

Towards Adaptive Service Ecosystems with Agreements Technologies

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August, 24th – 2011



Outline

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- A Base Architecture for Service-Oriented MAS
- The Service-Oriented Layer
- The Agreement Structure
- Case Study
- The next step: the Evolution
- Adaptive Organizations
- Conclusions



Introduction

- The coordination problem
 - Organization-oriented approach as an intermediate step towards adaptability
- Additional questions arise:
 - About the inner role of organizations in MAS
 - Services of an organization
 - About the need to provide coordination for organizations to achieve adaptation
 - Agreements between organizations



Introduction

Main goals:

- to evolve from an originally MAS design into an open Service-oriented ecosystem
- to define the infrastructure and methodology, with organizations as the nexus
- to provide internal coordination



A Base Architecture for Service-Oriented MAS

- The architecture to support the model
 - Open MAS, and also
 - Service-oriented
 - Organization-centric
- Central notion → Service
- Basic component → Agent
- Gluing all this together → Organization



A Base Architecture for Service-Oriented MAS

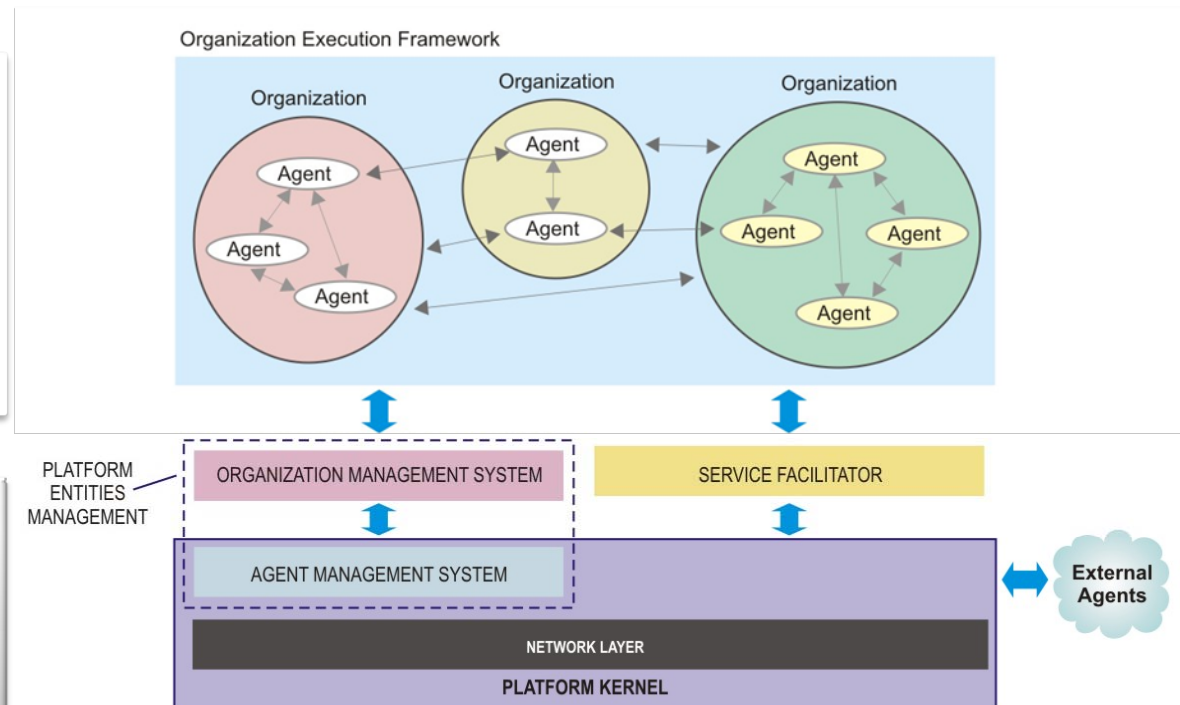
- Our solution alternative: agents supporting services
- An upper layer of services is added to provide interoperability
- The main idea: to export the agent system as a system of services
- A platform defined as a SOA, built on top of MAS

A Base Architecture for Service-Oriented MAS

THOMAS:

- Platform Kernel
- Service & Organization Management
- Organization Execution Framework

- **AMS** (*Agent Management System*)
- **OMS** (*Organization Man. System*)
- **SF** (*Service Facilitator*)



(THOMAS: Argente E. et al.: *An Abstract Architecture for Virtual Organizations: The THOMAS Project. "MeTHods, Techniques and Tools for Open Multi-Agent Systems"*.)



The Service-Oriented Layer

- According to the providers:
 - Base services
 - System services
- According the function and extent of capabilities:
 - Structural services
 - Information services
 - Dynamic services



The Service-Oriented Layer

- The role of organizations
 - Most important active element
 - Unifying notion of the architecture
 - Can be considered as a context or as a group
 - Composed of units (organizational units, OU)
 - Unit: an active entity with an observable behaviour and collective or autonomous nature
 - Also used to solve the scaling problem
 - Recursive organizational hierarchy



The Agreement Structure

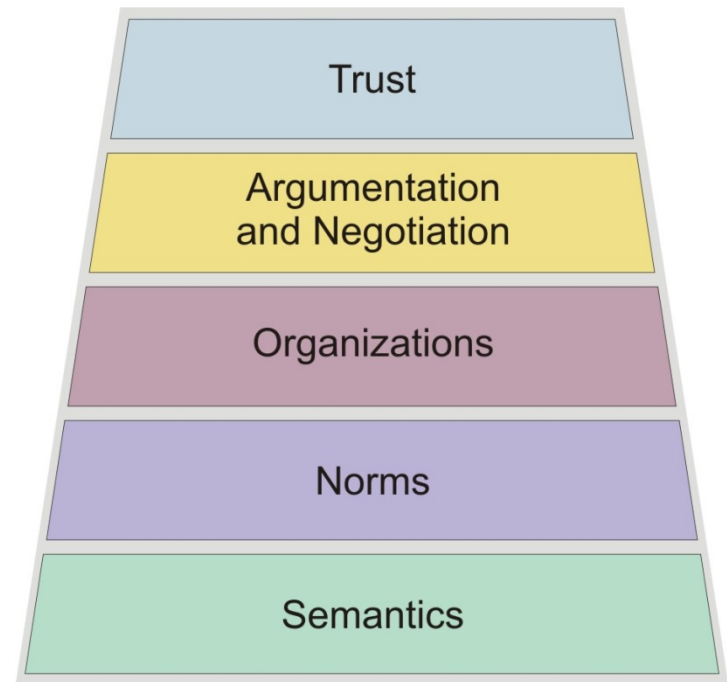
- Agreement

- A right approach to tackle the need for an adaptive structure between computational entities
- The objective is a suitable structure of controls and protocols
- Agents can organize themselves
- Leads to agreement-based organizations
- Organizations at top level, agents at lower levels
- Evolve from emergent coordination to emergent agreement

The Agreement Structure

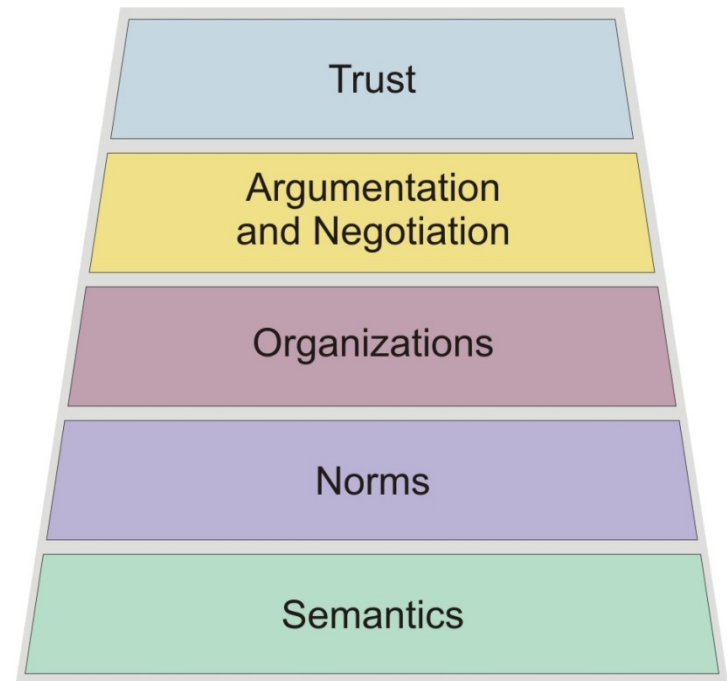
Key research topics to consider:

- **Semantics**
 - influence all others
 - to avoid mismatches
 - to have a common understanding
- **Norms**
 - definition of rules
 - determining constraints
 - the process to reach agreements
- **Organizations**
 - imply a super-structure
 - restricts the way to reach agreements



The Agreement Structure

- **Argumentation and Negotiation**
 - protocols
 - define the structure of an agreement
- **Trust**
 - trust mechanisms that summarize the history
 - to build long-term relationships
 - gives a notion of reputation
 - an agreement is built on top of it
 - to have reliable relationships between organizations





Case Study

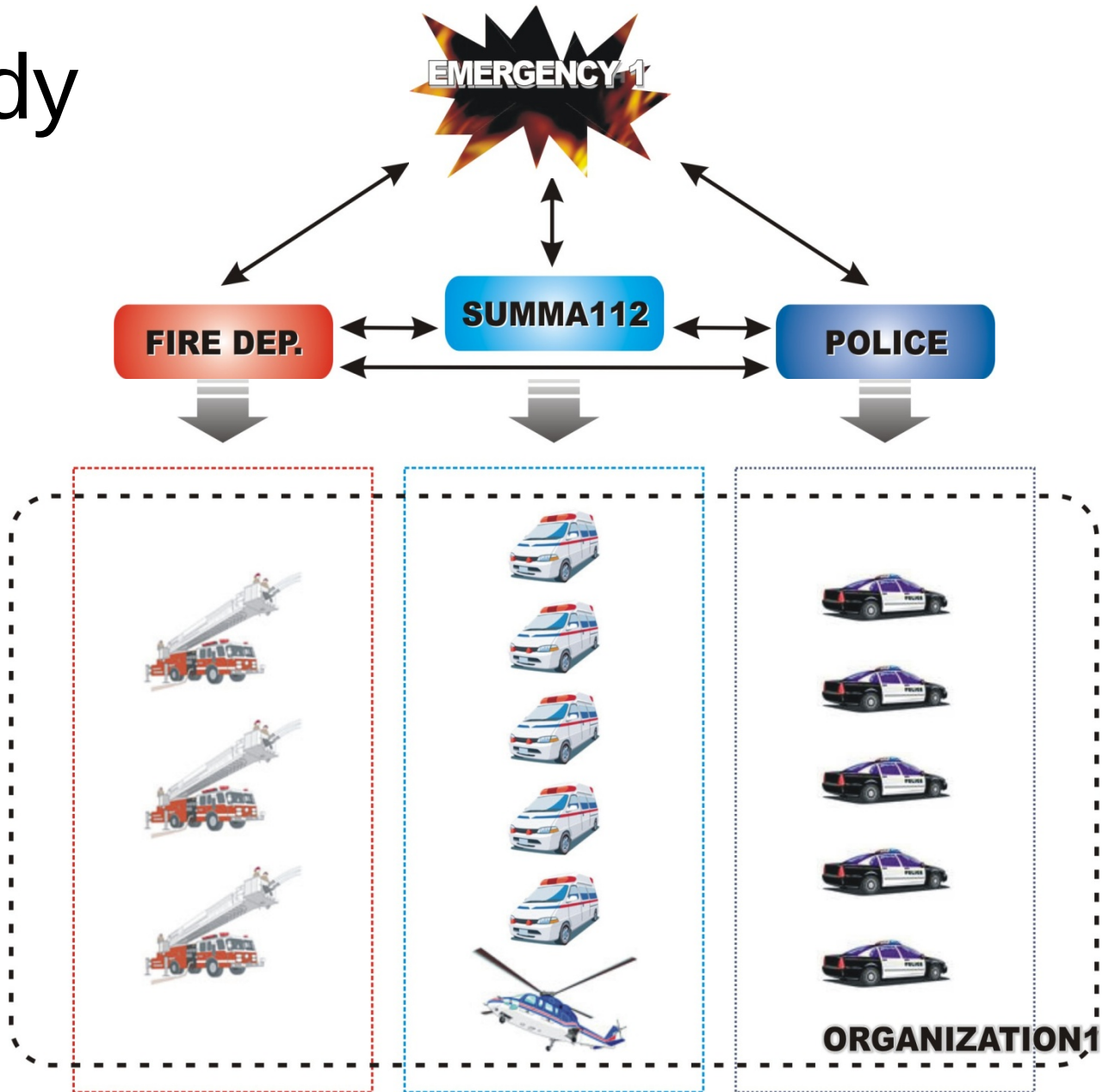
- The *mHealth* System
 - Medical emergencies domain
 - SUMMA112
- Real world scenarios
 - Emergency1
 - Emergency2



Case Study

Fire in
“Casa de Campo”

- Organization1
- MAS: 14 agents

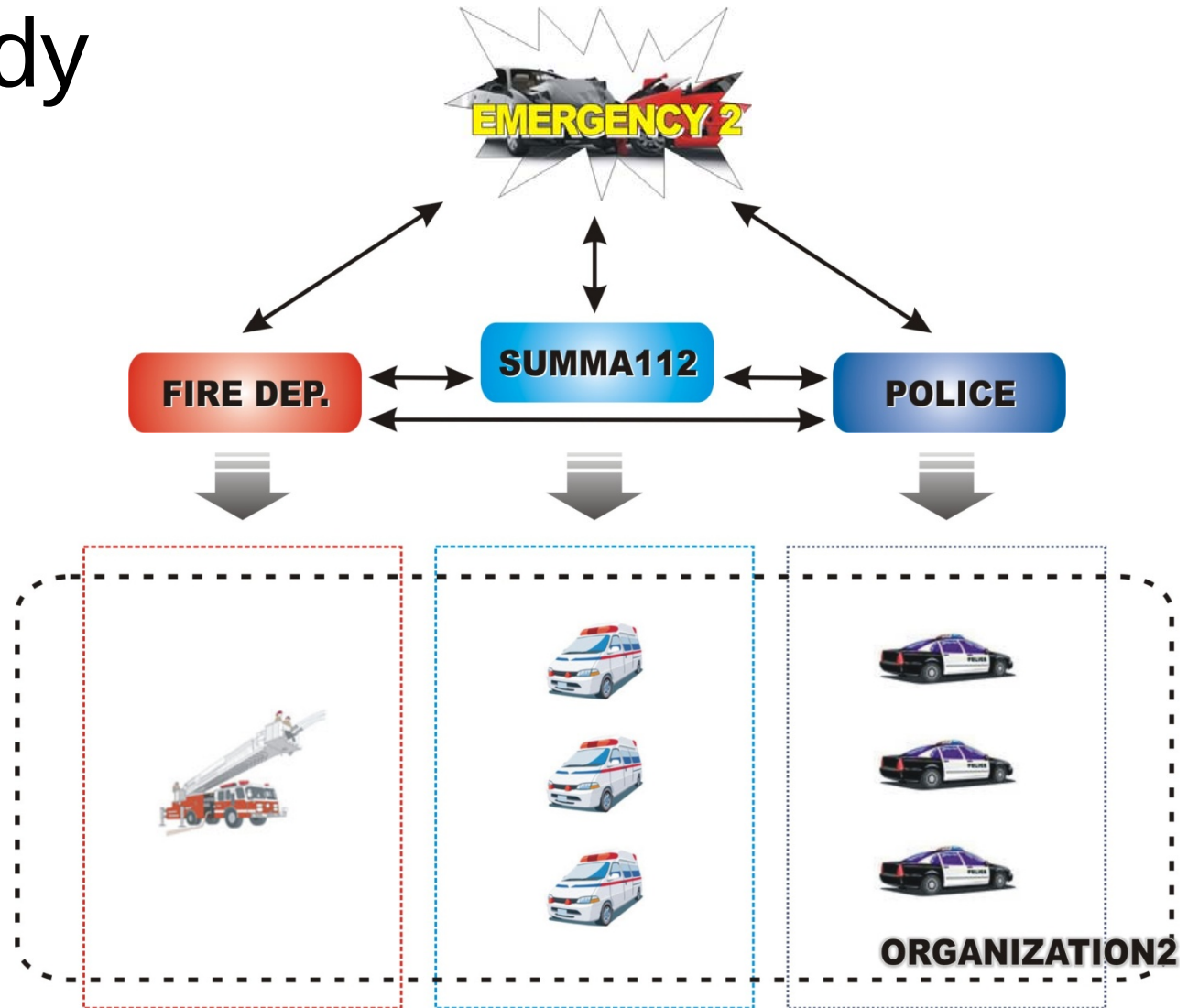


Case Study

One hour later ...

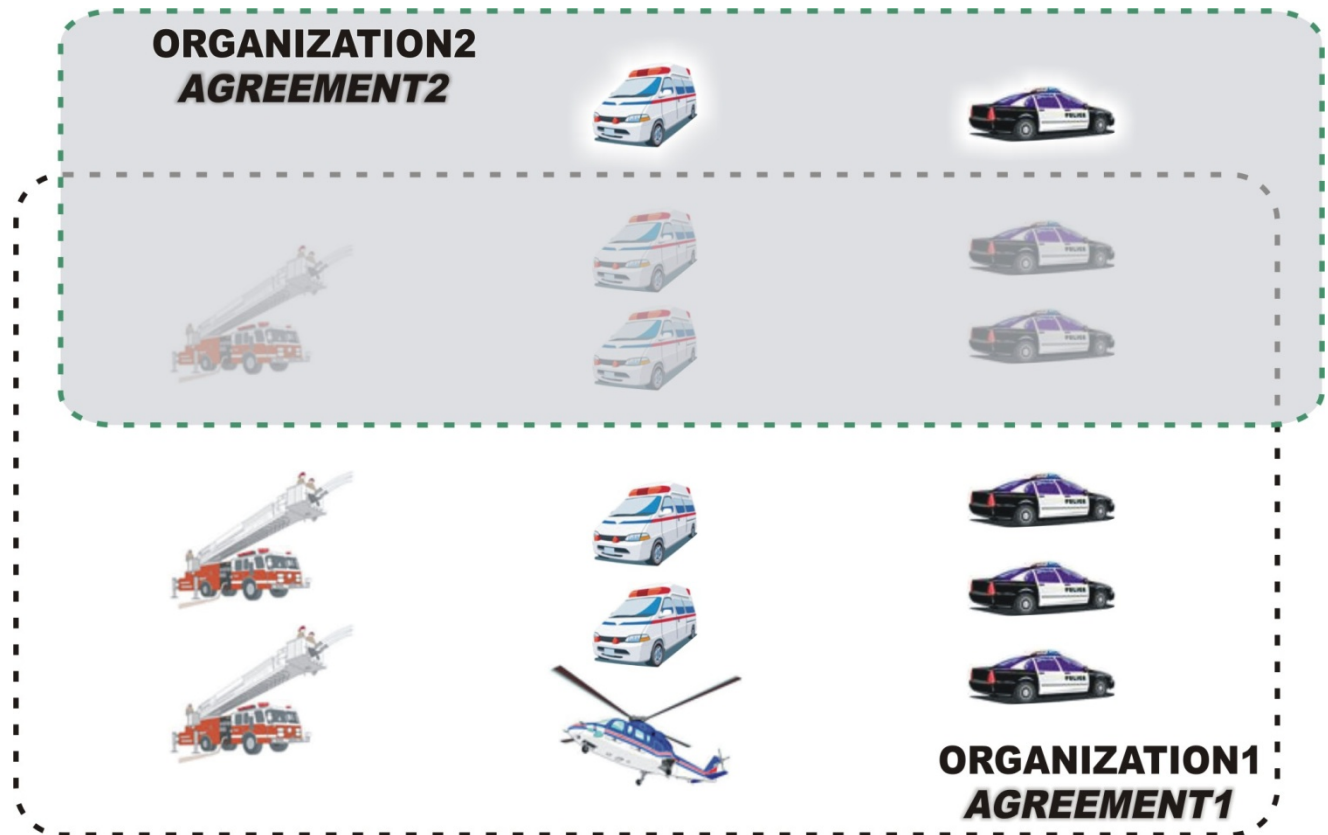
Car crash in the tunnel of "Paseo de Extremadura"

- Organization2
- MAS: 7 agents



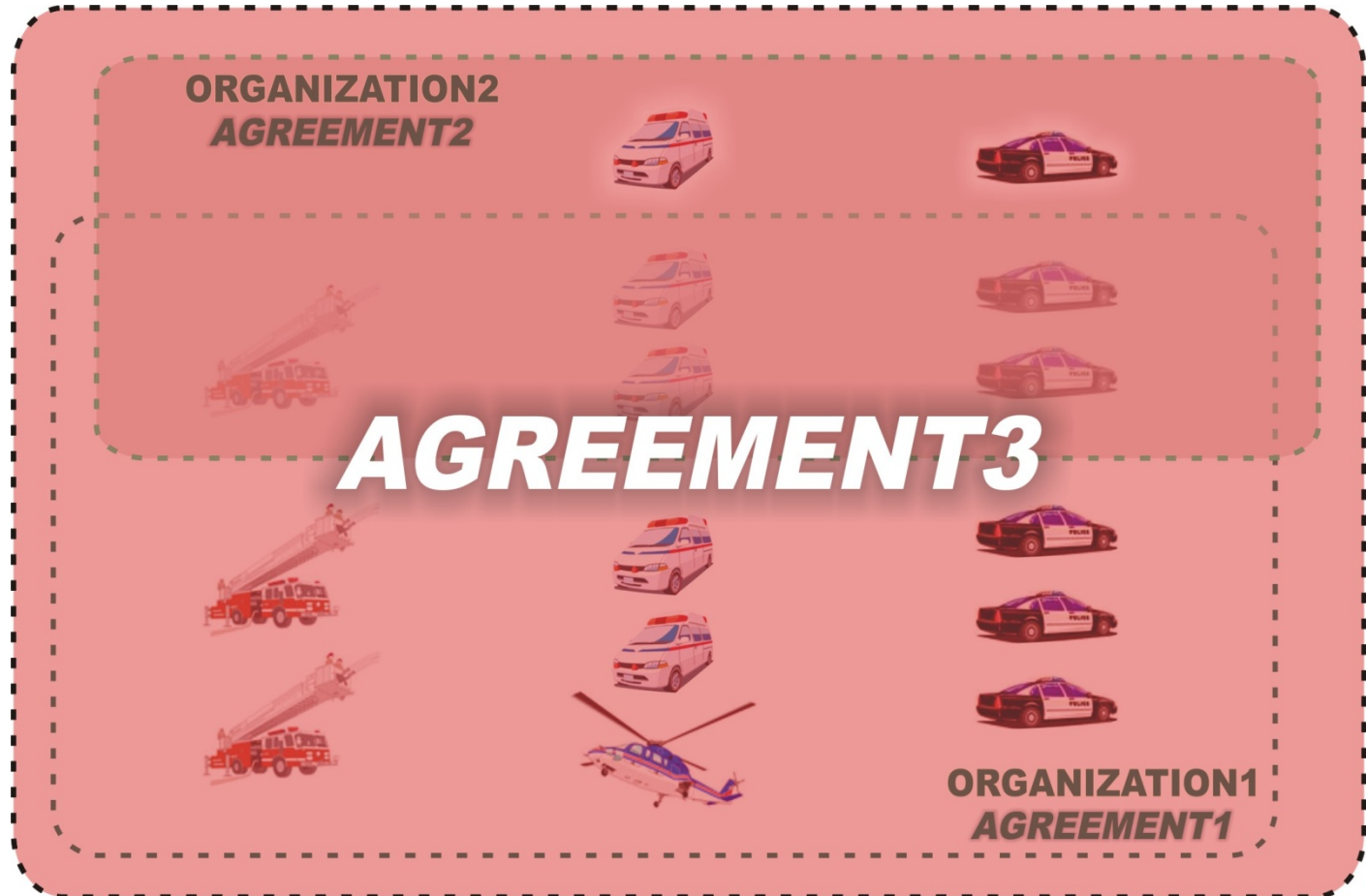
Case Study

- O1 *and* O2



Case Study

Another
agreement
emerges



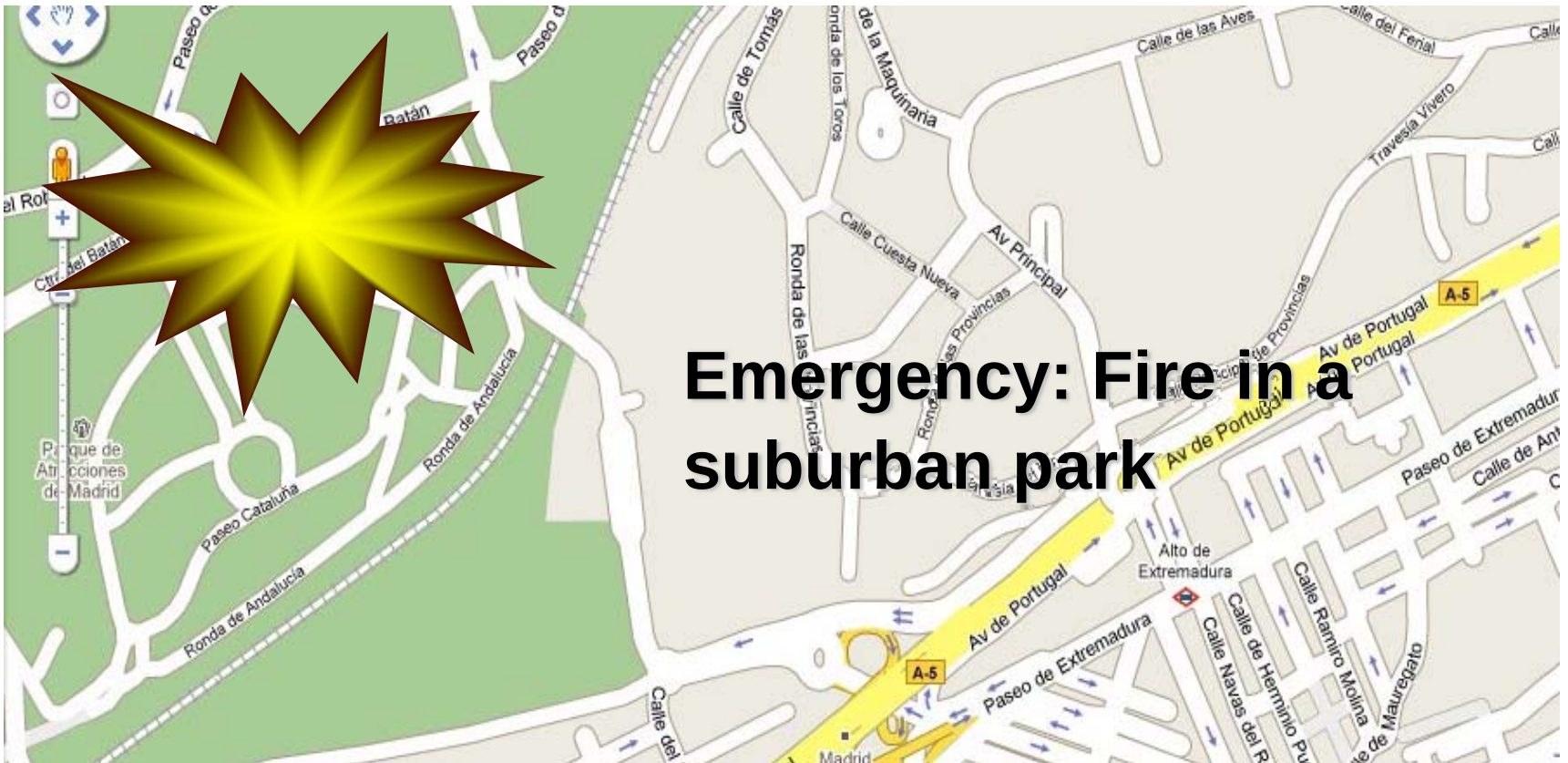


Case Study

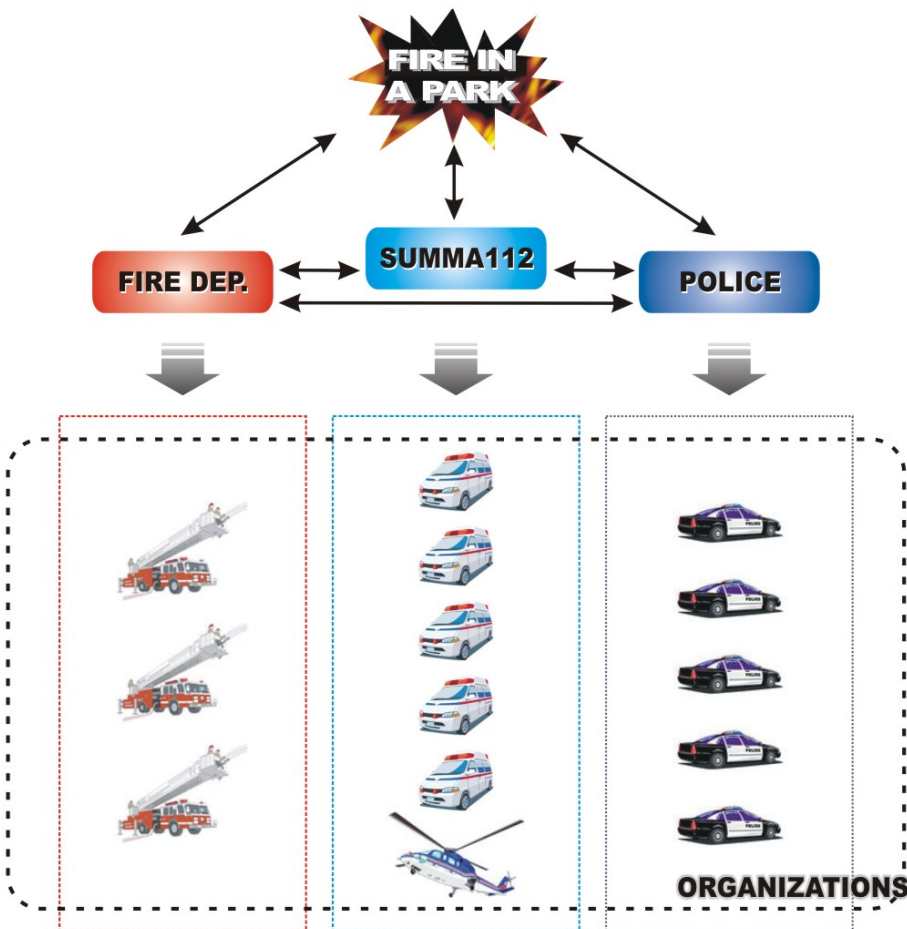
- The adaptation
 - Manually managed → directed evolution
 - Goal → automatic reconfiguration
 - The system evolves
 - Re-mapping resources
 - Reconfiguration of organizations
 - A larger agreement emerges
 - Behaviour and structure emerge

The next step...

Motivating example



Two scenarios



Scenario 1:

The agents arrive to the crisis area and they must to organize.

Scenario 2:

The organization loses an essential service.



Framework: the evolution

- Framework evolution
 - Adaptation to OSGi standard
 - To modularize applications → Bundles
 - To track registered services → Service Tracker
 - To pass messages → Whiteboard pattern
 - The OVAMAH Project (*“Organisaciones Virtuales Adaptativas...”*)
 - Agents could create or destroy organizational units
 - They also could add or delete norms
 - The system relations/topology could be changed at runtime ...



Adaptive organizations

- Controls and Protocols
 - Mechanisms that *enforce/forbid*, or
 - Mechanisms that *enable/channel* interactions, behaviours, architectural connections
- The “*INITIATIVE*”
 - A primary structure
 - An evolving/growing preliminary entity
 - Originated by controls and protocols
 - The path: *Initiative* → Agreement → Organization



Adaptive organizations

- The “*reconfigurations*”

Adaptation in established organizations,
“*pure adaptation*”

- **Case 1:** with no modification of the organization’s main objective → Internal search
- **Case 2:** with no modification of ... → Learning process
- **Case 3:** with no modification of ... → External search
- **Case 4:** change of the organization’s main objective, modifying or dividing it in partial goals



Adaptive organizations

- Adaptation Patterns
 - Architectural point of view → Architectural patterns
 - High level of abstraction and generality
 - Pre-designed from the required services to generate the *initiatives*
 - Useful to model the system evolution
 - High potential for scalability

Adaptive organizations

- Adaptation Patterns

Name	Description
FAÇADE	<i>To easily interact with an organization which still lacks a defined structure, some agent has to represent the organization itself. It redirects any incoming communication.</i>
MEDIATOR	<i>During the emergence process, some agent must act as a mediator, which makes possible to access to data sources, although indirectly, and also to perform the necessary translations.</i>
SURVEYOR	<i>During the emergence process, at least one agent must monitor the growing of the initiative itself. It has access to the pattern library and decides when a certain pattern must be triggered.</i>

Case study in THOMAS

■ Services

■ Unit Registration

RegisterUnit(UnitID, Type, Goal [ParentUnitID])

RegisterUnit(O1, default, default, default)

■ Registration as a Member

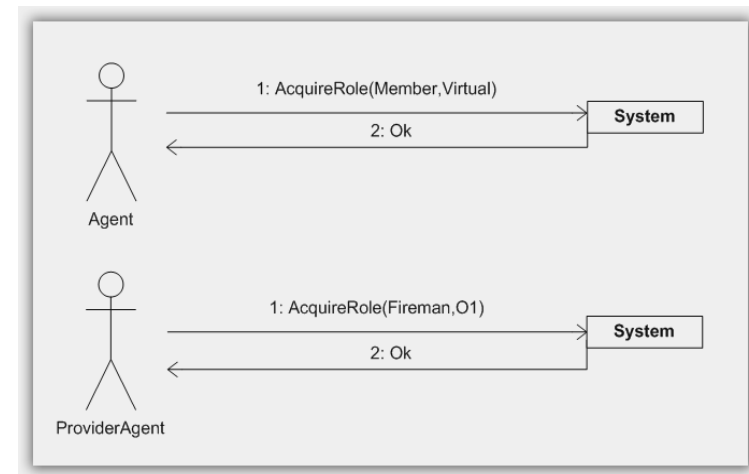
AcquireRole(Member, Virtual)

■ Registration as a Member with Role

AcquireRole(Fireman, O1)

■ Expulsion of a Member

Expel(AgentID, UnitID, RoleID)



Case study in THOMAS

The set of actions carried out by a certain agent (Fireman #1) in the E1-E2 example:

AcquireRole (Member, Virtual)	-- Activated as Fireman #1
Hello (F#1, O1)	-- Reaches O1 and presents itself
AcquireRole (Fireman, O1)	-- Joins O1 as a fireman
(...)	-- ... after some work...
Expel (F#1, O1, Fireman)	-- Fireman #1 released from O1
Hello (F#1, O2)	-- Reaches O2 and presents itself
AcquireRole (Fireman, O2)	-- Joins O2 as a fireman



Conclusions

- The proposed approach is to use architecture-level concepts to provide *self-adaptivity* to software systems
- We need to consider a general ecosystem instead a classic closed system
- The proposed concept of *initiative* can be considered as a starting point to provide mechanisms to change the composition patterns and element types within such systems



Conclusions

- The required dynamism can be supported by an *emergent agreement* - an evolving architectural structure, based on combining predefined *controls* and *protocols*
- The agents can be *coordinated* and *reorganized* in an architectural context
- All this in a *service-oriented*, *agent-based* and *organization-centric* context



Thank you very much.

Agreement Technologies Project

www.agreement-technologies.org

Agreement Technologies Cost Action IC0801

www.agreement-technologies.eu

Organizaciones Virtuales Adaptativas: Técnicas y Mecanismos de Descripción y Adaptación

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