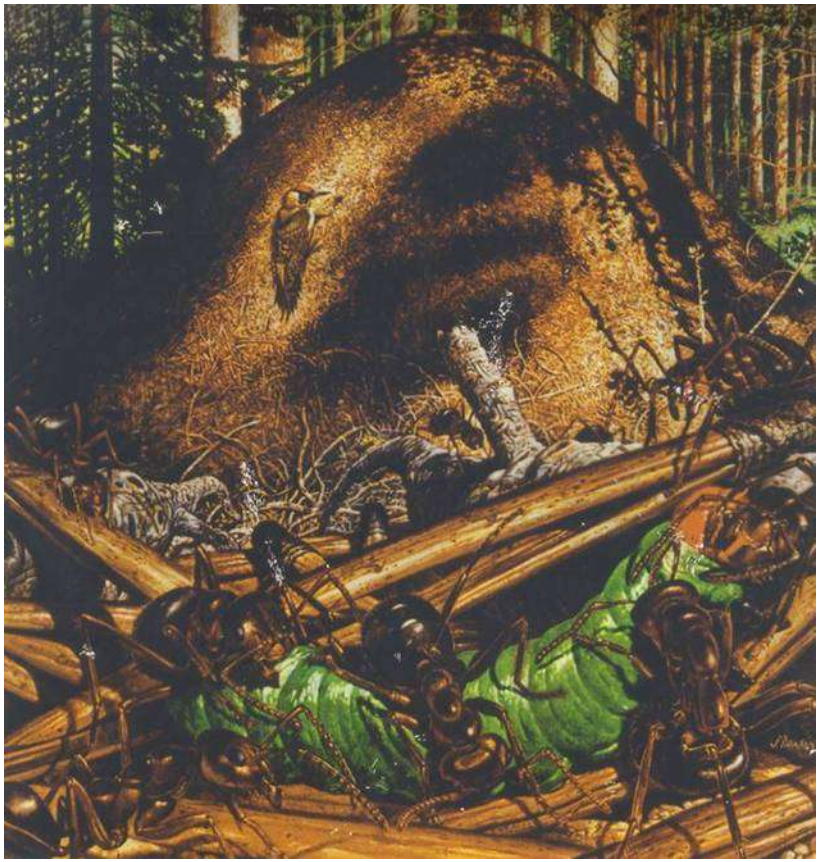
Cooperation

Shift of Programming Paradigm

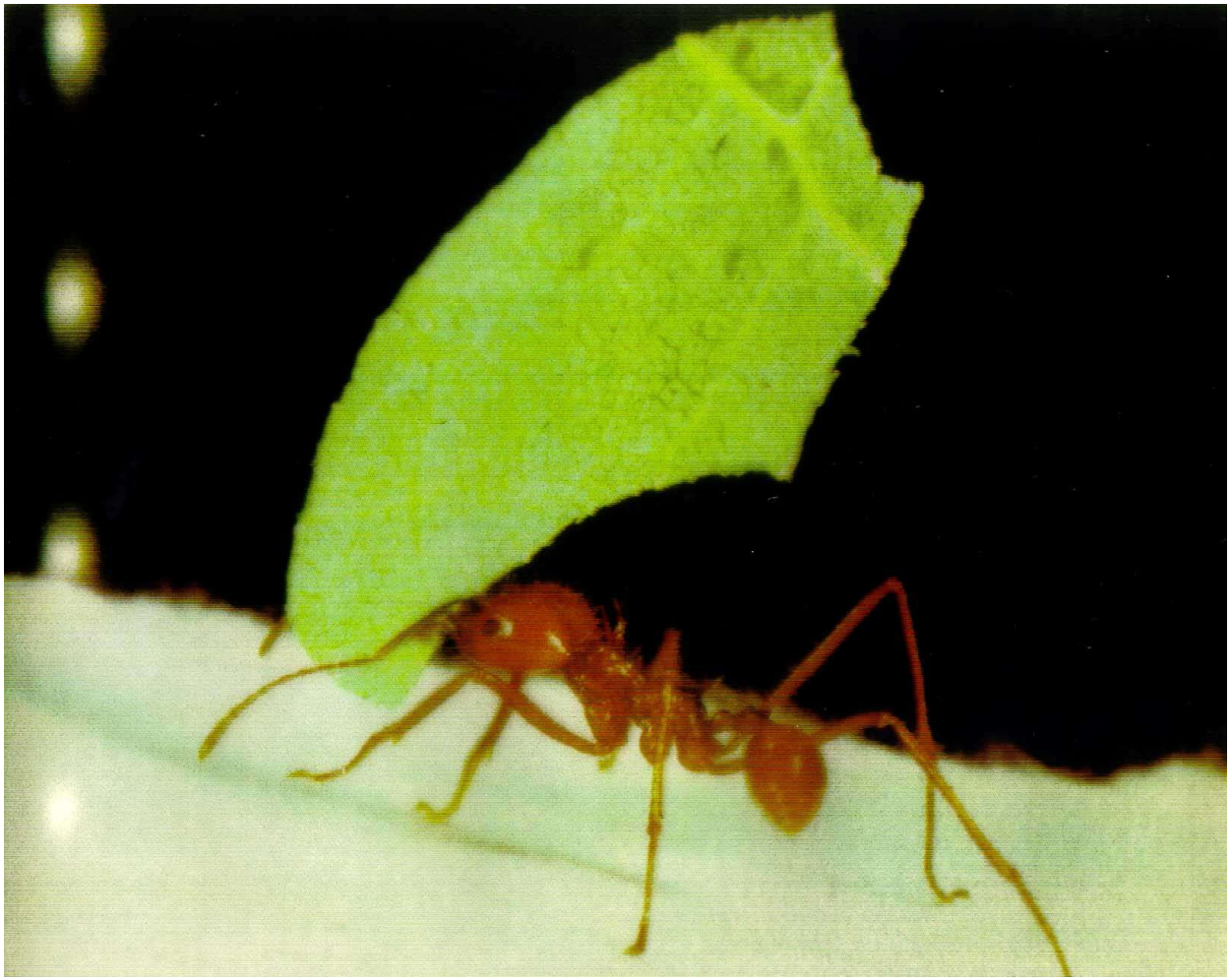
divide and conquer



emergent problem solving behaviour



Natural MAS:
Ants have astonishing Abilities



Termitarium

The Red Amazon Ant

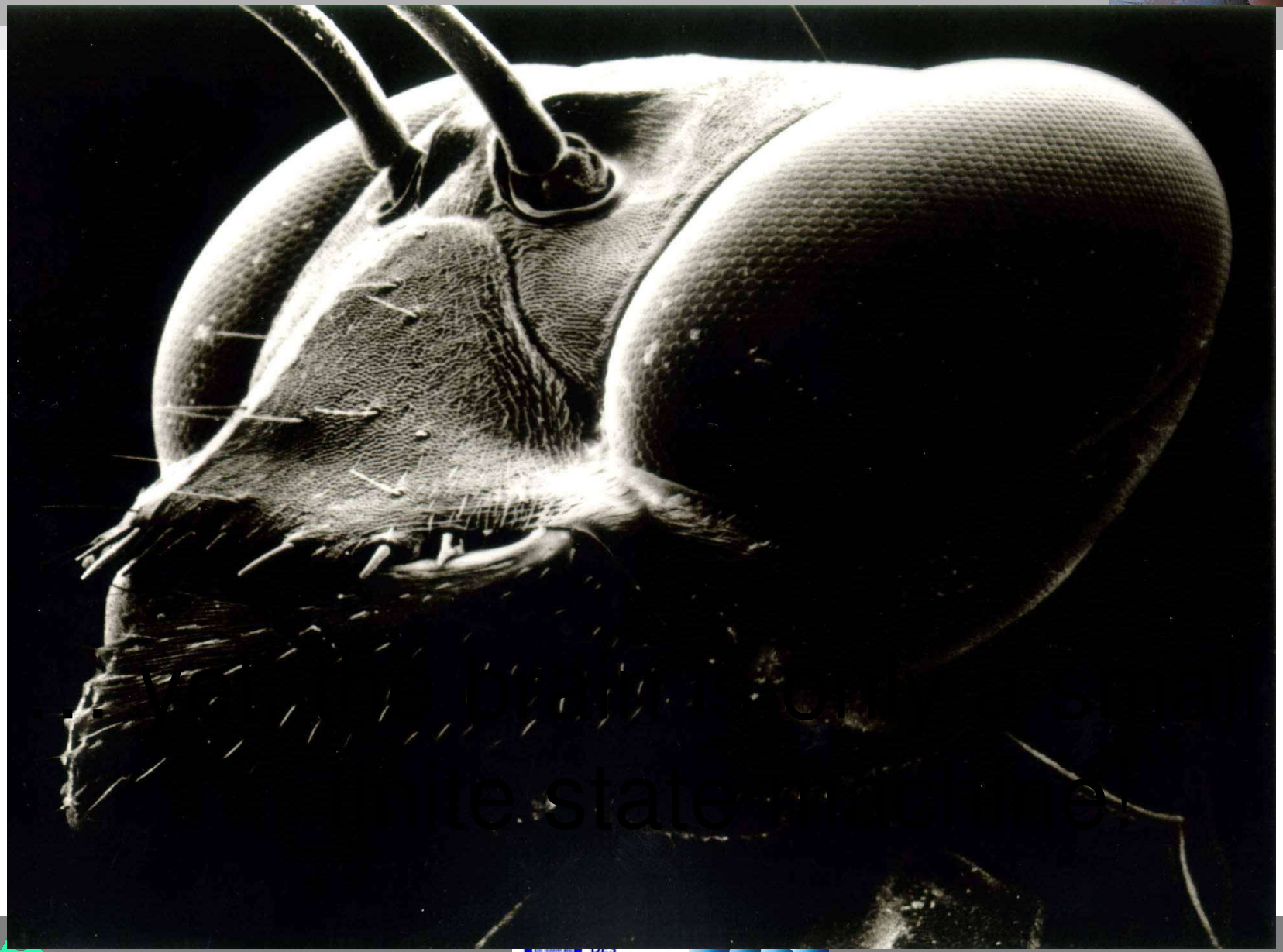
Ant Attack: Description

Plate 15. The red Amazon ants (Polyergus rufescens) invade the nest of Formica fusca to capture the pupae. At this moment, the scouts that discovered the site are leading a raiding party into the nest interior. Some defenders grasp the brood and attempt to flee. The mandibles of Polyergus are specialized fighting weapons with which they can easily penetrate the Formica worker's cuticle.
(From Hölldobler, 1984d; painting by J. D. Dawson reprinted with permission of the National Geographic Society.)

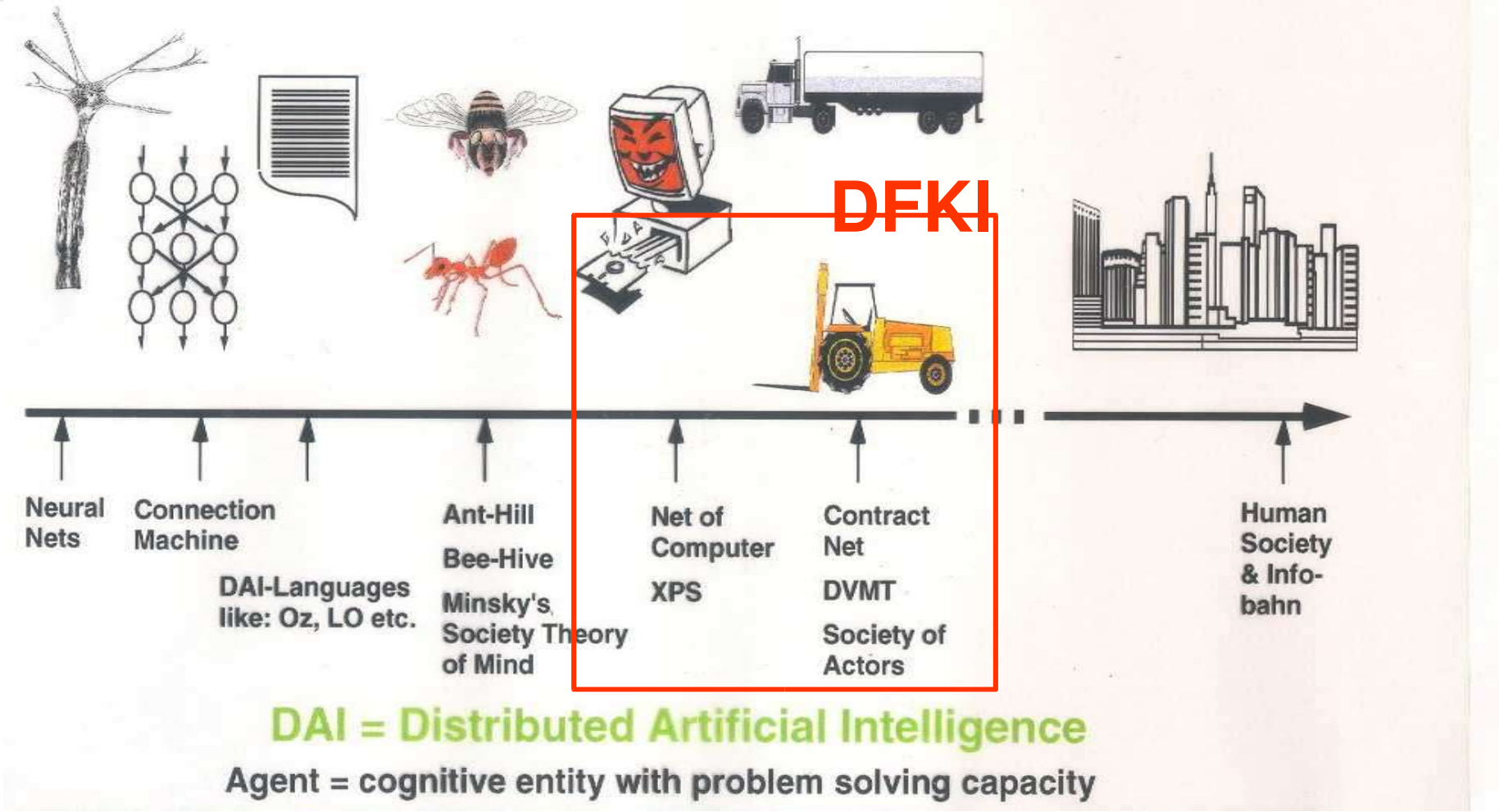
The African Weaver Ant

Weaver Ant: Description

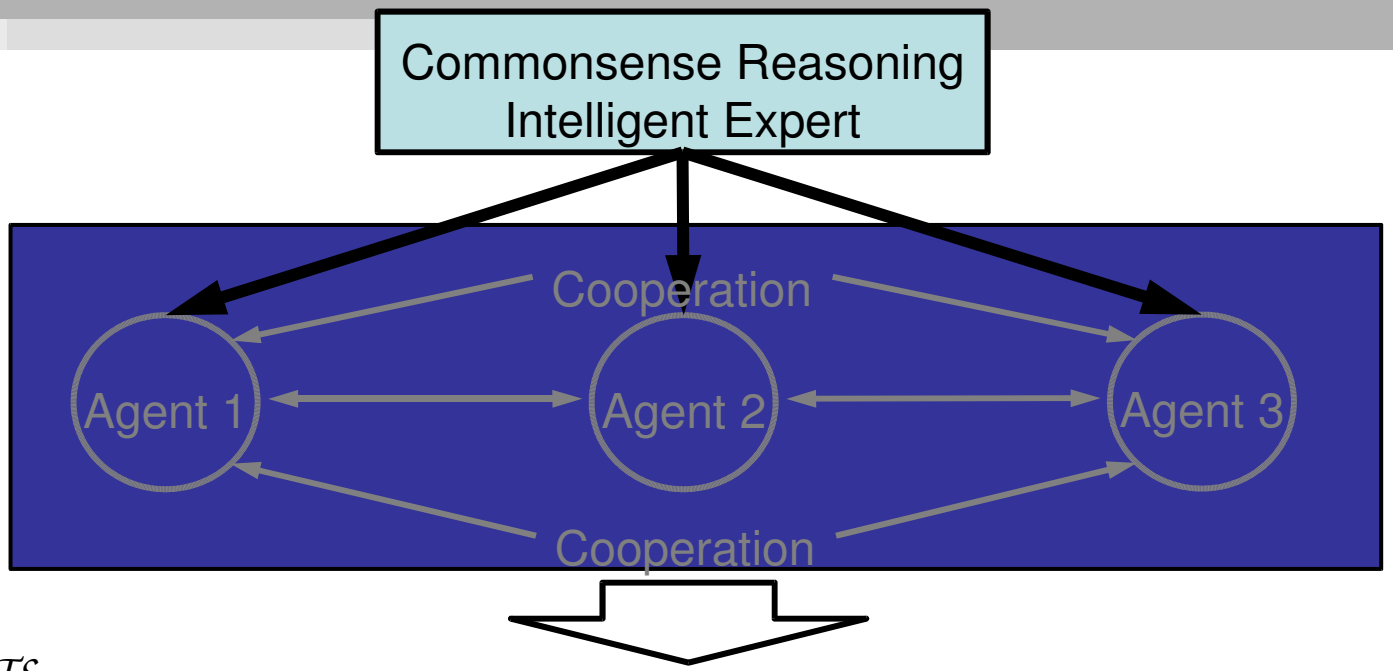
Plate 6. The African weaver ant, Oecophylla longinoda, establishes large territories in tree canopies. The maintenance and defense of the territories are organizes by a complex communication system. Confronting a stranger (left foreground), a worker displays hostility with gaping mandibles and the gaster cocked over the forward part of the body. Another pair in the background are clinched in combat. Rushing toward the leaf nest (upper right), another ant lays an odor trail with secretions from the rectal gland at the abdominal tip. The chemical substances in this trail will lead reinforcements to the fray. When capturing a prey object, such as a giant black African stink ant (Paltothyreus tarsatus), ant organize cooperation by means of chemical short-range recruitment signals from the sternal gland and alarm pheromones from the mandibular gland.
(From Hölldobler, 1984d; painting by J. D. Dawson reprinted with permission of the National Geographic Society.)



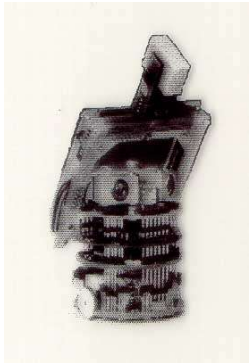
MAS-Research at DFKI in Saarbrücken



DFKI: Autonomous Cooperating Agents



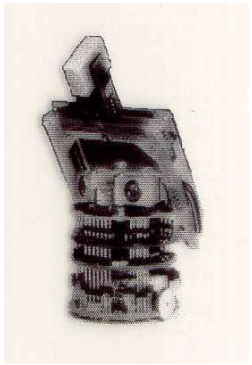
SOFTBOTS



Technical Applications:

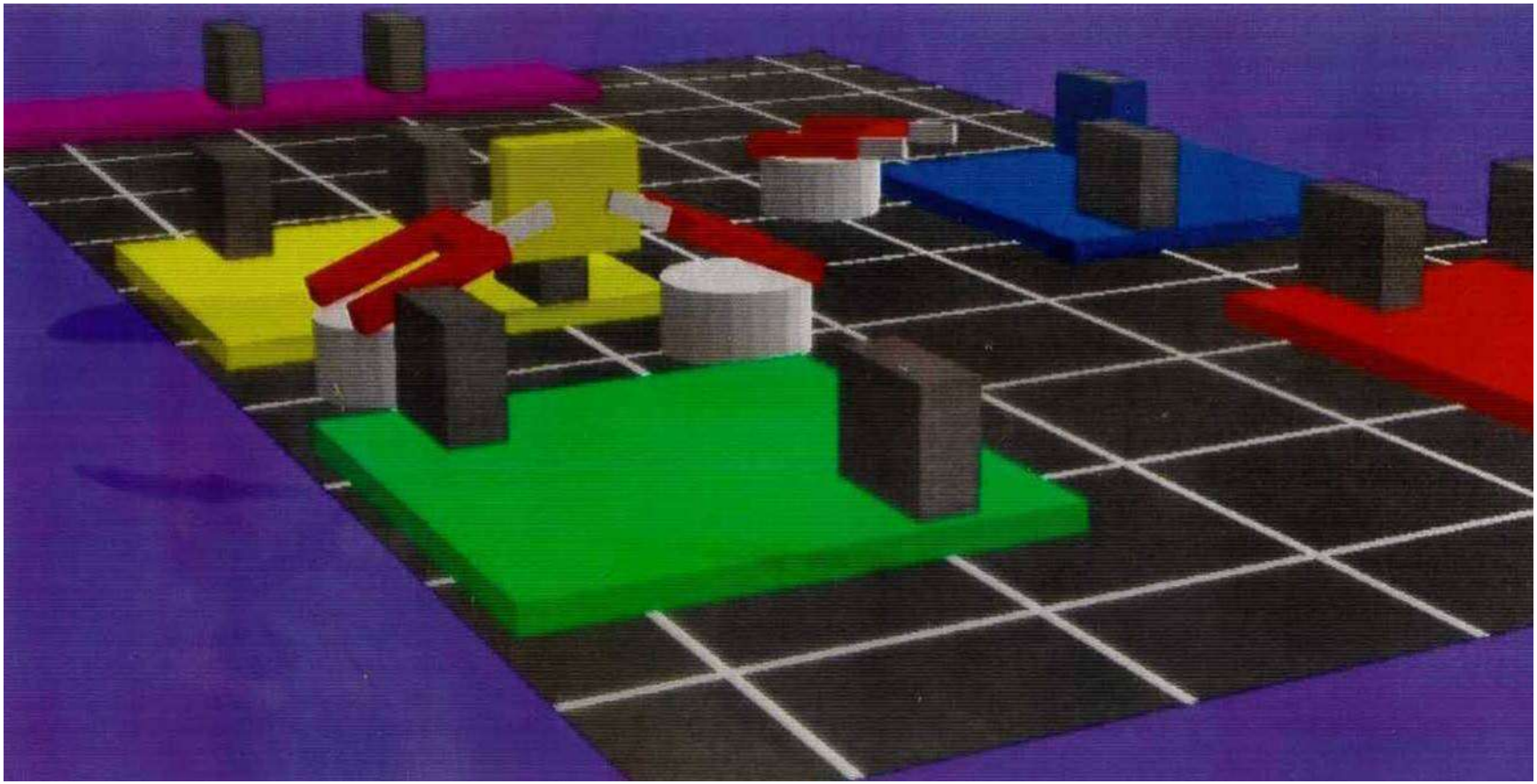
- Interacting Robots
- Air Traffic Control Systems
- Scheduling and Planning in CIM and Logistics
- Storehouse Administration
- Games
- etc.

ROBOTS

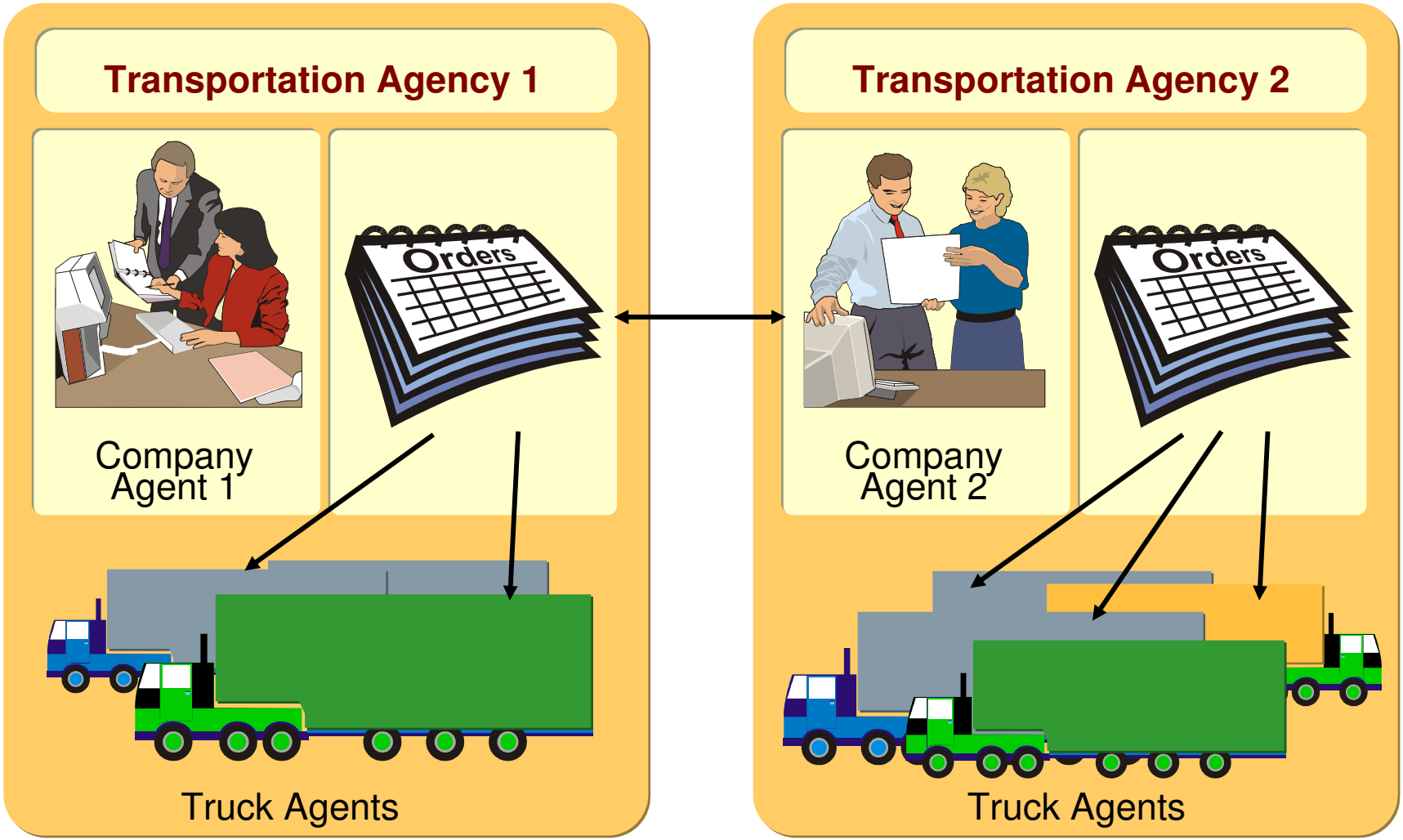


DFKI: Physical Implementation of the Loading Dock

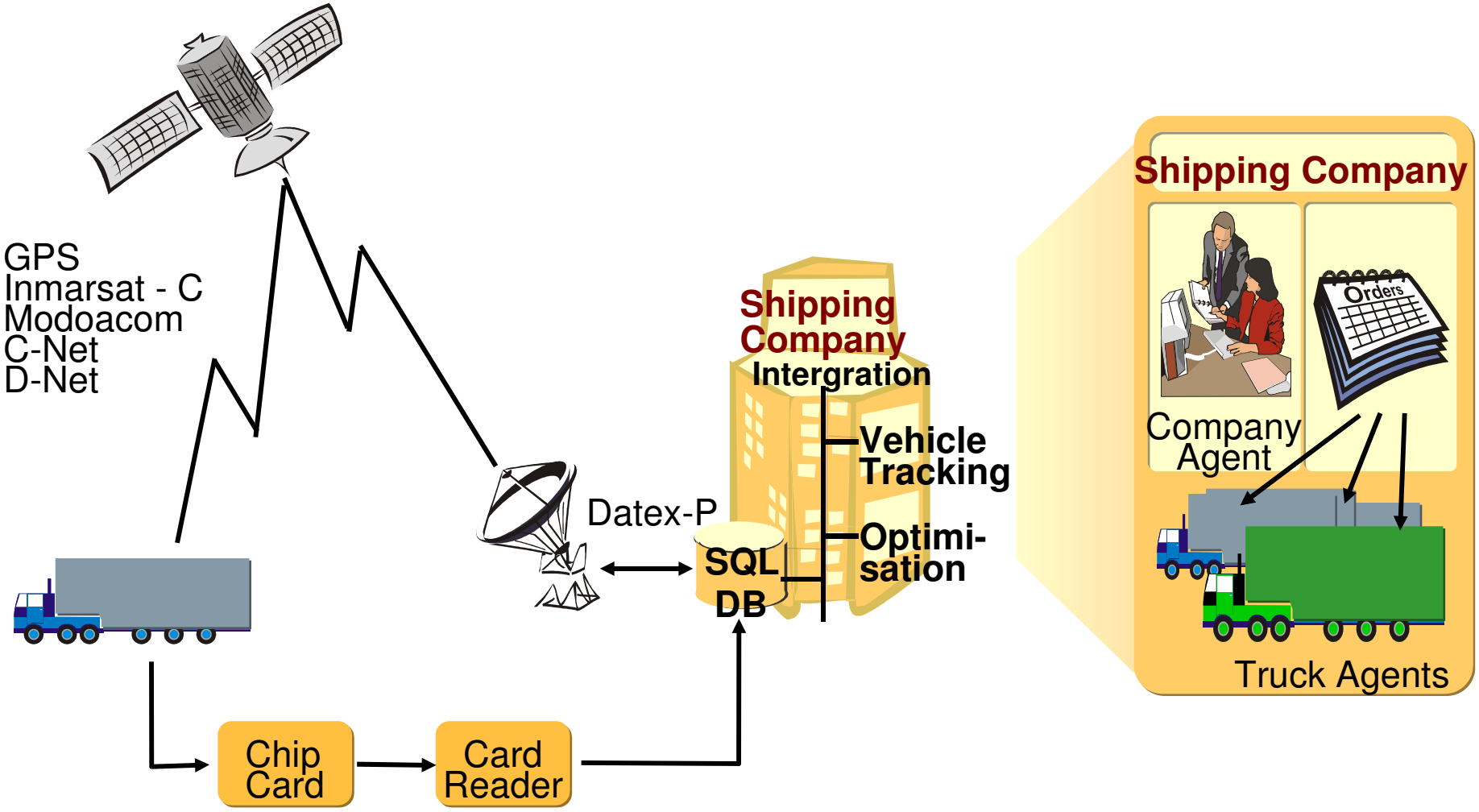
DFKI: Implementation in a 3D Simulated World



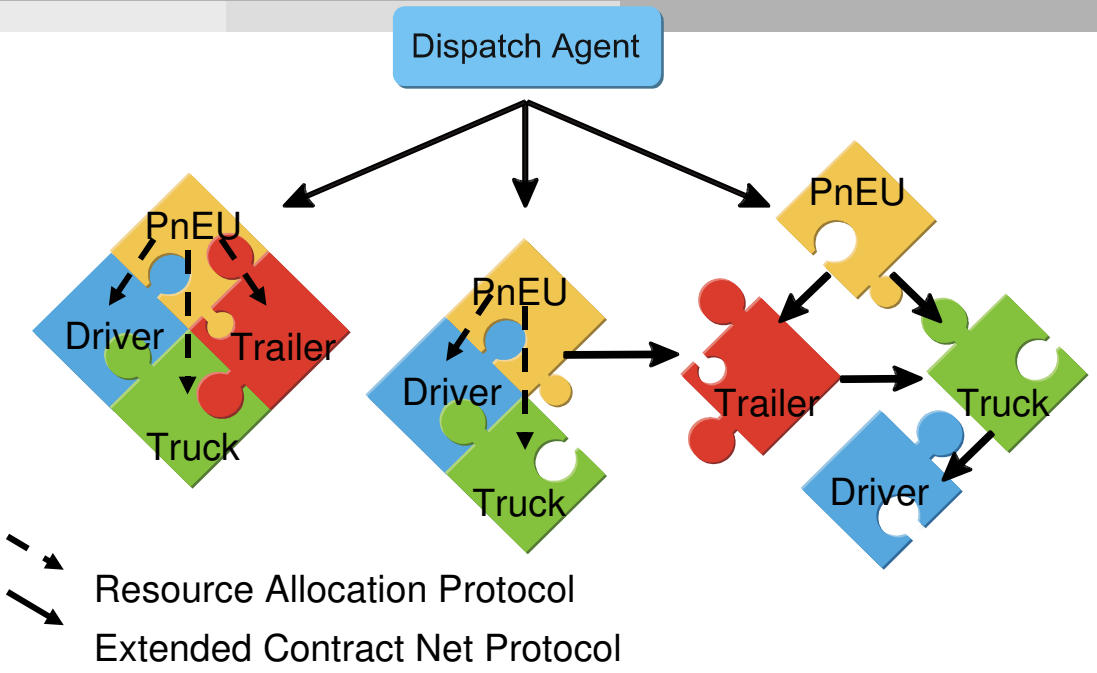
Traffic Telematics is one of the Main Application Areas



DFKI: The Project TELETRUCK



TELETRUCK: Resources and Allocation



Company resources:

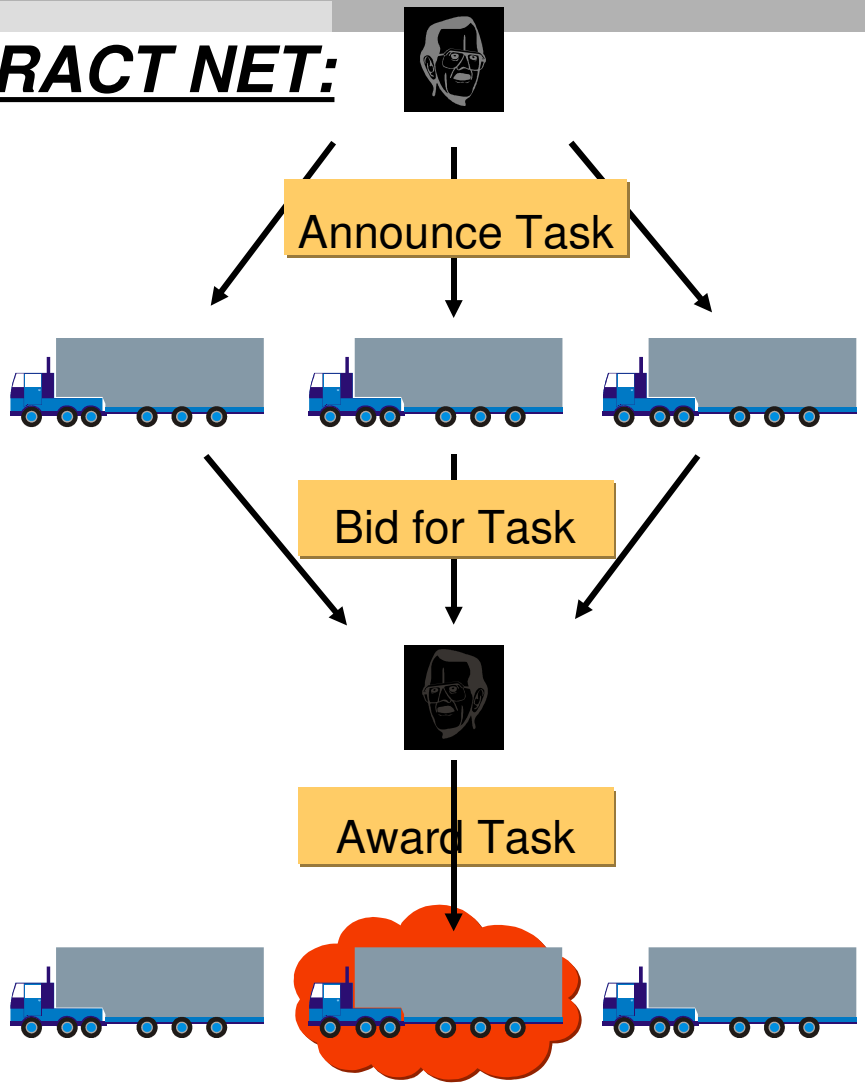
- Delivery tasks
- Planning and execution time
- Repair capacities
- Fleet size
- Freight monopolies
- Geographical dispersion

Inner-agent resources:

- Fuel
- Load capacity
- Repair state
- State of the human dirver

Task Allocation in the Transportation Domain

THE CONTRACT NET:



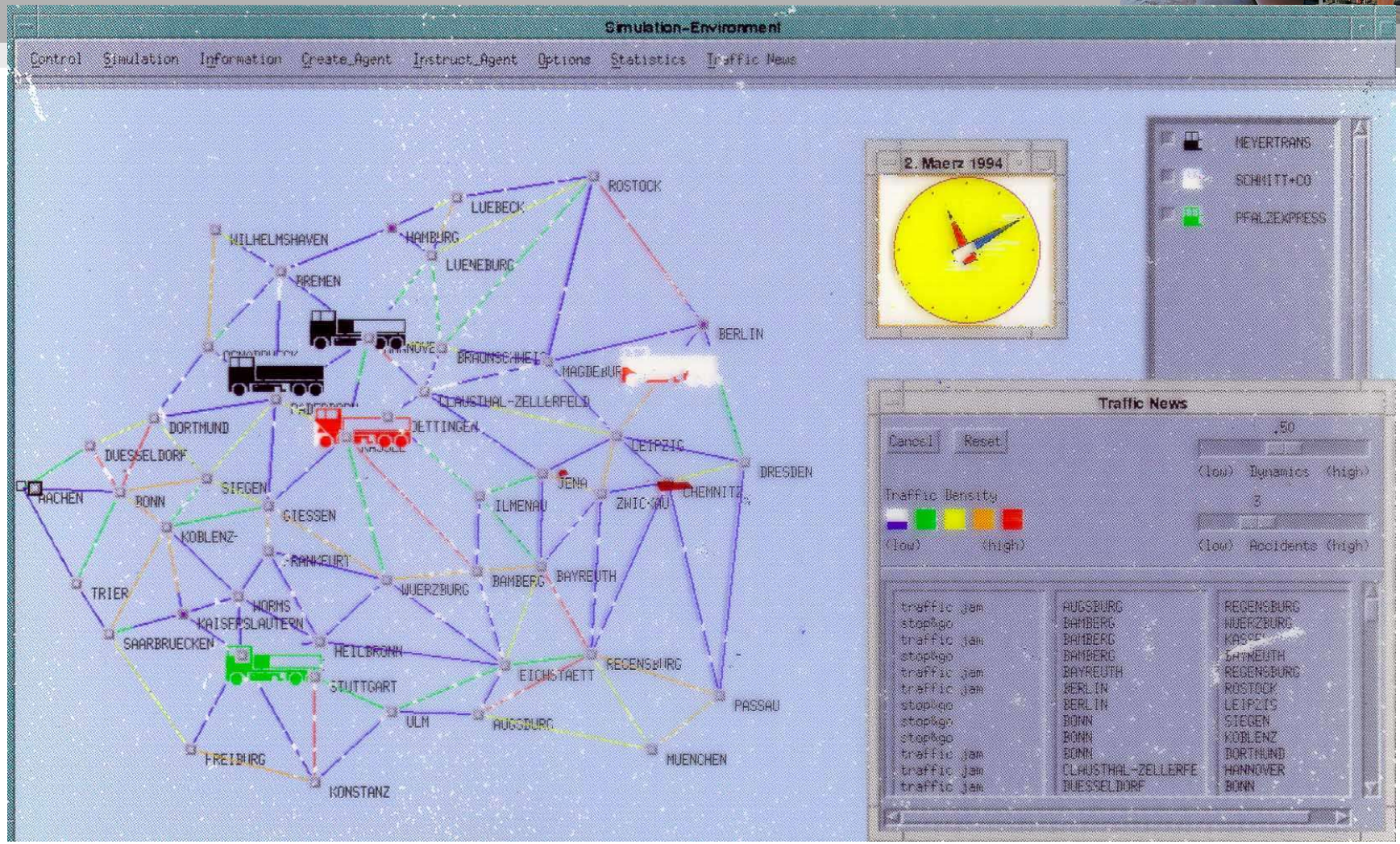
Select Bidders

Evaluate Orders

Select Best Bid

Execute Task

VERTICAL COOPERATION



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ROBO CUP: Examples

- **Ressources:**
  - stamina
  - attack
  - defence

- **Emotional States**:
  - fear: → attack
    → flight & run
  - hunger: → appetence

SFB-387:
“Resource Limited Cognitive Processes”

Emotions and Resources

Emotions are part of a management system to co-ordinate each individual's multiple plans and goals under constraints of time and other resources. Emotions are part of the biological solution to the problem of how to plan and to carry out action aimed at satisfying multiple goals in environments which ate mot perfectly predictable.

– Oatley and Johnson-Laird

Resource Driven Concurrent Computation