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Exploiting Reusable Organizations to Reduce Complexity in Multiagent System Design

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Organization-based Multiagent Systems (OMAS)

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- Design of MAS is complex and all possible configuration cannot be defined at design time
- OMAS have been viewed as an effective paradigm for addressing the design challenges of large and complex MAS
- Organizational perspective is the main abstraction
  - clear separation between agents and system
- Development of OMAS
  - several methodologies have been proposed: GAIA, TROPOS, OMACS, AGRé

Current Problems with OMAS

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- Decomposition is often suggested, but no rigorous process or guidance to recombine sub-organizations
- Designers generally handle complexity of large organizations based on intuition and experience, leading to ad-hoc designs that are difficult to maintain
- We need to provide an effective and systematic design for such systems

Contributions

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- We propose the use of reusable multiagent organizations which provide services at the organization level
- We rigorously specify the key concepts that allow the design of reusable OMAS
- We formally define the composition process through which reusable *OMAS components* can be composed to build larger organizations.

Organization Model

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- Organization Model for Adaptive Computational Systems (OMACS)
  - Metamodel for agent organizations
  - Structure allows multiagent teams to autonomously reconfigure at runtime
- An organization is comprise of:
  - a set of **goals** that the organization need to accomplish
  - a set of **roles** that must be played to achieve the goals
  - a set of **capabilities** required to play the roles
  - a set of **agents** who are assigned to roles in order to achieve organizational goals

Organization Model

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- Two main models to represent an organization:
  - **Goal Model**: Goal tree capturing AND and OR decompositions of organizational goals
  - **Role Model**: Graph of roles connected by protocols

Example: Cleaning Service

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- XML service specification

```
<service name= Cleaning>
  <operation name= clean>
    <connector>
      <protocol>clean_protocol</protocol>
      <event>clean_event(area) </event>
    </connector>
    <conditions>
          <pre> The area is accessible </pre>
          <post> The area has  been cleaned </post>
    </conditions>
  </operation>
</service>
```

Example: Service Provider

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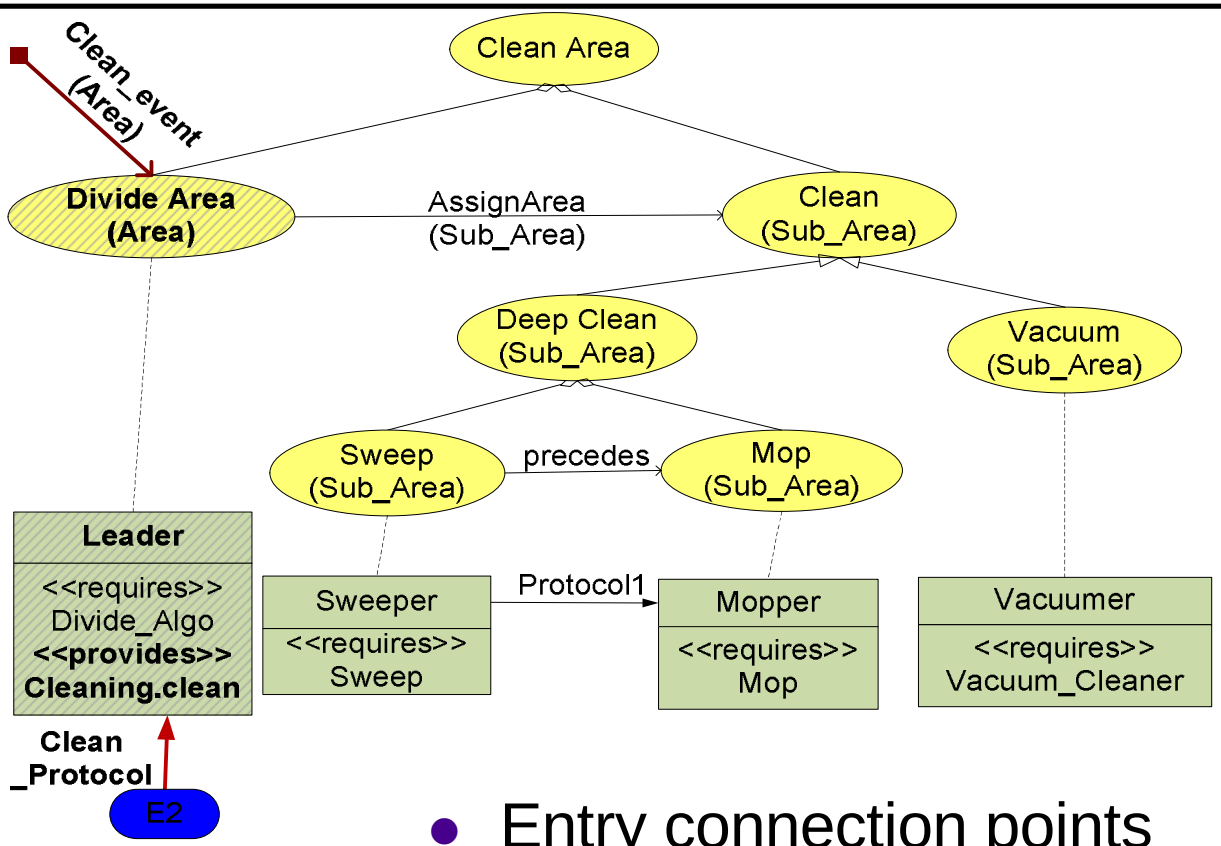
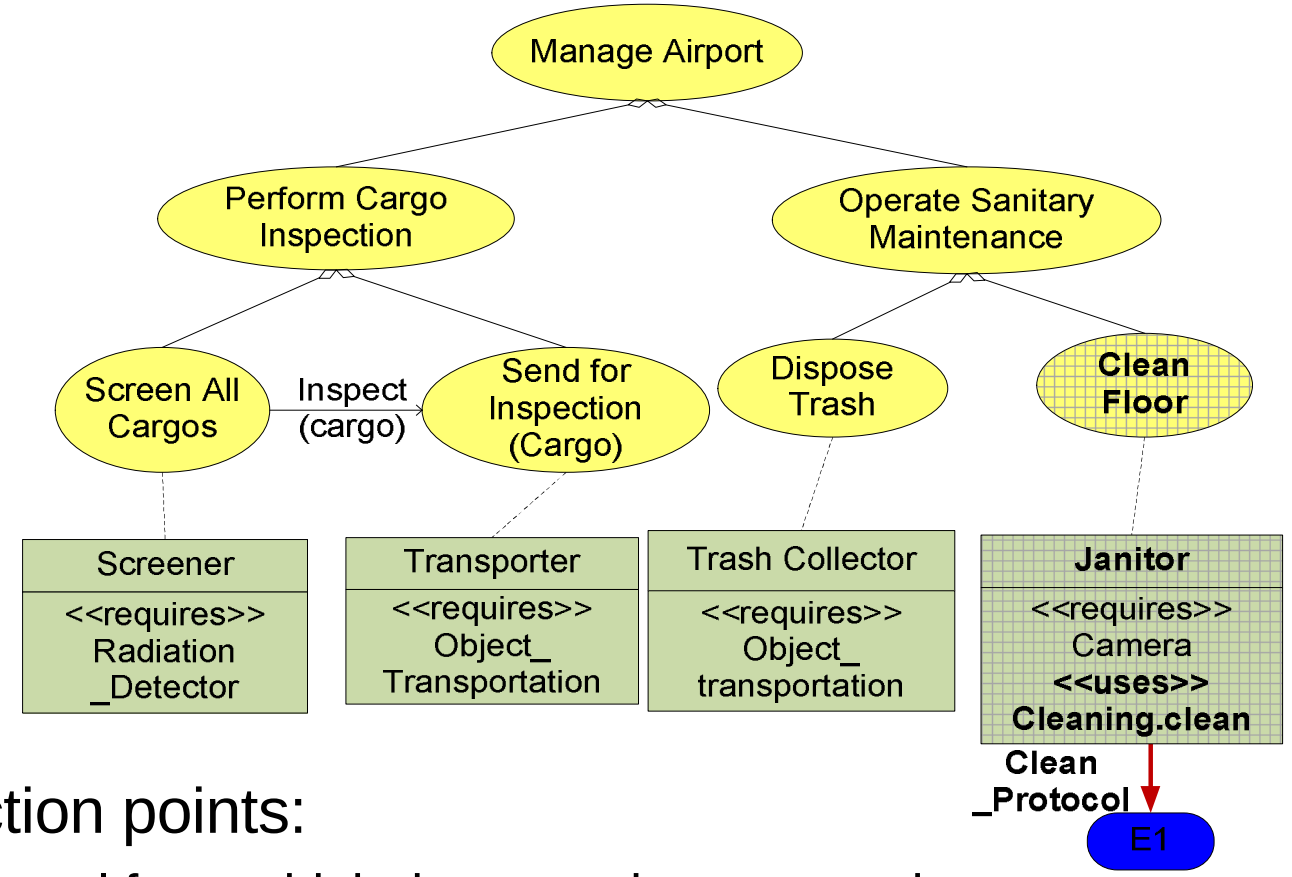


- Entry connection points
  - Entry Goal: used to initiate the operation
  - Entry Role: used to interact with the service

Example: Service Consumer



- Exit connection points:
  - Exit Goal: goal from which the event is generated
  - Exit Role: Role that requires the operation.

Composition Process

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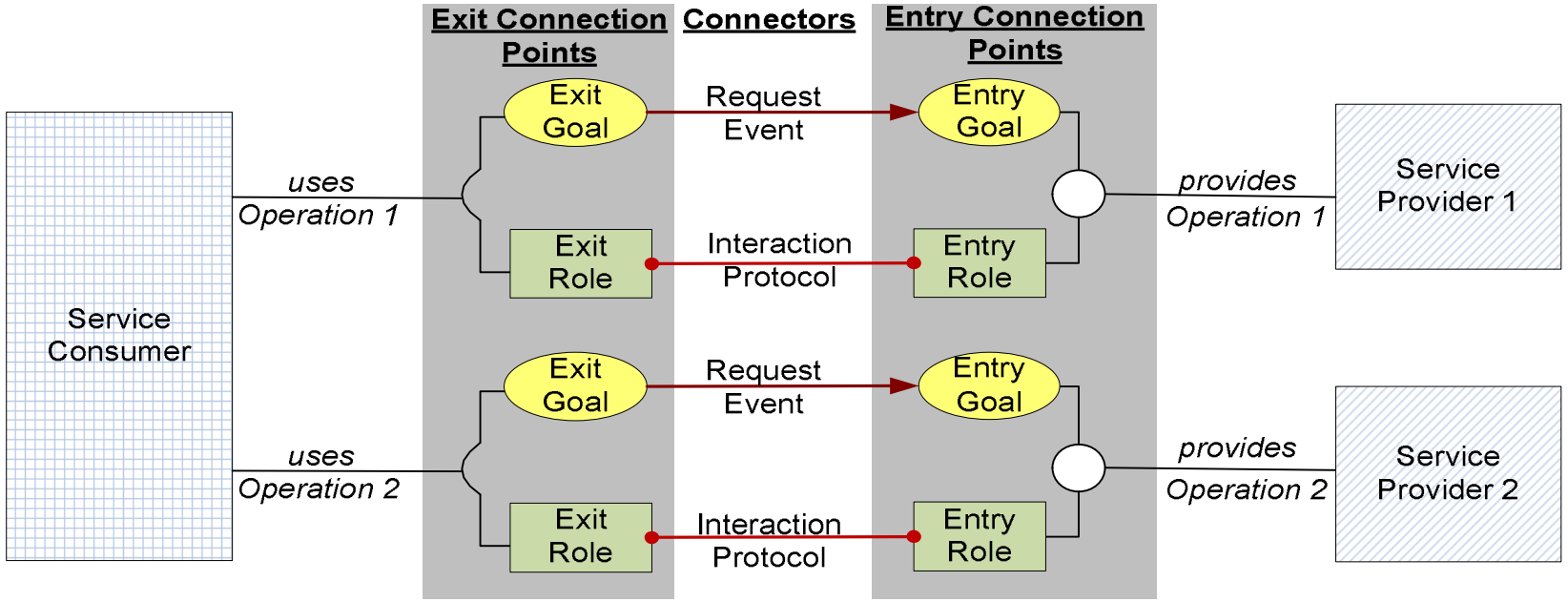

- Consumer organizatio ns can **invoke the operati on via the *request event***
- Consumer and Provider organizations can **interact via the *interaction protocol*.**

Example: Composite Organization

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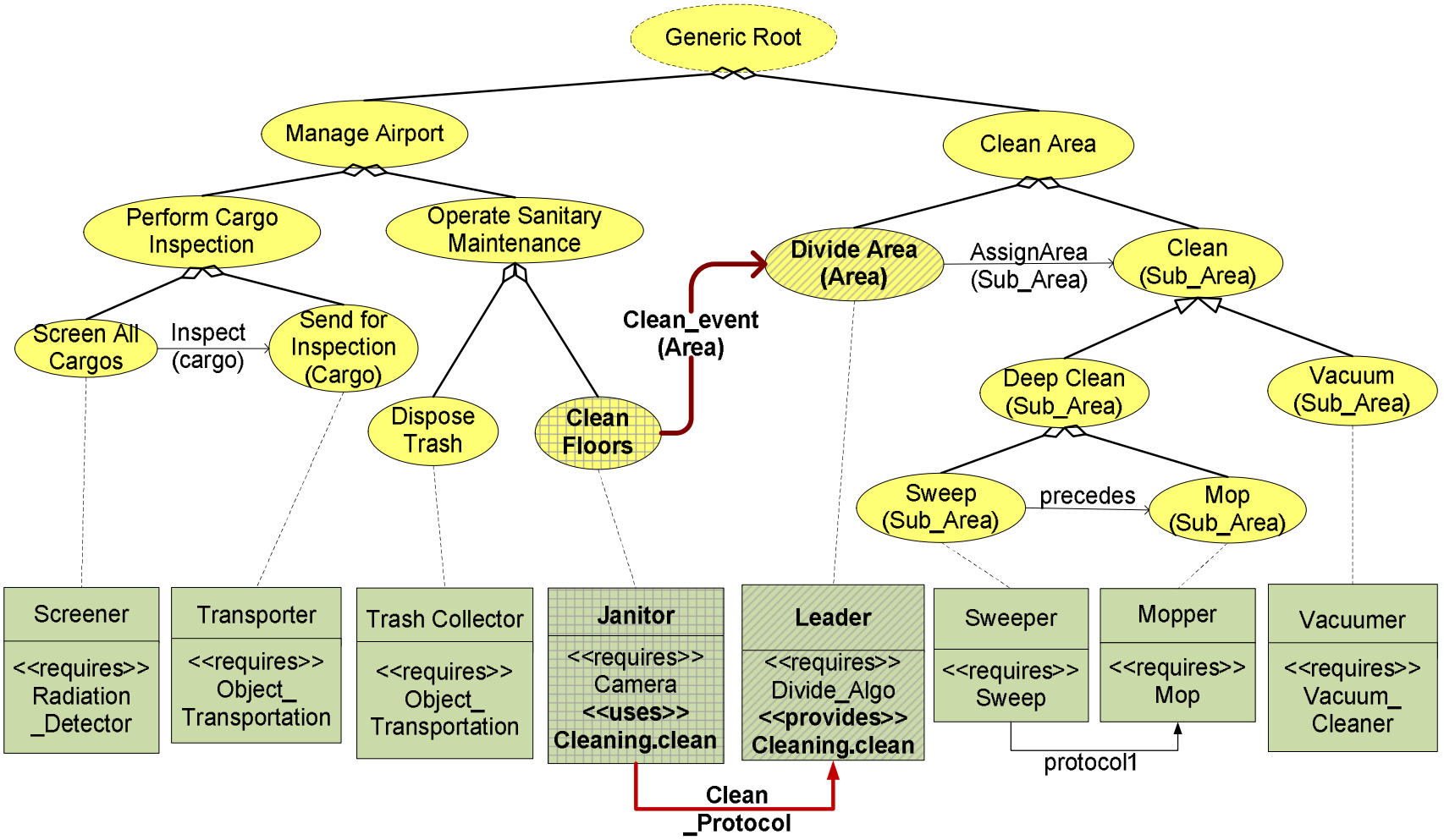

Conclusion

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- Our approach facilitates the development of complex OMAS by developing reusable organizations
- We describe how to design such organizations so that they expose the appropriate interfaces
- Our composition process merges compatible multiagent organizations into a single organization
- Future work: Methodological support
  - AgentTool III (http://agenttool.cis.ksu.edu/)
  - Organization-based Multiagent Systems Engineering methodology (http://macr.cis.ksu.edu/O-MaSE)

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THANK YOU!

Organizational Service Metamodel

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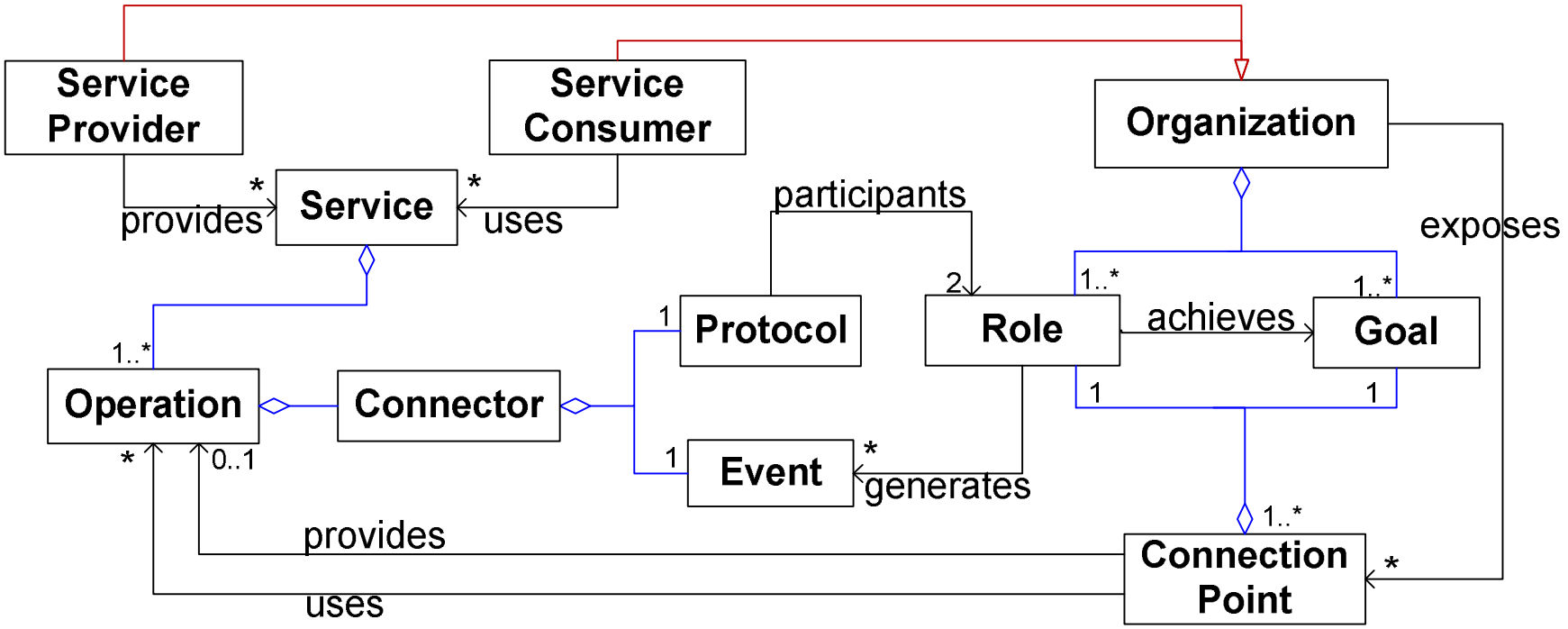

Service

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- A *service* is a logical entity that represents a coarse-grained multiagent functionality.
  - XML-based specification contains a *description* of what the service proposes and a specification of each operation provided.

Operations and Connectors

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- An *operation* as a set of application-specific organizational goals that an organization needs to achieve in order to reach a desired state
- A connector is represented by an <event,protocol> pair.
- Connectors provide the ñglueò that binds consumers and providers together

Connection Points

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- A *connection point* is composed of a goal-role pair
- Entry connection points:
  - Entry Goal: used to initiate the operation
  - Entry Role: used to interact with the service
- Exit connection points:
  - Exit Goal: goal from which the event is generated
  - Exit Role: Role that requires the operation.

Service Providers / Consumers

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- autonomous multiagent organizations that **provide** or **use** services
- Composition of compatible components results in a valid composite organization