Flexible hierarchical organisation of role based agents

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SARC'08

1. Background : bring MAS into human organization
2. Proposition of a holomas using roles
   - Elements of formalisation
   - Architecture
3. Dynamics in holonic multiagent organisation
   - Dynamic of roles
   - Robustness
   - Growth
4. Implementation
5. Application
6. Perspectives and Conclusion
   - Perspectives
   - Conclusion

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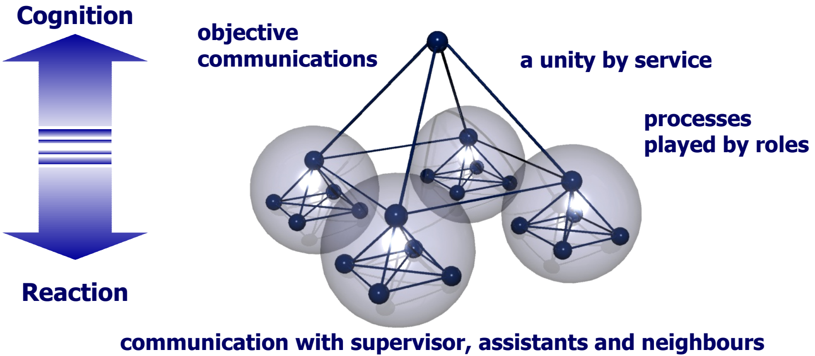
Application/Social Context



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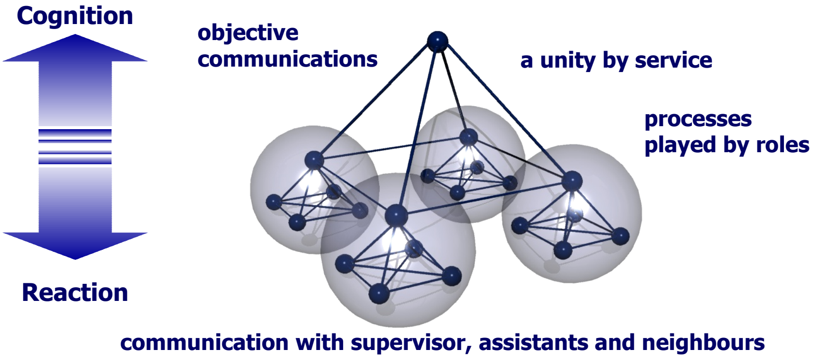

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objective communications

a unity by service

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communication with supervisor, assistants and neighbours

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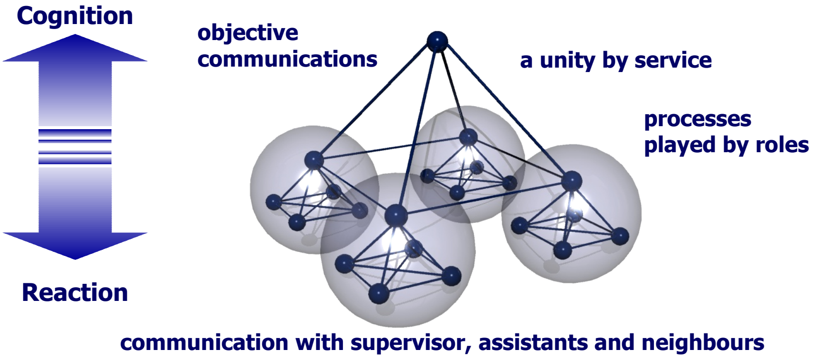

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mechanism.4 : "Holons on successively higher levels of the hierarchy show increasingly complex, more flexible and less predictable patterns of activity, while on successive lower levels we find increasingly mechanised, stereotyped and predictable pattern."

Rules formalisation

Rules

- we define a rule as a set of behaviours :

$$R = (name_R, priority_R, tasks_R)$$

$$tasks_R = \left\{ t_0^R, \ldots, t_{nt}^R \right\}$$

$$nt = number\ of\ tasks$$

Roles formalisation

Roles

- We define a Role as a set of essential rules and a set of secondary rules
- *A searcher has to publish (a lot of) articles. To help the laboratory, he/she can manage the library, the projects, the phd students . . . . . .*

$$role = \left(\begin{array}{l} name, priority, KP, KE, KS, \\ hardRules, flexibleRules \end{array} \right)$$

KP : Pre-requirement, consequences, weight,
KE : Environmental Knowledge (data)
KS : Social Knowledge (roles names and constraints)

- *For example : a speaker has to respect the time-limit fixed by the chair-man*

Agents formalisation

Agents

Holonic Agents : Our holonic agents are defined as follow :

$$agent_a = \begin{pmatrix} KP, KE, KS, HRA, messages_a, \\ perception_a, rules_a, roles_a \end{pmatrix}$$

KP : $\textit{(Personal knowledge)} = \{name; current\ \ state; individual\ \ goals(GI)\}$

KE : *(Environmental knowledge)* = partial representations of objects of the environment.

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HRA : *(Holonic Roles Agent)* = Agent that manages roles of the system.

MAS formalisation

MAS

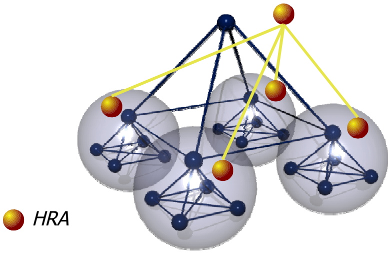
Mas and agent definition : MAS is simply defined as a set of agents.

Environment definition : $E = \{object_0, object_1, ..., object_n\}$

World definition : $world = (environment, mas)$

General architecture of our Holonic IMAS

Architecture



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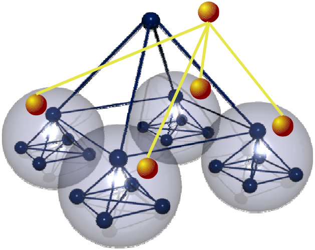

● *HRA*

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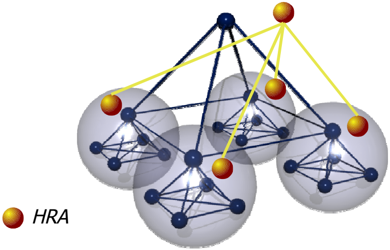
- A HRA could be a set of HRA distributed around the Holomas



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- A secondary rule can become a hard rule if all agents always choose it.

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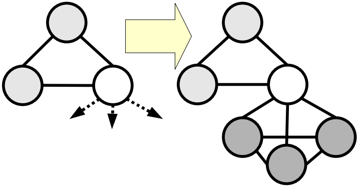
    - problem : loss of the data used during the breakdown

Growth in holonic multi-agent organisation

Growth when overload

- Downward Growth : The agent creates assistants and delegates some of its tasks to them.



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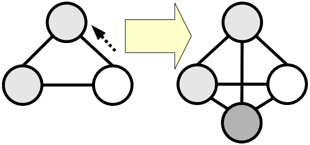

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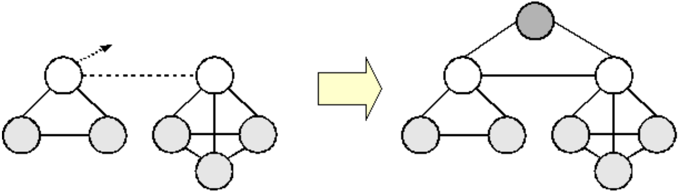

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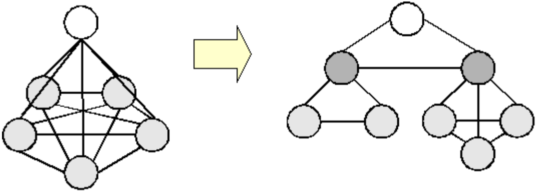
- Internal Growth : A HoloMAS agent creates internal coordinators.



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- Note : if a_1 is the assistant of a_0, $mwt_{a_1} = \alpha \times mwt_{a_0}$ with $(\alpha \in]0, 1[)$

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```
procedure HANDLECFP($ACLMessage\ cfp$)
    $loadAsked \leftarrow cfp.getContent()$
    $maxAssistantLoad \leftarrow \alpha \times mwt$
    $wla \leftarrow mwt - holonCurrentLoad$
    if $(wla - loadAsked) >= 0 \vee ((maxAssistantLoad - loadAsked) >= 0 \wedge \neg holon.isLeaf()))$ then
        if $(wla - loadAsked) > 0$ then
            RETURN($wla, gwl$)
        else
            RETURN($maxAssistantLoad, gwl$)
        end if
    else
        RETURN(Refuse)
    end if
end procedure
```

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ContractNetService : linked temporarily to the potential responders of the ContractNet protocol.

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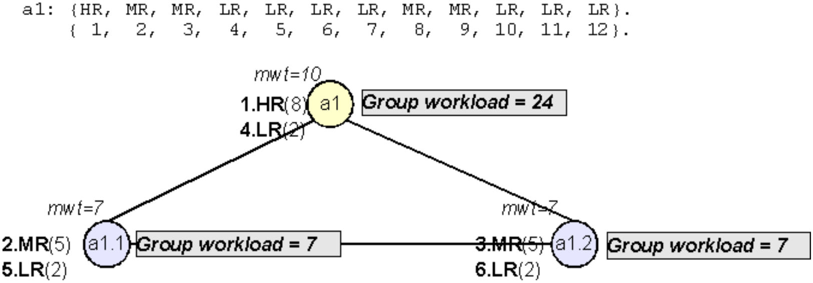

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a1: {HR, MR, MR, LR, LR, LR, LR, MR, MR, LR, LR, LR}.
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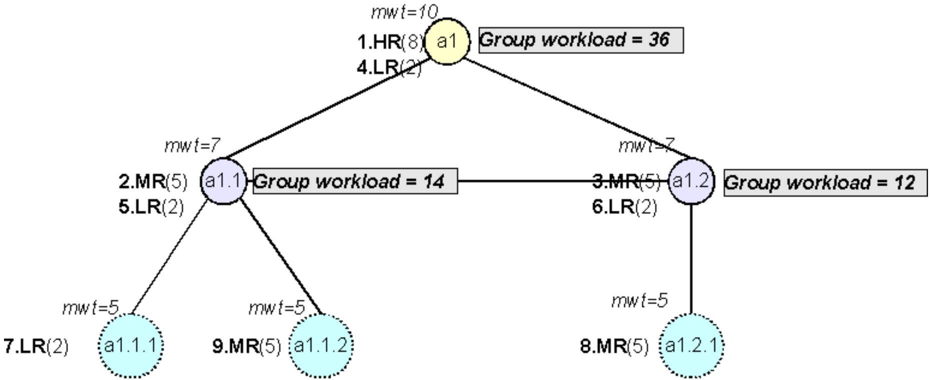

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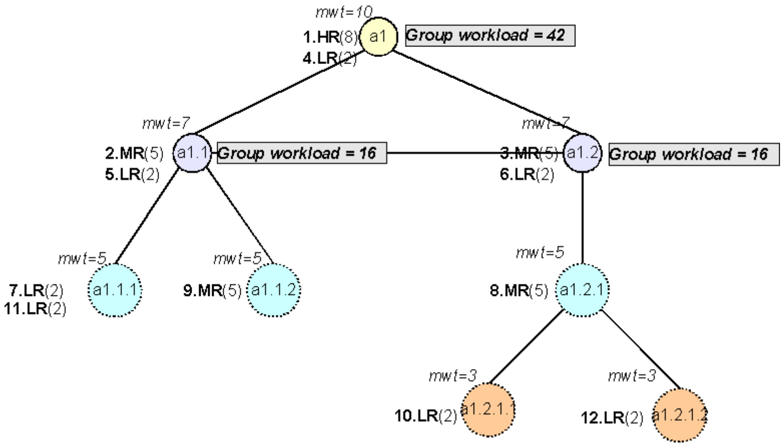

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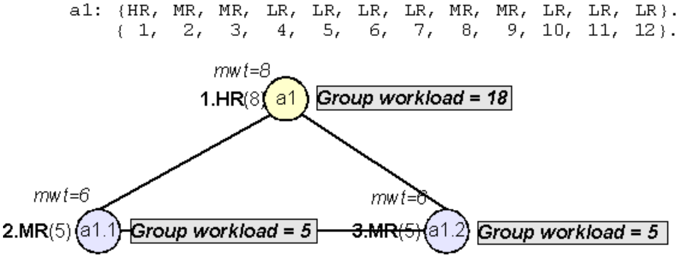

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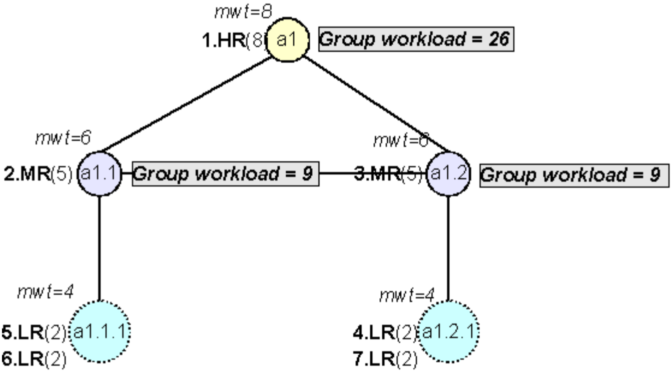

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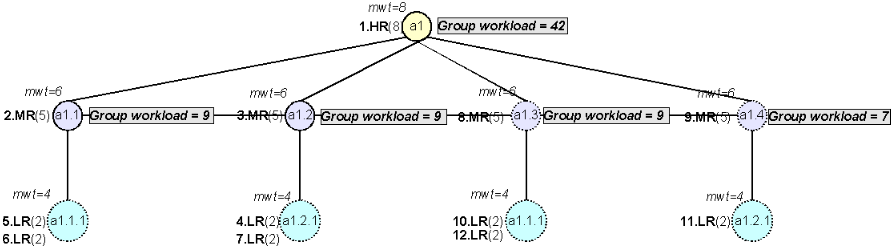

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- Currently : Turn to a OWL-S representation of roles and the HoloMAS

Applications

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- Assist cooperative work into a patent department [Holomas'00] and a technological watch department [AOIS'04]

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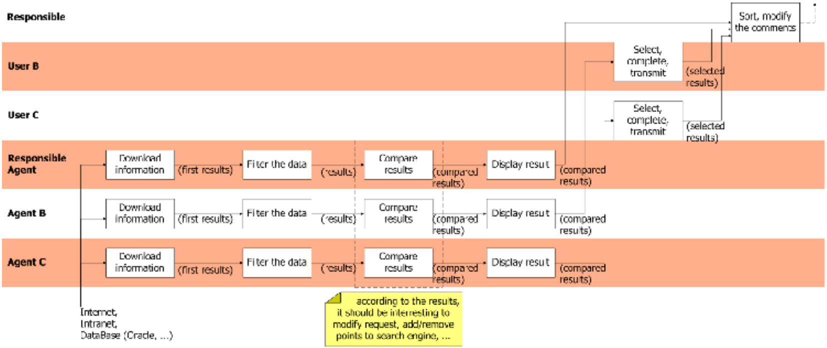
2. Improvement of the human organization based on the models
3. Design of a MAS based on holonic principles and modeled on the human organization

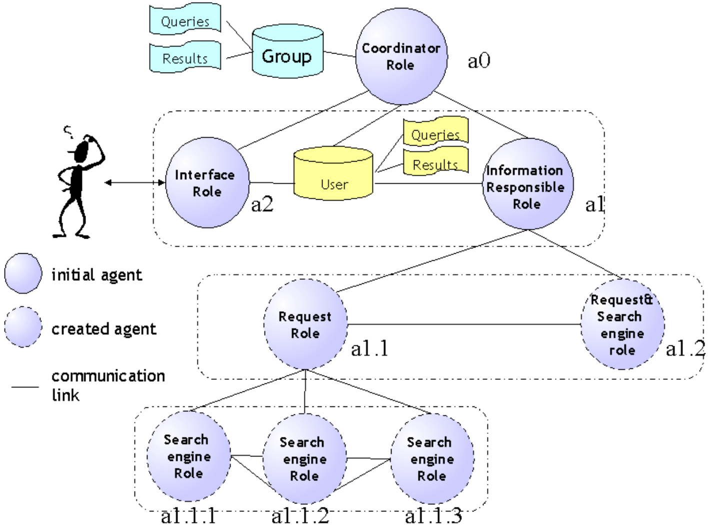
Example on a case study : Information MultiAgent System

Modeling the human activities



Example on a case study : Information MultiAgent System

Architecture of the proposed Holonic IMAS



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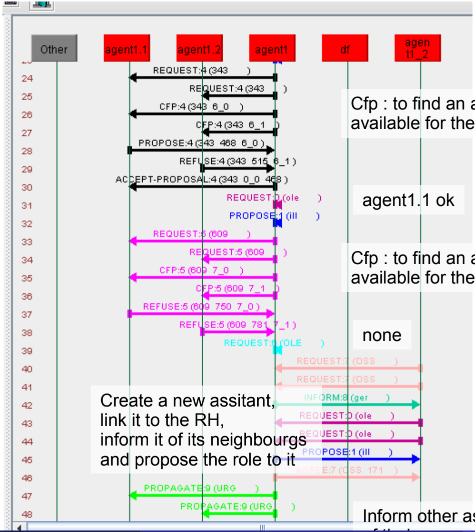
Exchanged messages during a delegation



Cfp : to find an assistant
available for the load of the role

agent1.1 ok

Cfp : to find an assistant
available for the load of the role

none

Create a new assitant,
link it to the RH,
inform it of its neighbourgs
and propose the role to it

Inform other assistants

Perspectives : self-* capacities

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- Evaluation of rules utility based on the reinforcement

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  - Problem : always use the same rules → to allow to test other rules

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  - Perspective : automatic detection of the inter-blocking situations / non cooperative behaviour
  - Implementation of the totality of our proposition

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- Improve the proposition by self-* capacities.

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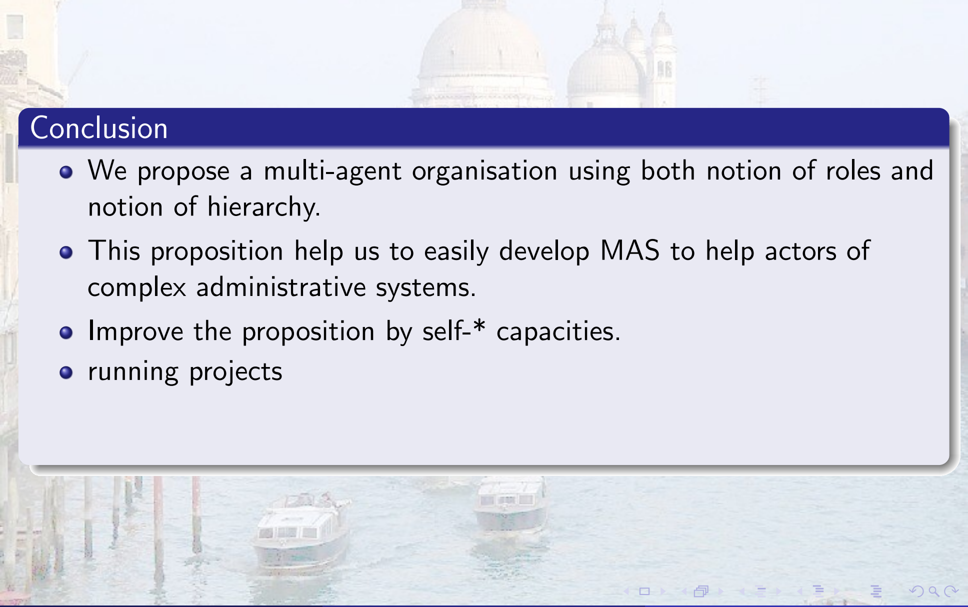

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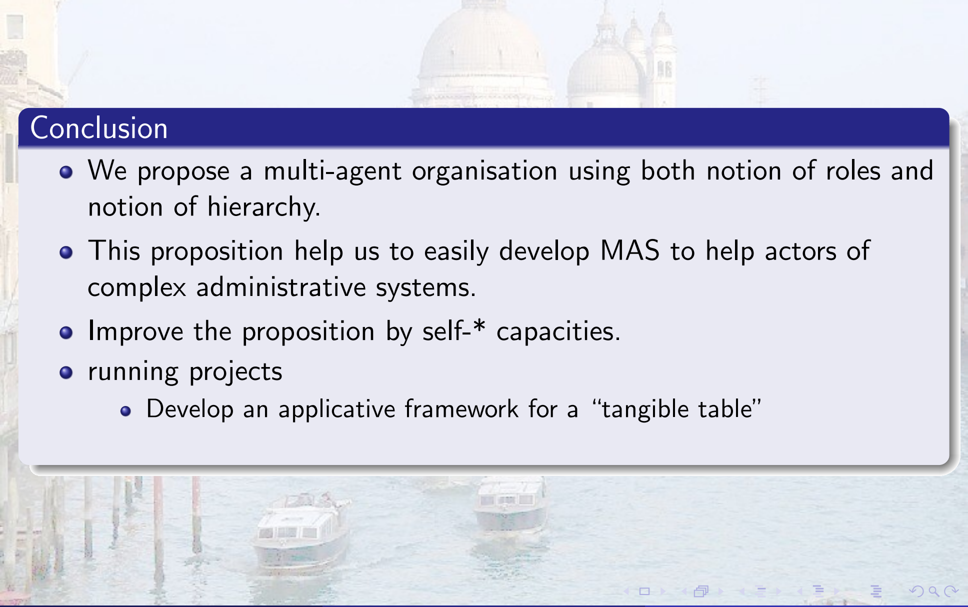

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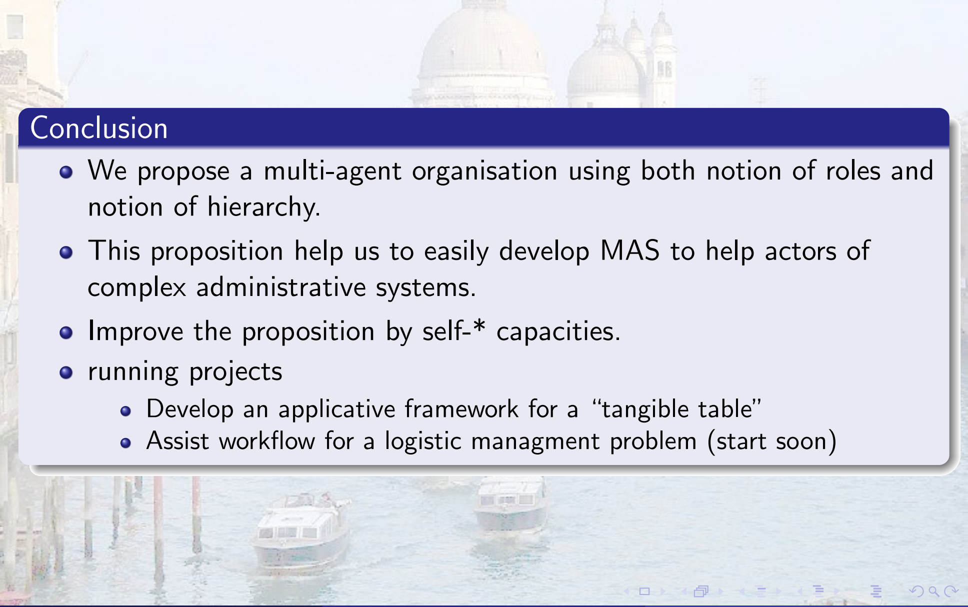

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- This proposition help us to easily develop MAS to help actors of complex administrative systems.
- Improve the proposition by self-* capacities.
- running projects
  - Develop an applicative framework for a “tangible table”
  - Assist workflow for a logistic managment problem (start soon)