Application-Centric Security Models

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UTSA INSTITUTE FOR CYBER SECURITY
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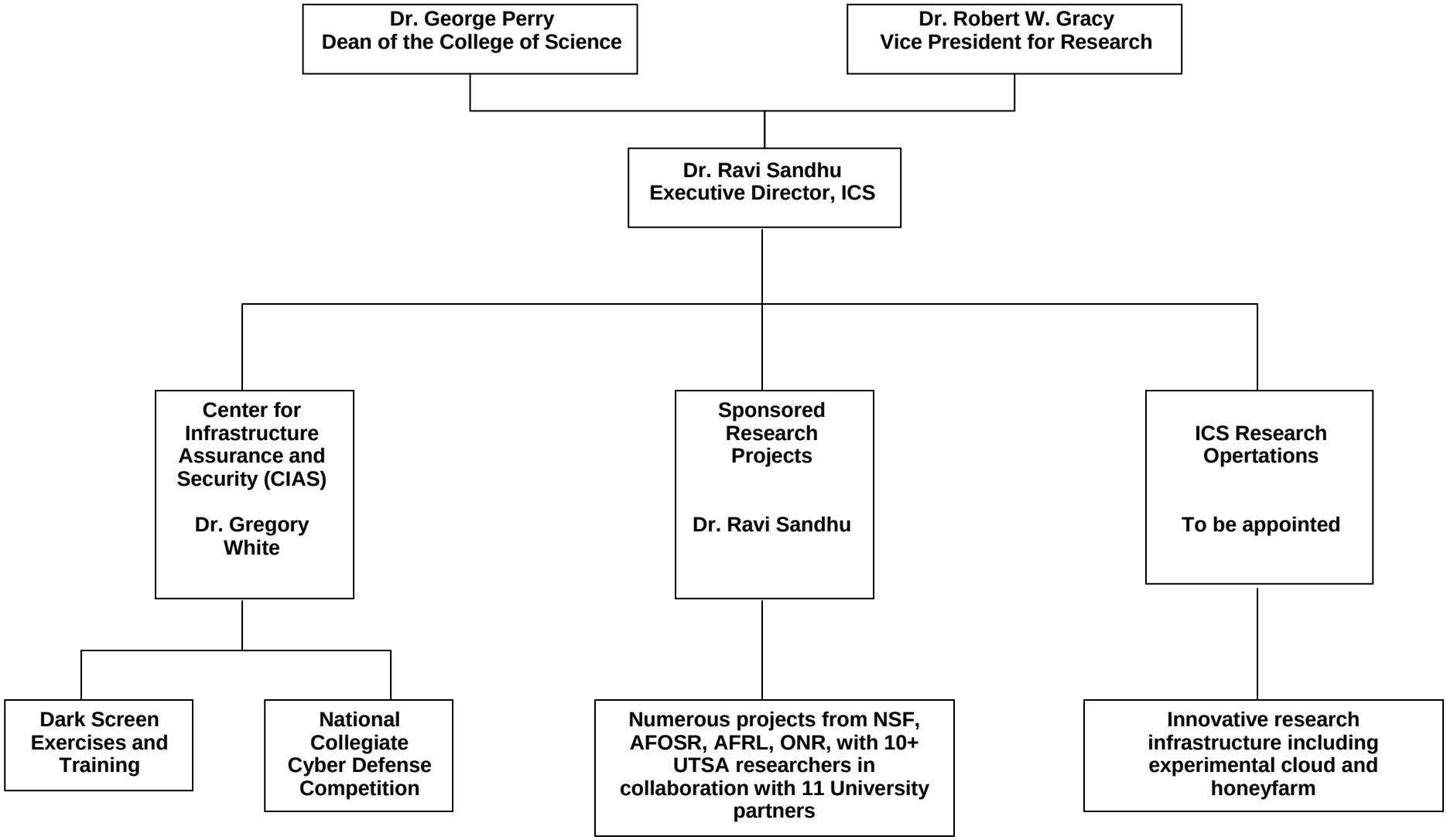
Institute for Cyber Security (ICS)
Founded 2007



World leading research with real world impact

ICS Key Assets

- World leading security modeling and analysis research
  - Role-Based Access Control (RBAC) Model (1996)
    - Catalyzes dominance of RBAC in commercial systems
    - Develops into a NIST/ANSI Standard (2004)
  - Usage Control (UCON) Model (2004)
    - Attribute-Based Access Control on Steroids
    - Unifies numerous extensions/enhancements
  - PEI Framework (2000, 2006)
    - Policy, Enforcement, Implementation Models
    - From what to how
  - Group-Centric Information Sharing (2007)
    - Sharing metaphor of meeting room
    - Equivalently: mission centric
  - Security for Social Networks (2008)
  - Botnet Analysis, Detection and Mitigation (2008)
  - Multilevel Secure Architectures (2009)
  - Secure Cloud Computing (2009)
- Bring in partners from leading research universities worldwide as appropriate
- Ready to commercialize when appropriate

Application Context

- Our Basic Premise
  - There can be no security without application context
  - Courtney's Law (1970s, 1980s ??):
    - You cannot say anything interesting (i.e. significant) about the security of a system except in the context of a particular application and environment
- Corollary
  - There can be no security model without application context
- Reality
  - Existing security models are application neutral
    - Assumption is they can be readily "configured" or "policy-ified" to suit application context

Existing Security Models (1)

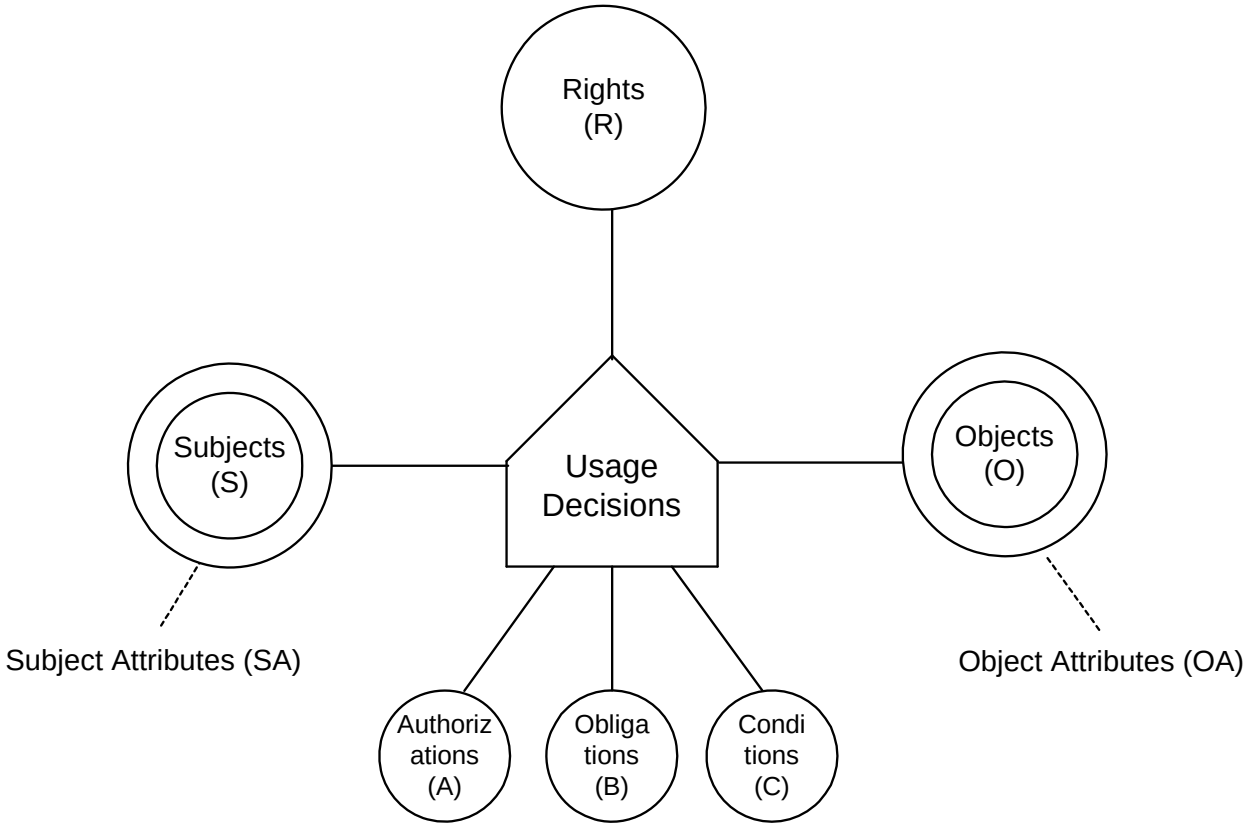
- Discretionary Access Control (DAC)
  - Characteristic: Owner-based discretion
  - Drawbacks:
    - Classic formulation fails to distinguish copy from read
    - Application context drives ownership and its delegation
- Lattice-Based Access Control (LBAC)
  - Characteristic: One directional information flow in a lattice of security labels
    - Also known as: Bell-LaPadula, Multi-Level Security, Mandatory Access Control (ignoring subtle differences)
  - Drawbacks: Many applications
    - Many applications violate one directional information flow
    - Many applications do not fit within preexisting security labels

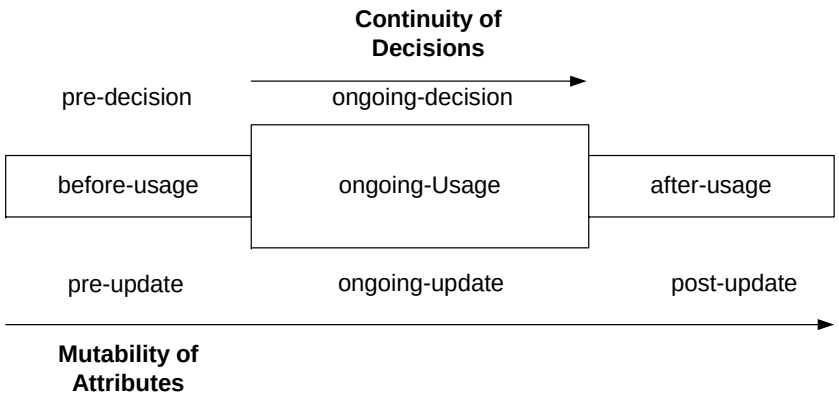
Existing Security Models (2)

- Role-Based Access Control (RBAC)
  - Characteristic: Role is central, administration is simple
  - Drawbacks:
    - Need to define the roles for each application/environment
    - Lack of standardized roles results in lack of interoperability
    - Too open: can be configured to do DAC or LBAC
- Attribute-Based Access Control (ABAC)
  - Characteristic: subsume security labels, roles and more as attributes and enforce attribute-based policies
  - Drawbacks:
    - All the RBAC drawbacks on steroids
    - Administrative complexity

Usage Control Model (UCON)

- unified model integrating
  - authorization
  - obligation
  - conditions
- and incorporating
  - continuity of decisions
  - mutability of attributes





UCON is Attribute-Based Access Control on Steroids

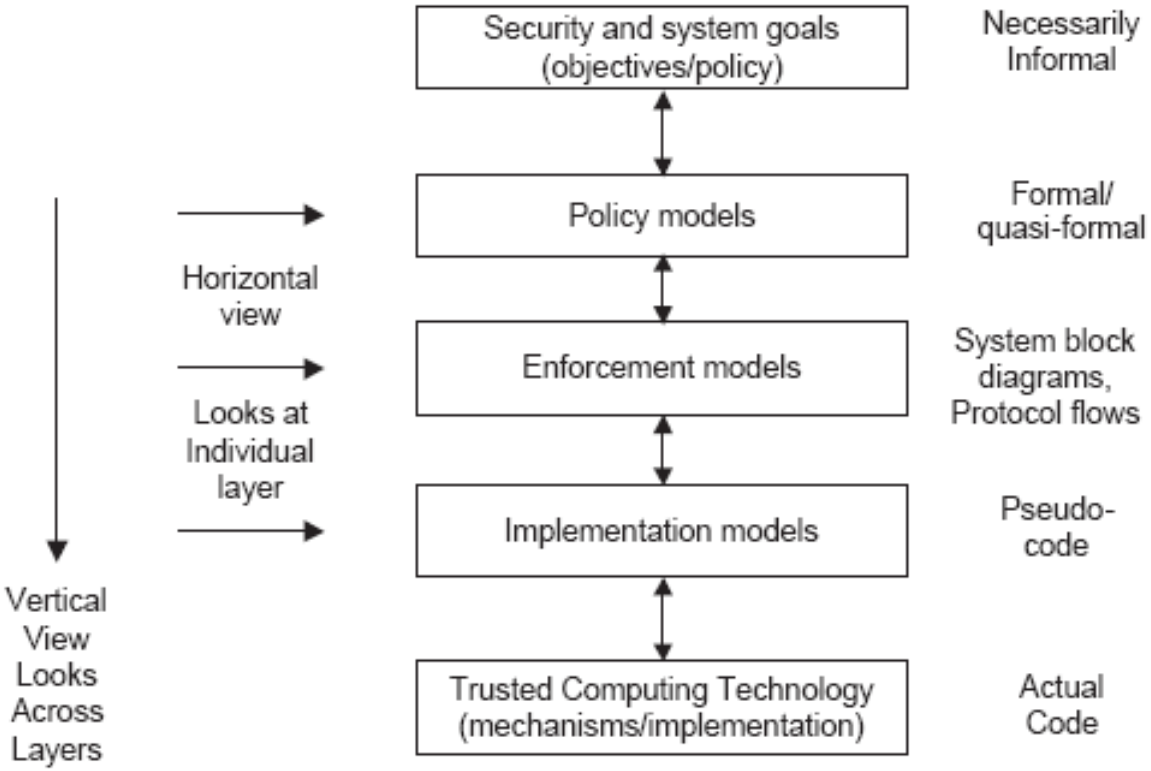
Usage Control Model (UCON)

- DAC
- LBAC
- RBAC
- ABAC
- … and many, many others
- UCON
  - ABAC on steroids
  - Simple, familiar, usable and effective use cases demonstrate the need for UCON
    - Automatic Teller Machines
    - CAPTCHAs at Public web sites
    - End User Licencse Agreements
    - Terms of Usage for WiFi in Hotels, Airports
    - Rate limits on call center workers

Application-Centric Security Models

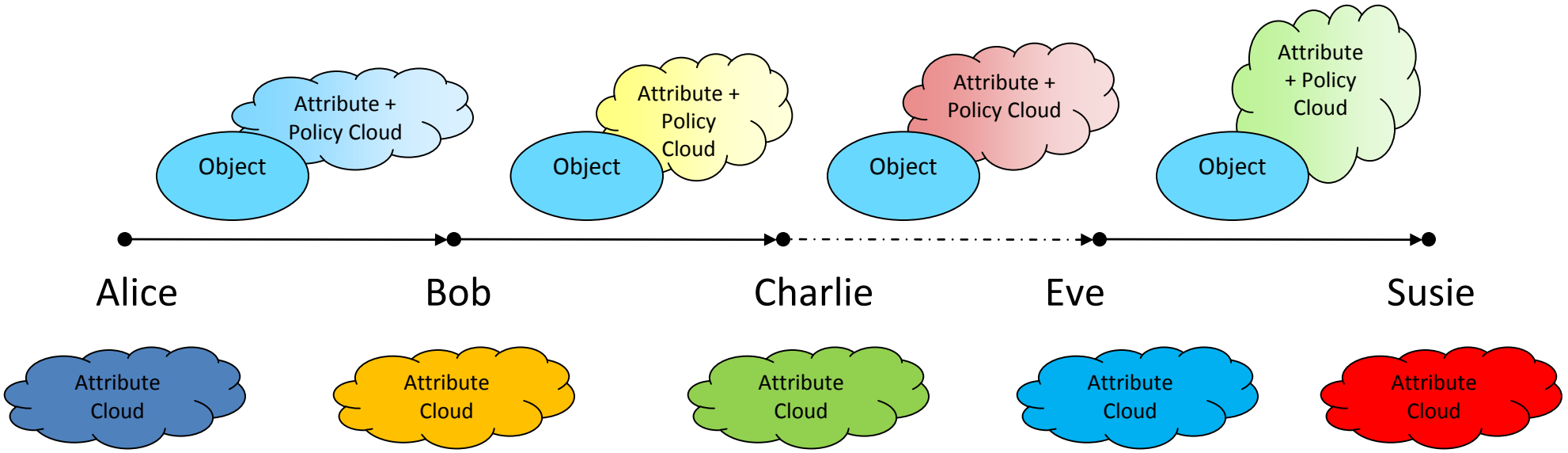
- Our Basic Premise
  - There can be no security model without application context
- So how does one customize an application-centric security model?
  - Combine the essential insights of DAC, LBAC, RBAC, ABAC and UCON in a meaningful way
  - Directly address the application-specific trade-offs
    - Within the security objectives of confidentiality, integrity and availability
    - Across security, performance, cost and usability objectives
  - Separate the real-world concerns of practical distributed systems and ensuing staleness and approximations (enforcement layer) from the policy concerns in a idealized environment (policy layer)

PEI Models: 3 Layers/5 Layers



Dissemination-Centric Sharing

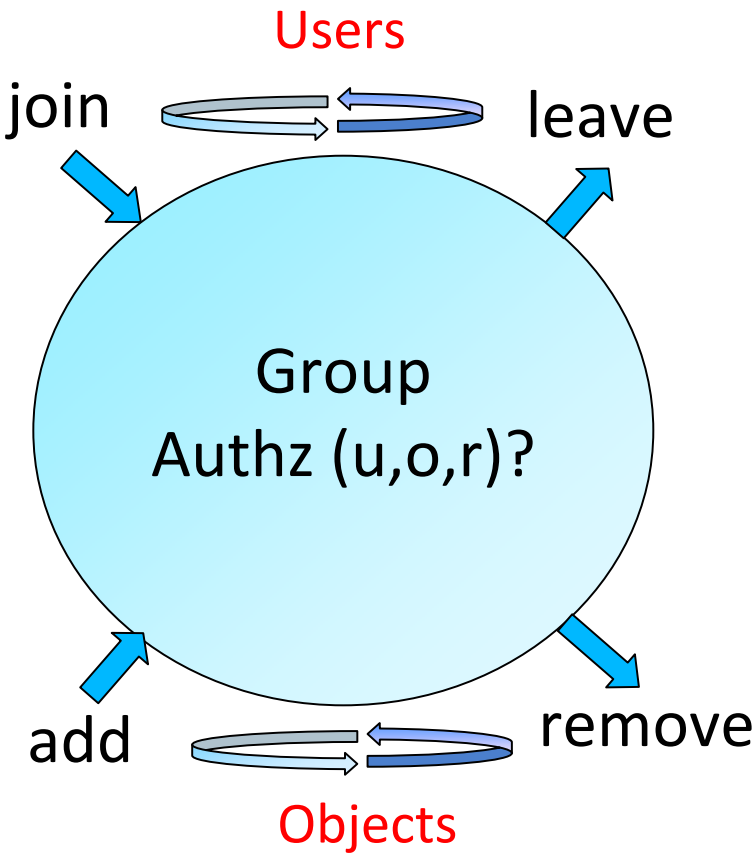
- Extensive research in the last two decades
  - ORCON, DRM, ERM, XrML, ODRL, etc.
- Copy/usage control has received major attention
- Manageability problem largely unaddressed



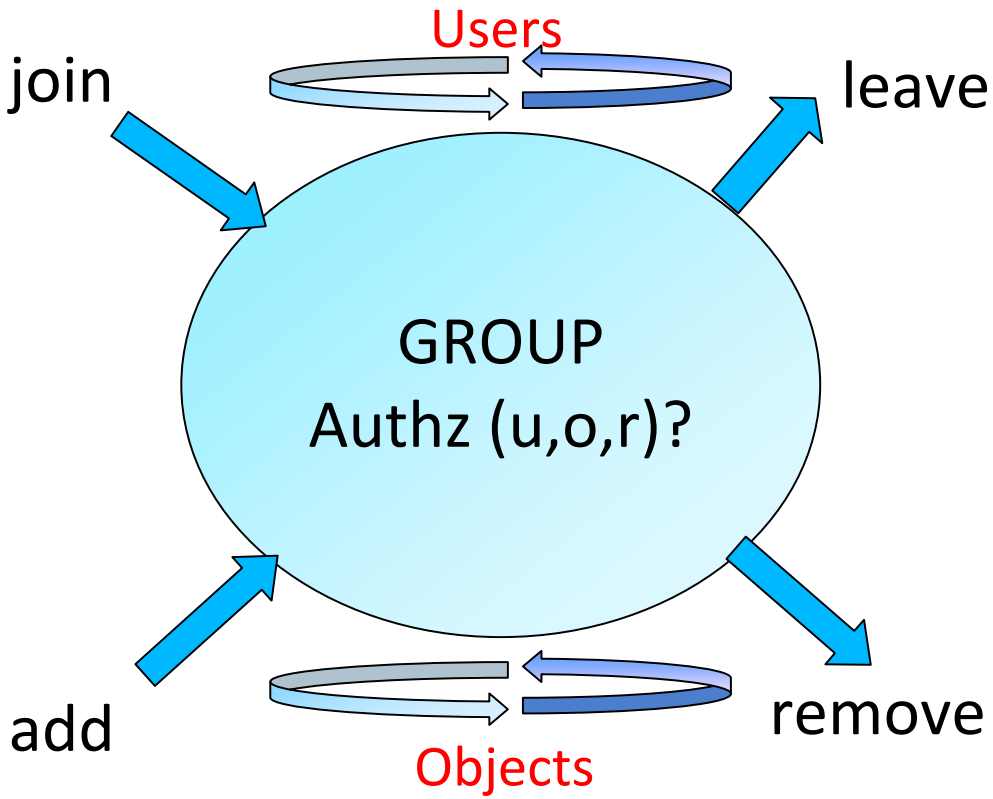
Dissemination Chain with Sticky Policies on Objects

Group-Centric Sharing (g-SIS)

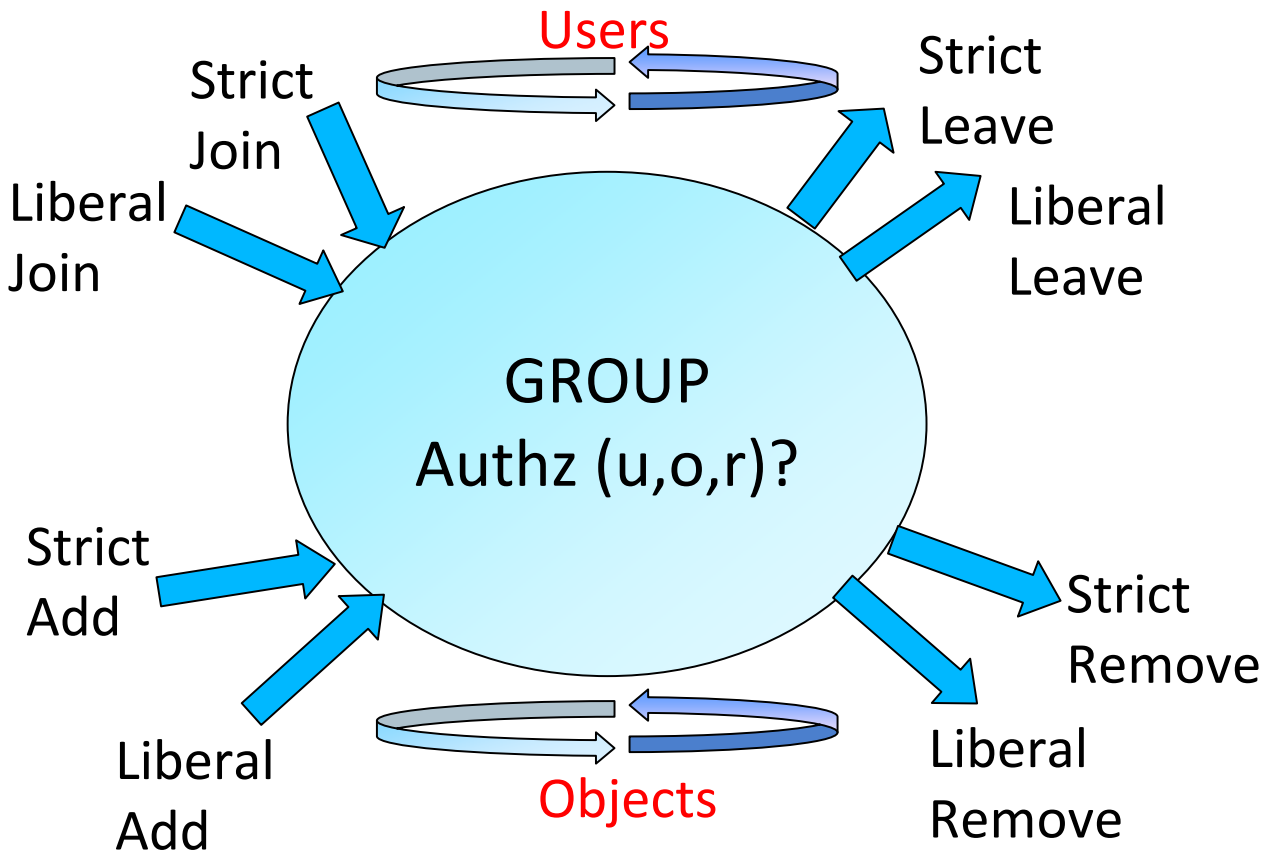
- Brings users & objects together in a group
  - Focuses on manageability using groups
  - Co-exists with dissemination-centric
  - Two metaphors
    - Secure Meeting Room (E.g. Program committee)
    - Subscription Model (E.g. Secure multicast)
- Operational aspects
  - Group characteristics
    - E.g. Are there any core properties?
  - Group operation semantics
    - E.g. What is authorized by join, add, etc.?
  - Read-only Vs Read-Write
- Administrative aspects
  - E.g. Who authorizes join, add, etc.?
  - May be application dependant
- Multiple groups
  - Inter-group relationship



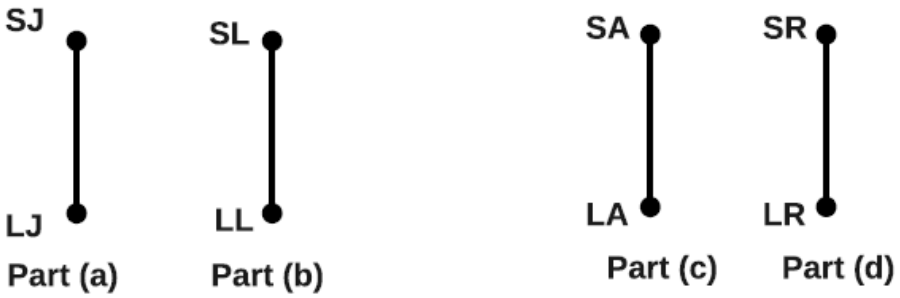
g-SIS Operation Semantics

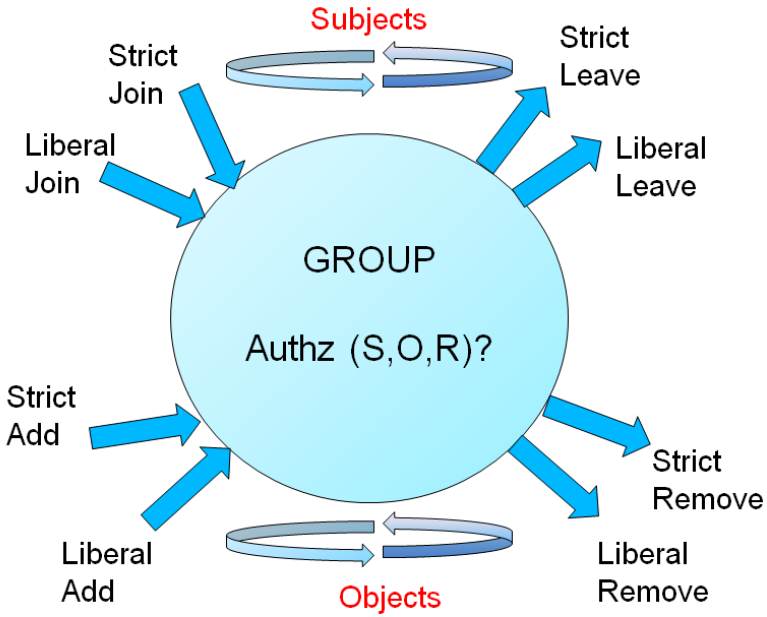


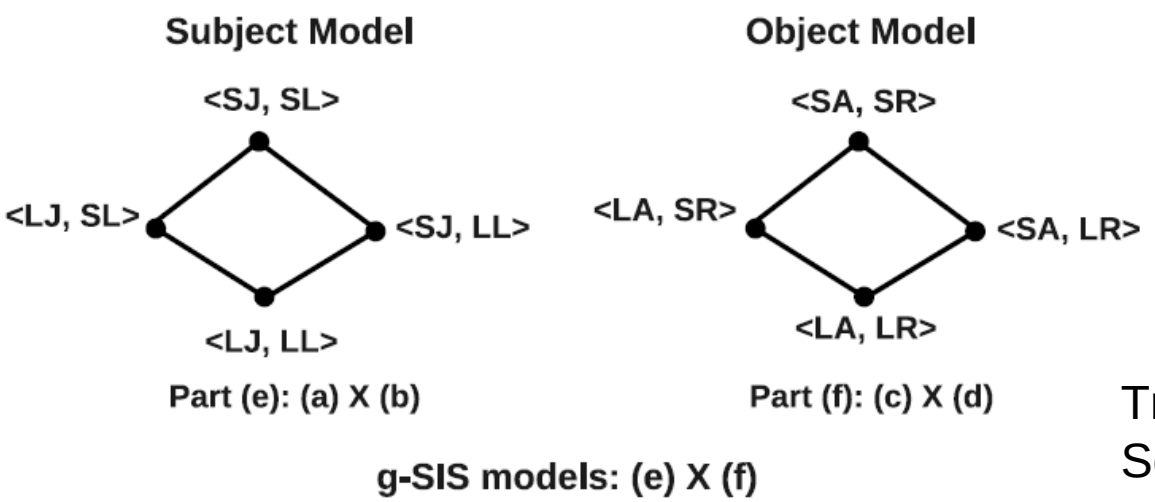
g-SIS Operation Semantics



Family of g-SIS Policy Models







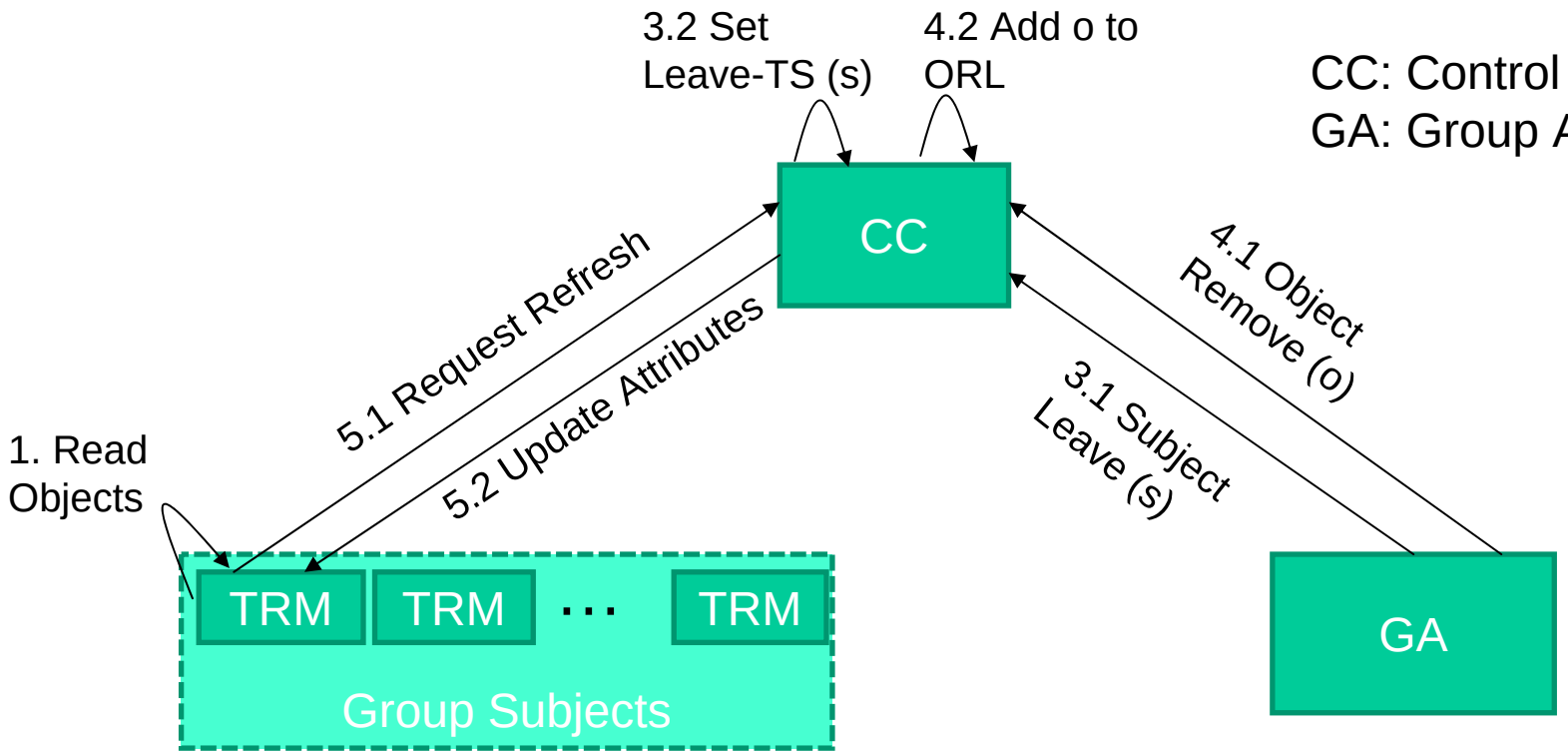
g-SIS models: (e) X (f)

Traditional Groups: <LJ, SL, LA, SR>
Secure Multicast: <SJ, LL, LA, *>

Most Restrictive g-SIS Specification:

$$\Box(\text{Authz} \leftrightarrow (\neg\text{SR} \wedge \neg\text{SL})\ \mathcal{S}\ (\text{SA} \wedge (\neg\text{SL}\ \mathcal{S}\ \text{SJ})))$$

g-SIS Enforcement Model



Subject Attributes: {id, Join-TS, Leave-TS, ORL, gKey}

ORL: *Object Revocation List*

gKey: *Group Key*

Object Attributes: {id, Add-TS}

Refresh Time (RT): TRM contacts CC to update attributes

From Policy to Enforcement

- Additional Trusted/Semi-Trusted Servers
- Approximate Enforcement

- Finally, the Implementation layer models spell out protocol details and details of TRM algorithms

Conclusion

- Application-Centric Security Models require
  - State-of-the-art approaches such as UCON, PEI
  - Mix-and-match DAC, LBAC, RBAC, UCON, g-SIS
  - …..
  - …..
- The future of cyber security research will revolve around
  - Application-centric models
  - Technology-centric models
  - Attack models
  - …..
  - …..