Norms as a Basis for Governing Sociotechnical Systems

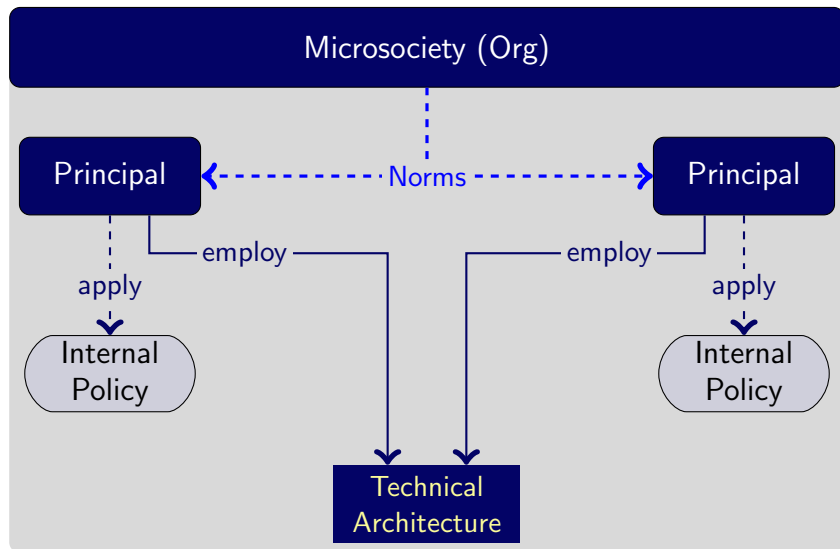## IJCAI Journal Track Presentation

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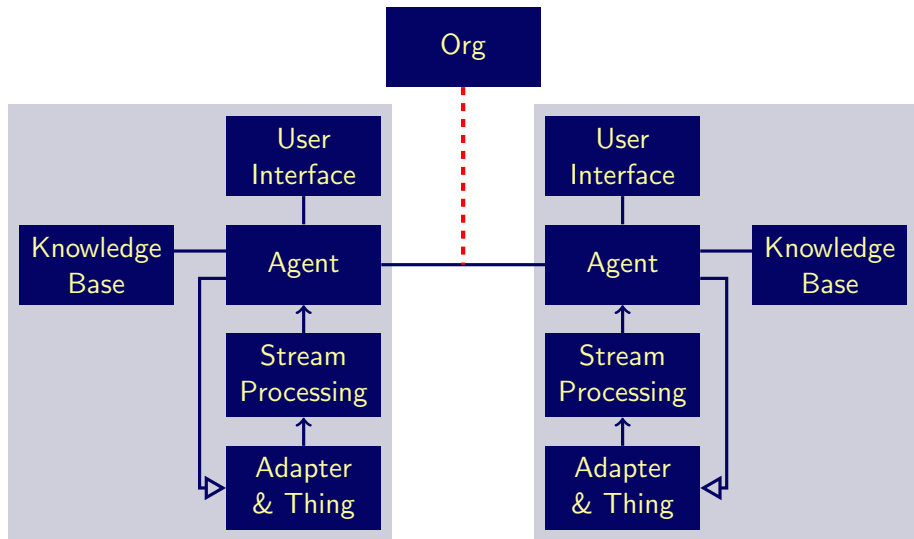singh@ncsu.edu

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A Sociotechnical System (STS) is a Microsociety

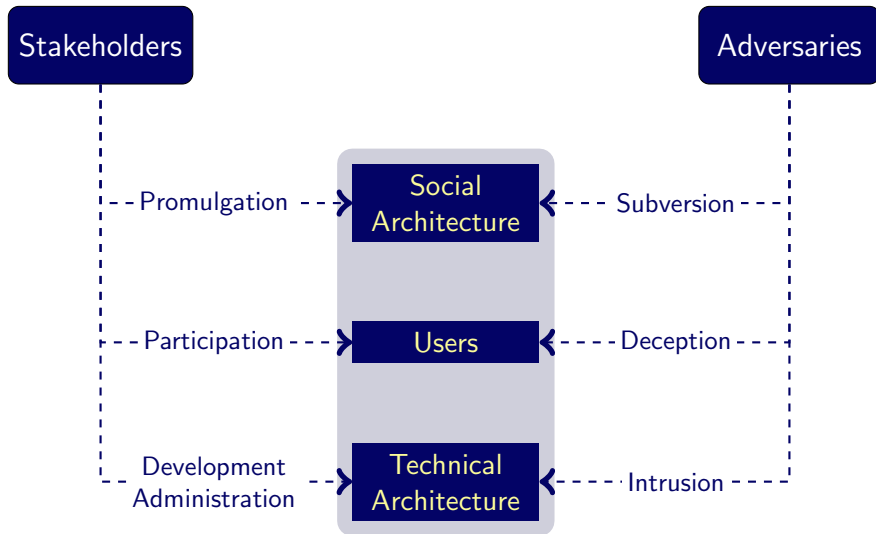*Traditional view:* A "system" is an artifact, e.g., a computer

STS Setting: Collaboration in the Internet of Things

Each agent represents an autonomous party, contains a reasoner; interact within Org

STS Setting: Participants and Artifacts in Security

Greatest challenges arise in the upper two; most past effort is on technical architecture

Internet of Oceans: Global Hybrid Profile Mooring Launch
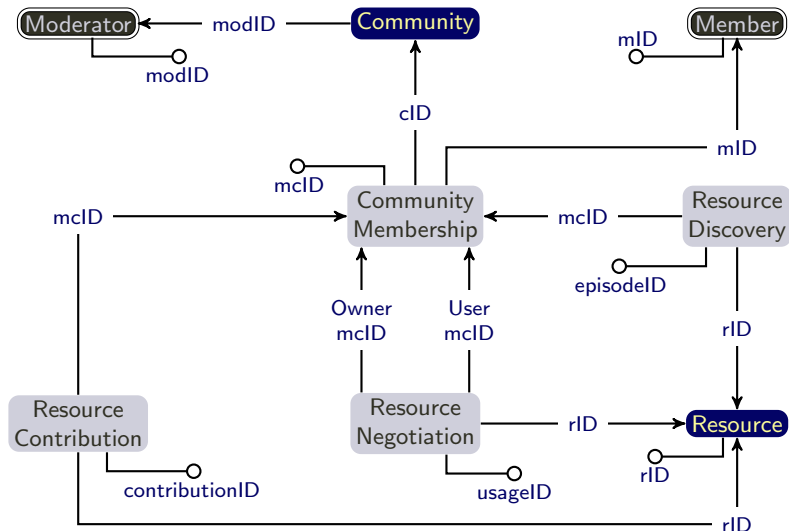

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Internet of Oceans: Glider Being Launched

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Schema for IoT Resource Sharing: Four Protocols

What are the normative requirements or meanings behind these protocols?

Governance Challenges: Autonomy and Dynamism
Capturing norms is essential to addressing these challenges

- Support *configurational adaptation*, for example
    - Resource sharing: Offer ocean instrument for sharing
    - Affiliation: Add new laboratories
    - Sanction: Allow external sharing of results to fulfill deliverables
- Support *operational adaptation*, for example
    - Resource sharing: Preempt low-priority users in case of oil spill
    - Affiliation: Forbid unilateral publishing of results
    - Sanction: Absolve researcher who reveals results to prevent public endangerment (extenuating circumstances)
- Research challenges
    - Abstractions to capture rules of encounter
    - Methods to design and analyze such abstractions
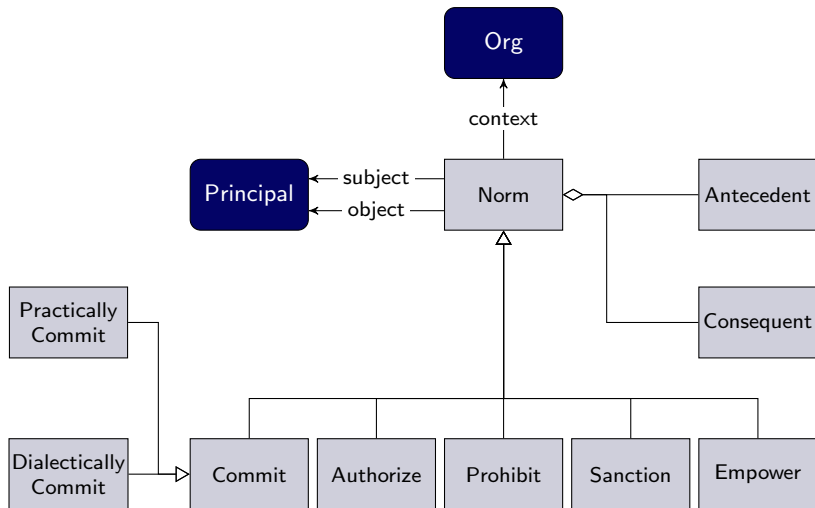   - Methods to implement such abstractions
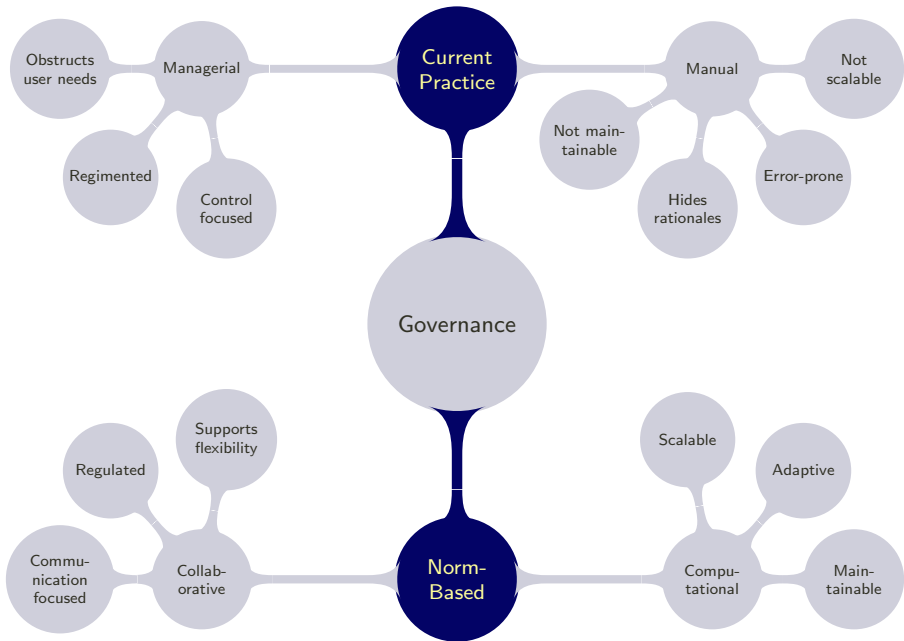
Social Architecture for Governance of Secure Collaboration
Principals and Orgs
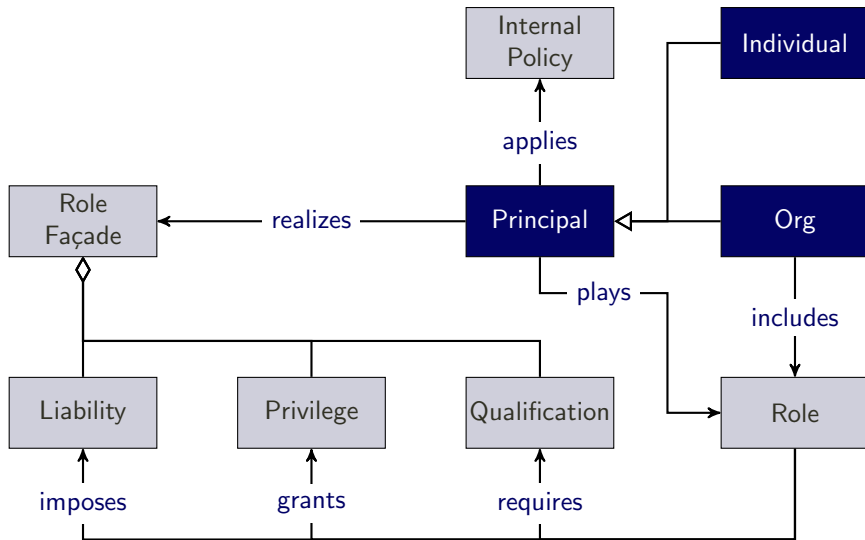
Normative Relationships for Governance

Each norm type is a directed relationship: crucial for accountability

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

Life Cycle for Norms: 1
Using a variant of the UML state diagram notation
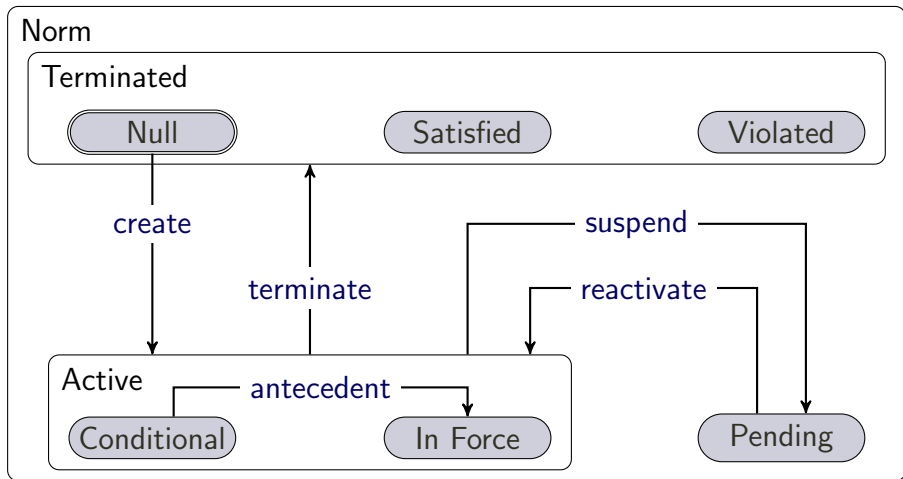
Life Cycle for Norms: 2
Substate of a terminated norm

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

Governance and Policies: Two Kinds of Interaction

Conversations with autonomous parties; control over resources
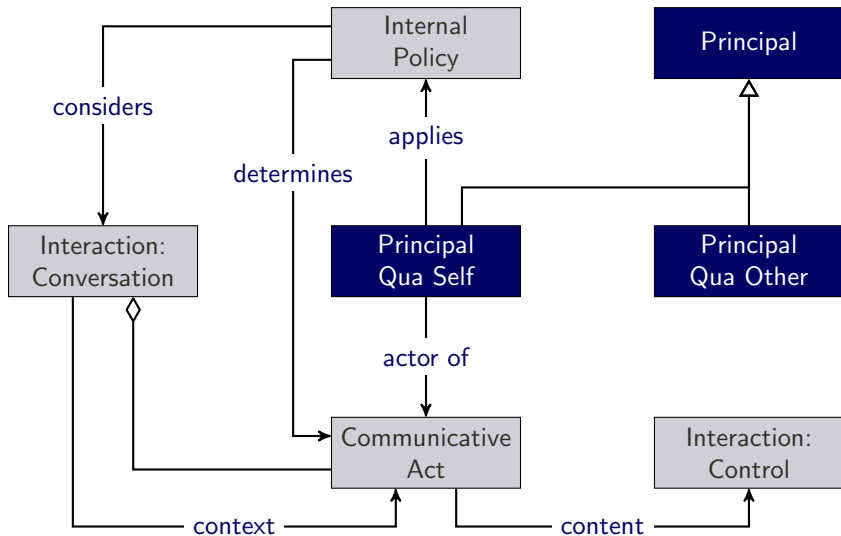
Vocabulary for Governance and Policies

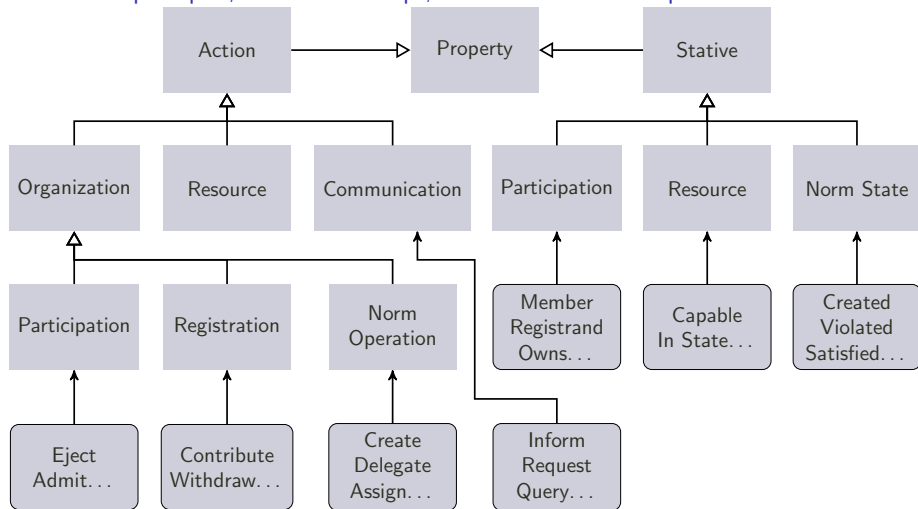Attributes of principals, their relationships, resource states and capabilities

Challenges and Partial Recent Progress

- ▶ Fully declarative model of communication [AAMAS 2011, 2012]
- ▶ Storing and retrieving events to determine the state of a norm
  - ▶ Mapping commitments to relational algebra [AAAI 2015]
- ▶ Maintaining alignment of views despite decentralization
  - ▶ Communications to guarantee (eventual) alignment [AAMAS 2015]
  - ▶ TBD: maximizing partial or "quick" alignment
- ▶ Designing protocols and Org contexts for monitorability
  - ▶ Failure of compositionality of monitorability [IJCAI 2015]
  - ▶ Automatically close a context to ensure monitorability
- ▶ Designing protocols and Org for robustness and resilience
  - ▶ Typology of sanctions and sanctioning processes [Draft]
  - ▶ TBD: Formalization of normative robustness and resilience
  - ▶ TBD: Reasoning about sanctions for design of Orgs
- ▶ Design processes conducive to autonomy
  - ▶ Abstract formal model of a sociotechnical design process [RE 2014]
  - ▶ TBD: Methodologies

An Information Model and Commitment Specification

```
TakeCharge(tcID, nuID, phID, patID, tcThreshold) key tcID
CardiacEvent(ceID, nuID, phID, patID, ceMagnitude)  key ceID
CPR(cprID, nuID, phID, patID, cprDuration)  key cprID

commitment CardioCare nuID to phID
create TakeCharge
detach CardiacEvent [, TakeCharge + 180]
  where ceMagnitude >= tcThreshold
discharge CPR [, CardiacEvent + 5]
```

A Cardio Care commitment from a nurse to a physician is

- ▶ *created* upon Take Charge;
- ▶ *detached* if a CardiacEvent for this patient happens above the specified threshold within 180 minutes
    - ▶ Else the commitment *expires*
- ▶ *discharged* if CPR on this patient happens within five minutes of the Cardiac Event (else *violated*)

Generate Log Schema

```
CREATE TABLE TakeCharge (
  tcID  VARCHAR(10), nuID  VARCHAR(10), phID  VARCHAR(10),
      patID  VARCHAR(10), tcThreshold  VARCHAR(10),
  stamp  DATETIME,
  PRIMARY KEY(tcID)
);

CREATE TABLE CardiacEvent (
  ceID  VARCHAR(10), nuID  VARCHAR(10), phID  VARCHAR(10),
      patID  VARCHAR(10), ceMagnitude  VARCHAR(10),
  stamp  DATETIME,
  PRIMARY KEY(ceID)
);

CREATE TABLE CPR (
  cprID  VARCHAR(10), nuID  VARCHAR(10), phID  VARCHAR(10),
      patID  VARCHAR(10), cprDuration  VARCHAR(10),
  stamp  DATETIME,
  PRIMARY KEY(cprID)
);
```

Generate Canonical Queries for Accountability Checking
In relational algebra (Jun Yang's notation)

Query for which Cardio Care commitments are detached
```
((\ select_{(stamp >= stamp38)} (
(TakeCharge) \join
(\rename_{ceID, nuID, phID, patID, ceMagnitude, stamp38}
 (\ select_{ceMagnitude = tcThreshold} (CardiacEvent))))))
     \union
  (\ select_{(stamp >= stamp37)}
    ((\ select_{ceMagnitude = tcThreshold}
      (CardiacEvent)) \join
      (\rename_{tcID, nuID, phID, patID, tcThreshold, stamp37}
       (TakeCharge)))));
```

Opportunities for Research

- Taking AI and MAS into the real world
- Major applications areas
    - Internet of Things
    - Cybersecurity
    - Software and analytic organizations
- Numerous research challenges, centered on autonomy
    - Models of interaction, incorporating resilience
    - Strategic aspects, as in game theory
    - Machine learning of strategies
    - Human aspects of emotion and cognition regarding norms
    - Empirical validation of external validity of systems
    - Agent-based simulations of complex systems

Thanks and Plugs

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