Governing Sociotechnical Systems

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OOI Clip

- Scale
- Variety of resources
- Lifetime
- Number and variety of stakeholders
- No central ownership

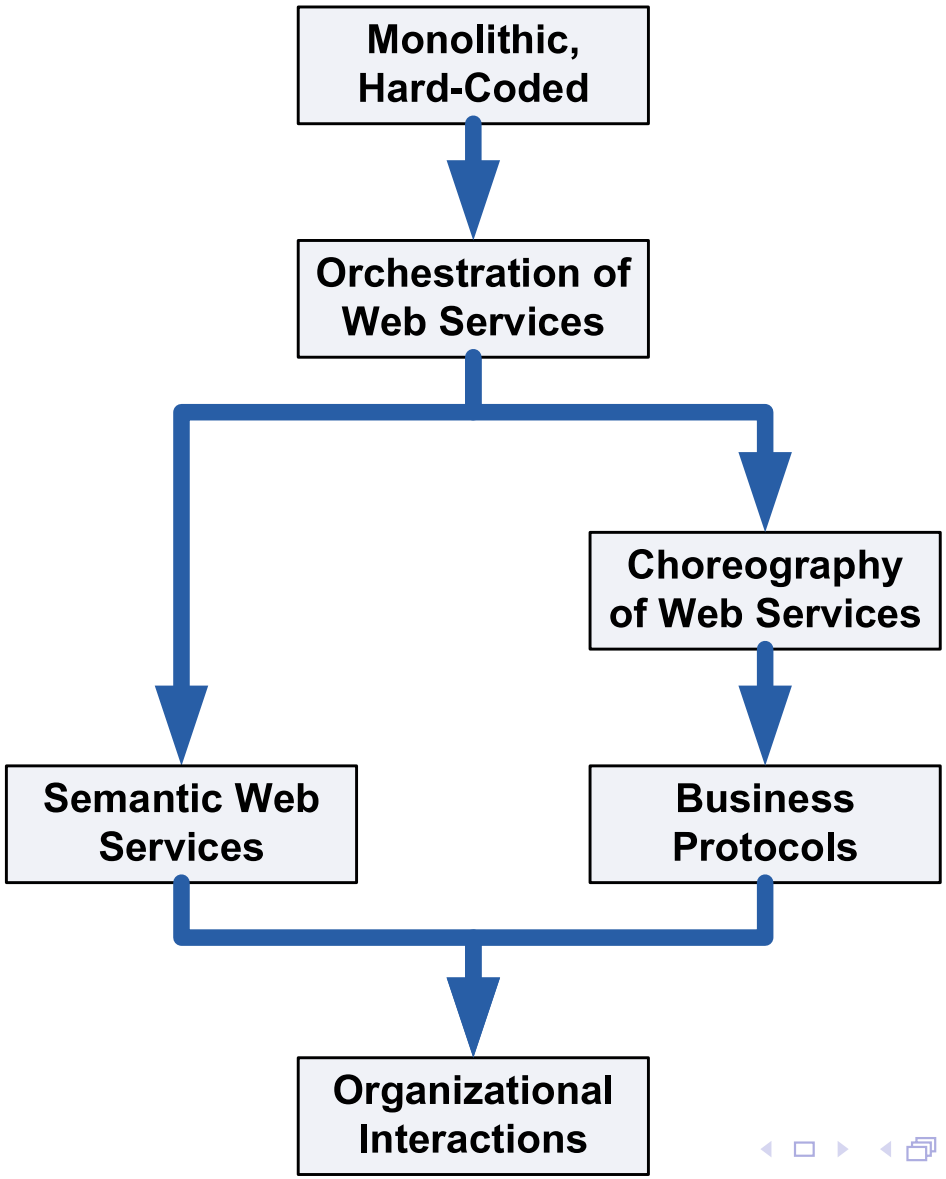
Sociotechnical Systems

Combine IT with real-life societal considerations

- System characteristics
  - Longevity and identity
  - Autonomy
  - Essentially a society
  - Characterized via norms, not operationally
- Member characteristics
  - Longevity and identity
  - Autonomy
  - Heterogeneity
  - Ability to deal with norms, e.g., via goals
- Realization
  - Top down: Members fit into existing system
    - Adopt suitable goals given system norms
  - Bottom up: Members design new system
    - Negotiate suitable norms given individual goals

Approaches for IT Applications and Services

Beginning to deal with openness . . .



Approaches for IT Applications and Services

- **Applications:** Control of computations hidden in code; integration a nightmare
- **Workflows:** Control abstracted out; integration still difficult
- **Standards-driven orchestration:** Integration improved; limited support for autonomy
- **Messaging:** Integration simplified by MoM and transformations; limited support for autonomy
- **Choreography:** Model conversations over messages; limited support for autonomy
- **Governance:** Administer resources via interactions among autonomous stakeholders

Governance Understood

Broadly, administering sociotechnical systems

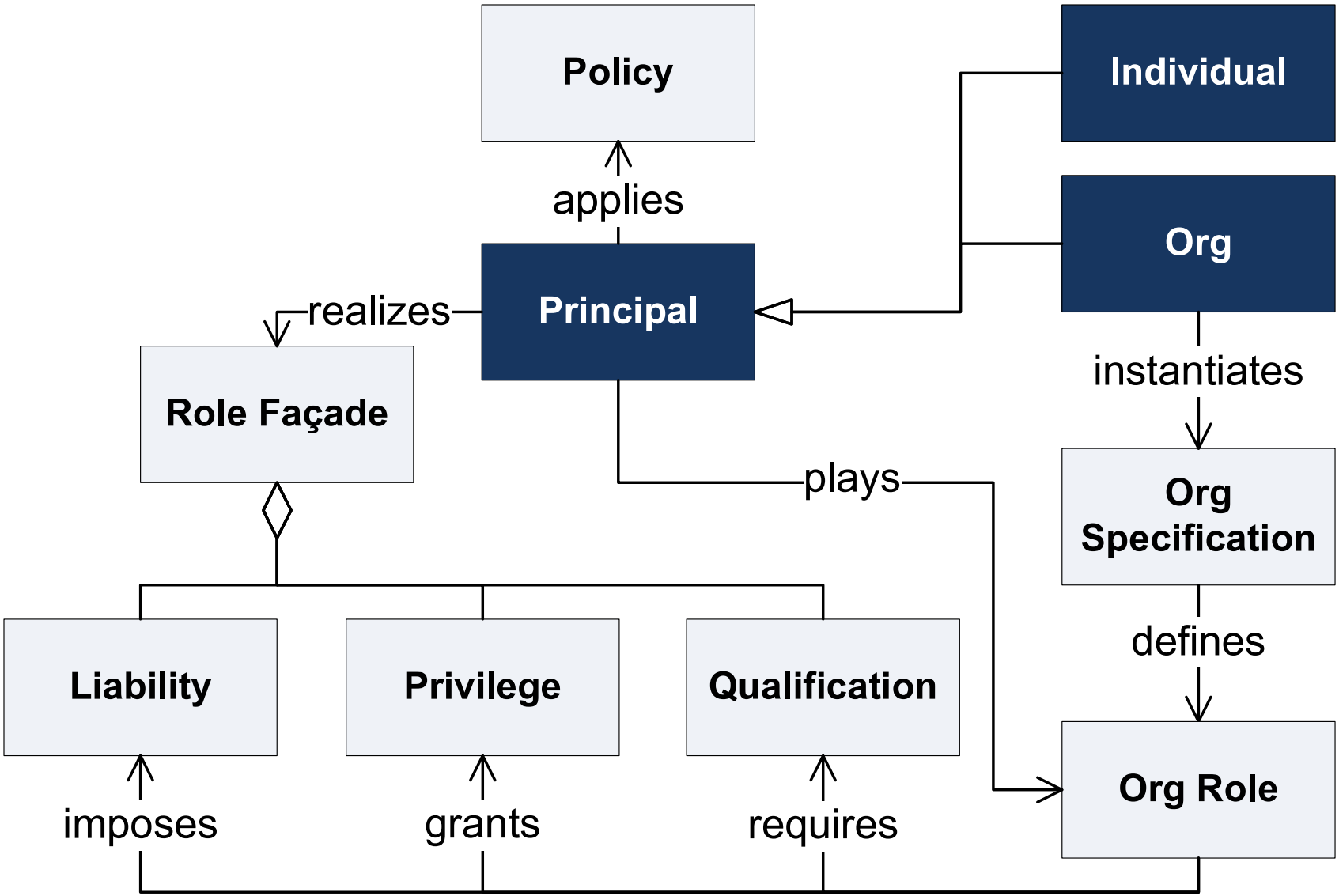
- Currently, humans achieve governance manually
  - Low productivity
  - Poor scalability to fine-grained, real-time governance decisions
  - Hidden, implicit considerations yield low confidence in correctness and poor maintainability
- Benefits of automating governance
  - Share resources in a controlled manner
  - Configure and reconfigure
  - Enable unanticipated uses for resources
  - Administer respecting human organizational needs
- Research challenges
  - Abstractions to capture rules of encounter
  - Methods to design and analyze such abstractions
  - Methods to implement such abstractions

Principles of Governance

Administration that is intelligent and intelligible

- Vividness of modeling
  - Grounded in applications; modeled entities are real
- Autonomy and interdependence of participants
  - Stating rules of encounter; omitting policies from specifications
- Centrality of organizations
  - Modeling businesses, communities of practice; specifying rules of encounter; monitoring contracts; sanctioning violators
- Minimality of operational specifications
  - Leaving restrictions unstated except where essential to correctness
- Institutional actions
  - Creation and manipulation of commitments; granting or denying powers, authorizations; effecting sanctions
  - Separation of concerns from those of operational interactions
- Reification of representations
  - Explicit: hence, inspectable, sharable, and manipulable

Governance Overview



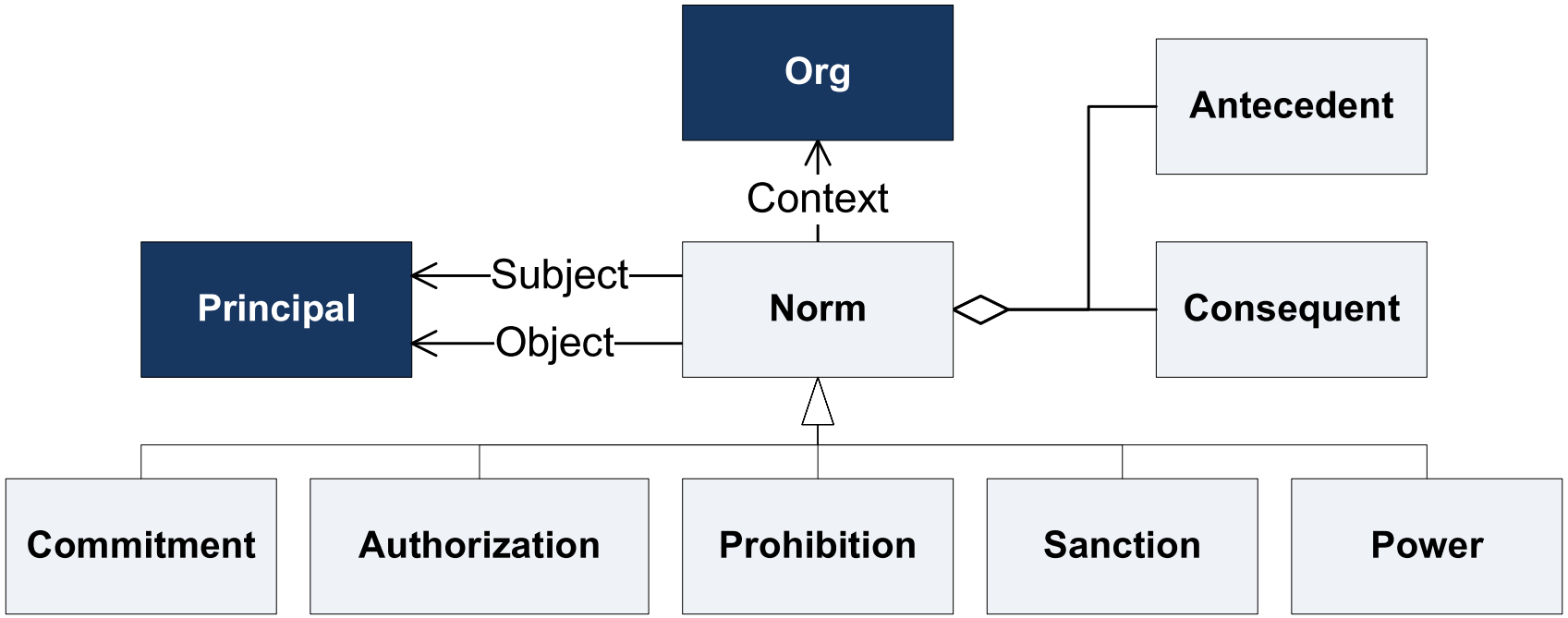
Achieving Governance: Principals and Orgs

Put collaboration in organizations center stage

- Principals are the stakeholders: people and organizations
  - Provide a locus for interaction
- Orgs are like *institutions:* have an identity and life time distinct from their members; also principals
  - Examples: NCSU, DoD, ...
  - Provide a locus for roles
  - Characterized via norms
  - Potentially enforce norms on members playing specific roles
    - An Org's main hold over its members is the threat of expulsion

Types of Norms

Unified logical form: Norm(subject, object, context, antecedent, consequent)

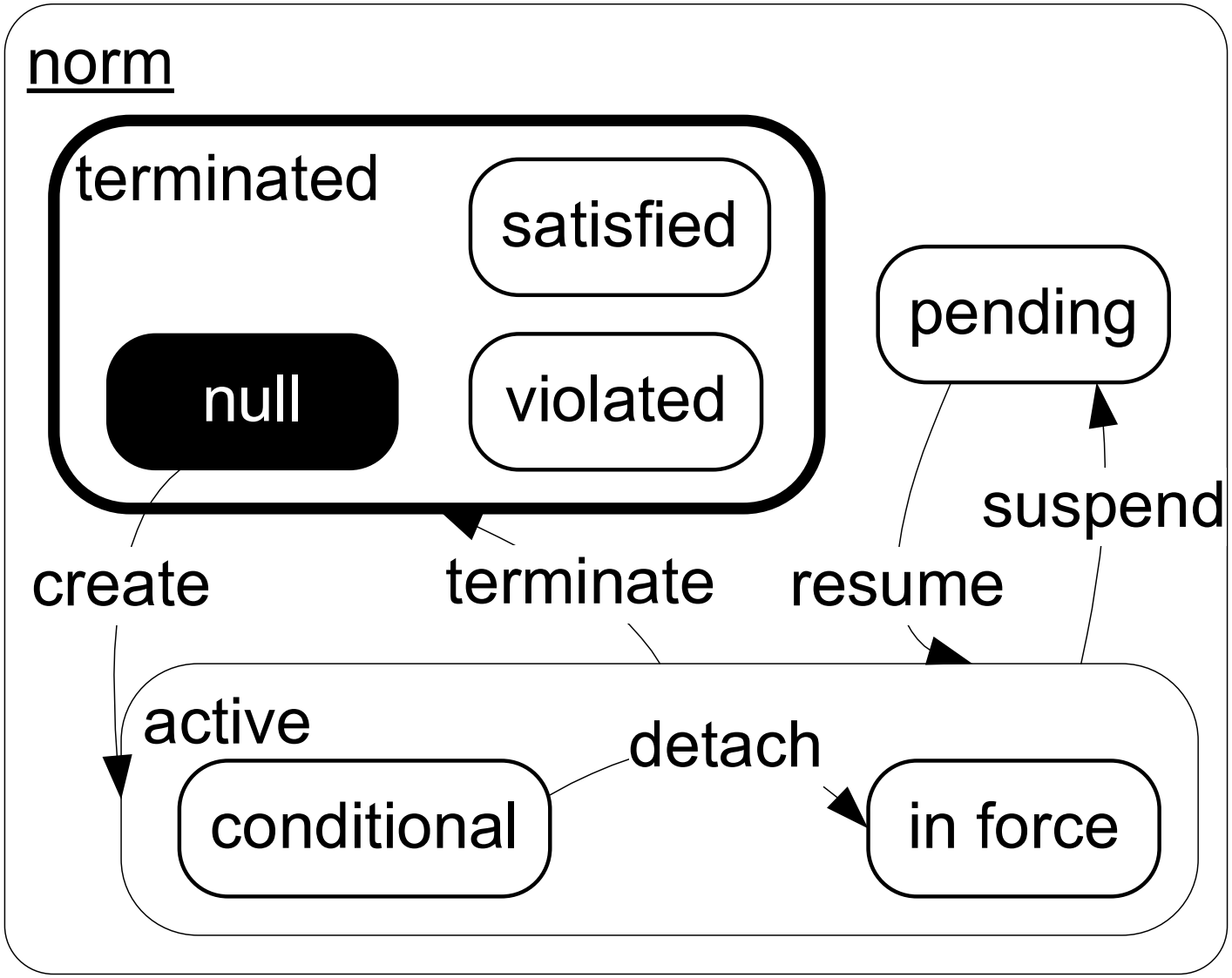


- Directed
- Declarative
- Composable
- Manipulable

Norms as Façades

Norm	**Subject's Façade**	**Object's Façade**
Commitment	Liability	Privilege
Authorization	Privilege	Liability
Power	Privilege	Liability
Prohibition	Liability	Privilege
Sanction	Liability	Privilege

Norm Life Cycle: 1

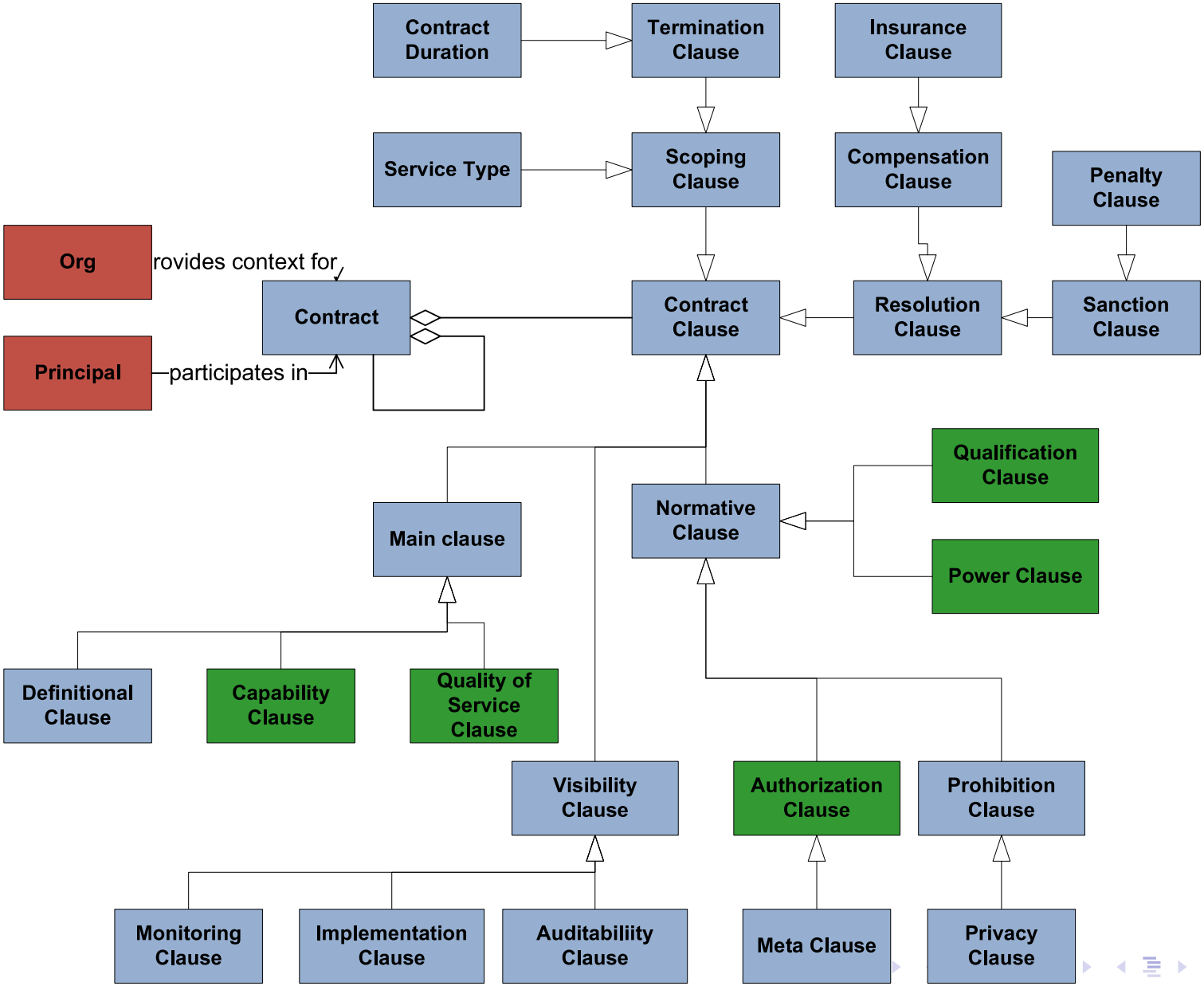


Norm Life Cycle: 2

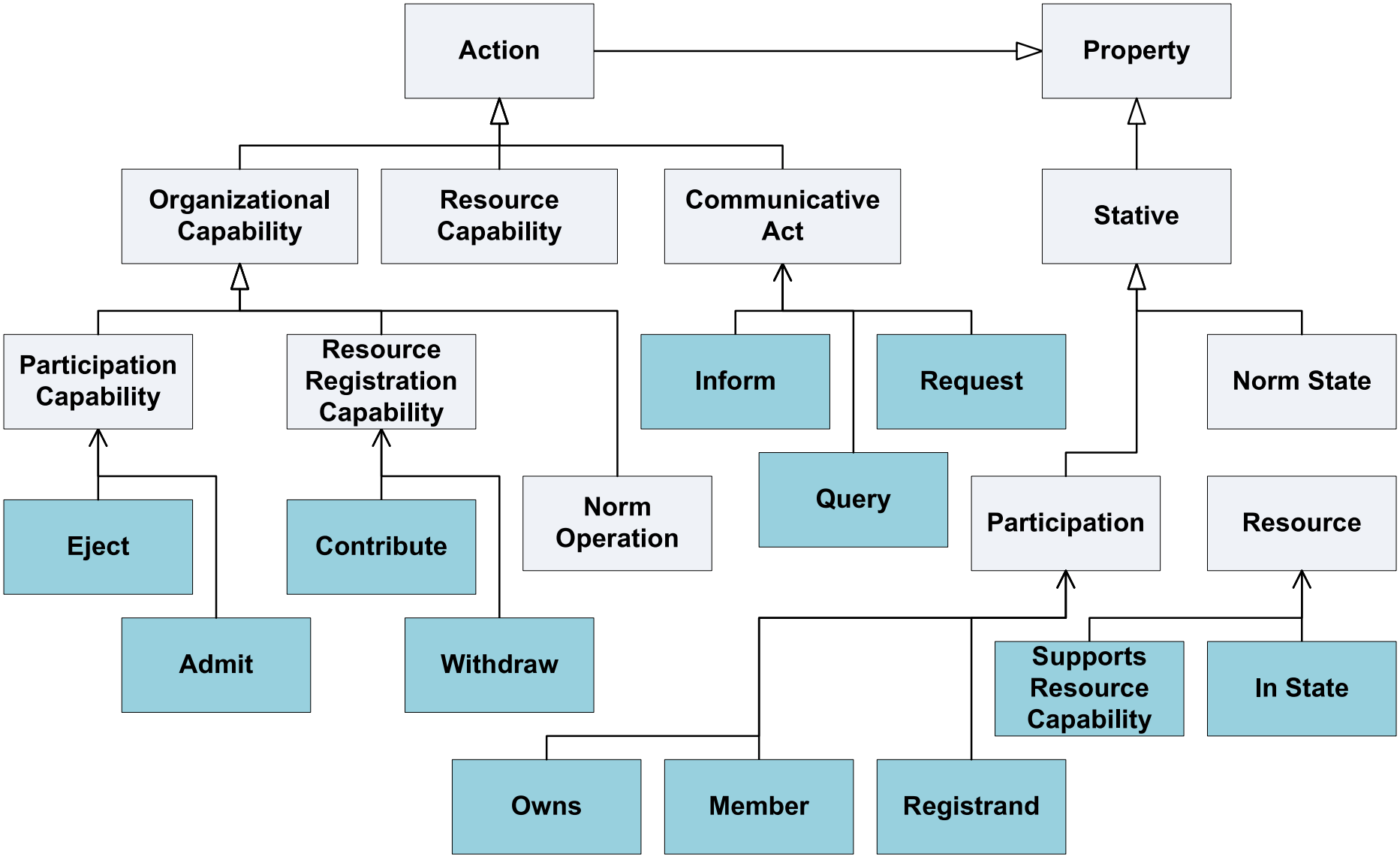
Substate of a terminated norm

If terminated in		Then				
ant	**con**	**Com**	**Aut**	**Pro**	**San**	**Pow**
false	false	null	null	null	null	null
false	true	sat	vio	null	null	null
true	false	vio	null	sat	null	vio
true	true	sat	sat	vio	sat	sat

Contracts as Bundles of Norms

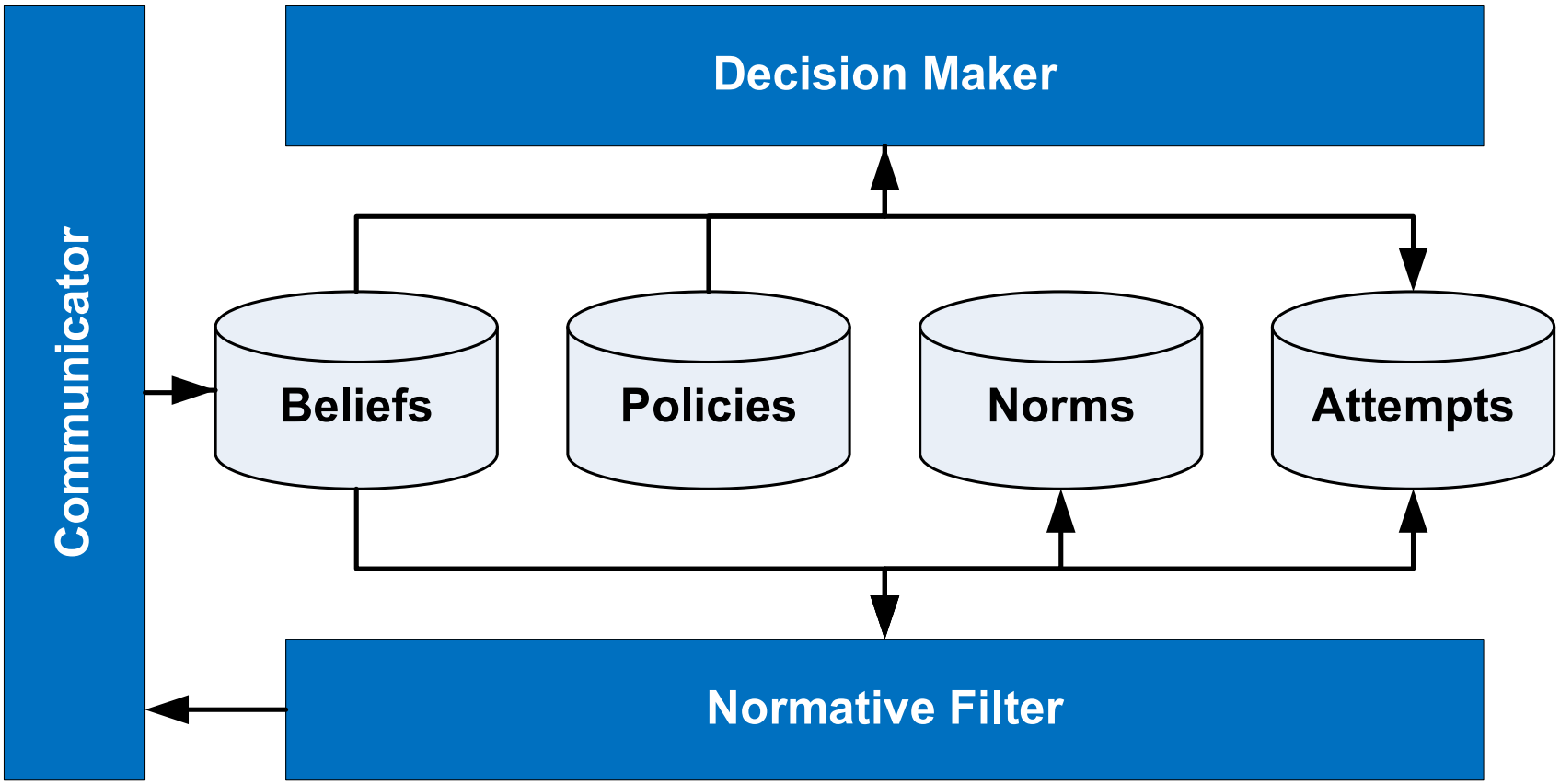


Vocabulary for Norms and Orgs



Simplified Architecture of an Agent

Representing a principal (individual or Org)



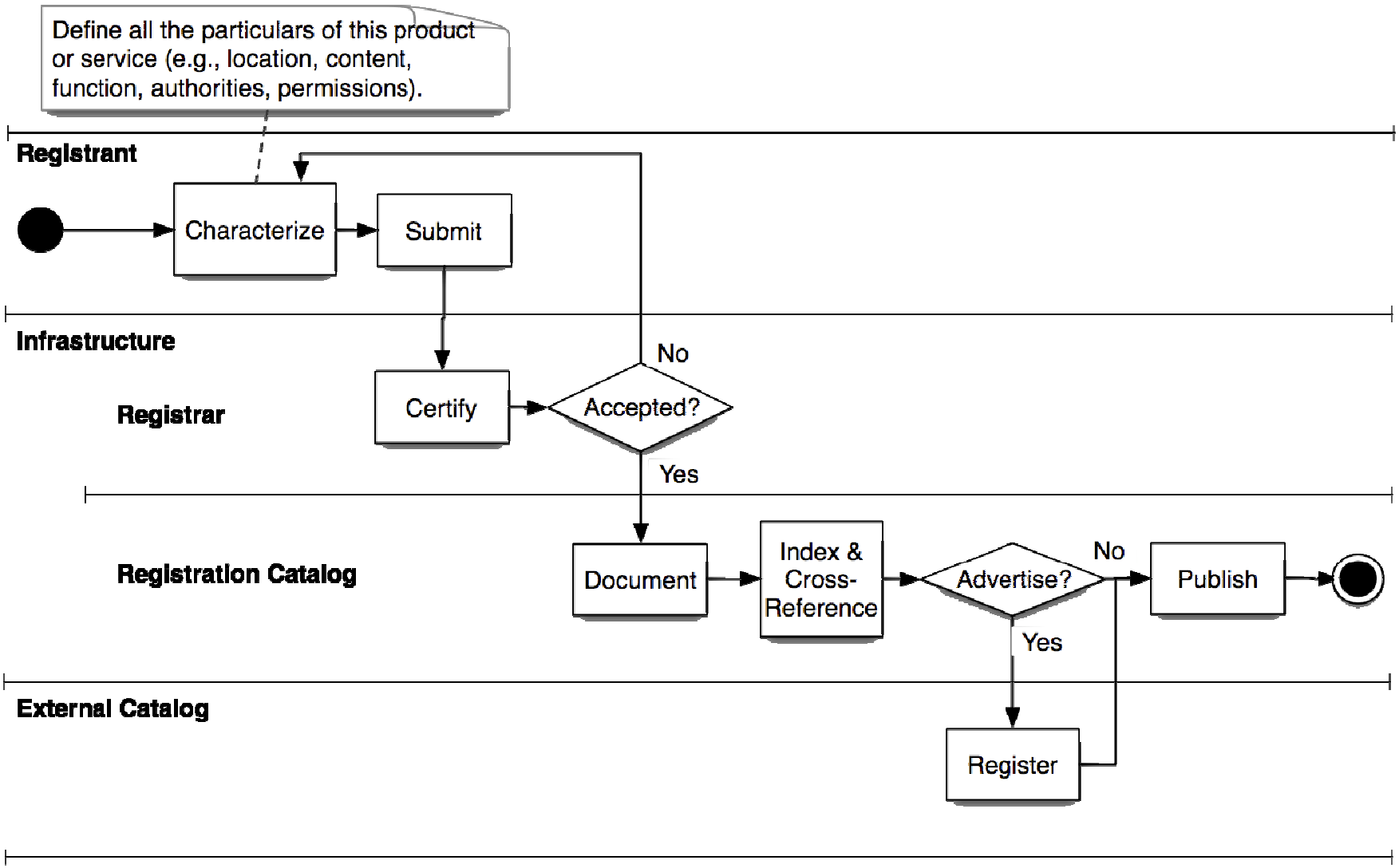
Ongoing Studies

Ocean Observatories Initiative (OOI)

- Primary: Operational Activity Model (OV5) document describing the entire life cycle via several use cases
  - Resources being created
  - Resources being registered and published
  - Resources being commissioned and decommissioned
  - Several more . . .
- Secondary: OOI Concept of Operations document

The OV5 Register Activity Diagram

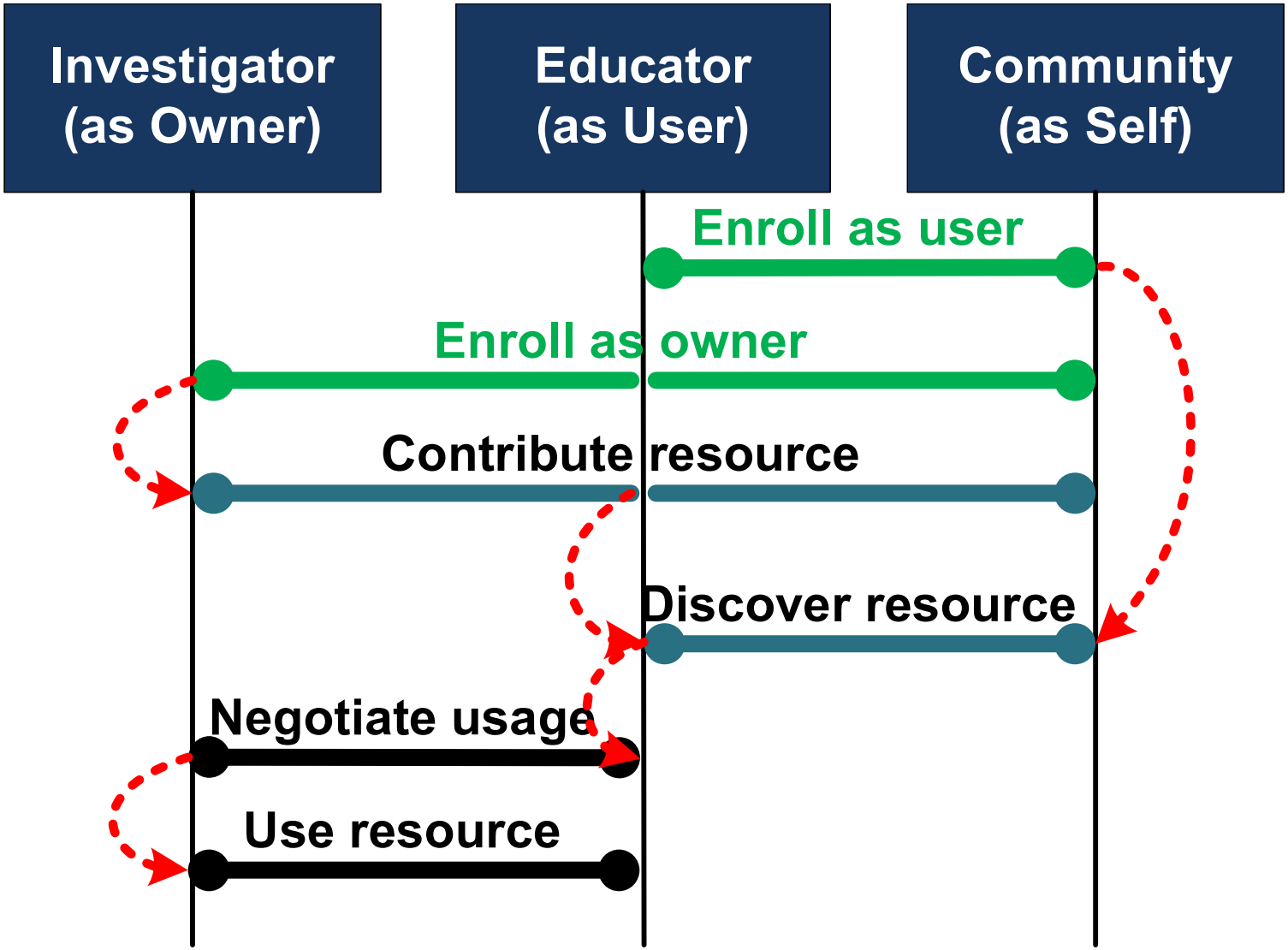
Developed by others



What We Extract from the OV5 Register Activity

- Roles
  - Registrar (e.g., facility administrator)
  - Registrant (e.g., a researcher)
- Main interactions
  - Registrant registers a new resource (e.g., a data stream) to make it available to others
  - Registrar advertises a registered resource
- Policy points for the registrar
  - Whether to accept the registrant's request
  - Whether to advertise a registered resource

Governance for Resource Sharing

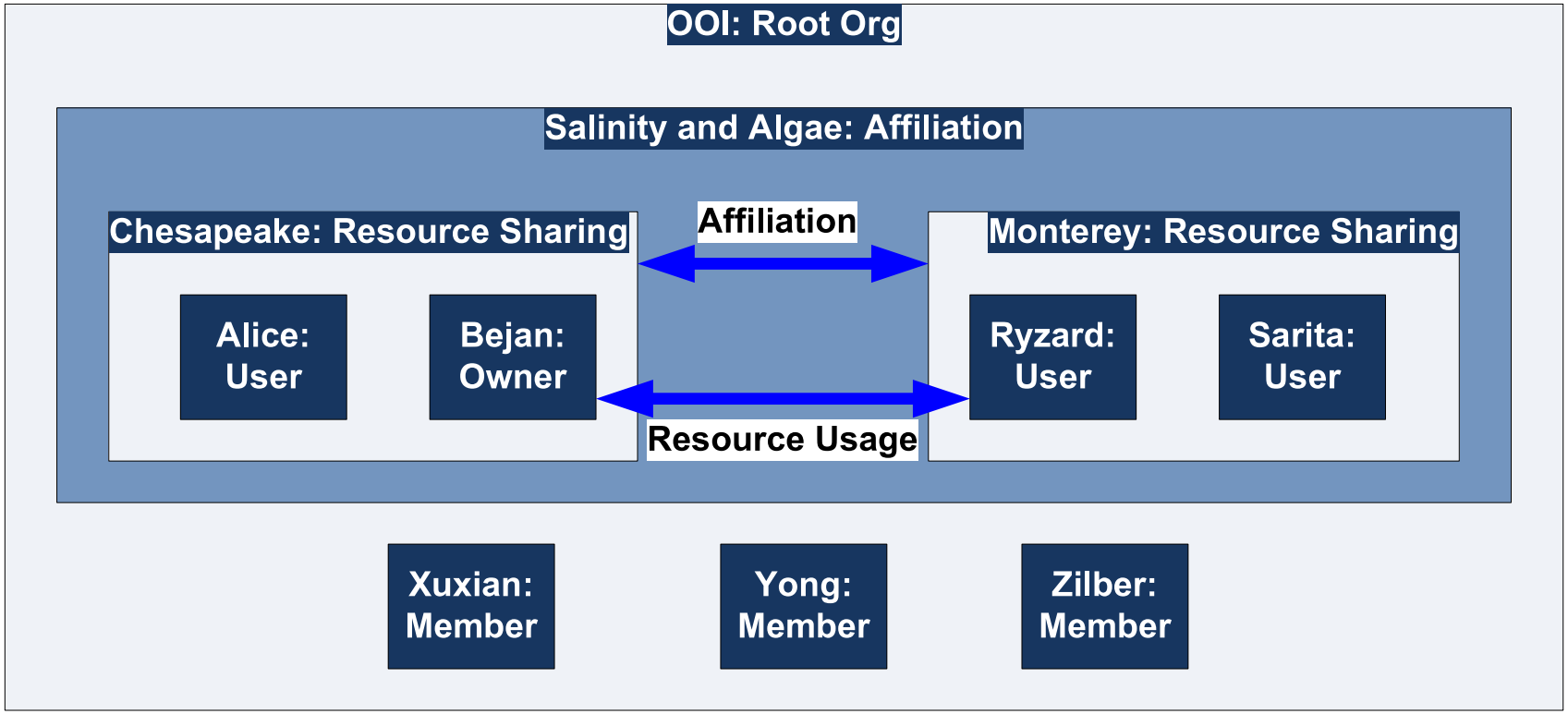


Vocabulary Example for a Resource Sharing Community

```
// The following are the generic properties of our formal governance
// model, and may be used in any specification.

// The following are the signatures of the various properties that we
// use.  These are introduced in the governance models (see
// governance-models.vsd).

// The prefixes of the property names ("C_" and such) are introduced
// in the governance models vocabulary.

 Capability:Communicative C_Request (?Who, ?Whom, ?What);
 Capability:Normative N_Grant(?Who, ?Whom, ?What);
 Capability:Normative N_Revoke(?Who, ?fromWhom, ?What);

 Capability:Participation P_Admit(?Who, ?Org, ?Role, ?Whom);
 Capability:Participation P_Eject(?Who, ?Org, ?Role, ?Whom);

 Capability:Resource R_Contribute(?owner, ?anOrg, ?aResource, ?aCapability);
 Capability:Resource R_Withdraw(?owner, ?anOrg, ?aResource, ?aCapability);

  // A S_Member is any principal playing any role in an Org
 Predicate:Participation S_Member(?anOrg, ?aPrincipal, ?aRole);

  // A S_Registrand (note that the last letter is "d") is a resource
  // that has been contributed (and not yet withdrawn) to an org; the
  // contributor is the "registrant"
 Predicate:Participation S_Registrand (?anOrg, ?aRegistrant, ?aResource, ?aCapability);

  // S_Owns simply reflects the idea that a principal owns a resource.
  // In some cases, we could instead apply an alternative relationship
  // such as "controls" or "represents" but then we would need to
  // describe how such an alternative relationship arises.  Mostly, it
  // would be rooted in the owner transferring its powers to another
  // principal (in the sense of a power of attorney).  In some cases,
  // it could involve stewardship of a resource wherein the owner of a
  // resource may be divested of all authority over it, and such
  // authority invested in another party.
--\--  Governance-Vocabulary.txt   15% (31,0)      (C++/l Abbrev)----------
Loading cc-mode...done
```

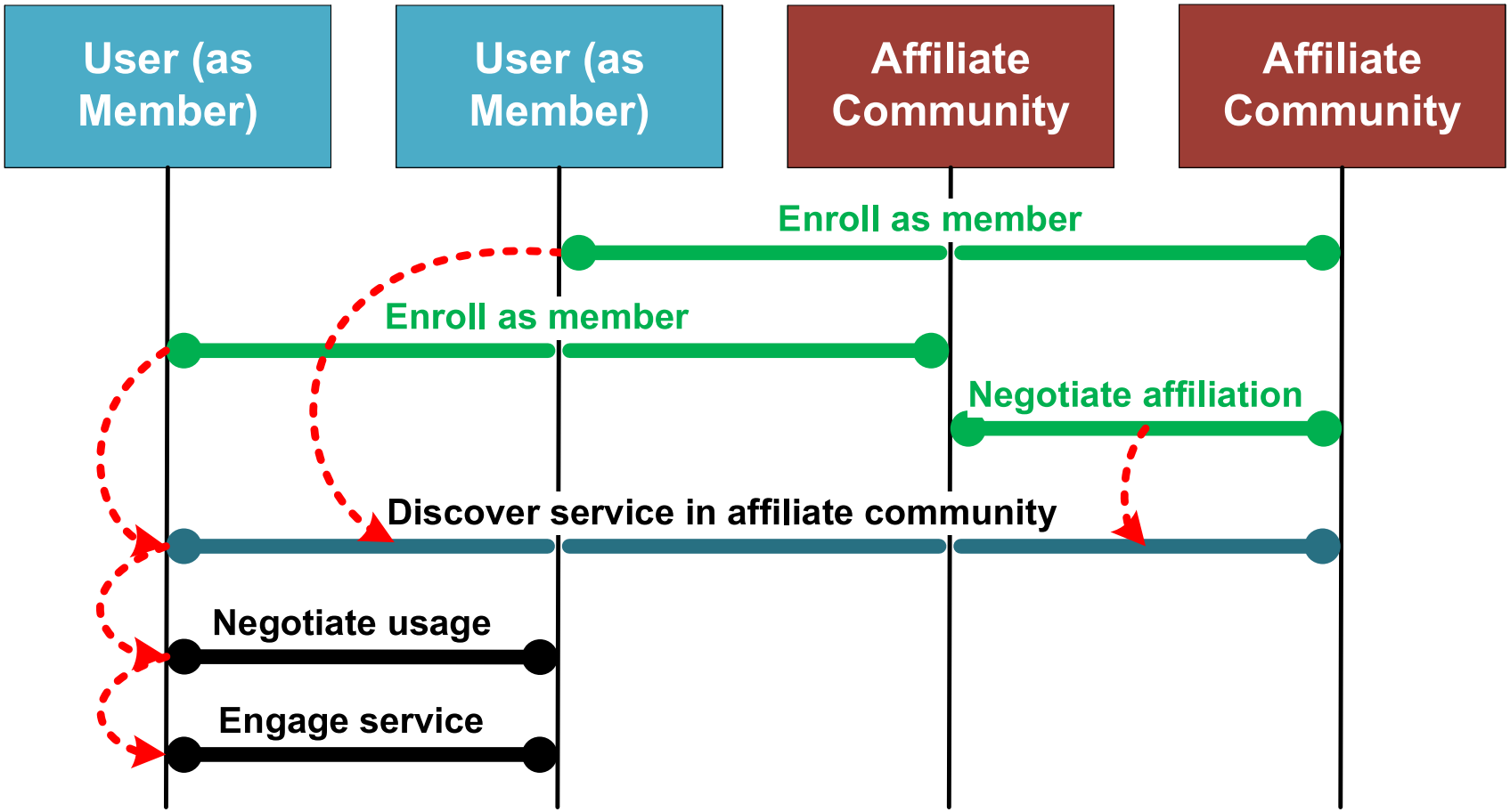
Governance of Community Affiliation Scenario

Static view



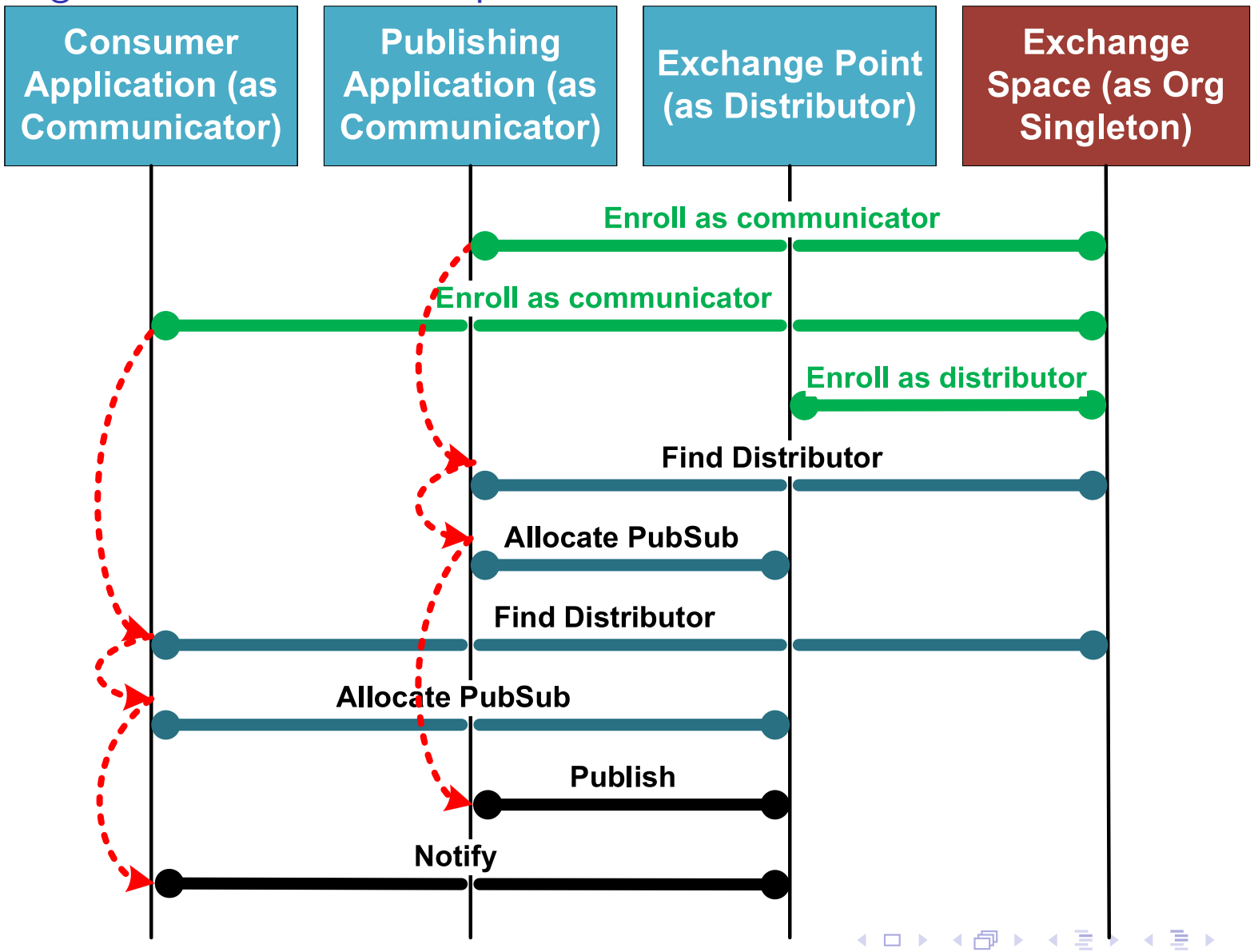
Governance of Community Affiliation Scenario

Dynamic view



Governance of AMQP Exchange Space

Highlighting the business relationships



Norms and Goals

Norms and goals ought to cohere

- An agent adopts goals that
  - Support discharging its liabilities given in its role façades
  - Potentially exploit its privileges given in its role façades
- An agent adopts norms that
  - Packaged as role façades
  - Support achieving its goals
- Relevant works
  - Mallya and Singh, 2004: protocols from Tropos dependencies
  - Chopra, Dalpiaz, Giorgini, and Mylopolous, 2009–2010: commitments and goals
  - Chopra and Singh, 2011: argumentation for protocols (SOCCER workshop)
  - Telang, Yorke-Smith, Singh (in preparation): commitments and goals

Highlights

Differences with some of the literature

- A norm
  - First-class concepts, not confused with agents beliefs or goals
  - Directed
  - Manipulable
  - Helps define Orgs and is defined within Orgs
  - Provides a principled basis for Key Performance Indicators (KPIs)
- An Org
  - Active entity, not specifications
  - Lacks any special powers
  - Doesn't regiment interactions: members can violate norms
- A role
  - A specification, not an active entity
  - Inherently incomplete: an adopting agent would supply its policies to determine specific decisions
- Enactment of operations
  - Minimize operational restrictions
  - Overlay a declarative language *Blindingly Simple Protocol Language*

Themes for Further Study

- Conceptual models
  - Norms and institutions
  - Organization theory
  - What comes first: norms or goals?
- Operational models
  - Declarative language: Blindingly Simple Protocol Language
  - How to map conceptual models to operational models
- Development of Key Performance Indicators (KPIs) based on norms
- Agent representation and reasoning to support governance
  - Incorporating goals as duals of norms
  - Policy languages and architectures (Ponder; Datalog; Rei; . . .)
- Understanding service engagements broadly in terms of governance

Thanks!

http://www.csc.ncsu.edu/faculty/mpsingh/