

Rethinking MAS Infrastructure with Activity Theory

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IT Infrastructure

- HW/SW Application's substratum
 - existing independently of any individual apps
 - shared by potentially many apps
- Implicitly / explicitly forcing a model to apps
 - through run-time abstractions
 - providing shared services to individual apps

Infrastructure for MAS

- Modelling and shaping the agent environment
 - agent point of view
 - designer point of view
- Infrastructure for AOSE
 - Impact on design
 - Infrastructure model
 - Keep the abstraction alive
 - Online Engineering

Governing Infrastructure

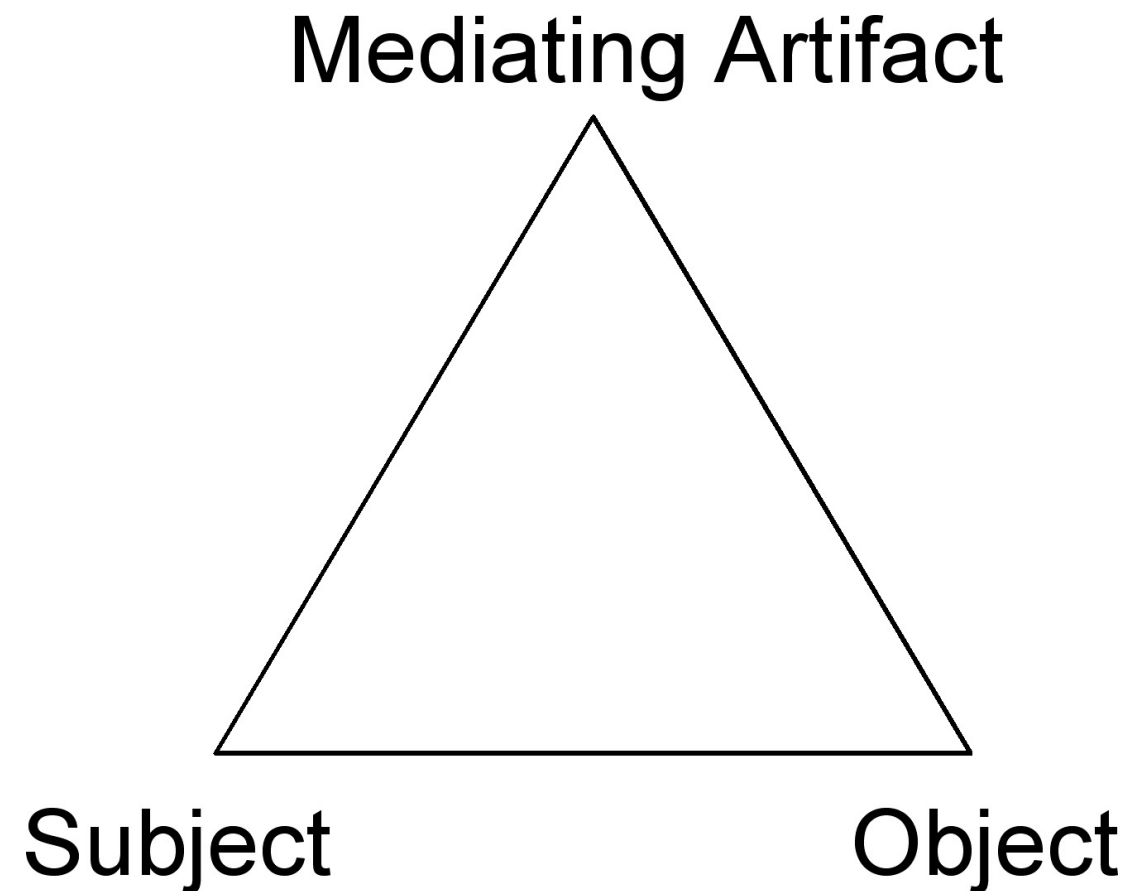
- From Enabling to Governing
 - eInstitutions, Social Order, Team-Oriented Coordination...
- Governing Dimension
 - Security / Policies
 - Organisation
 - Coordination
- Need for (Meta-)Models
 - inter-disciplinary approach

Activity Theory

- Social psychological theory about activities in complex societies (e.g. humans)
 - From soviet union psychologist ('20) to CSCW and HCI (~2000)
- Environment, context, mediating tools as first class conceptual entities
- Focus on mediated interaction

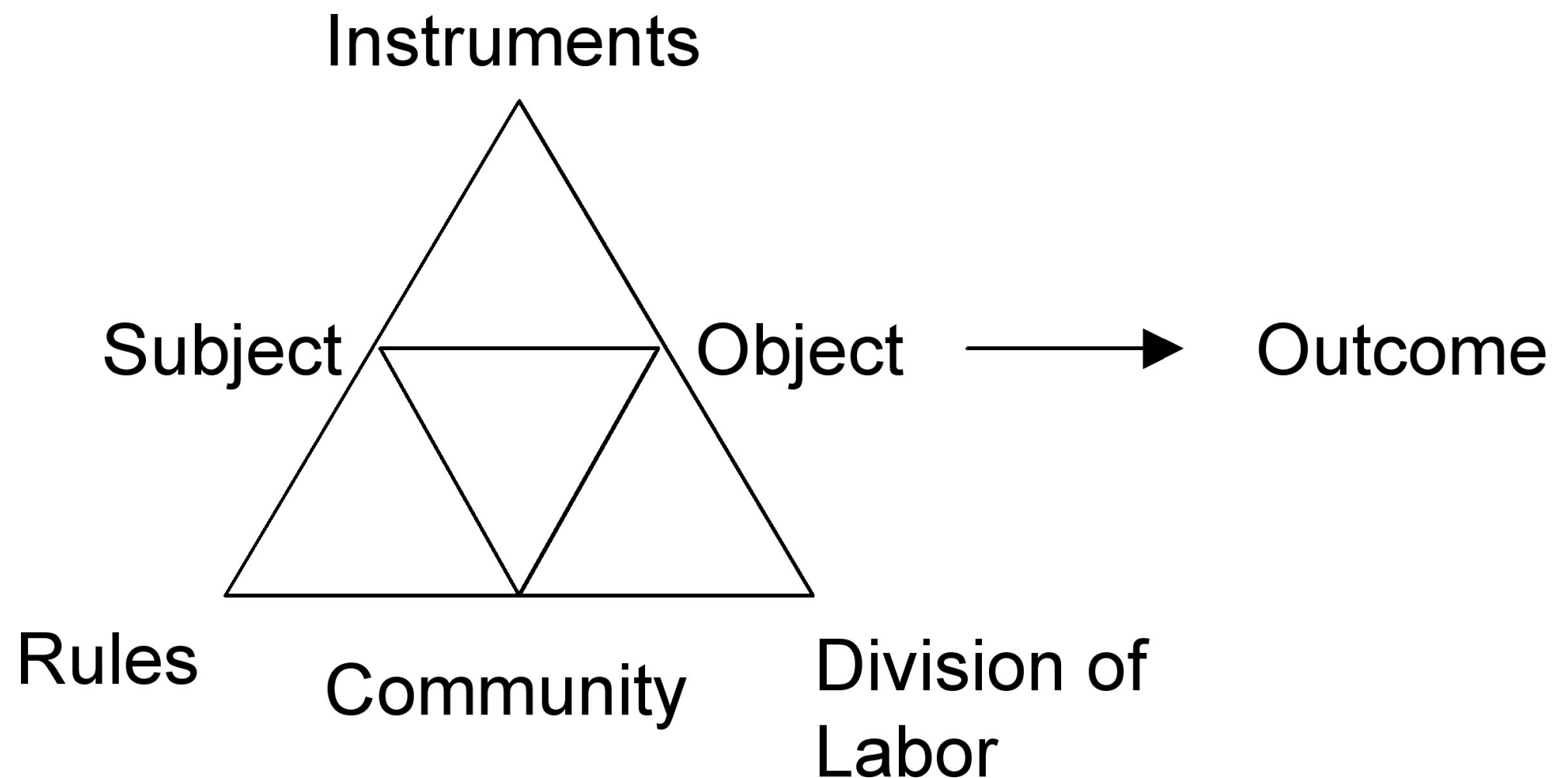
Activities

(Vygot'sky/Leont'ev)

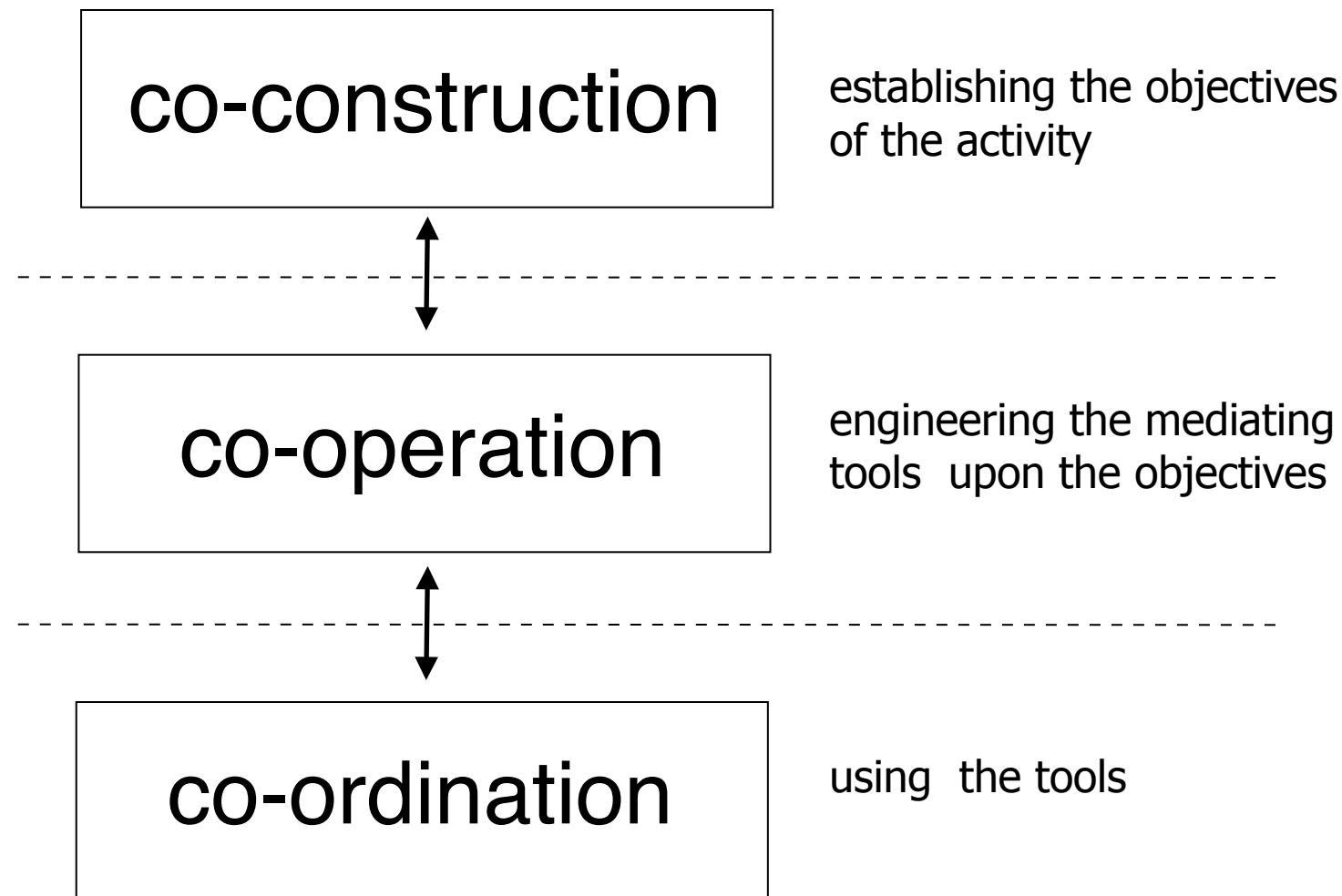


Activity Systems

(Engestrom)



Dynamic (Activity) Levels



AT for MAS

- Conceptual framework for understanding MAS Infrastructures/Environment & social activities
- Meta-model for describing existing approaches
 - Bridging the gap between subjective and objective coordination, between coordination and cooperation activities, ...
- Inspiration for Modelling & Engineering Governing Infrastructure
 - Theory & Practice of Coordinating Artefacts for MAS
- Inspiration for AOSE Methodology

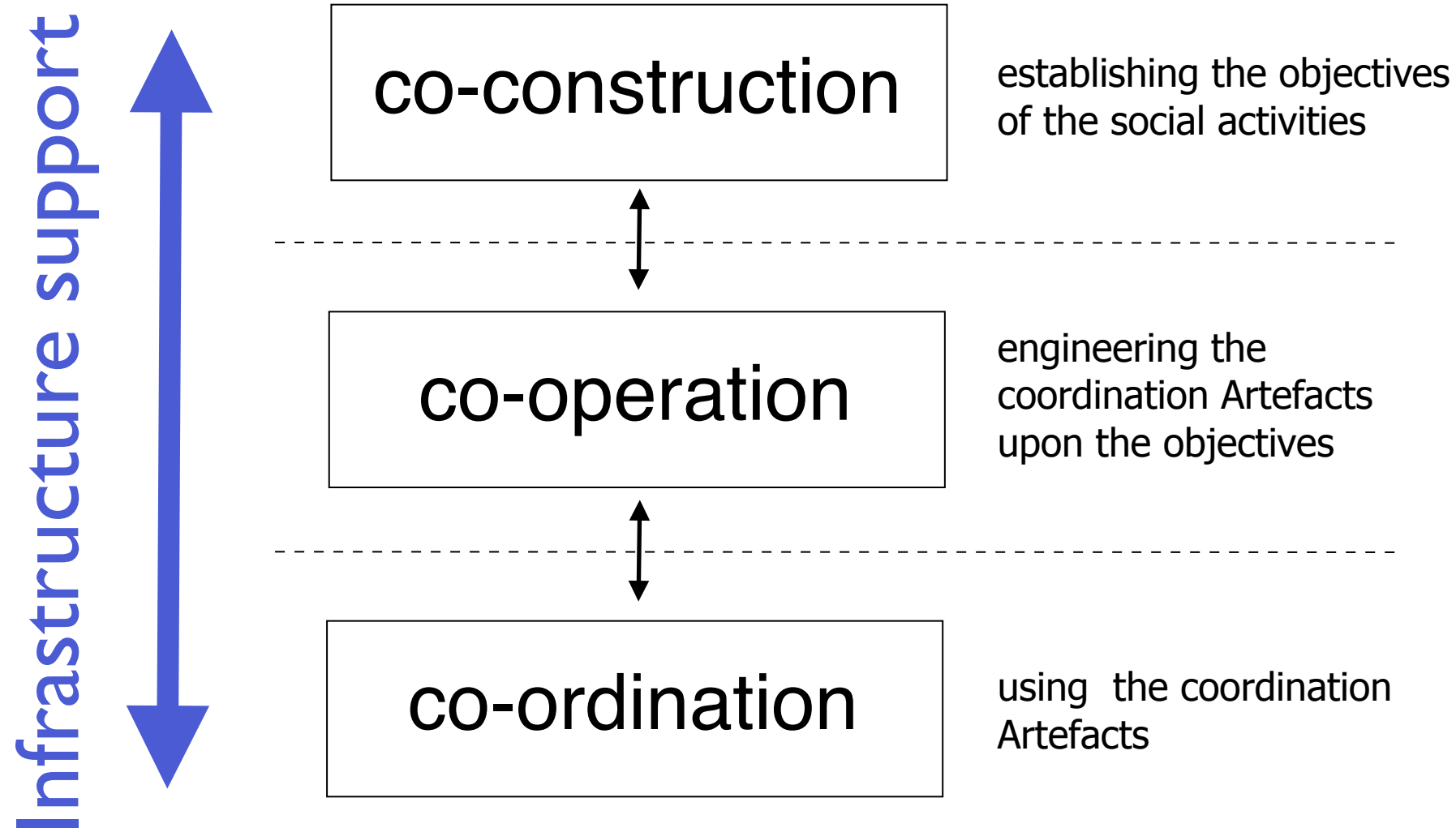
Coordination Artefacts

- Encapsulating/providing runtime coordination services for Agent Societies
 - [Social aspect] Coordinating social activities
 - [Normative aspect] Enforcing social norms (rules)
- Related Concepts
 - Coordination media (Concurrent Systems & SE), Coordinative Artefacts (CSCW), Coordination Structures (Distributed Cognition)..

Coordination Artefact Properties

- **Inspectability**
 - Inspecting at runtime the coordination service instructions & functionalities
- **Malleability**
 - Changing/Adapting at runtime the coordination service functionalities
- **Controllability / Predictability**
 - Formal Semantics of Coordination behaviour specification

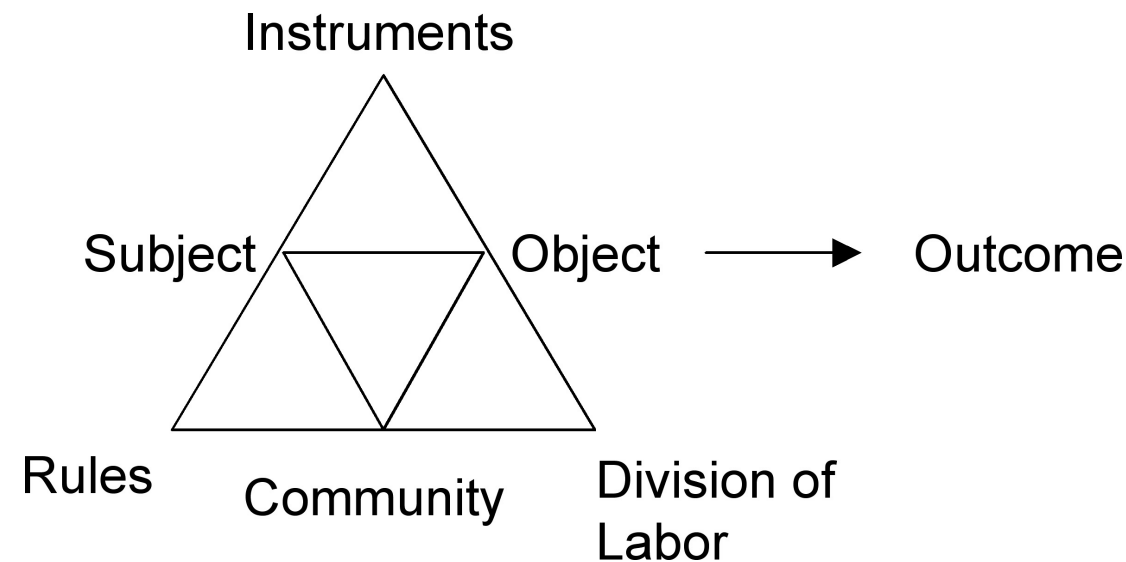
Online Engineering: Dynamic Levels



Coordination Artefacts for Governing Infrastructure

- Coordination Artefact provided by MAS Infrastructure should
 - Provide Basic Services for Artefact Management & Use
 - Support Activity Dynamic levels
 - Coordination Artefacts construction/inspection/change (co-operation)
 - Coordination Artefacts use (co-ordination)
 - Promote Controlled Self-adaptation
 - through Agent Intelligent Activity over Coordination

Organisational Artefacts



- Activities always happen in a Context
 - Coordination Artefacts cannot be used but in a Organisational context
 - Coordination Artefacts should account for Organisational aspects, too

Agent Coordination Context (ACC)

- Design Abstraction
 - Fully Accounting for Environment Perception / Manipulation by Individual Agent
 - Control Room Metaphor
- ACC Negotiation & Use
 - Each agent negotiates its ACC in order to enter the Organisation
 - Runtime Abstraction provided by the infrastructure

ACC for the Organisation Dimension

- Organisation Abstraction
 - Agent Role(s) inside Societies
 - Organisational Rules
- Security Abstraction
 - Role-Base Access Control (RBAC-like model)
 - Enforcing Interaction Protocols

ACC + Coordination Medium => MAS Artefacts

- Conceptual Unity
 - Modelling / Managing *Objective* Coordination
 - through Coordination Media
 - Modelling / Managing *Subjective* Coordination
 - through ACCs
 - Modelling / Managing *Cooperative* Activity
 - via ACC mediation upon Coordination Media
- Each abstraction has its own conceptual unity
 - the infrastructural model is complete, yet it promotes *conceptual integrity*
 - Essential for AOSE

Impact on AOSE

- Promoting Methodologies
 - Exploiting infrastructural models
 - not as limits to their freedom
 - but as conceptual (not simply technological) resources
 - Driving Engineers to find the best balance between infrastructural / systems / components activities
 - obj. vs. subj., coord. vs. coop., ...
 - Allowing many separate aspects of system engineering
 - like security, organisation, coordination
 - to be faced altogether
 - within a uniform conceptual framework
 - over a coherent and effective infrastructural technology

Ongoing Work

- Coordination Artefacts for Cognitive Agents
 - support for (individual & social) intelligent activity
- Coordination Artefacts & Trust
 - joint work with Cristiano Castelfranchi
- Coordination Artefacts & Law
 - joint work with Giovanni Sartor
- TuCSoN Infrastructure technology
 - Open Source Technology