



Dynamic Agent Coalitions for Mediating EC B2B Activities

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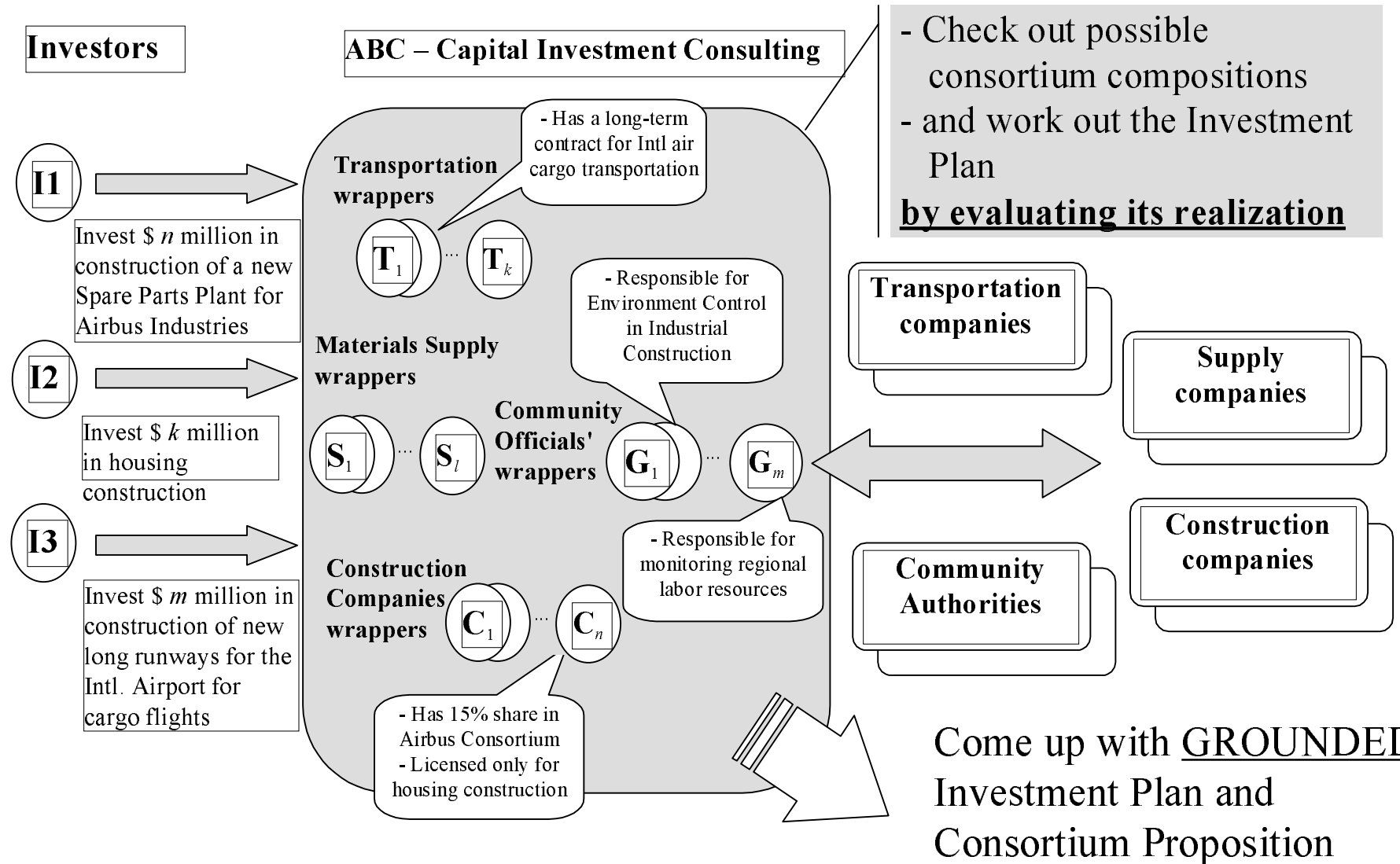
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What do I want to talk about

- Motivating Application** – ... suppose ABC is a successful Real/Virtual Company in Capital Investment Consulting domain providing Investment Plans and Consortia Compositions...- a kind of **planning by evaluation**
- The approach in a Nutshell** - modelling real/virtual organizations in EC B2B domain: generic character, scalability, flexibility and dynamic character
- Agent-Based Framework models** – please use the Nutshell picture as the Check List
- Case studied and lessons learned**: Planning by Evaluation
- Co-ordination as the core problem**: the types and the solutions
- Our weak points** and what are we planning to do with the staff

Motivating Application: EC B2B domain (1): Mediating B2B activities and cross-organizational relationships



Motivating Application: EC B2B domain (2):

What are the challenges? ...

1. The domain is inhabited with typically self-interested actors with uncertain and changing behavior...

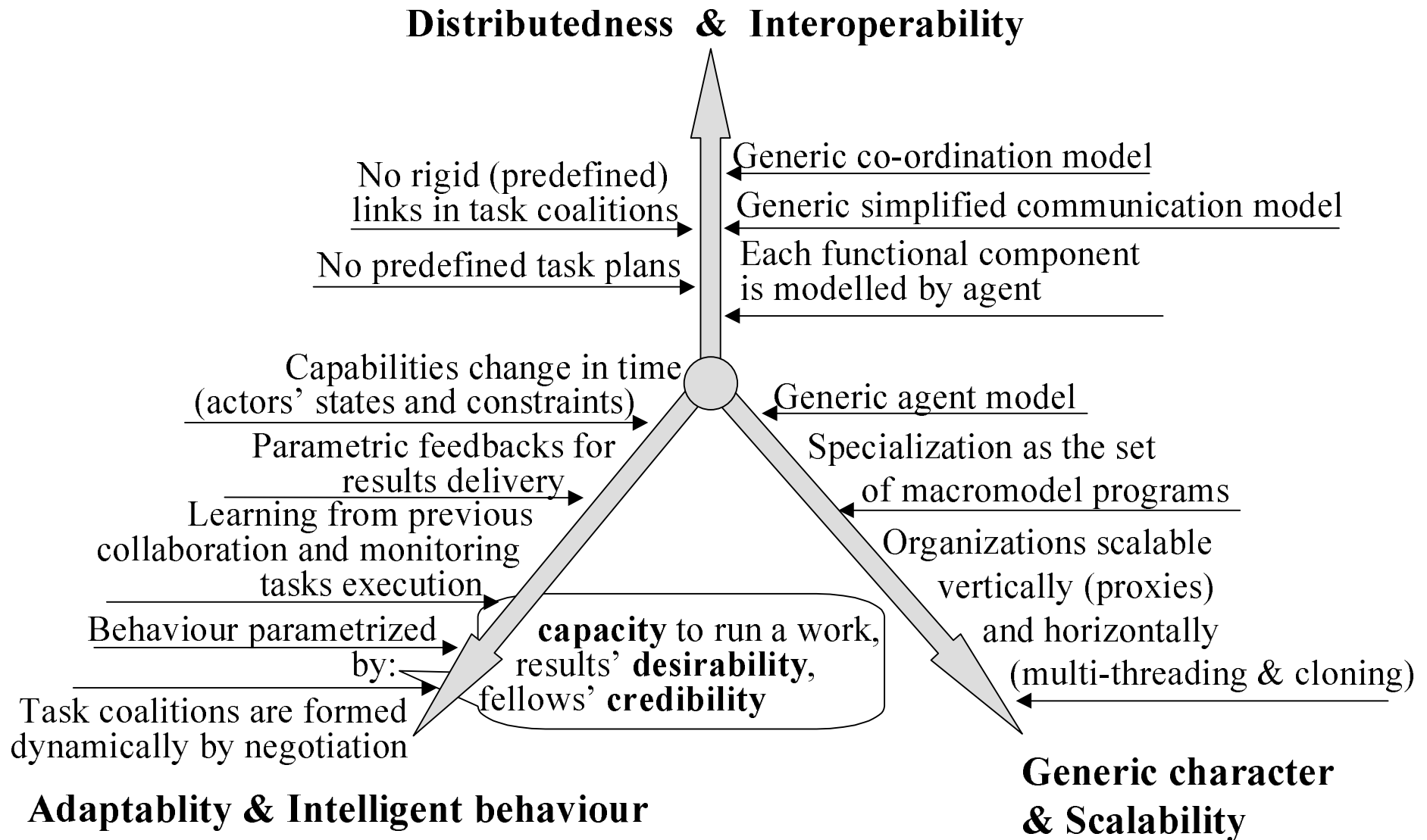
Degrees of uncertainty:

- Conflicting interests and competition within the organization between different actors wrapping various companies
- Conflicting interests between Investors and Wrapped Companies
- Resource limitations and capabilities are changing over time
- Actor's individual commitments and interests may be conflicting and may change in time

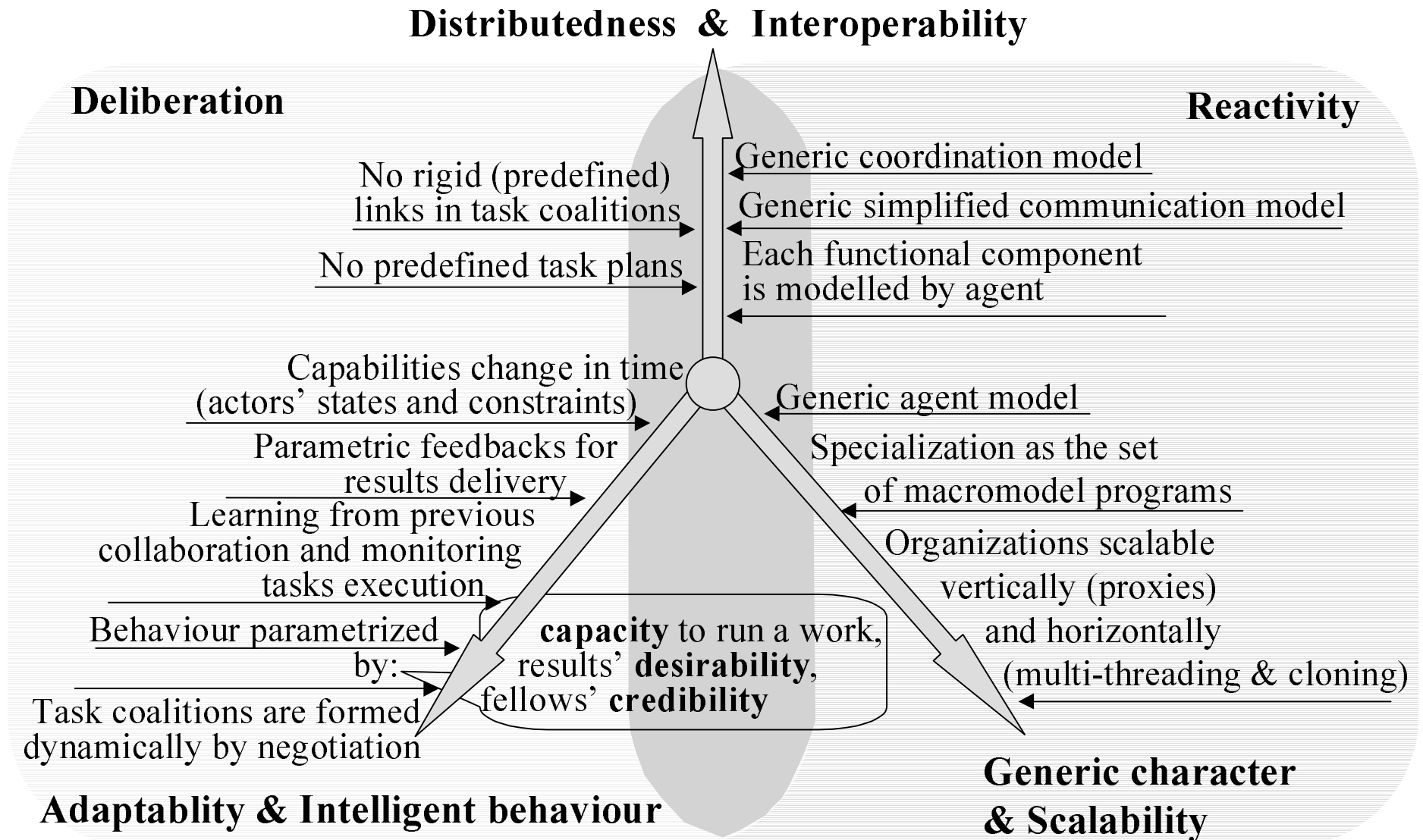
2. The actors are of intrinsic autonomous and distributed nature from one hand and are predisposed to collaborative activities from the other...

The balance between **self-interested** and **benevolent** components forms **“Satisficing” behavior**

The approach in a Nutshell: Agent-Based Framework



The approach in a Nutshell: Agent-Based Framework

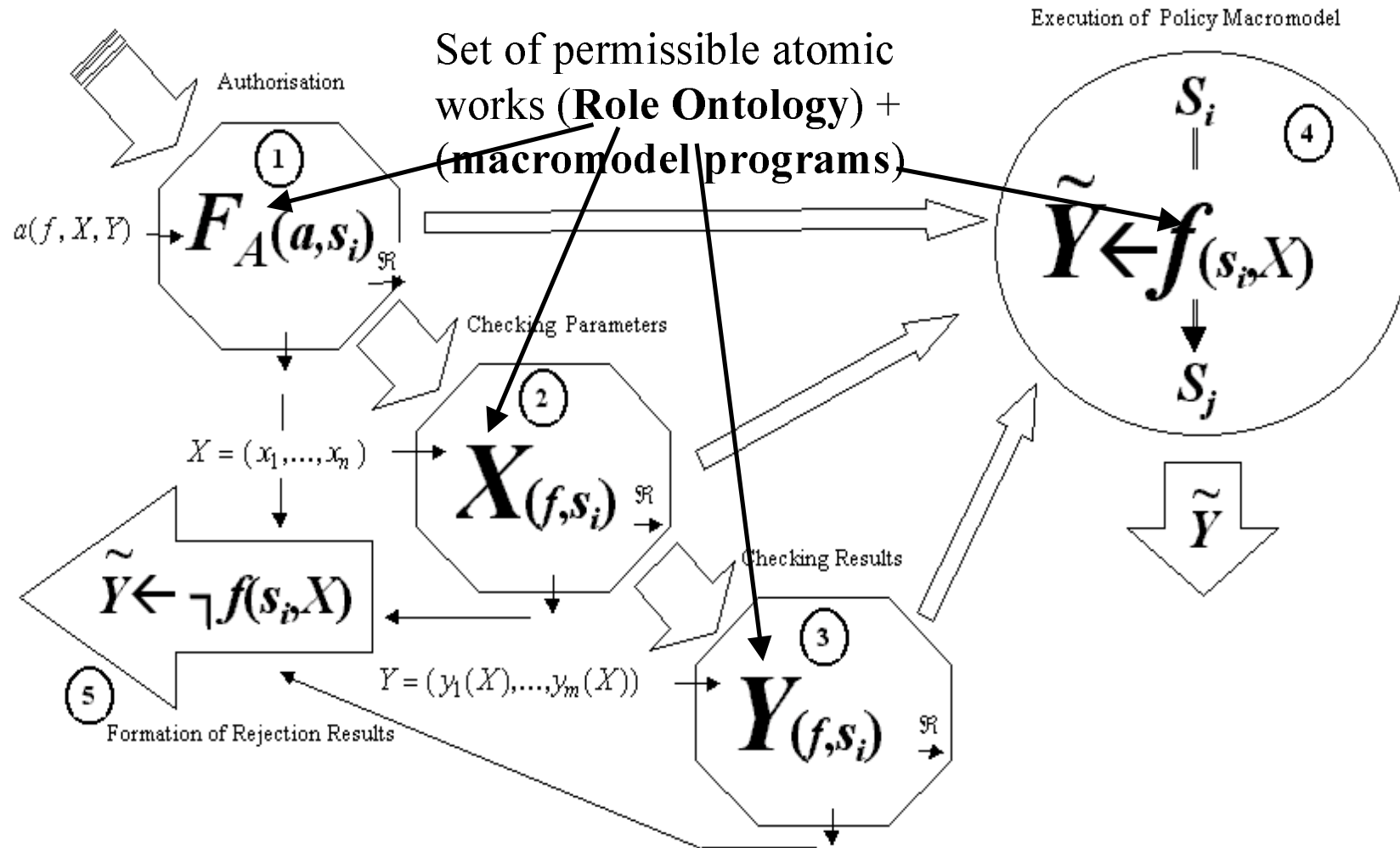


Agent-Based Framework models:

- Generic Agent Model** – generic skeleton + specialization
- Communication Model** – simplified communicative acts
+ parametric feedbacks
- System/Component Model** – Proxy, Tasks decomposition
- Tasks Execution Model** – Coalition formation
- Evolution Model** – Agent's changes and Learning
- Coordination models** – Negotiation on joining the Coalition,
Managing Task execution sequence,
Monitoring Agent's activities

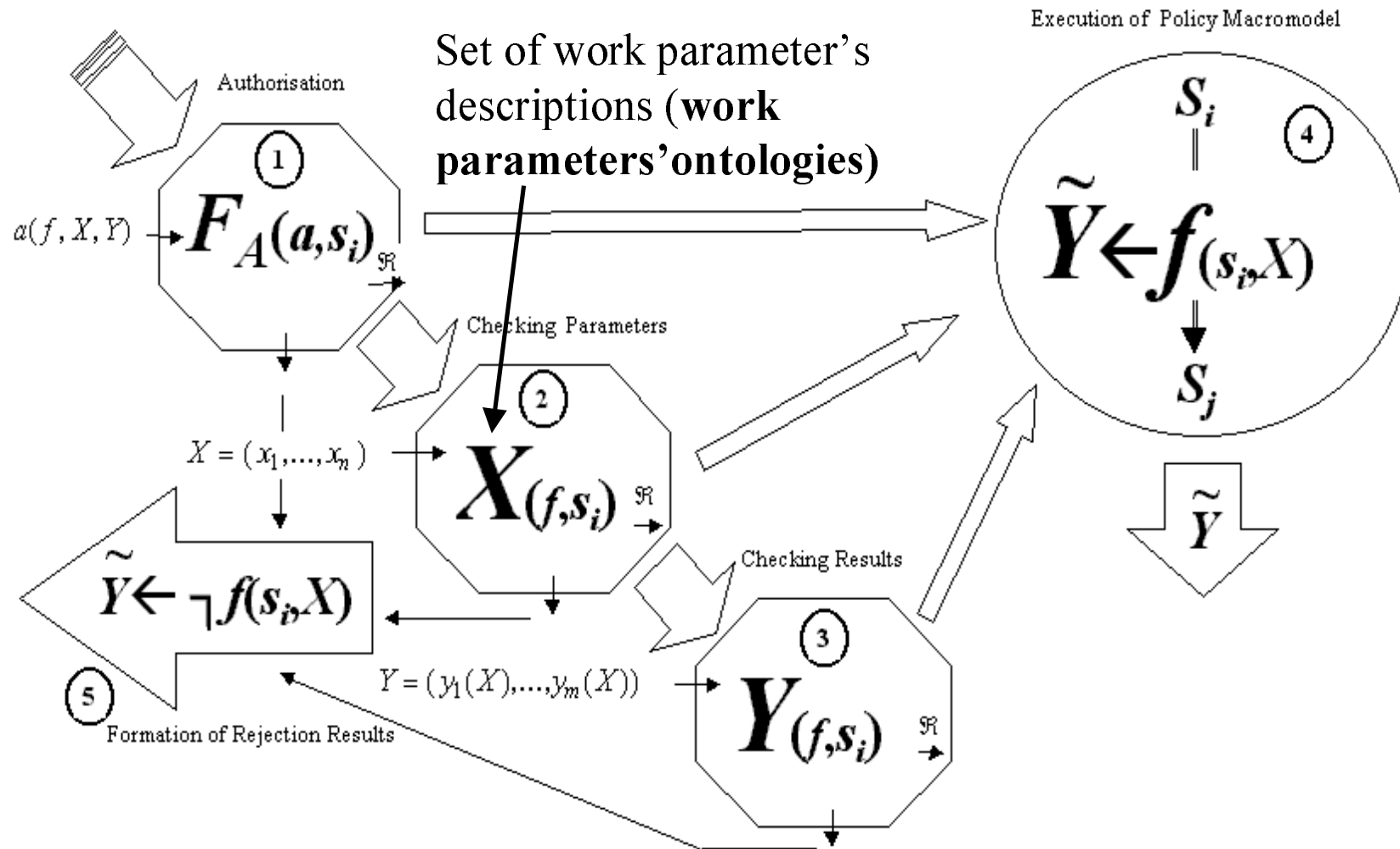
Agent-Based Framework models: An Actor

Generic Agent Model



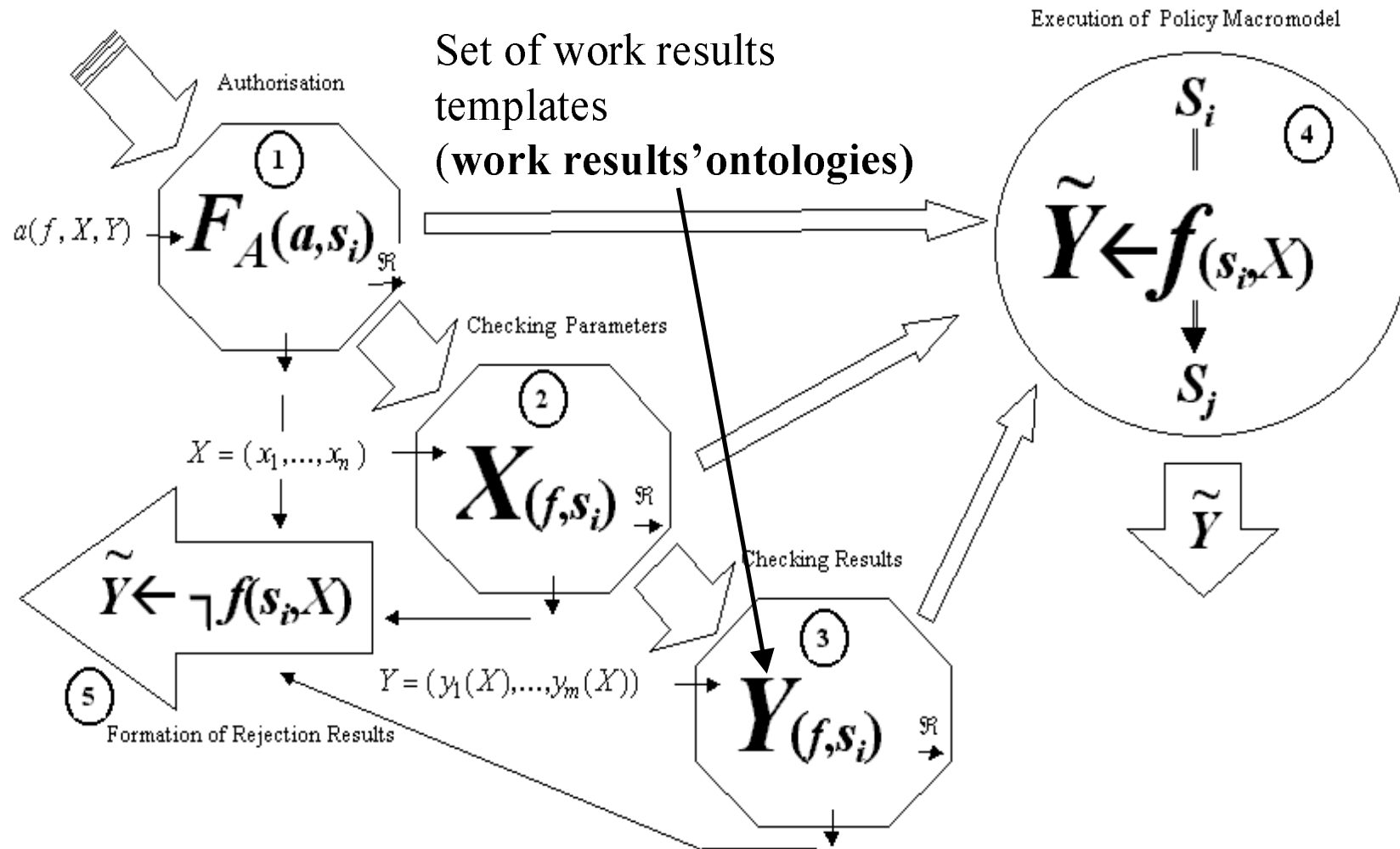
Agent-Based Framework models: An Actor

Generic Agent Model



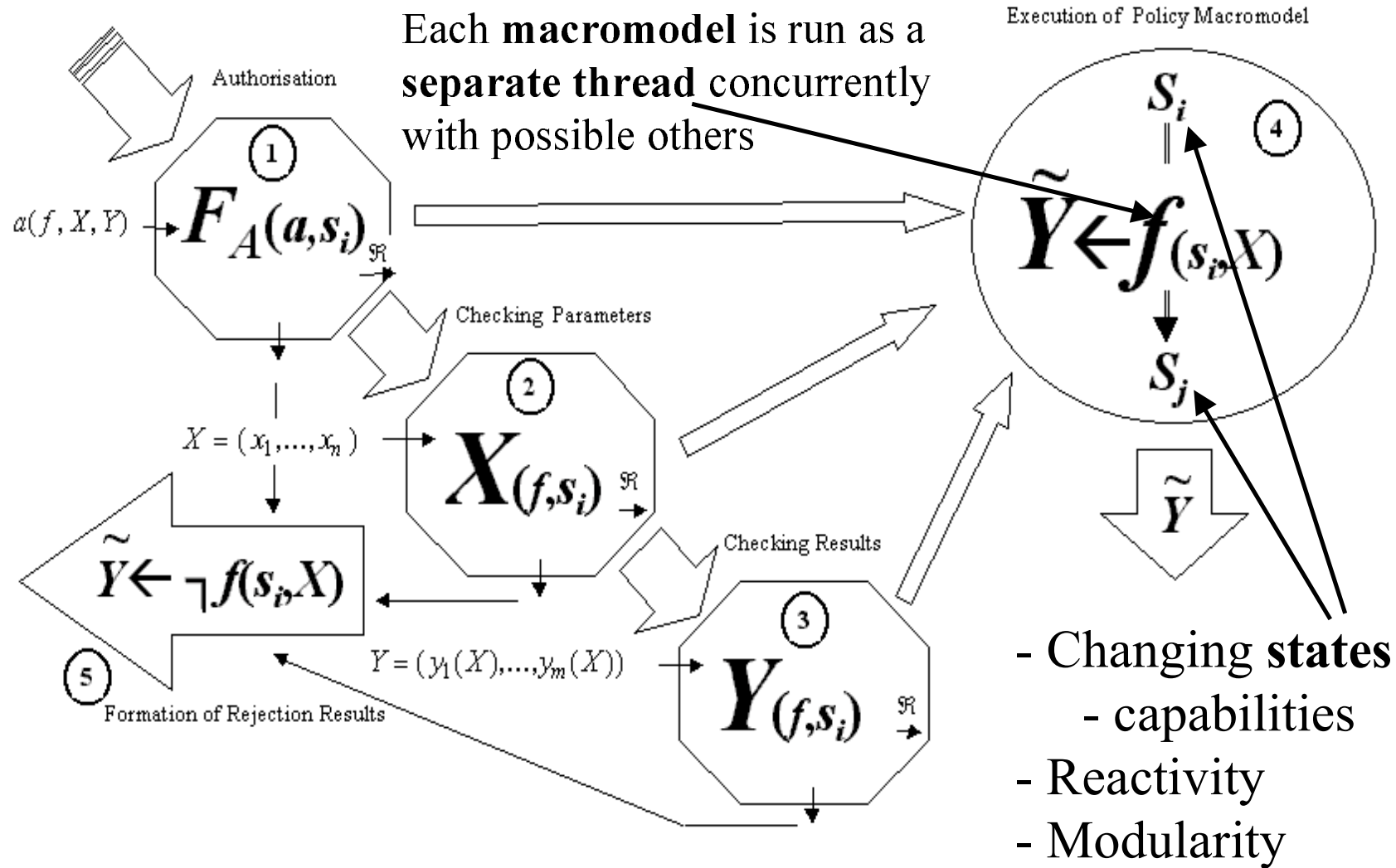
Agent-Based Framework models: An Actor

Generic Agent Model



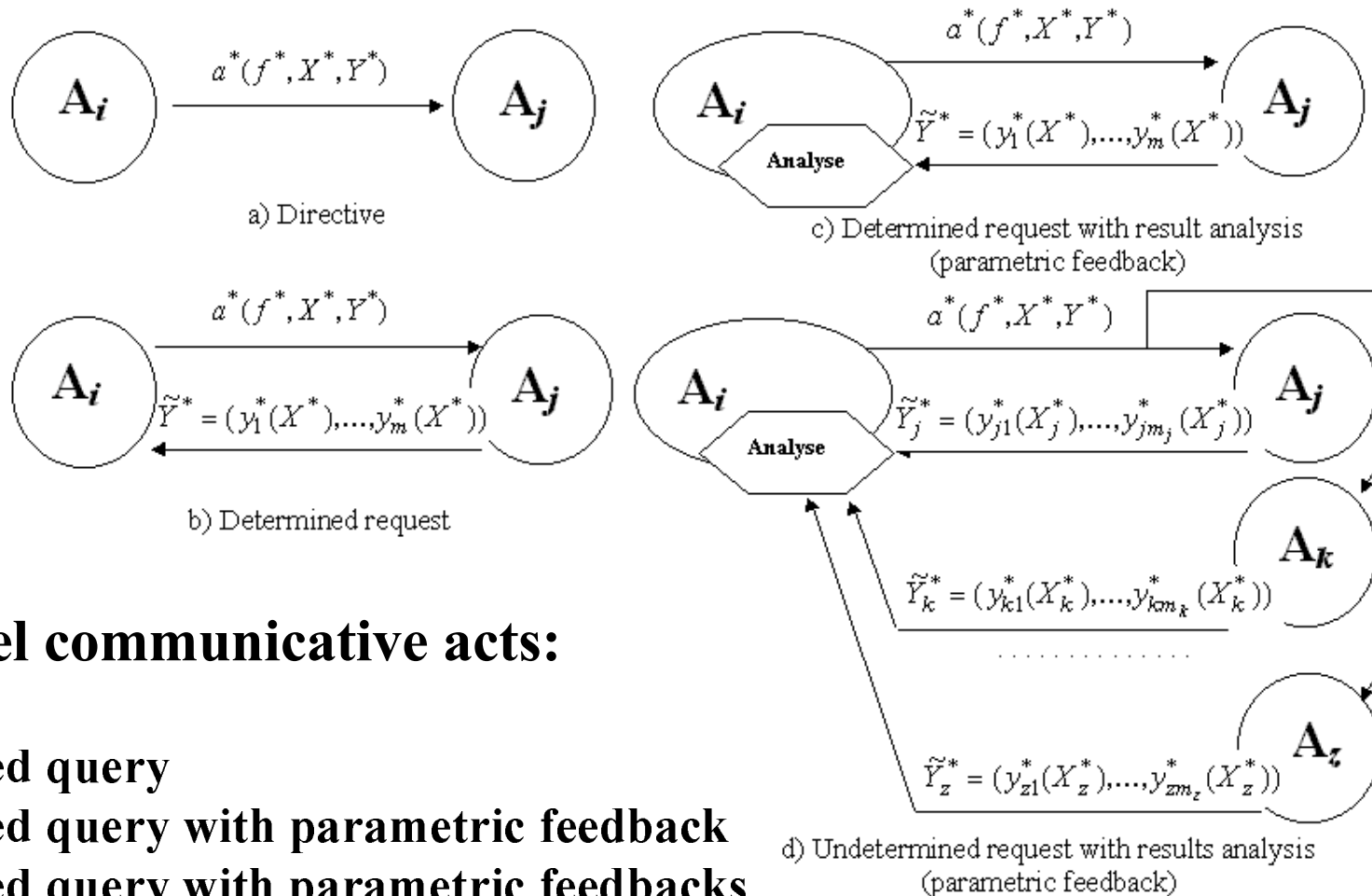
Agent-Based Framework models: An Actor

Generic Agent Model



Agent-Based Framework models: Communication (1)

Generic Simplified Communication model



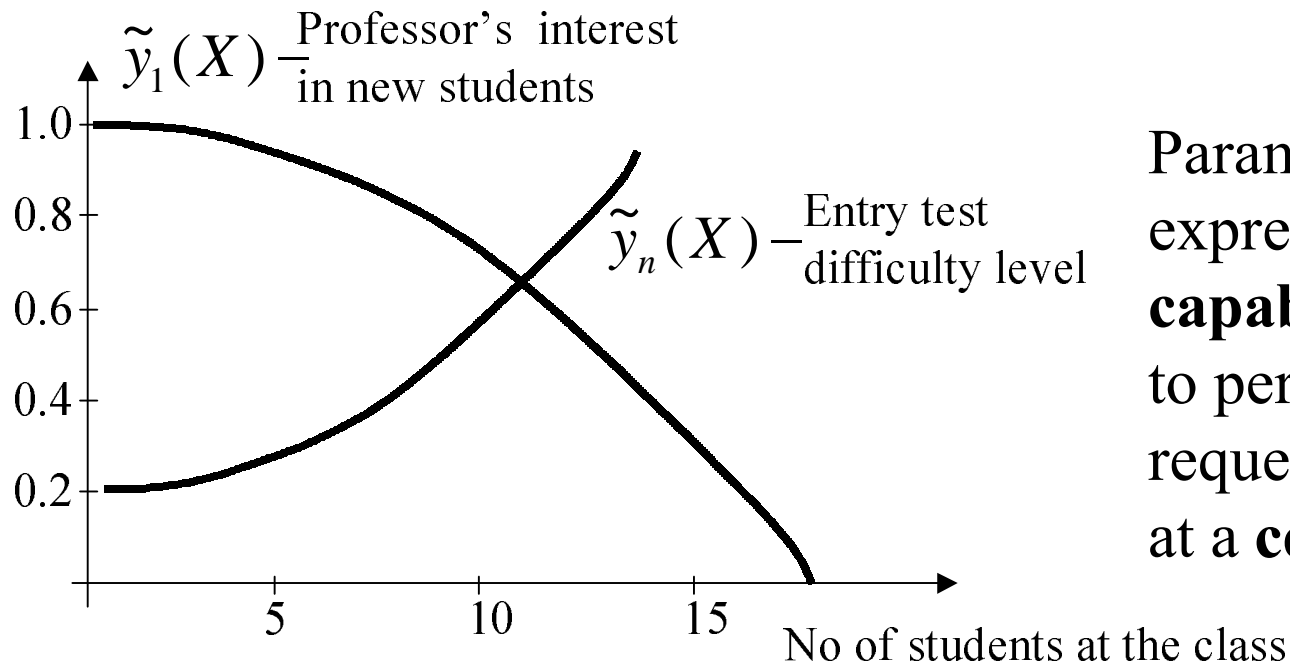
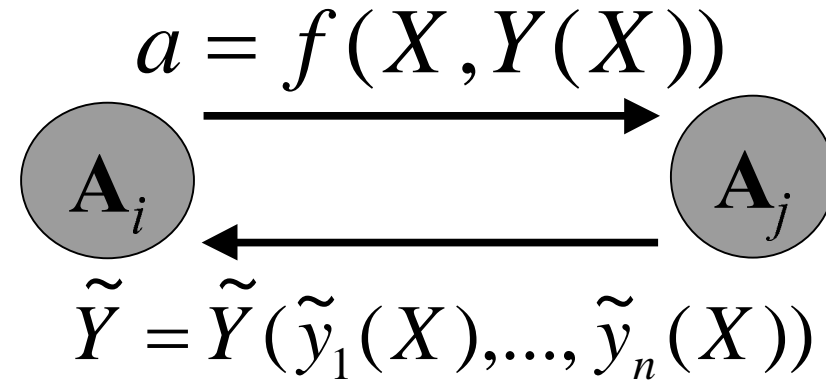
4 low level communicative acts:

- Directive
- Determined query
- Determined query with parametric feedback
- Multicasted query with parametric feedbacks

Agent-Based Framework models: Communication (2)

Agents' Interactions – Parametric Feedbacks

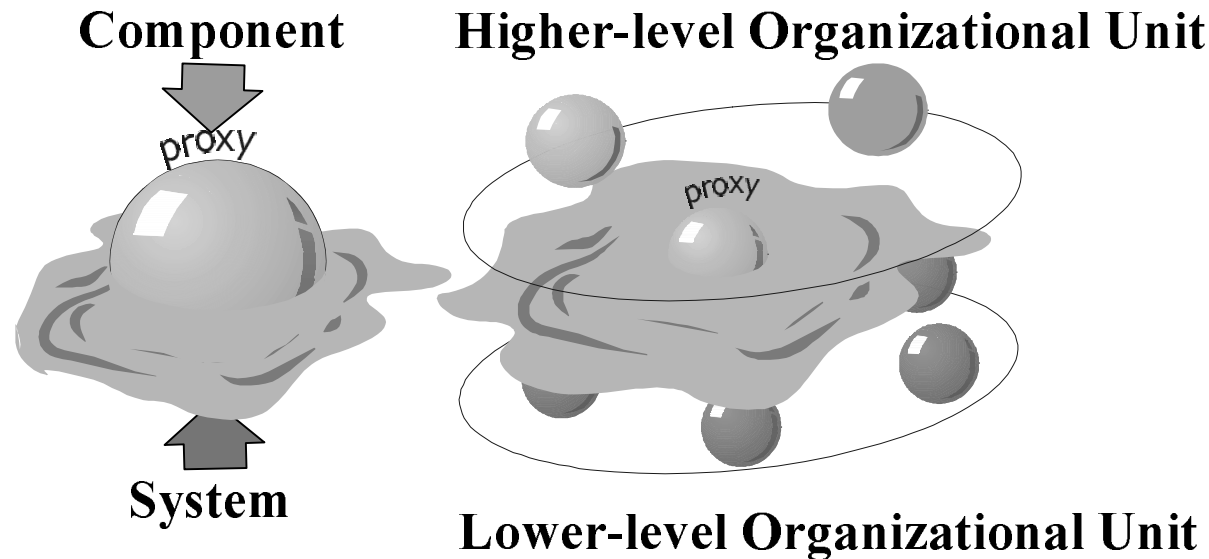
a – accept a new student to the class



Parametric feedbacks – expressed **attitude**, **capability** and **readiness** to perform requested action at a **certain state**

Agent-Based Framework models: System/Component

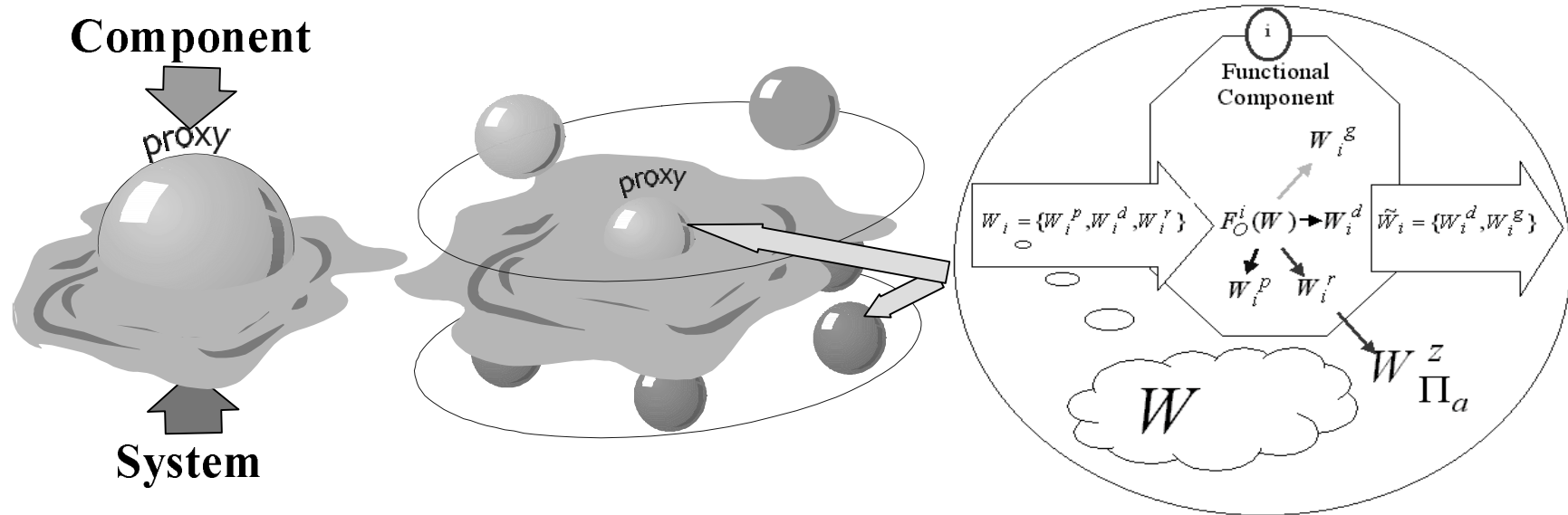
Functional System/Component Model, vertical scaling



- On the higher level **Proxy** is viewed as a functional **component**. And it expands to the **functional system** on the lower level of organization
- **Proxies** “wrap” respective **organizational units** (MAS) and are the representative members in the **higher level units** (MAS)

Agent-Based Framework models: System/Component

Functional System/Component Model, vertical scaling

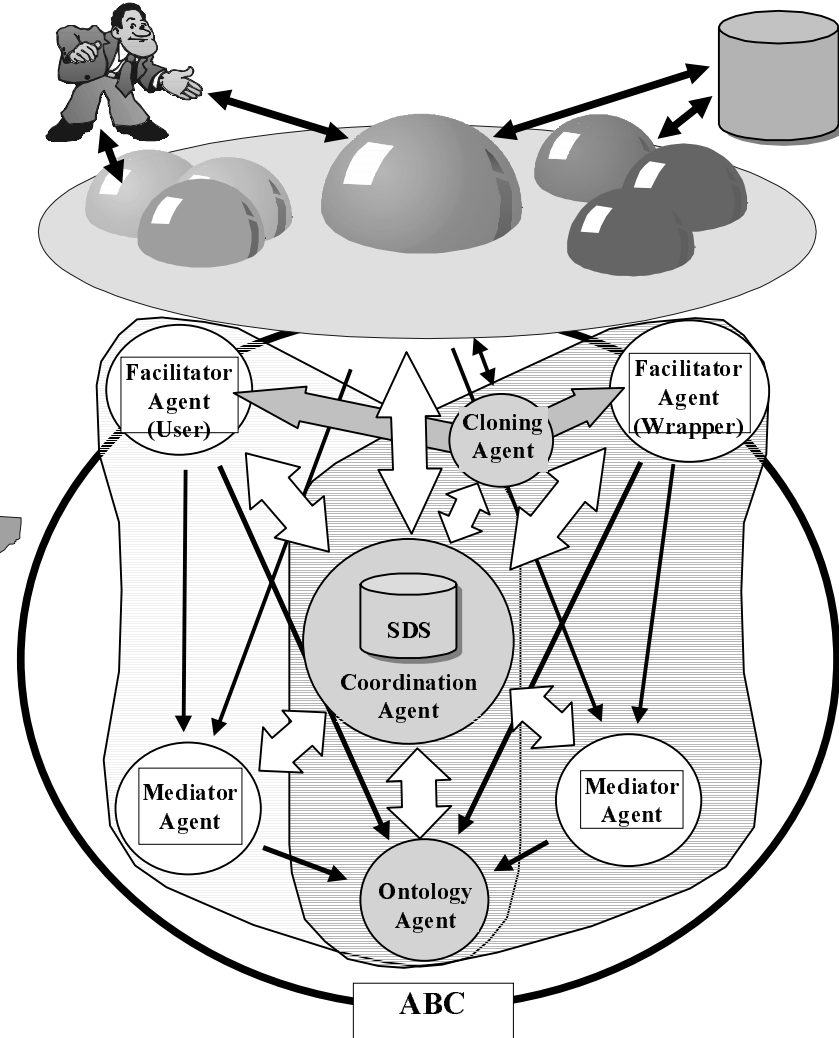
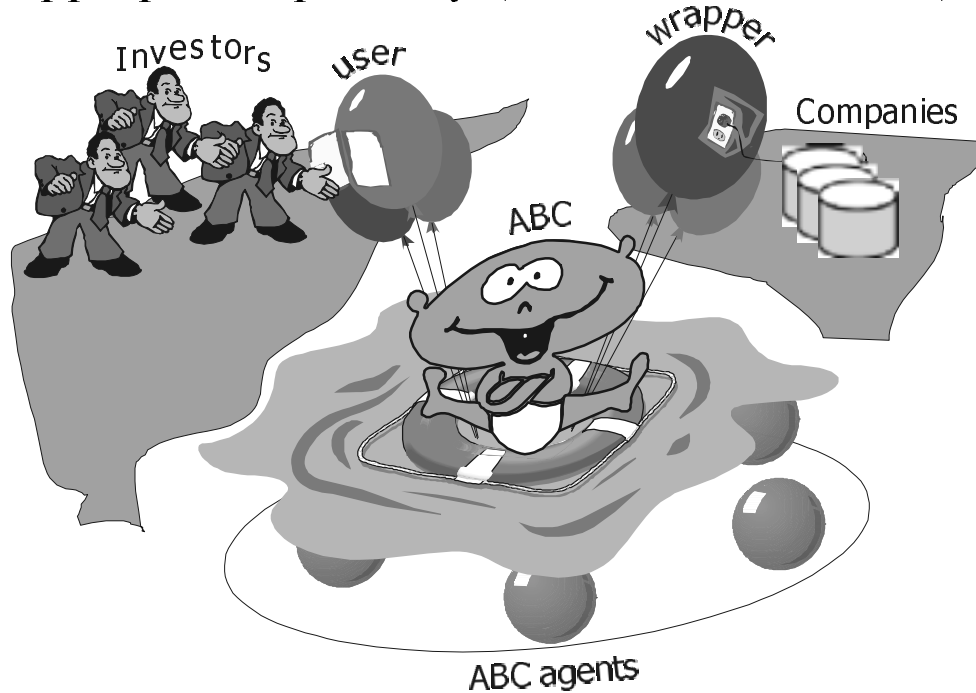


- A generic functional component (Agent) is the unit for **Generating, Redirecting, Executing, Rejecting** atomic works received from accepted (sub-)task -- *(sub-)task/atomic work defs close to WPMC Process Model Metadescription*
- Agents, as **functional components**, form coalitions for to optimally perform tasks – flows of atomic works...

Agent-Based Framework models: System/Component (2)

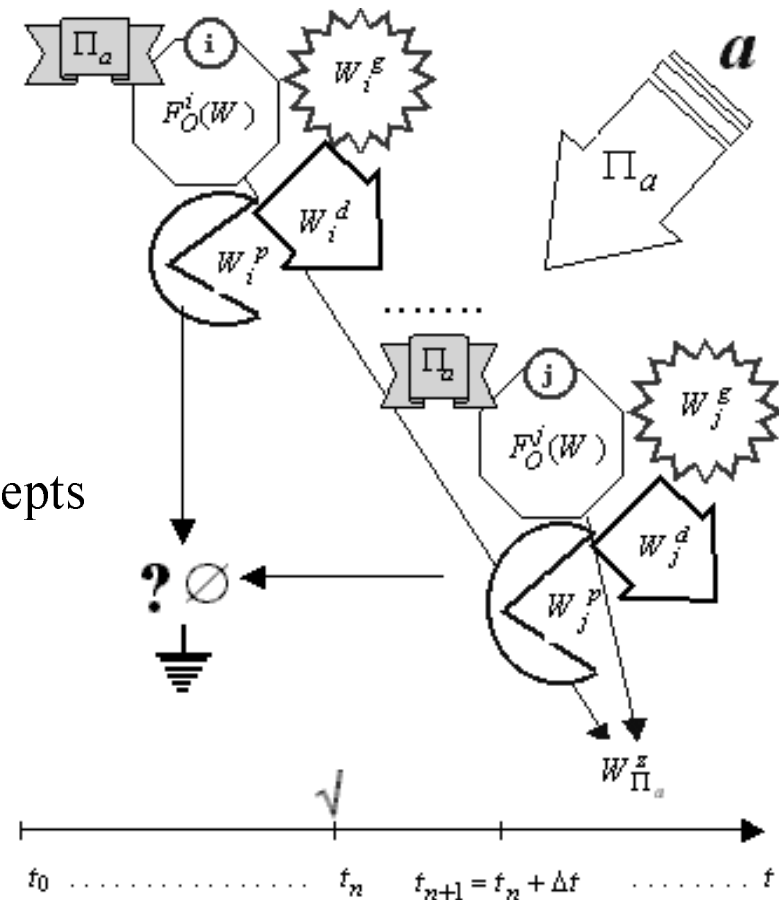
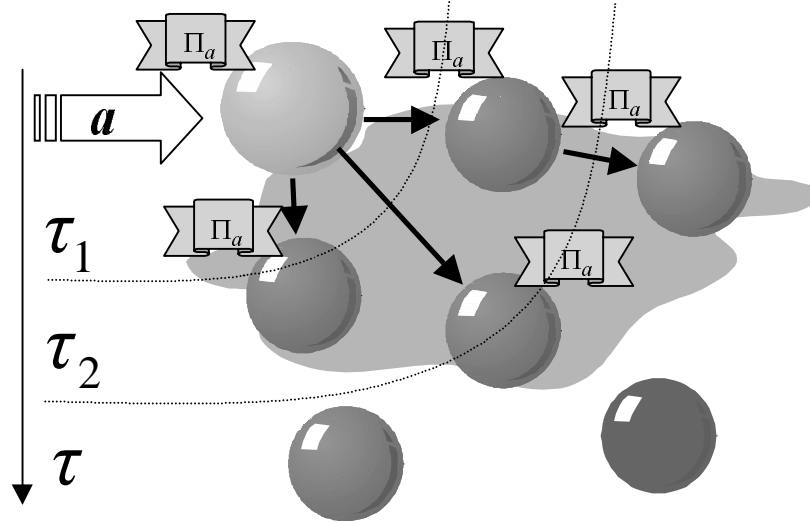
Functional Component cloning - horizontal scaling: B2B mediation

- Facilitators are cloned each time a new investor appears or a new company registers
- Proxy places cloning works to the Cloning Agent
- It clones agent's generic skeleton plus appropriate speciality (Set of Macromodels)



Agent-Based Framework models: Task Coalition

Task Execution Model and Dynamic Coalition Formation

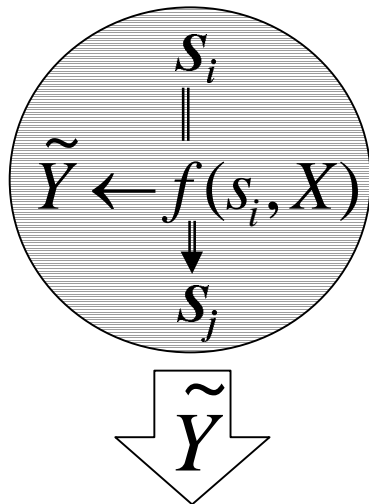


- Task execution starts after **the Proxy** accepts the external influence or one of the MAS members generates the task
- **Agent** joins the **Task Coalition** when it accepts the work or the subtask within the arrangement phase
- Task execution is completed if all the coalition fellows have stopped to accept and execute works

Agent-Based Framework models: Evolution (1)

Actors' changes – capabilities, capacities

Capabilities



$$s_i, s_j \in S_A$$

$$s_i = \{r(X_A), q(F_A), t(F)\}$$

$r(X_A)$ - parameter constraints

$q(F_A)$ - work constraints

$t(F)$ - transition function

Capacities

Capacity $N(w_i)$ w.r.t. work w_i is the ability to execute certain quantity of w_i per unit time interval τ

E.g.:

A is printing A4 pages: then $N(w_i) = 8$ in case A has 1 printer doing 8 pages per τ and will be doubled if A gets one more printer of the same type.

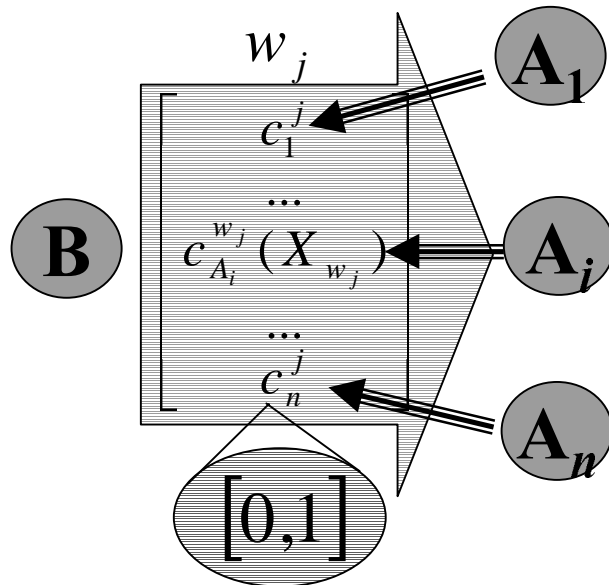
Capacity may be **limited** or **unlimited**

Limited capacity is shared in time according to the actor's **priorities** and **commitments** between the bulk of w_i works placed by different tasks to the executor

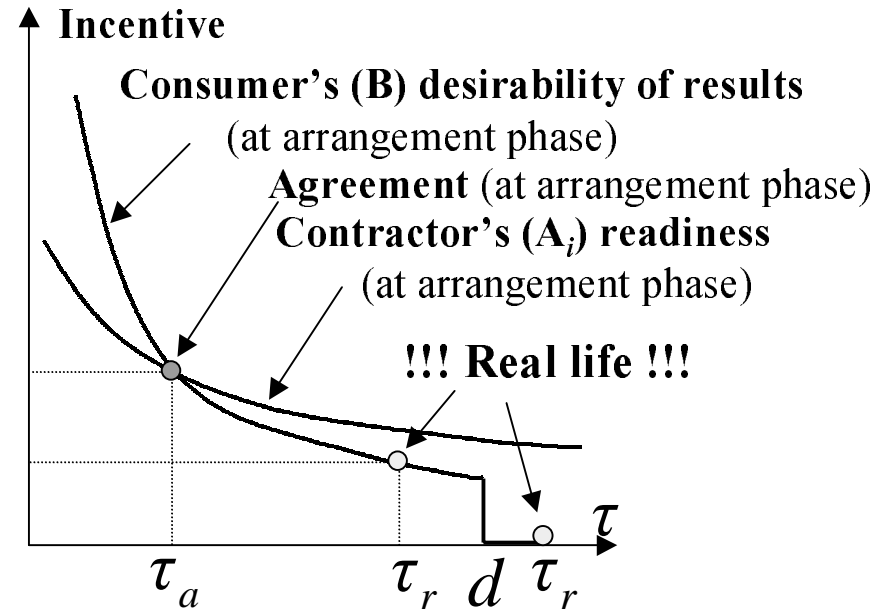
Agent-Based Framework models: Evolution (2)

Actors' learning - beliefs, fellows' credibility estimations

Beliefs



Credibility estimations

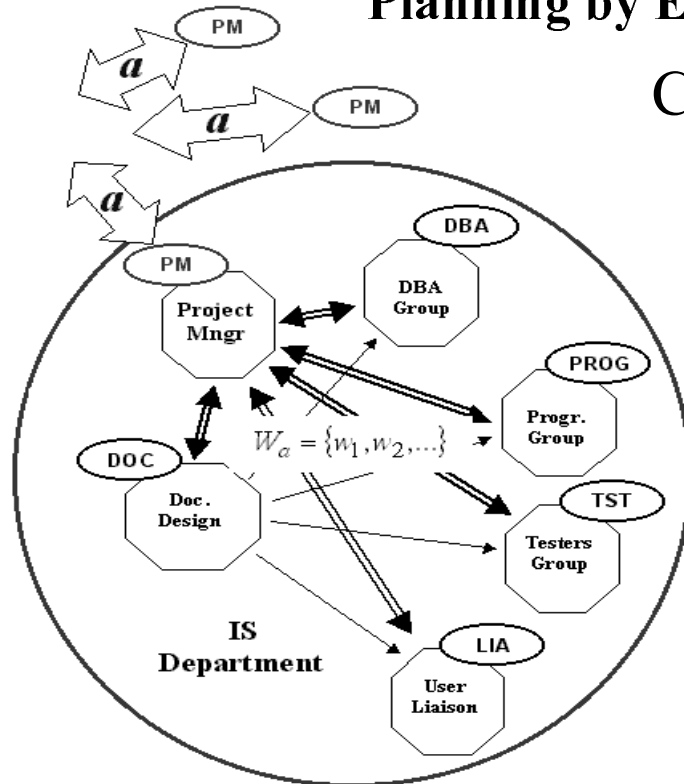


$$Cr_i^j := Cr_i^j \times \begin{cases} 1, \tau_r \leq \tau_a \\ p(w_j) \times (\tau_a / \tau_r), \tau_a < \tau_r \leq d \\ 0, \tau_r > d \end{cases}$$

More details on arrangement negotiation → coordination models

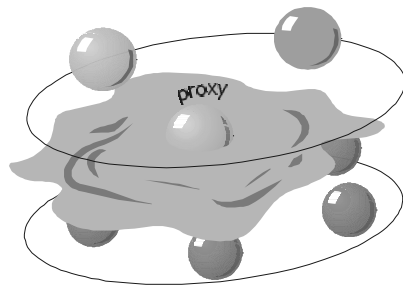
Case Study: Business Process Management

Planning by Evaluation (1): Software development project



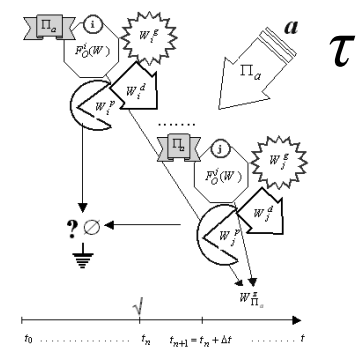
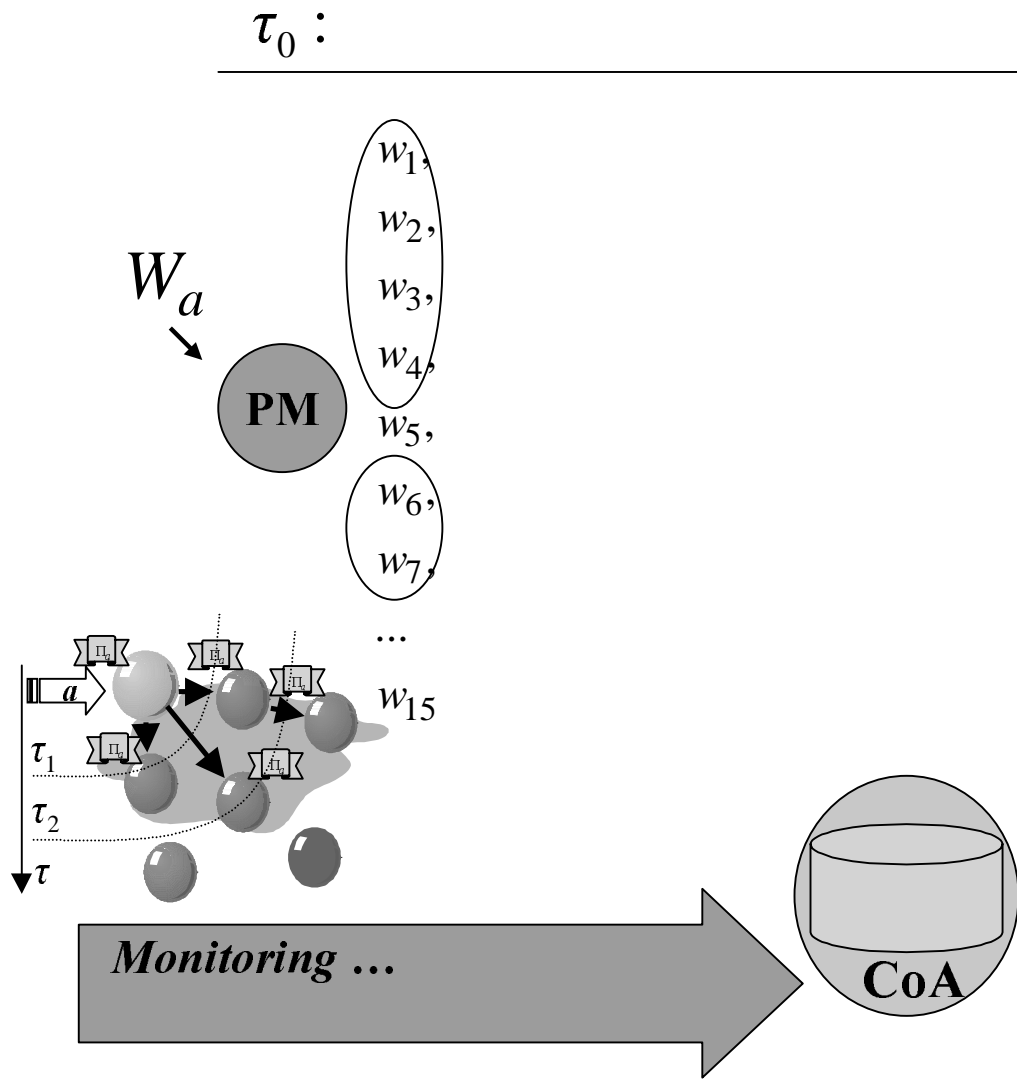
Case Assumptions:

- IS Department is **one of many candidates** to be evaluated for the project
- IS Department (Proxy) as well as the other parties are considered as the **member agents of the higher level organisation**
- Agents organisation of IS Department comprises Project Manager (**PM agent - Proxy**), DBA Group (**DBA agent**), Programmers Group (**PROG agent**), Documentation Design Group (**DOC agent**), Testers Group (**TST agent**), User/Customer Liaison Group (**LIA agent**) as functional components.
- If necessary to go in more details with one of the functional components, this **component may be expanded to a functional system - agents organisation (MAS)**



Case Study: Business Process Management

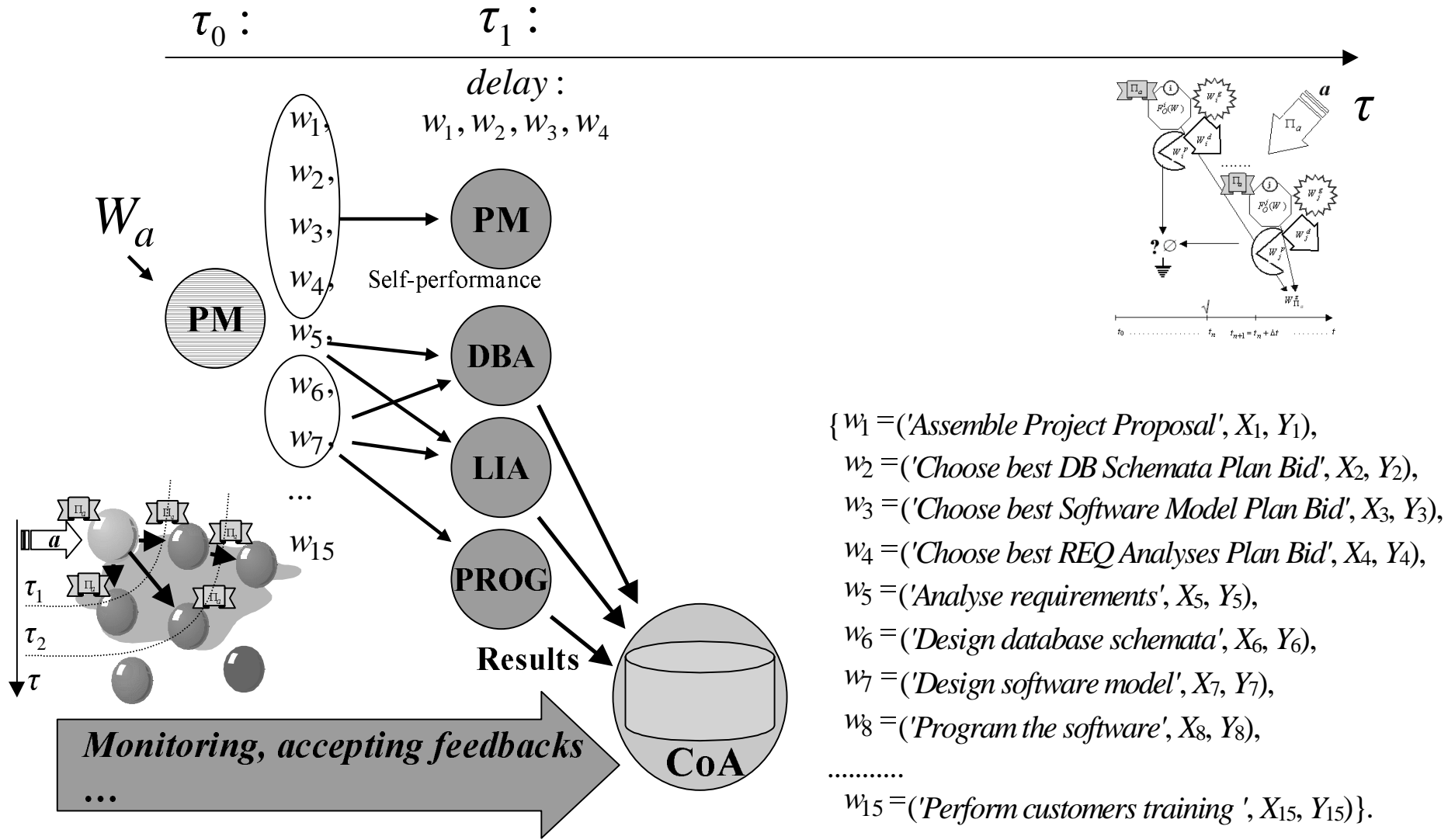
Planning by Evaluation (2): Process execution flow



- $\{ w_1 = ('Assemble Project Proposal', X_1, Y_1),$
- $w_2 = ('Choose best DB Schemata Plan Bid', X_2, Y_2),$
- $w_3 = ('Choose best Software Model Plan Bid', X_3, Y_3),$
- $w_4 = ('Choose best REQ Analyses Plan Bid', X_4, Y_4),$
- $w_5 = ('Analyse requirements', X_5, Y_5),$
- $w_6 = ('Design database schemata', X_6, Y_6),$
- $w_7 = ('Design software model', X_7, Y_7),$
- $w_8 = ('Program the software', X_8, Y_8),$
-
- $w_{15} = ('Perform customers training ', X_{15}, Y_{15}) \}.$

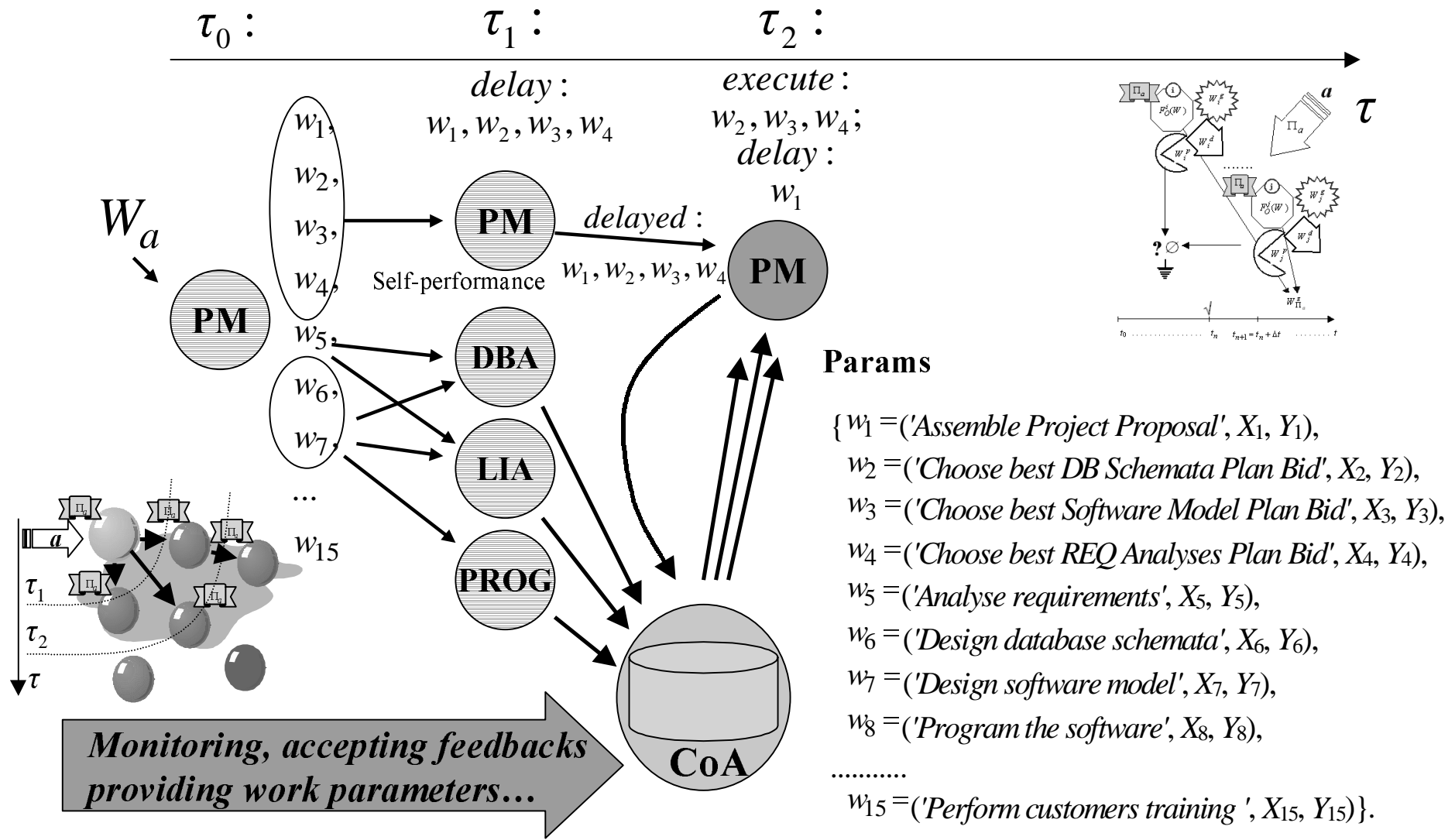
Case Study: Business Process Management

Planning by Evaluation (2): Process execution flow



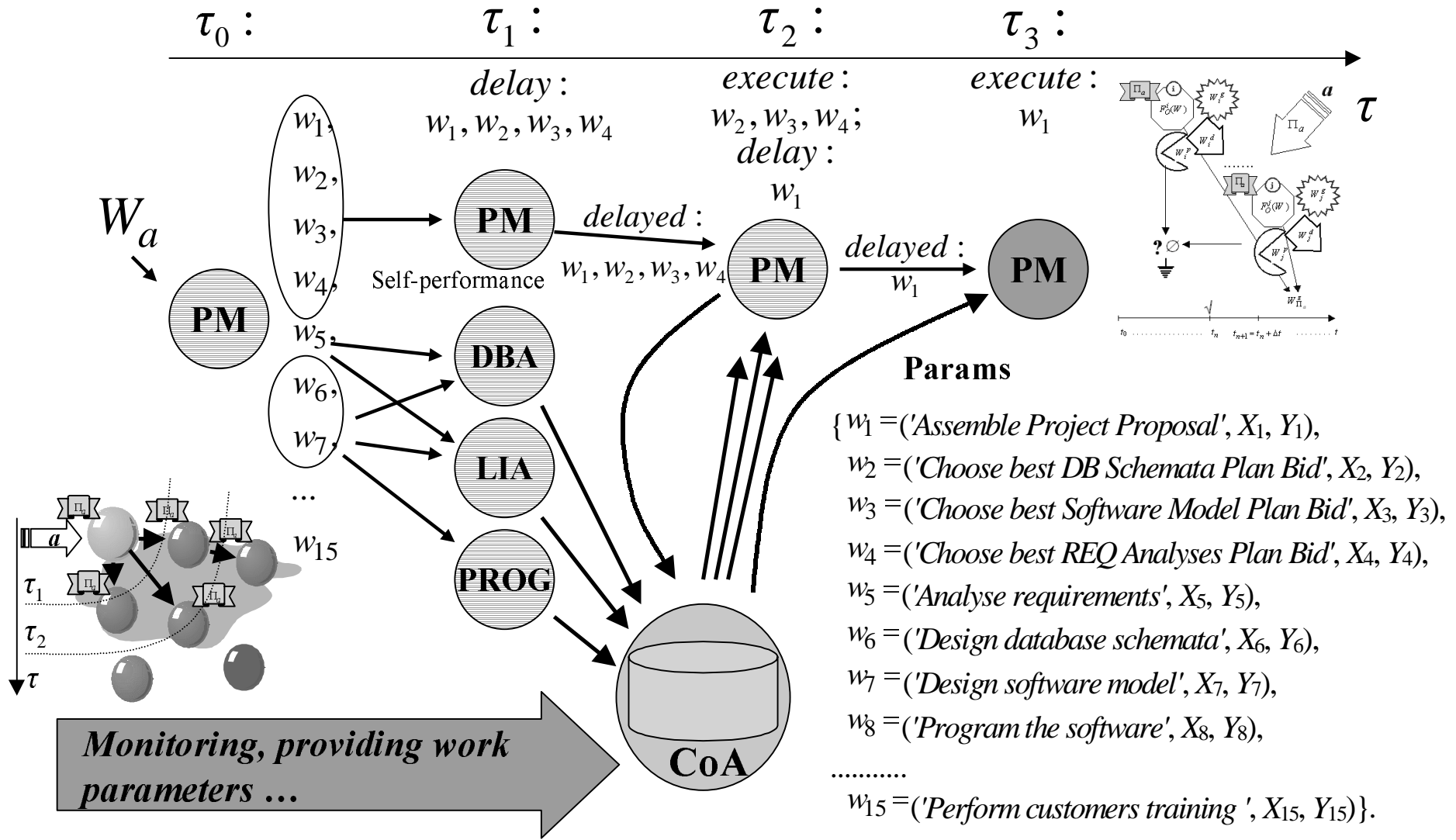
Case Study: Business Process Management

Planning by Evaluation (2): Process execution flow



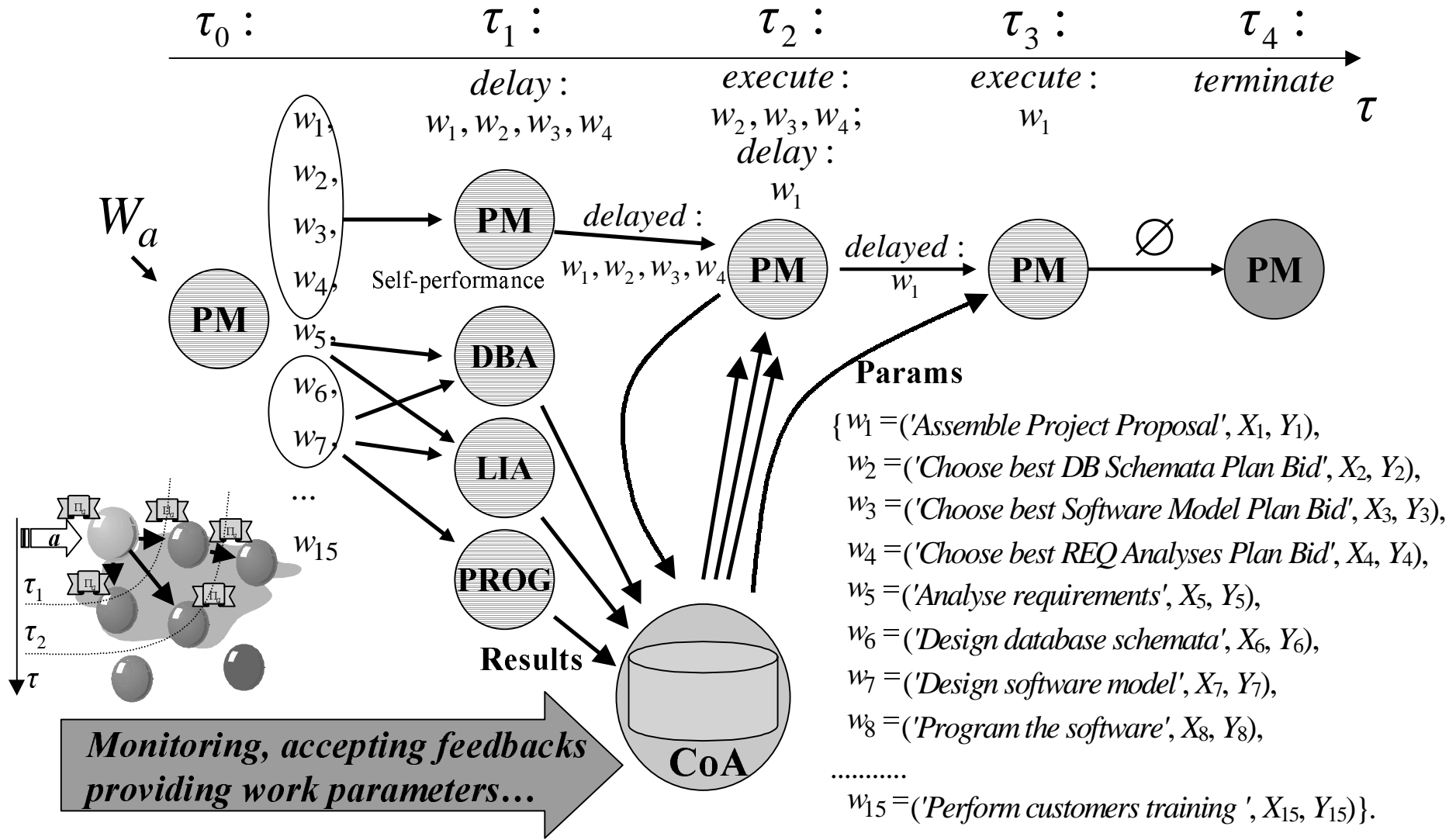
Case Study: Business Process Management

Planning by Evaluation (2): Process execution flow



Case Study: Business Process Management

Planning by Evaluation (2): Process execution flow

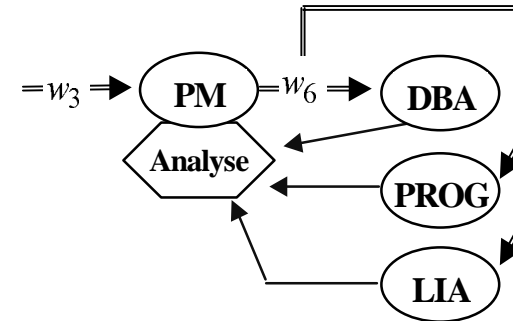
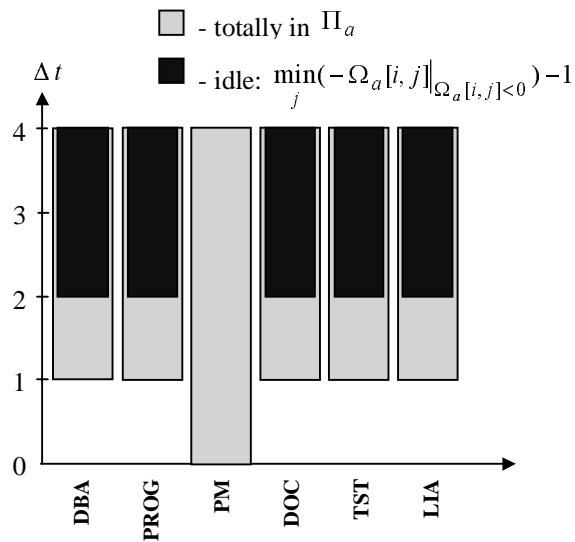


Case Study: Lessons Learned (1)

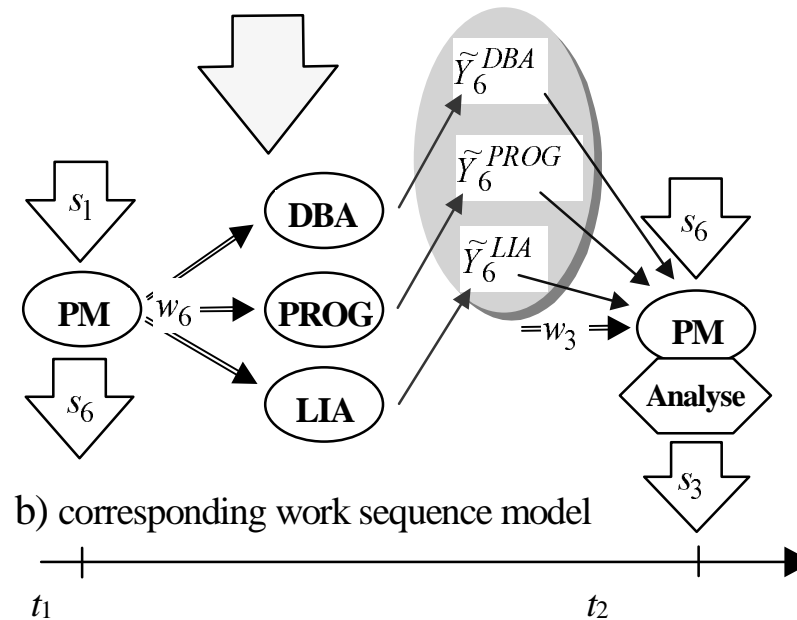
- Competitive work execution by several actors – **QoS evaluation:** Using the best, in terms of quality, bid from several work results
- Agents' **Workload evaluation** –
derived from CoA monitoring results
- Planning by evaluation** – agents propose project workpackages' bids after autonomous evaluation of the possible execution of the workpackages
- Sophisticated **communication protocols** (eg., FIPA CNP) arranged
as work sequences + simplified communication acts
- No predefined task plans** – task flows are developed
in step-by-step execution process. No global workflow descriptions
- Needed **manual preparation efforts** for:
Macromodel Programs, Role Ontologies, State Constraints
- Role **Ontologies** - the descriptions of: works (actions), work parameters and expected and provided feedback results

Case Study: Lessons Learned (2)

Task/Work	t_1	t_2	t_3	t_4
Tasks Specification	PM			
REQ Analyses Planning		LIA		
DB Schemata Design Planning		DBA		
Software Model Design Planning		PROG		
Programming Planning		PROG		
.....		...		
Customers' Training Planning		LIA		
REQ Analyses Plan Optimisation			PM	
Software Modelling Plan Optimisation			PM	
DB Schemata Design Plan Optimisation			PM	
Project Plan Assembly				PM



a) communication act diagram



b) corresponding work sequence model

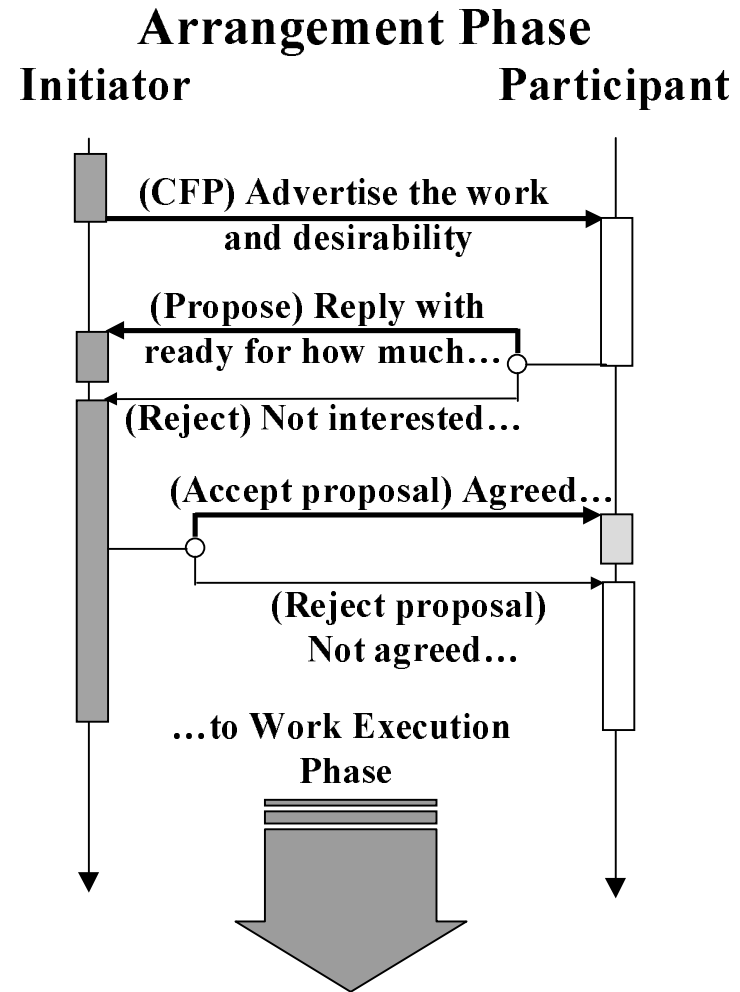
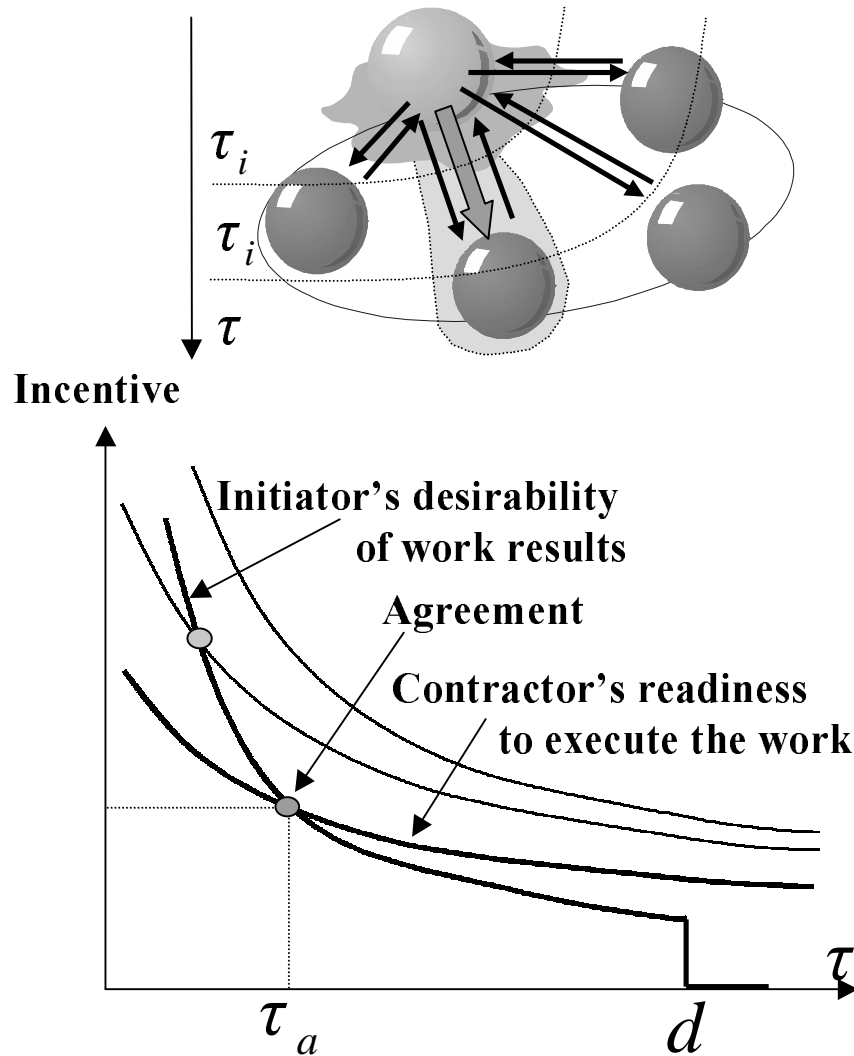
Coordination as the key problem

Generic co-ordination activities/models:

- **Negotiation on placing the work (and joining the coalition)** at arrangement phase (takes place each time before the work/sub-task is accepted by the newcomer or the coalition member)
- Providing Shared Data Space (a kind of a tuple space) for work results storage and for **facilitating to parametric feedbacks and synchronizing work sequences**
- **Monitoring Agents activities** within the coalition for providing data on agents load, on their changing capabilities and on works not been executed

Coordination as the key problem: Models (1)

Negotiation on placing the work and joining the coalition -



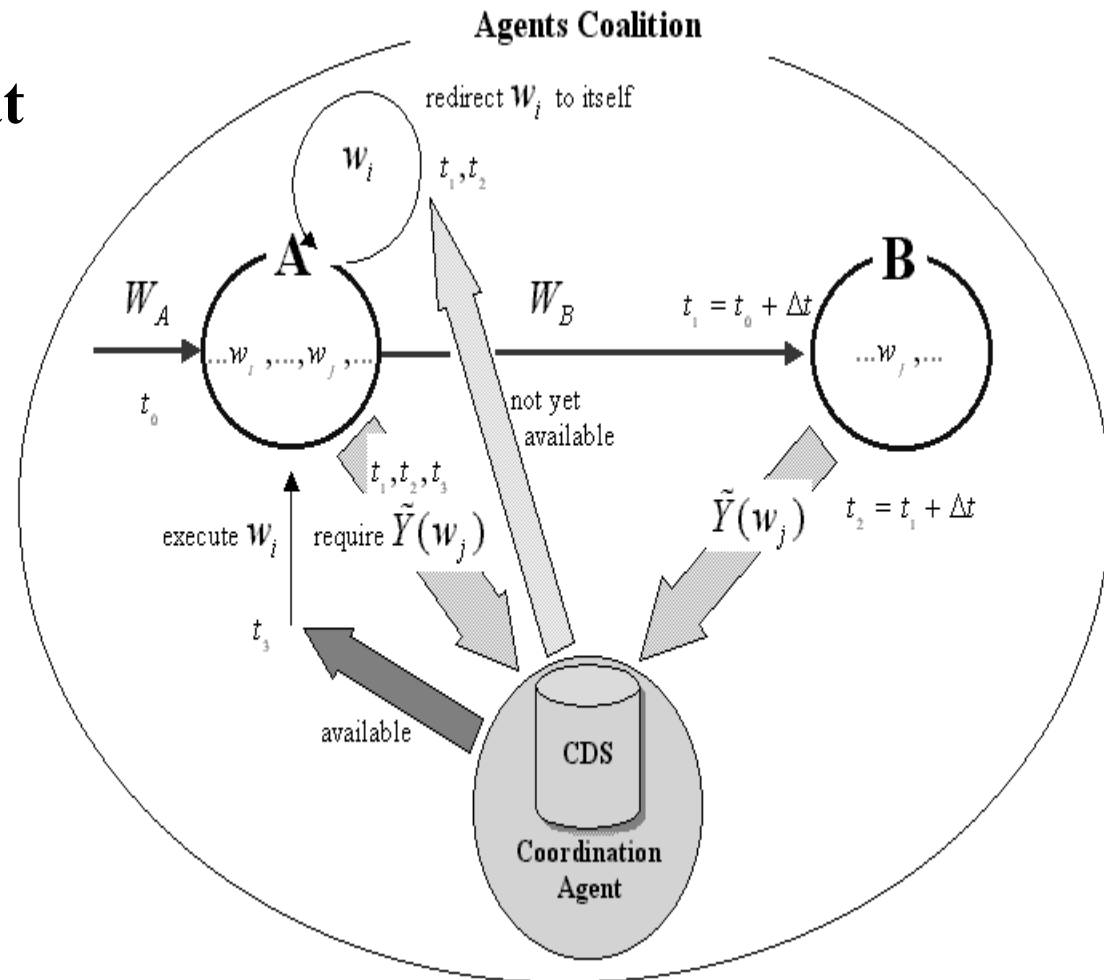
Coordination as the key problem: Models (2)

Coordinating the Flow of Works

-Placing work results at
CoA SDS – a kind of
Tuple Space →

-Providing for
Feedbacks →

-Coordinating the flow
of works in a proper
sequence →



Coordination as the key problem: Models (3)

Monitoring agents' activities within the task coalition (Planning Case Study)

Coalition State Matrix

$$\Omega_a = \begin{matrix} \ominus_{DBA} \\ \ominus_{PROG} \\ \ominus_{PM} \\ \ominus_{DOC} \\ \ominus_{TST} \\ \ominus_{LIA} \end{matrix} \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & -3 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & -3 & 0 & 0 \\ -1 & -2 & -2 & -2 & 0 & 0 & 0 & 0 & \dots & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & -3 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & -3 & 0 & 0 & 0 & -3 & 0 \end{bmatrix}$$

Agents' workload w.r.t. to W_a task coalition
after τ_4 modelling step

Inexecutable Works

$$W_{\Pi_a}^z = \begin{matrix} DBA \\ PROG \\ PM \\ DOC \\ TST \\ LIA \end{matrix} \begin{bmatrix} 0 & 0 & 0 & 0 & 1 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & \dots & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 1 & 0 & 0 & 0 \end{bmatrix}$$

Inexecutable works (W_a) after τ_4 modelling step

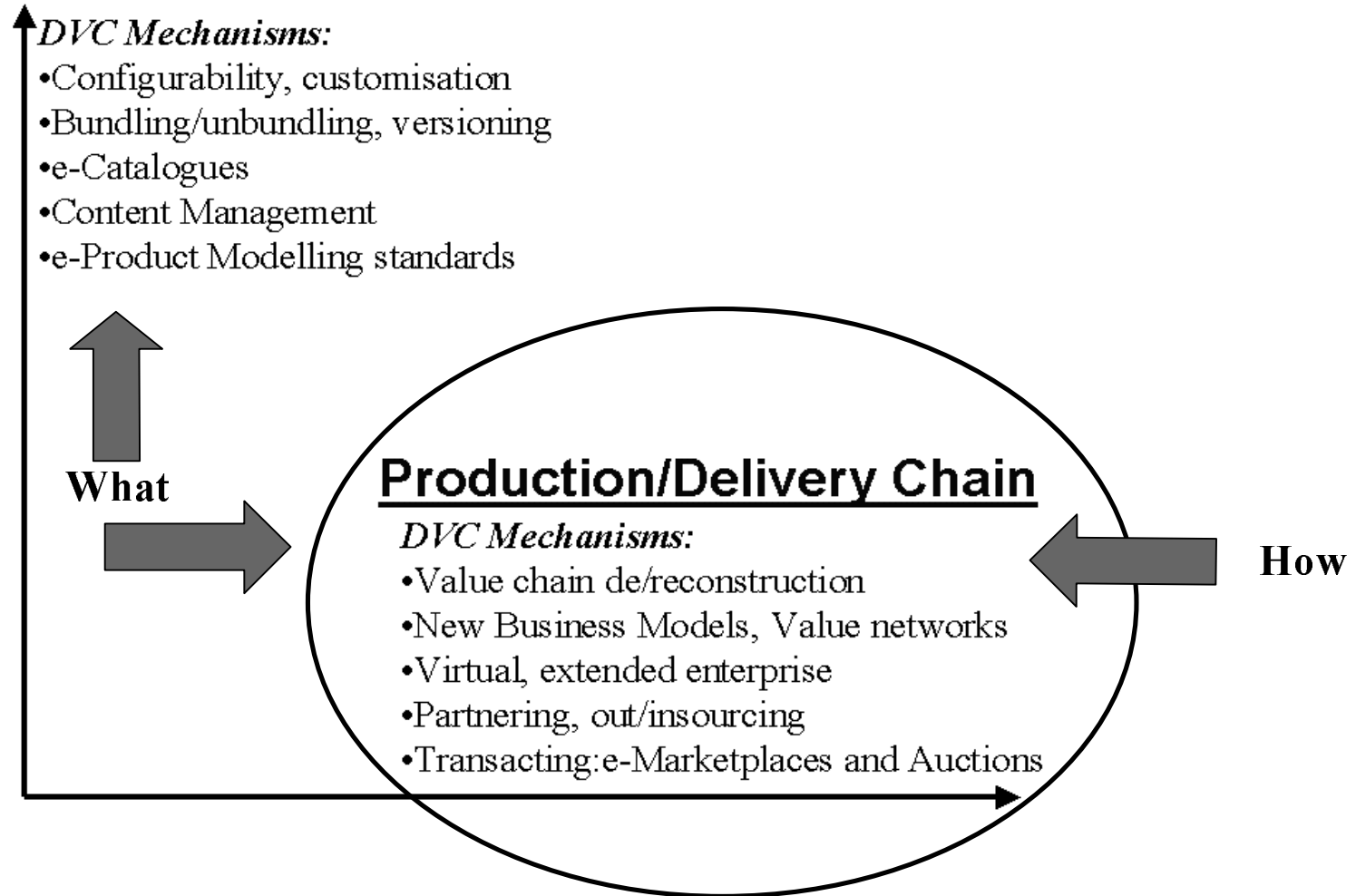
$$D_a = \begin{matrix} w_1 & w_2 & w_3 & w_4 & w_5 & w_6 & w_7 & w_8 & & w_{15} \\ \boxed{2} & \boxed{1} & \boxed{1} & \boxed{1} & \boxed{0} & \boxed{0} & \boxed{0} & \boxed{0} & & \boxed{0} \end{matrix}$$

Work delays

Coalition Work Delays

Relationship to Semantic Web and DVCs

Product/Service Content



Our weak points:

... and what we are planning to do with the staff

- The approach is not really good for flat organizations comprising hundreds or thousands of actors**
- The framework assumes that agents are homogeneous – the same generic model**
- All this looks very nice, but it's time to go on with real implementations:** we have a formal generic framework, the architectural framework is coming soon, implementation is merely the question of proper funding and ...
- The problem of semantic interoperability among the actors within these coalitions is still open: Role Ontologies** formalized, say, in **DAML/OIL** seem to be appropriate for solving the problem among the Artificial Actors of Artificial Dynamic Organizations
- Guess, you certainly add some more points in discussion ...**