The FP7 EU-Project eHealthMonitor: Modelling methods for managing the interdependencies between mobile apps

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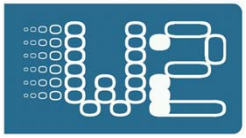

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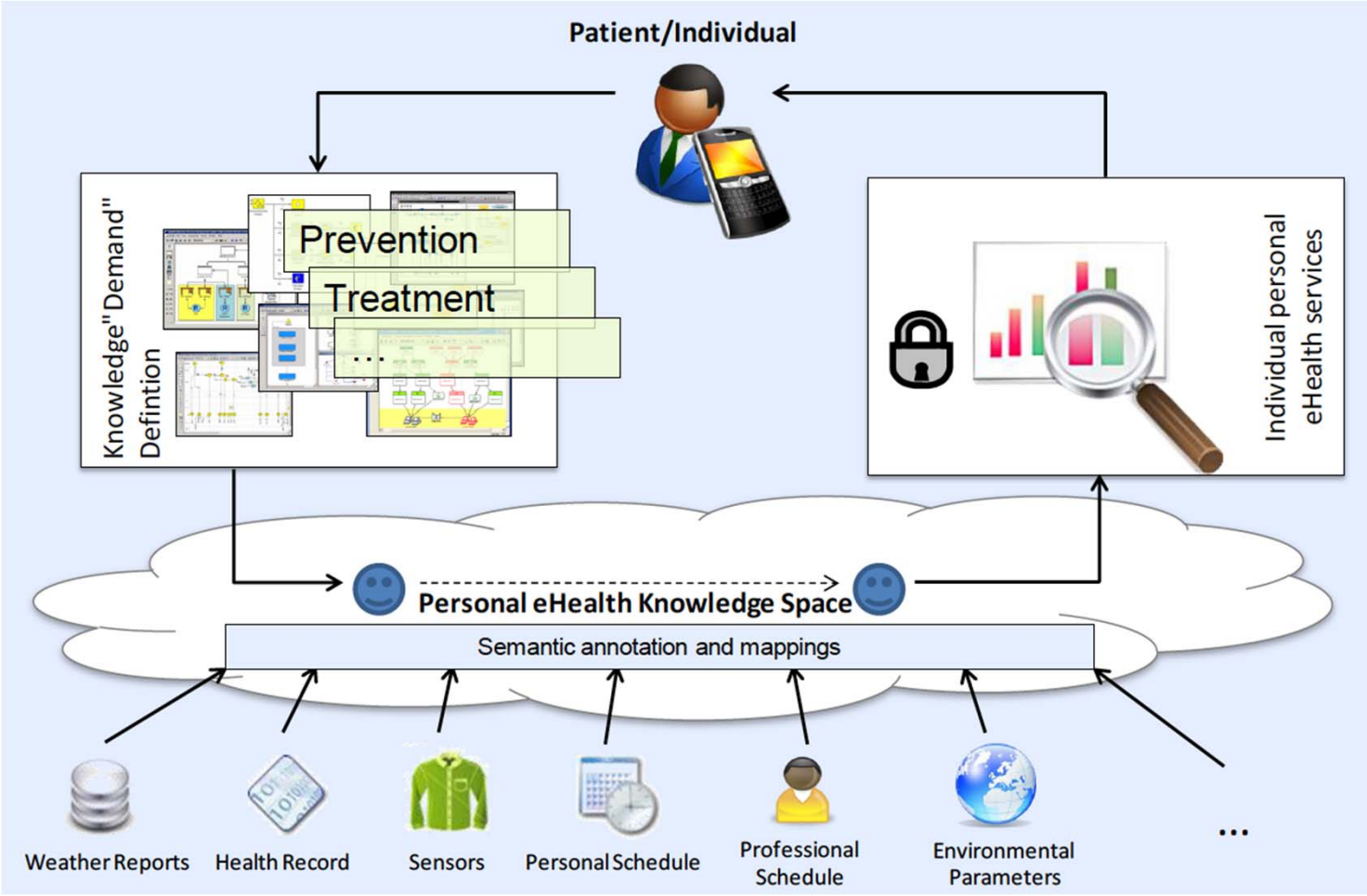
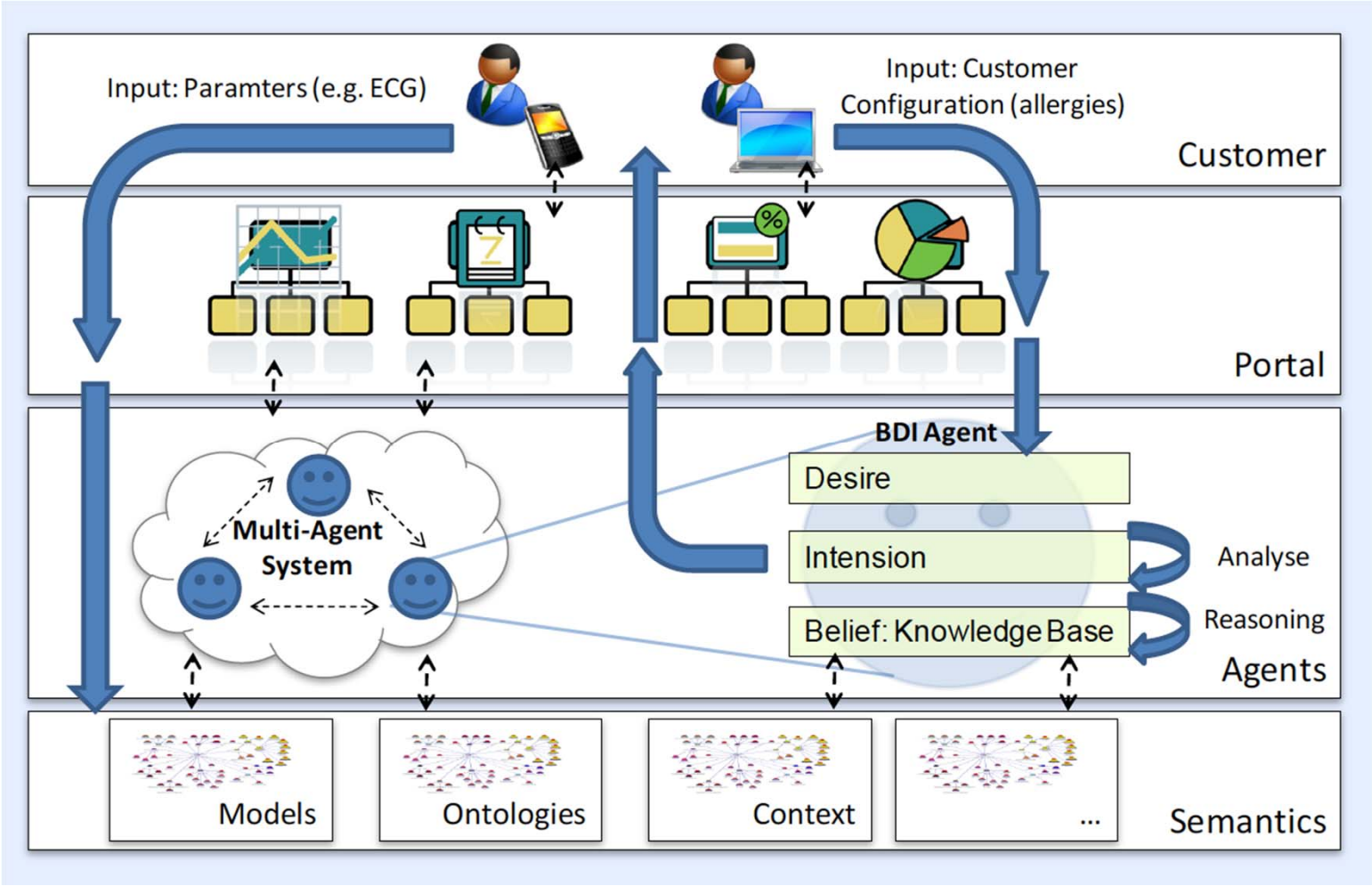

Patient/Individual
Knowledge"Demand"
Defintion
Prevention
Treatment
...
Individual personal
eHealth services
Personal eHealth Knowledge Space
Semantic annotation and mappings
Weather Reports
Health Record
Sensors
Personal Schedule
Professional
Schedule
Environmental
Parameters
...

eHealthMonitor Architecture



Focus Today: Coordination of Interacting Apps

- Application of multiagent coordination methods ...
- ... for distributed, adaptive knowledge sharing.

- Considering privacy protection requirements ...
- ... of the involved stakeholders (patients, medical professionals, informal caregivers, family members and social services).

- Provision of tools for manual and semi-automatic sharing of knowledge.

- Enabling cooperation and decision making of the participants ...
- ... in the eHealth service delivery life cycle.

II.

Conceptualization

Basic Assumptions, Research Challenge, Status

- **Care-givers** use smart mobile devices with eHealth apps.
- **Apps** provide software services for typical eHealth coordination, information & knowledge management tasks.
- **Wrapper agents** encapsulate each app thus transforming them it into intelligently cooperating software (app) agents.
- **Software Assistants:** Each app agent represents, and acts on behalf of its human / organizational owner.
- **Agent Society:** All app agents together form an "app agent" society.
- **Multiagent system**: App agents may form a multiagent system (sub-system of app agent society) in order to collaborate on a particular task.

RESEARCH CHALLENGE: improvement of multiagent concepts to develop agent-oriented models (user requirements) for typical eHM scenarios

Status: very early research

Scenario: (German) Care-Level 3

An old lady lives in the household of her daugther. She needs advice whenever she washes her face, her hands, and her intimate areas. Sometimes it requires a care-giver to carry out these activities for the rest of her body, dental care, combing, and dressing.

Whenever she is eating, advice is required, but often to feed her by a care-giver, too.

Several times a day, the lady requires personal help when she needs to frequent the toilet. Also 1-2 times during the night, followed by washing her intimate areas again.

Whenever the lady wishes to walk through the flat she needs help by a care-giver because walking with the walking frame is exhausting and time-consuming.

[translated from: http://www.pflegestufe.info/pflege/pflegestufe_3.html; 2012-09-10]

Care-giver: Professional nurse, or family member.

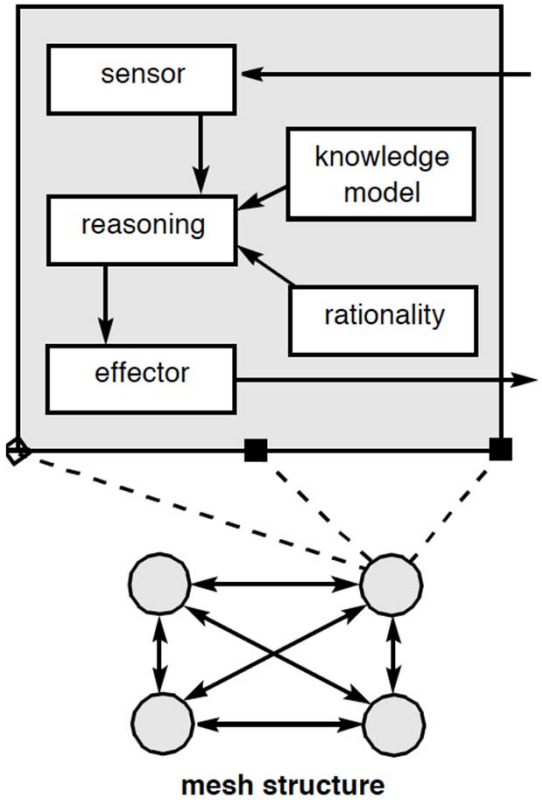
The allocation of tasks to care-givers requires fine-grained coordination, based upon mutual trust relationships, in often very exhausting situations. It´s self-evident, that goal-conflicts arise between the care-givers. Any IT-support has thus to consider information asymmetries, and conflicting goals between family care-givers and professional care-givers.

III.

App Agent Architecture

Software Agents

"An **agent** is a computer system that is *situated* in some *environment*, and that is capable of *autonomous action* in this environment in order to meet its *design objectives*." [Wooldridge & Jennings 1995]



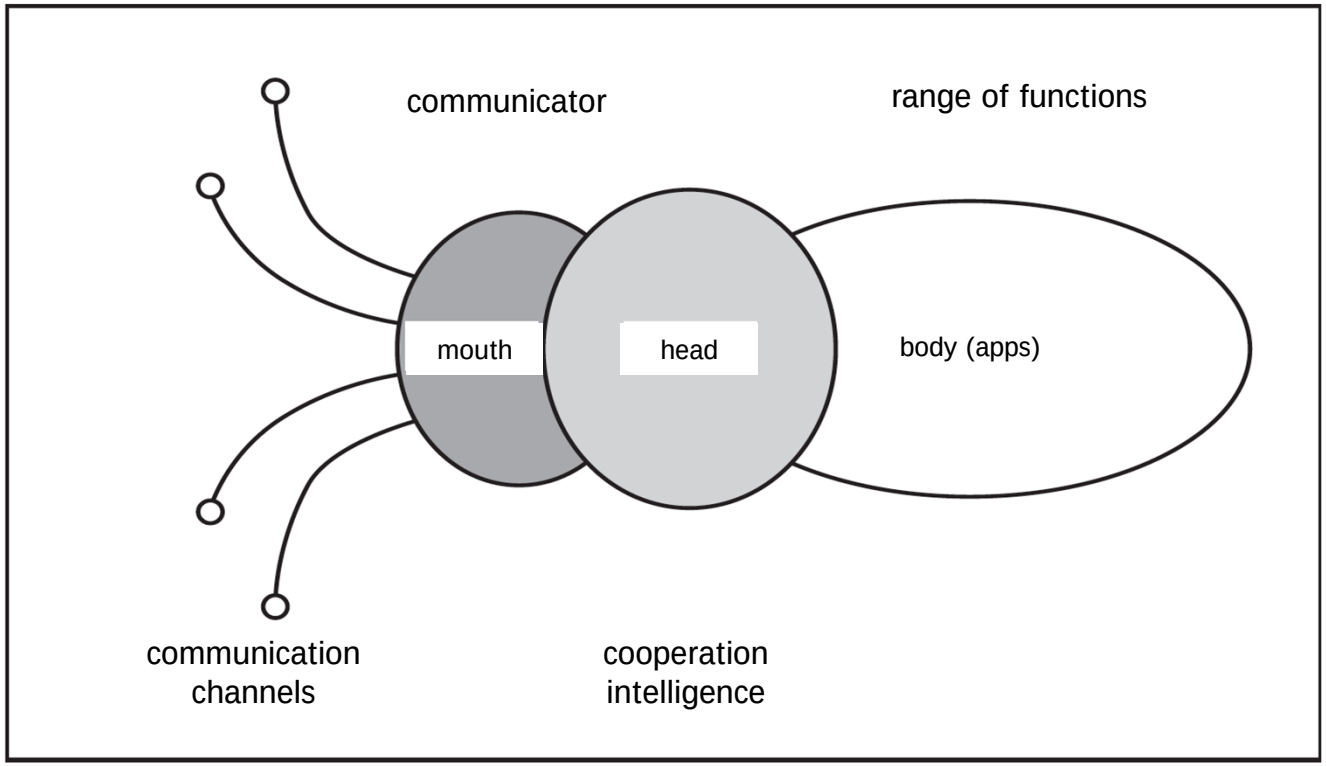
[Lee et al. 1998]

E-Health Apps everywhere !

Mouth-Head-Body-Architecture

- "Agentification" of apps through Mouth-Head-Body-Architecture
- Mouth: Communication abilities of the agent
- Head: Social competence & cooperation intelligence of the agent
- Body: range of functions of the agent (encapsulates the apps)

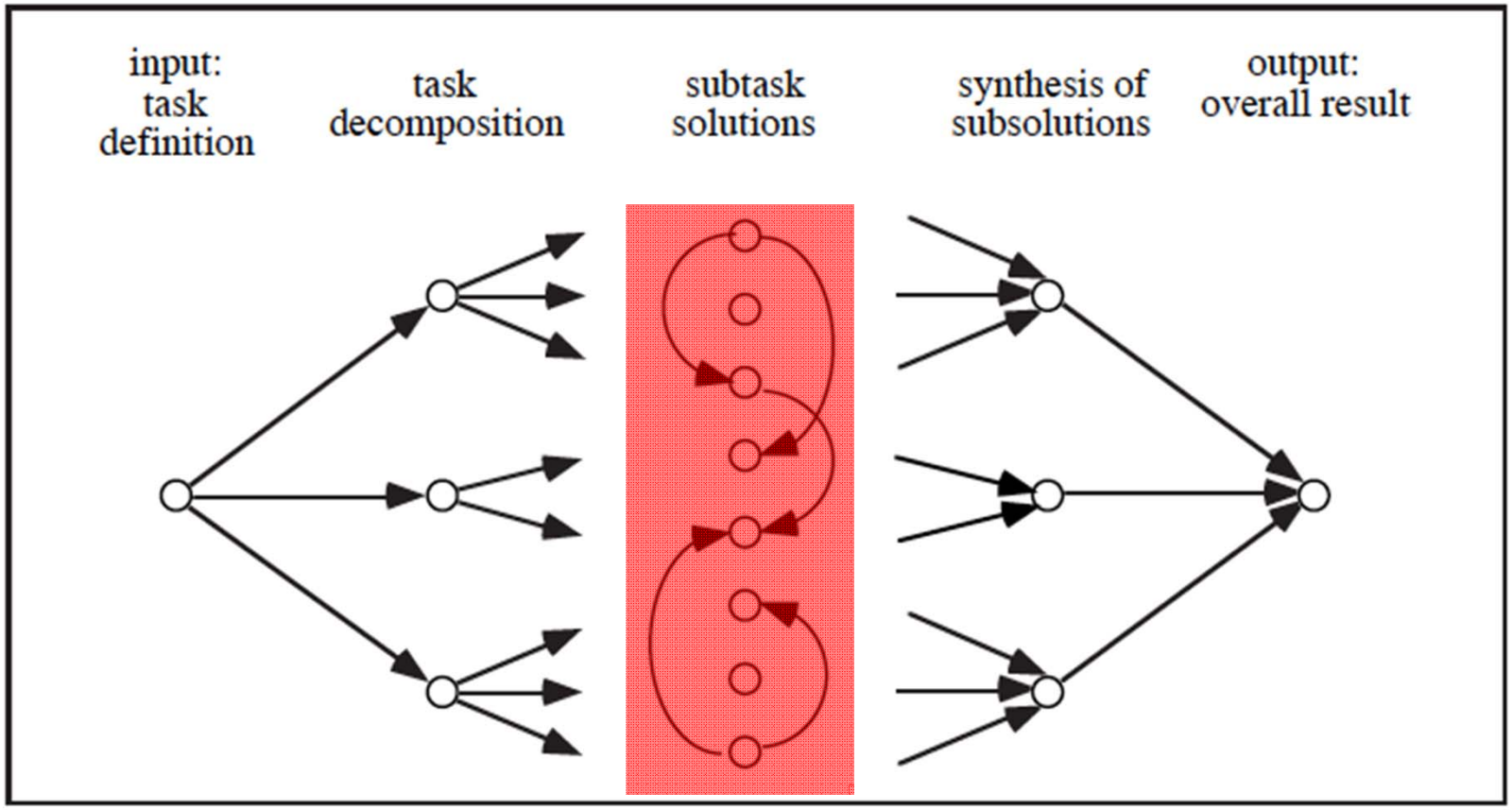
[Steiner/Haugeneder (1989)]



IV.

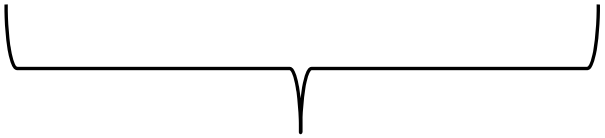
Contract Protocol for Task Allocation

General Approach: Task Decomposition ...



… and Task Allocation Tables

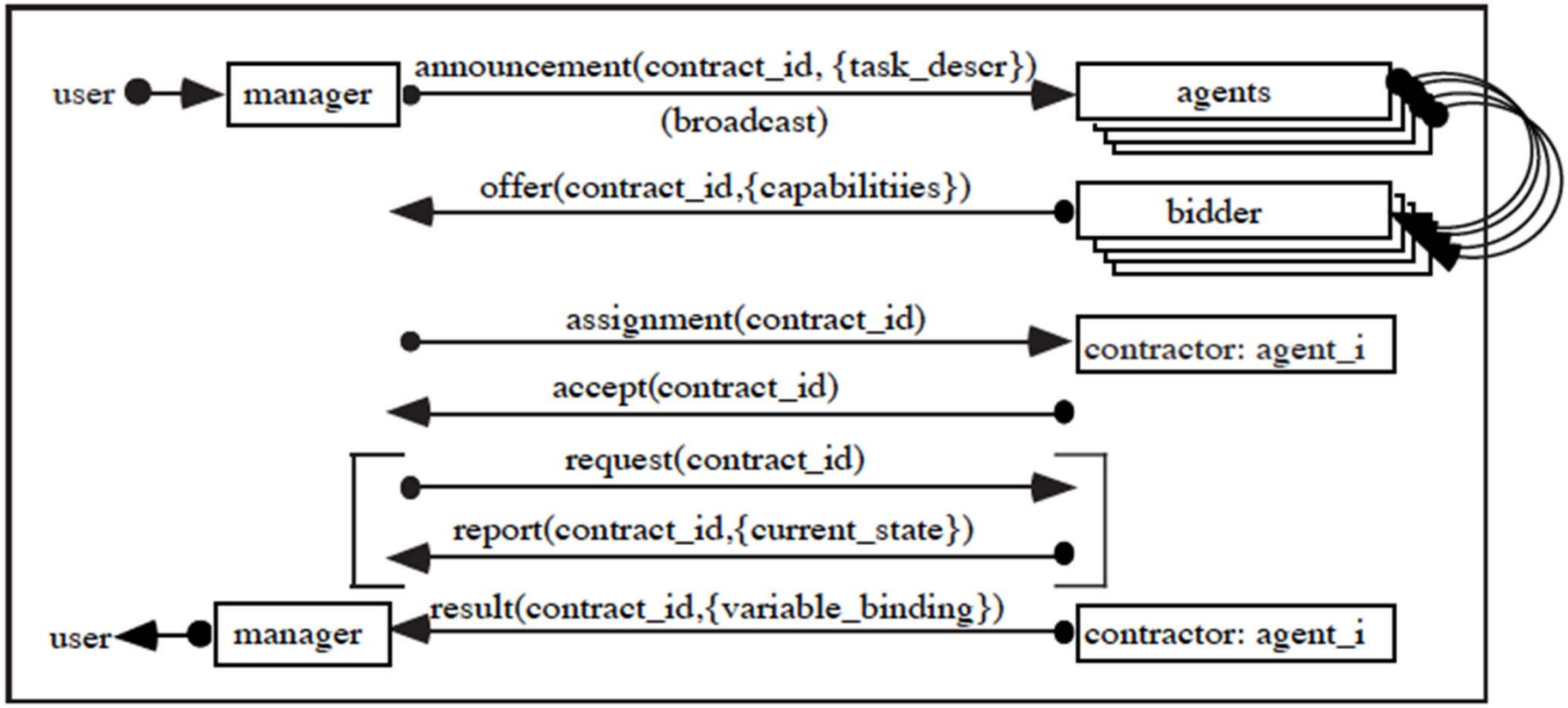
Task Allocation	Patient alone	family care-giver	professional care-giver
washing	x	x	
toilet		x	x
walking in the flat		x	x
service at night		x	x
meals	x	x	x



requires negotiations to coordinate:
– which care-giver
– shall provide which service
– at which time?

But: there are significant information asymmetries between family care-givers and professional care-givers, and there are siginificant conflicts of interest between these parties, too.

Negotiation-based Task Allocation: Contract Net Protocol



Pros: very flexible, easy to implement, distributed AI standard, ...
Cons: (1) does not support any dependencies between sub-tasks (!), (2) no support of any learning relationships at all, (3) no possibilities to model strategic behavior, (organisational / individual) preferences, risk behaviors, decision models, etc. of the agents (which are supposed to be rational agents)

Remarks

A MA approach is in particular appropriate if the following user requirements are addressed (German Priority Research Program on cooperative intelligent agents, 2000-2006):

- if highly flexible business processes shall be supported,
- if dynamic inter-process relationships play an important role,
- if the autonomy of organizational actors (org. units, employees) needs to be supported
- if significant local control is required, because of highly dynamic local settings, local situations, local environments

But: most work in MA coordination adresses system requirements.

Research issue: There is a significant lack in research, and in state of the art knowledge, how MA modelling concepts and coordination methods can be applied / need to be extended to represent user requirements in a valid way!

V.

Business Context: Formal Organizational Models (User Requirements)

Organisation Meta-Models in WFMS

[Rosemann / zur Mühlen '95]

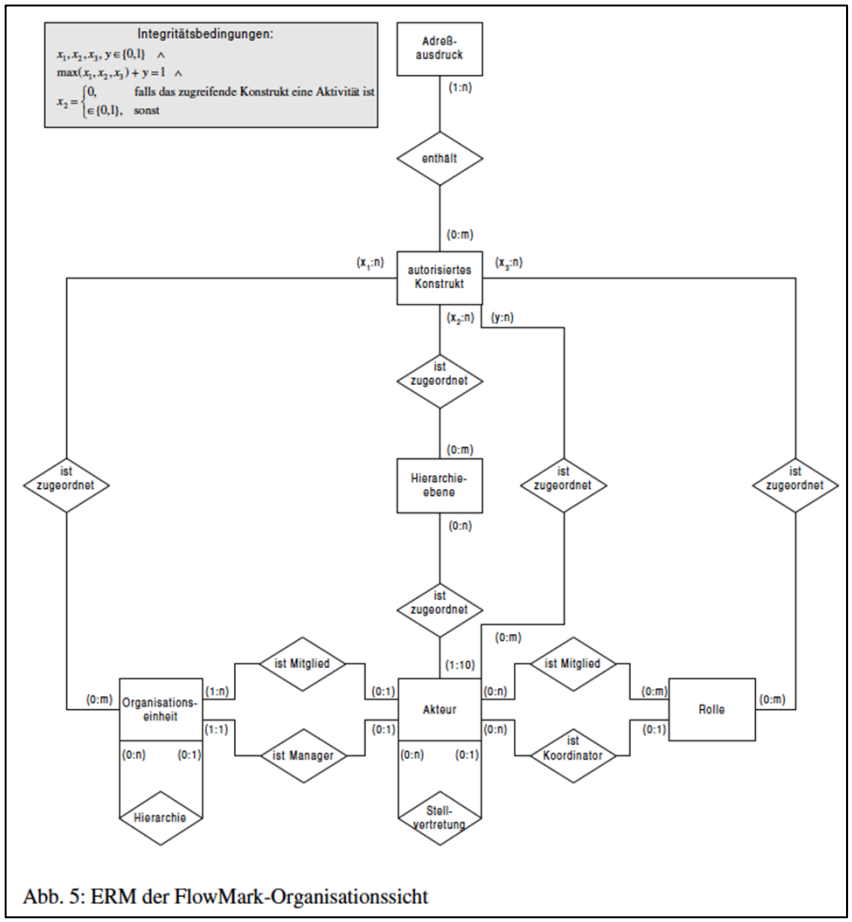


Abb. 5: ERM der FlowMark-Organisationssicht

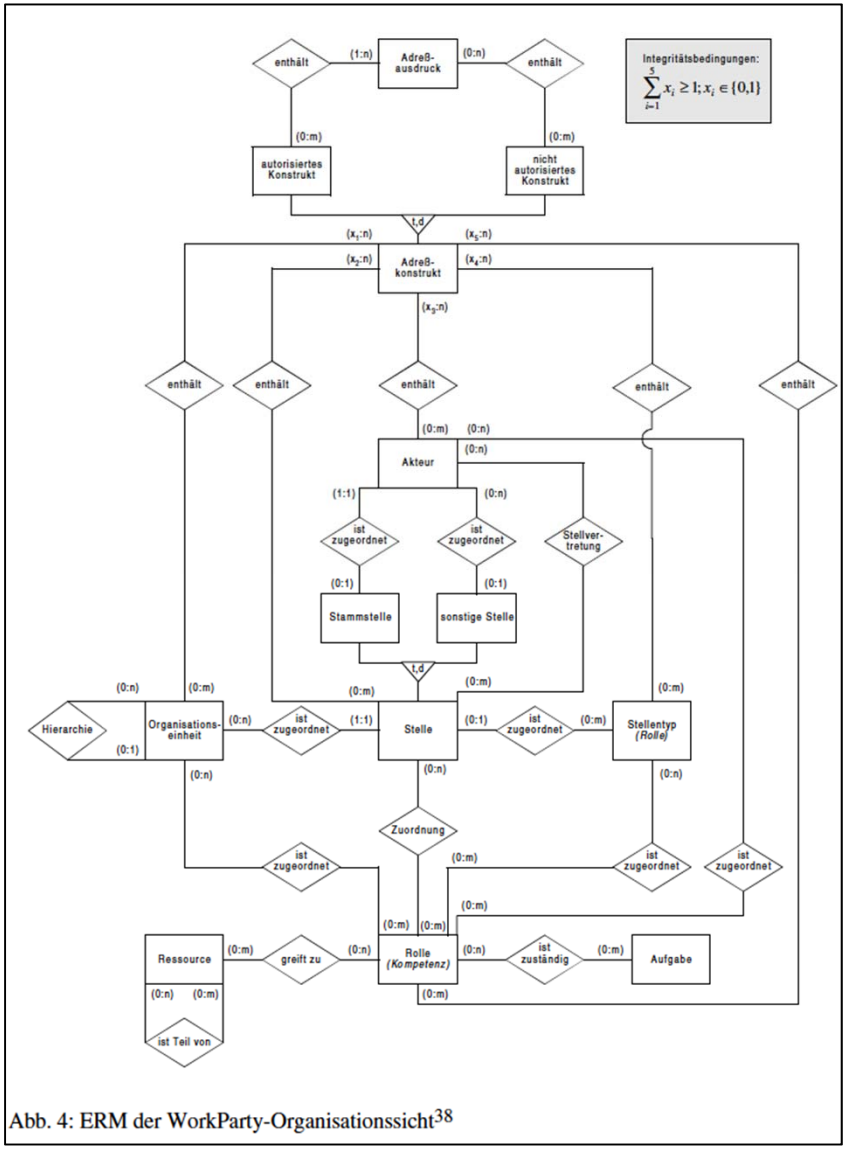


Abb. 4: ERM der WorkParty-Organisationssicht[38]

Process Meta-Models in WFMS

[Rosemann / zur Mühlen '95]

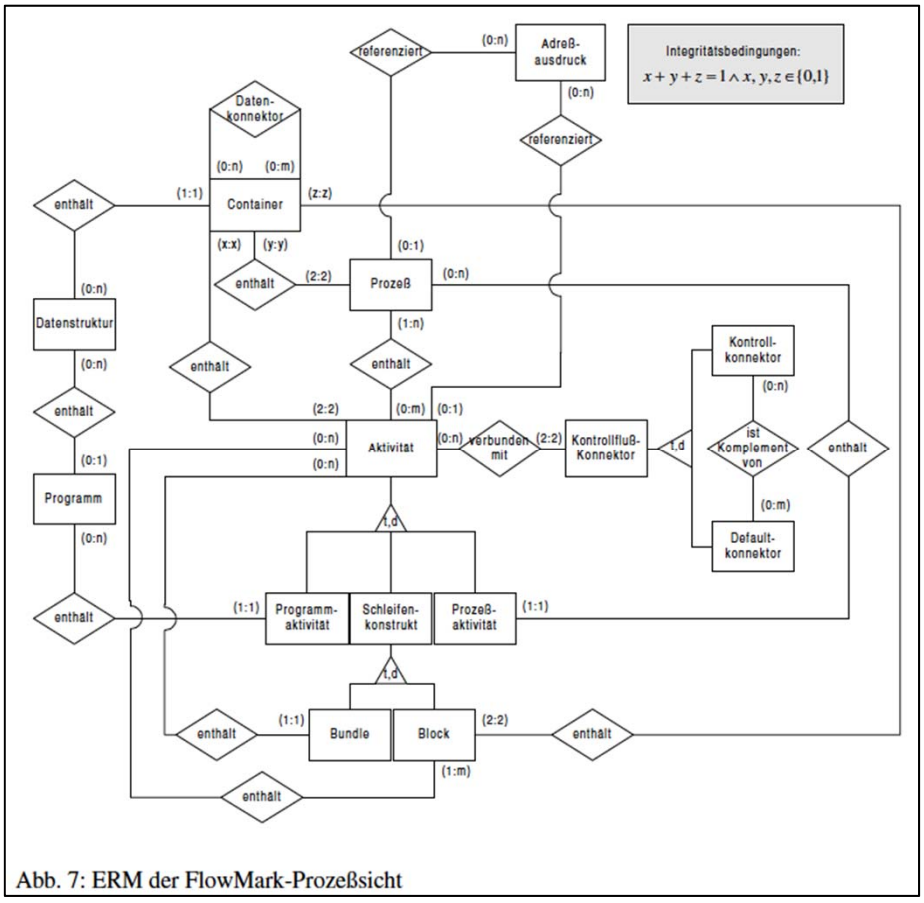


Abb. 7: ERM der FlowMark-Prozeßsicht

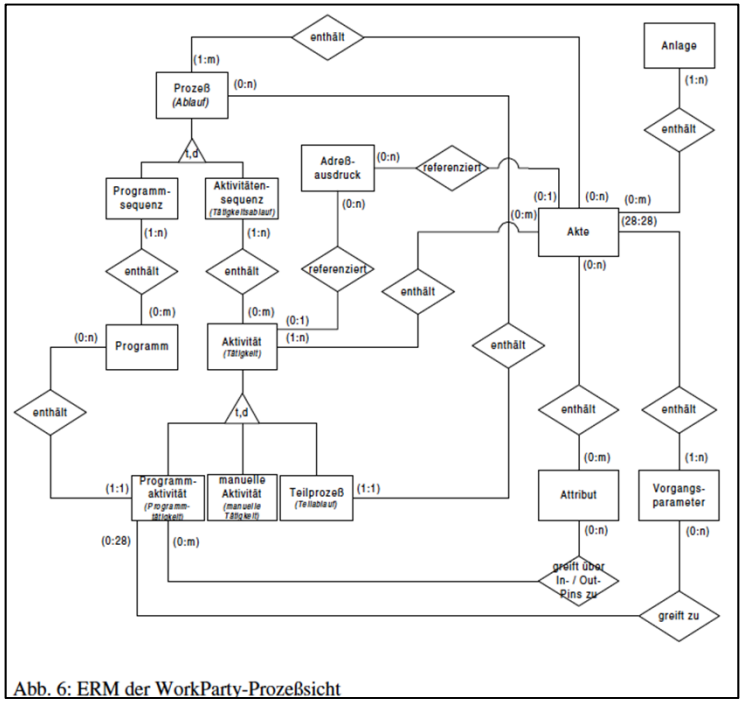


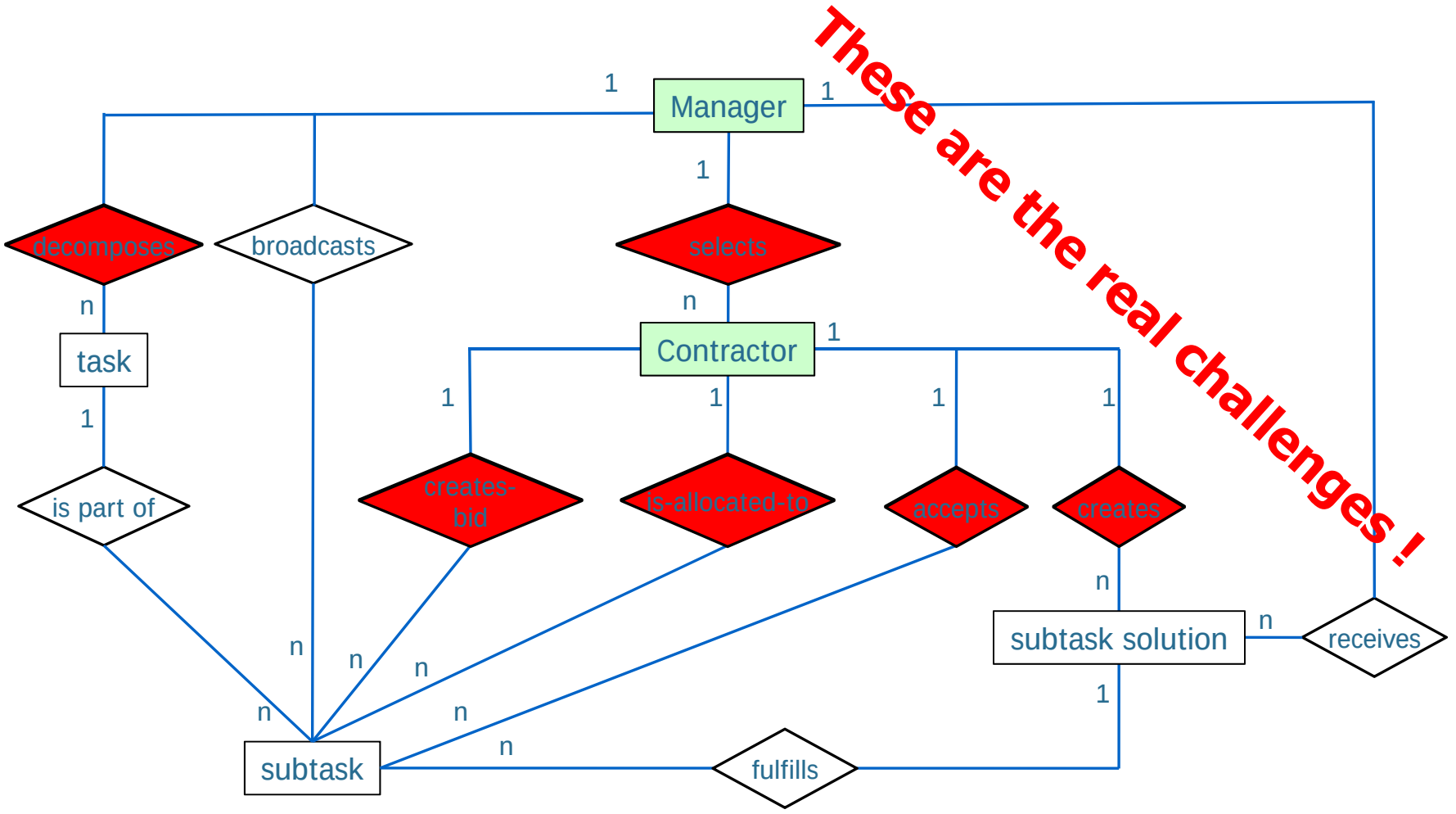
Abb. 6: ERM der WorkParty-Prozeßsicht

Lessons Learned

- significant differences between these meta-models for organizational structures and business processes
- the reasons behind are not documented (but probably due to more or less ad hoc decisions during design / implementation)
- the Workparty meta-model of organizational structures is significantly complex (and powerful), but does also have some critical inconcistencies
- important: no organizational theory / process theory could be identified on which these models may have been built, or could be built in future

In contrast to these approaches, the organizational model of the contract net protocoll is quite simple ...

Evaluation: The Organizational Meta-Model of the Contract Net-Approach



Lessons Learned

By definition, Manager and Contractor are rational agents, i.e., they are supposed to pursue selfish aims, even on the basis of strategic behaviors (opportunism). Generally, they consider information asymmetries, and conflicts of interest.

As the agents are supposed to act on behalf of their users, the contract model needs to be extended by components derived from the principal agent theory. E.g.:

- If alternative task decompositions are possible: Why – strategic motivation behind? – did the manager choose just that particular task decomposition plan?
- Why did the manager select just that contractor he had selected? => Are there any agents with potentially better qualification? Which strategy (signalling) an agent should apply to make the manager aware of its higher qualification?
- When creating its bid, did the contractor try to benefit from information asymmetry?
- Are there any clues for strategic behaviors of the contractor, e.g.: hidden information, hidden action, or hidden intention?
- For which solution can/should the manager go: paing incentives for the contractor, observation / monitoring the contractor, implementating concepts of trust and reputation, establishing an appropriate organizational culture, ...?
- Finally (decision theory/decision models): both actors exhibit either risk avoidance, risk neutrality, or risk proclivity. This needs to be integrated into the contract model, too.

VI.

Further Research

Further Research

- As agents are supposed to be rational agents, managers and (potential) bidder/contractors pursue selfish aims, following an opportunistic theory. They are aware of the problems / chances coming to them with information asymmetries, and conflicts of interest.
- First evaluations led to the hypothesis, that the enhancement of MA concepts by socio-economic theories improves the applicability of multiagent theories to user requirements modelling. Examples are:
  - theory of organizational design
  - situative organizational theory
  - resource based organizational theory
  - decision theory
  - principal agent theory
  - property rights theory
- Expected outcome (~summer 2013): semantically enriched MA modelling concepts for agents, multiagent systems, coordination methods in order to make MA approaches much better applicable to user requirements modelling than they are today.