Multiagent Oriented Programming

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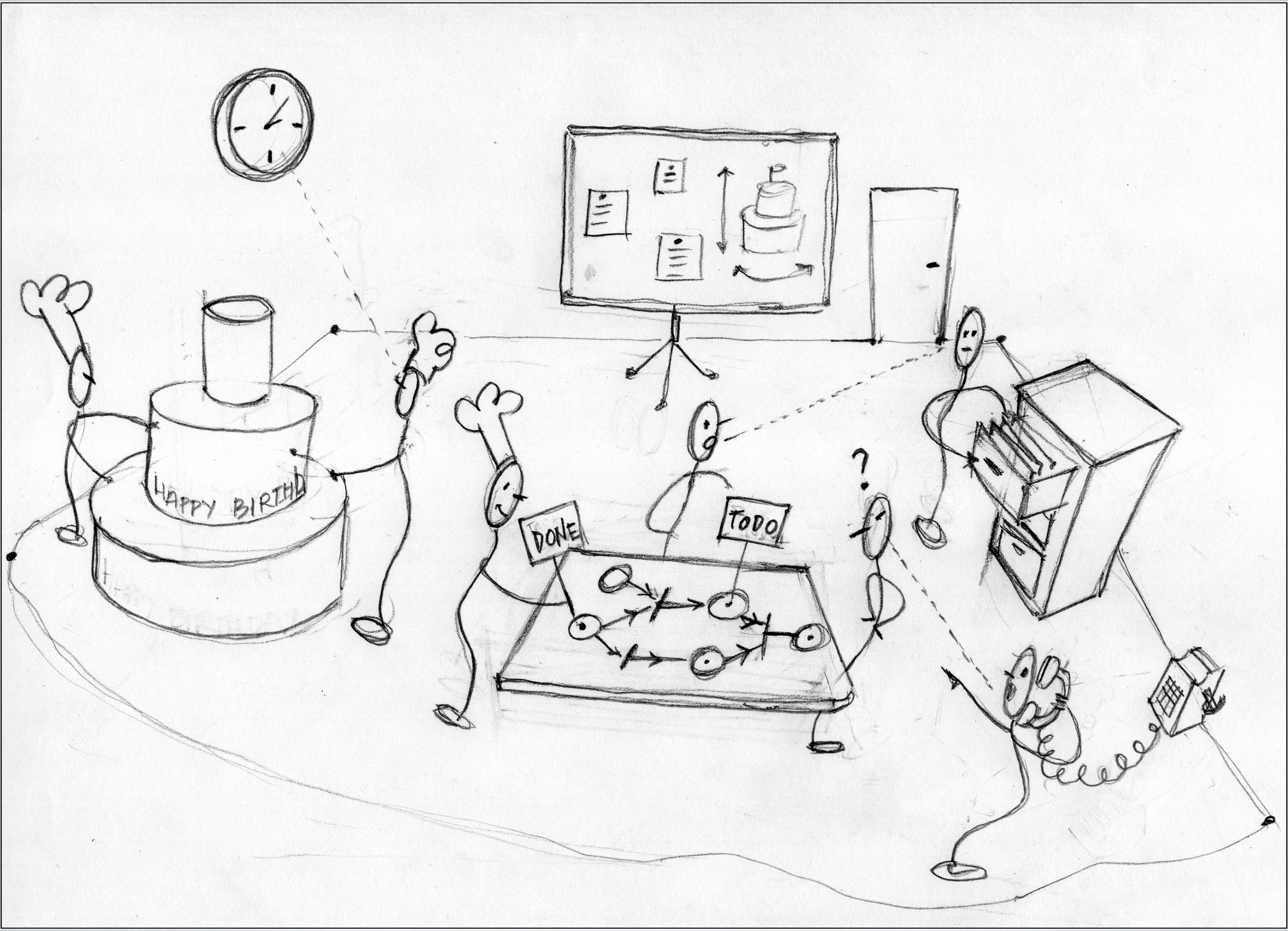
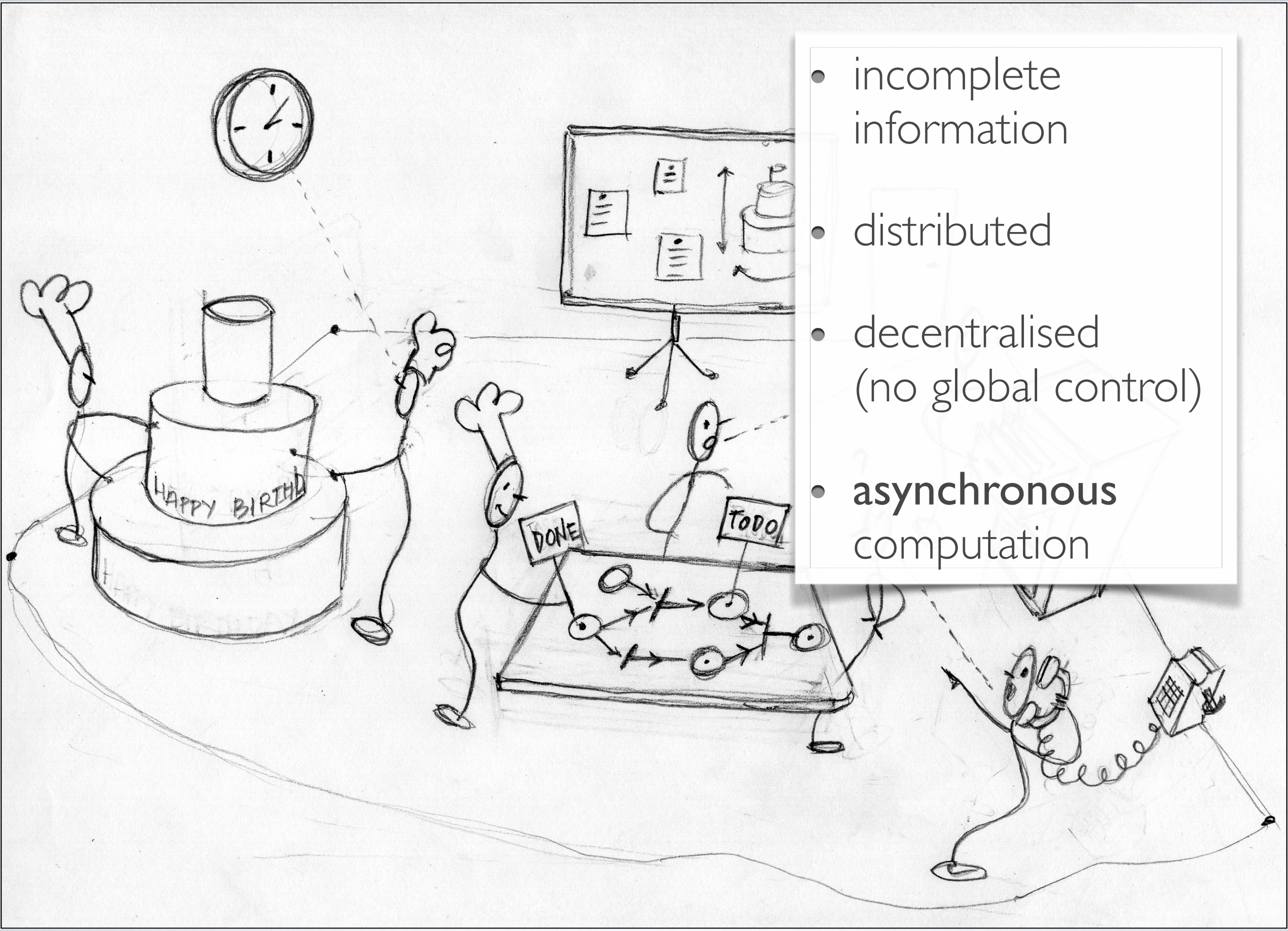

HAPPY BIRTH
DONE
TODO
?



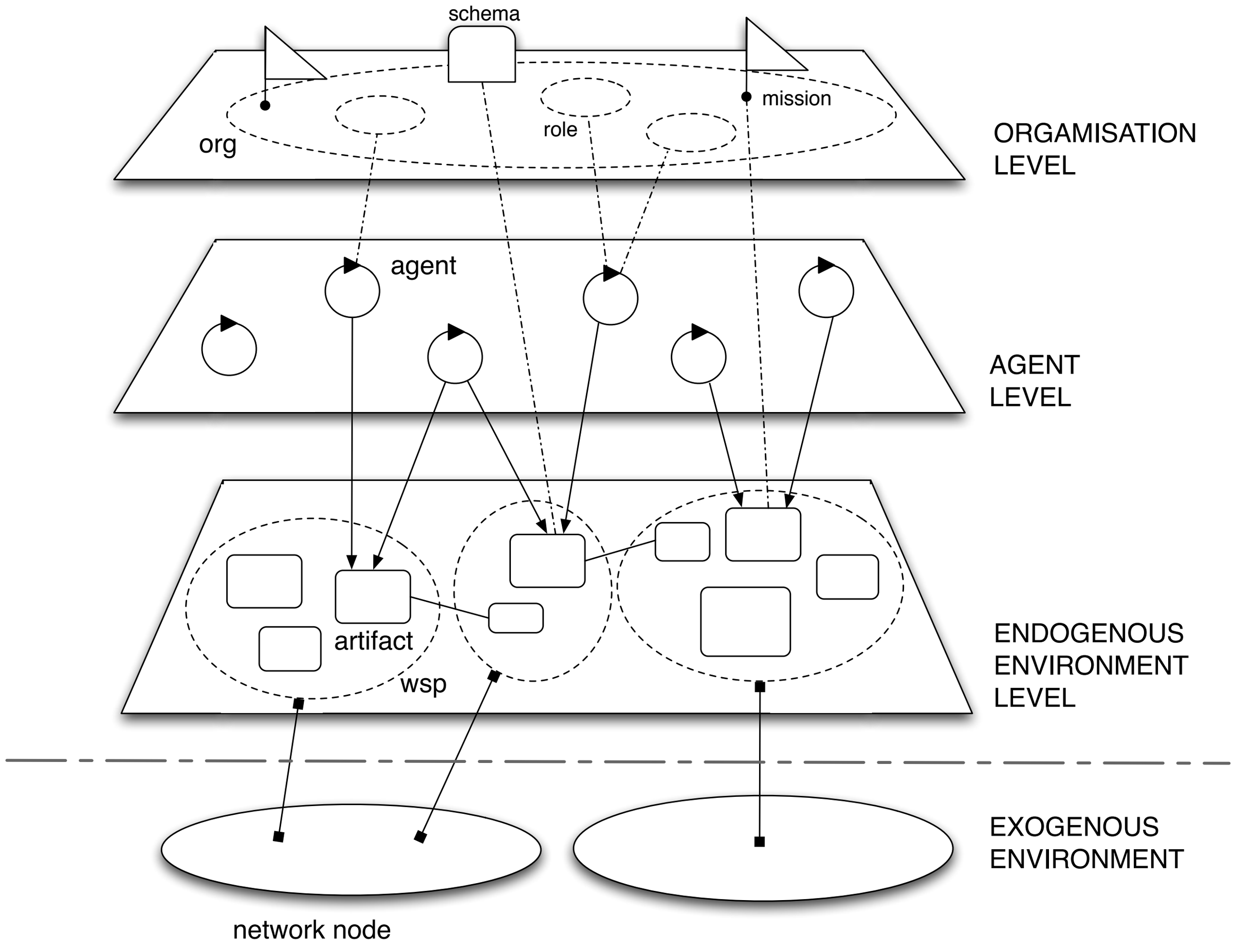
- incomplete information
- distributed
- decentralised (no global control)
- **asynchronous** computation

"An MAS is a loosely coupled network of problem solvers that interact to solve problems that are beyond the individual capabilities or knowledge of each problem solver"

– Durfee and Lesser 1989

Our Definition

- an organisation of autonomous agents interacting together within a shared environment
- conceptual and practical tools to design and implement distributed, complex, huge, open, ... systems


schema
org
role
mission
ORGAMISATION LEVEL
agent
AGENT LEVEL
artifact
wsp
ENDOGENOUS ENVIRONMENT LEVEL
EXOGENOUS ENVIRONMENT
network node

APPLICATIONS

- Energy distribution
- Air Traffic Control
- Supply chain management
- Multi robot systems (e.g. RoboCup (rescue))
- Games (e.g. Age of Empires)
- Social Simulation

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a way to approach the problem

a method to specify the system

languages to program the system

JACAMO

- Conceptual and practical tools to design and implement distributed, complex, huge, open, ... systems

- First class entities:

  Agents, Environment, Interactions, Organisation

- Jason + CArtAgO + Moise + ...

- JaCaMo is a joint work with Bordini, Ricci, and Boissier

AGENT PROGRAMMING

- Autonomous entities of the system
  - encapsulate state, behaviour, control
- BDI theory
  - practical reasoning
  - reactivity + long term goals

AGENT F

- Autonomous ent
  - encapsulate sta
- BDI theory
  - practical reasoning
  - reactivity + long term goals

high level of abstraction

beliefs, plans, and intentions

naturally concurrent, distributed, decoupled, open, …

EXAMPLE

- Giacomo wants to build a house
- We consider two main phases:
  - Contracting specialised companies
    (Giacomo hires various companies specialised in different aspects of construction)
  - Building the house
    (Contractors execute the main workflow for building the house under Giacomo's supervision)

PHASE 1: CONTRACTING SPECIALISED COMPANIES

- The objective here is to hire one company for each of these tasks:

(a) Site preparation
(b) Lay floors
(c) Build walls
(d) Build roof
(e) Fit windows
(f) Fit doors
(g) Install plumbing
(h) Install electrical system
(i) Paint the exterior of the house
(j) Paint the interior of the house

NB: The same company can be hired for more than 1 task

PHASE 2: BUILDING THE HOUSE

- After the companies have been hired, they have to execute their tasks on time and in coordination with each other

- Some tasks depend on others and some tasks can be done in parallel, as represented by the workflow (";" for sequence and "|" for parallel)

- a ; b ; c ; (d | e | f) ; (g | h | i) ; j

PHASE 2: BUILDING THE HO

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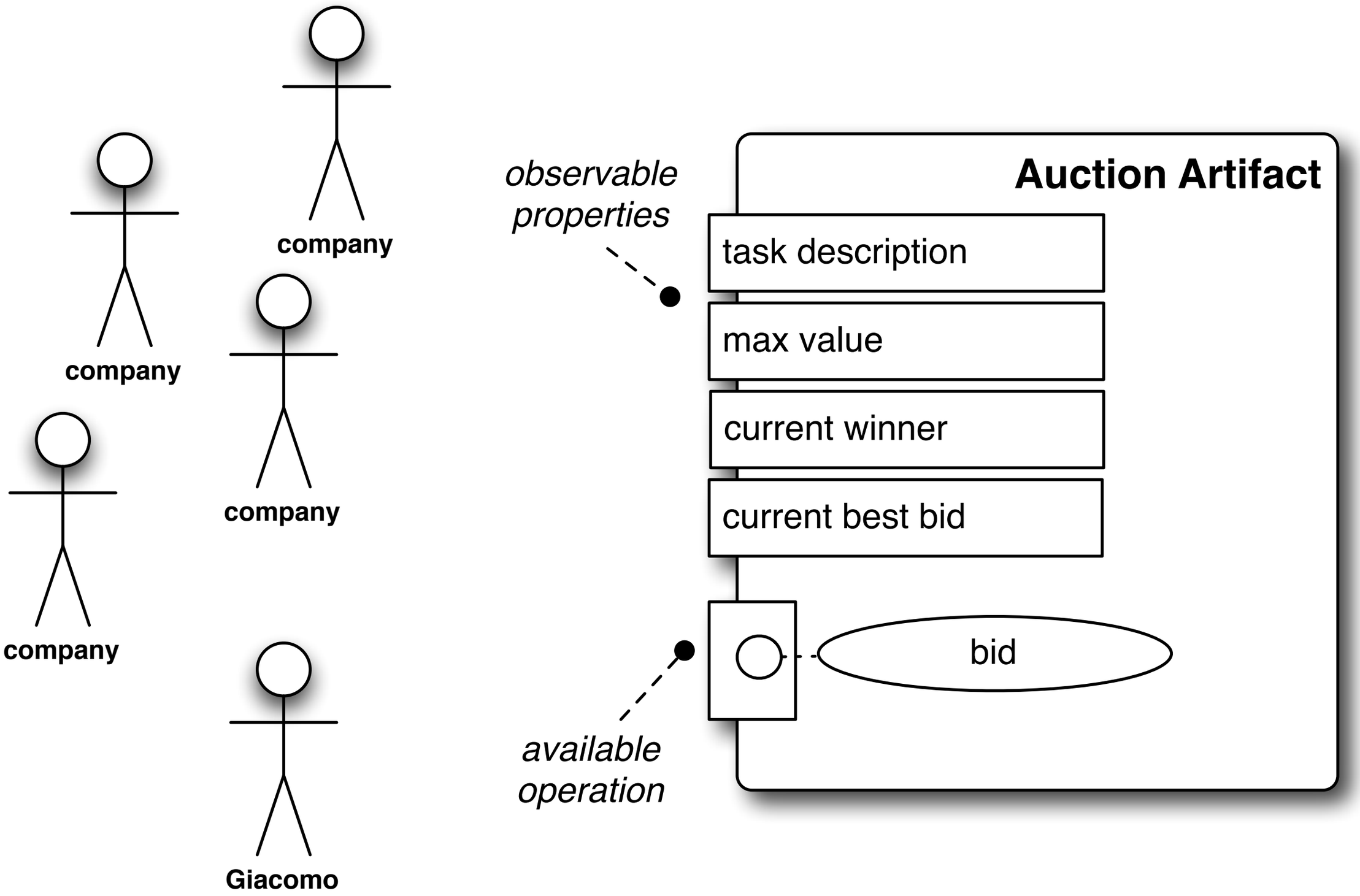
ENVIRONMENT PROGRAMMING

- agents inhabit an environment
- interaction model is based on perception and actions
- agents need tools
- tools are not agents and agents are not tools

Agent & Artifacts


company
company
company
company
company
Giacomo
observable properties
Auction Artifact
task description
max value
current winner
current best bid
bid
available operation

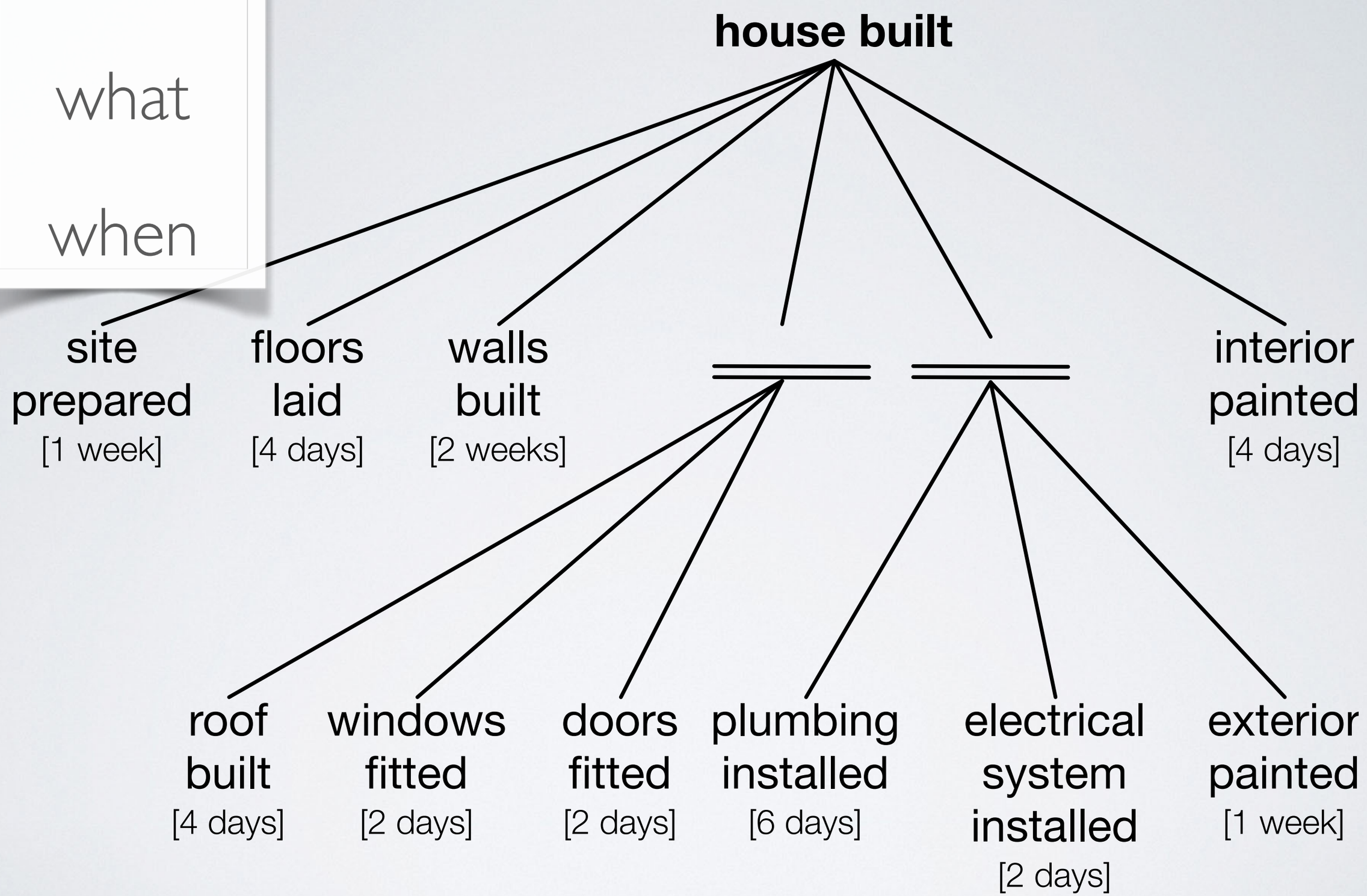
ORGANISATIONAL PROGRAMMING

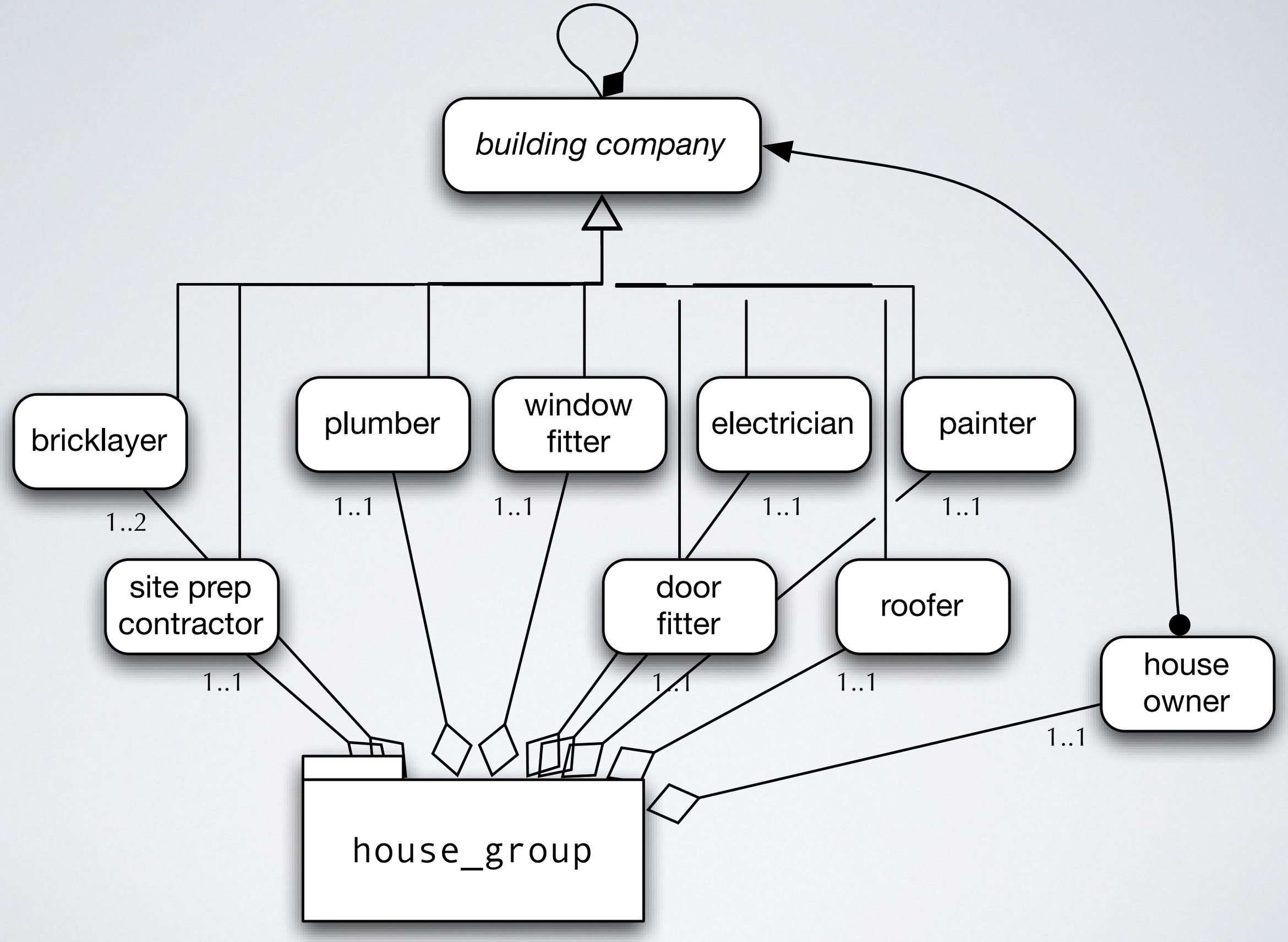
- control [malicious] agents
- help agents to [cooperatively] achieve goals
- simplifies reasoning about the organisation

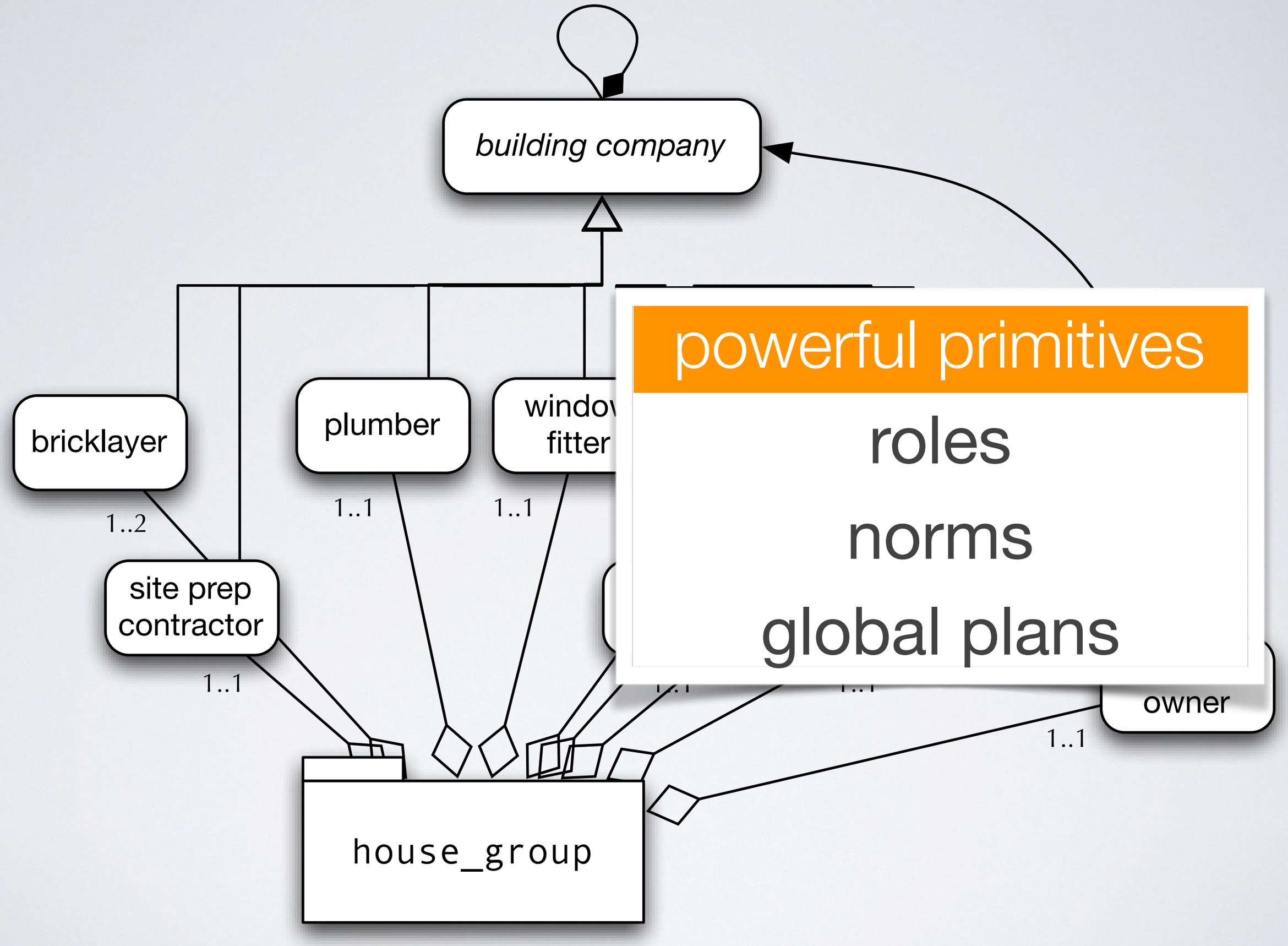
who

what

when




building company
bricklayer
plumber
window fitter
electrician
painter
site prep contractor
door fitter
roofer
house owner
house_group
1..2
1..1
1..1
1..1
1..1
1..1
1..1
1..1
1..1


building company
bricklayer
plumber
window fitter
1..2
1..1
1..1
site prep contractor
1..1
owner
1..1
house_group
powerful primitives
roles
norms
global plans

WHAT WE HAVE LEARNT?

- MAS is not only agents
- MAS is not only organisation
- MAS is not only environment
- MAS is not only interaction

WHAT WE HAVE LEARNT?

- MAS is not only agent
- MAS is not only organ
- MAS is not only envir
- MAS is not only interaction

from AOP

to

MAOP

MAOP

- Agents: beliefs, intentions, goals, ...
- Environment: artifacts, perception, ...
- Interaction: messages, protocols, ...
- Organisation: roles, norms, ...
- http://jacamo.sourceforge.net

CONCEPTUAL INTEGRATION