Ingredients of an Early Design for Protecting the GENI Facility

GENI Distributed Services Working Group
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Disclaimer

- This talk summarizes the early design of security mechanisms to protect against abuse of the GENI facility
  - Prior to establishment of BBN as GPO
- I have no knowledge of how this relates to the security facilities envisioned today for GENI
- In particular, I in no way speak for BBN or the current state of GENI on this matter

Some Topics We Considered

- Threat model
- Goals/requirements

- Access control
- Authentication and key management
- Auditing
- Intrusion detection

Threat model

Exploitation of a slice

- Runaway experiments
  - Unwanted Internet traffic
  - Exhausting disk space
- Misuse of experimental service by end users
  - E.g., to traffic in illegal content
- Corruption of a slice
  - Via theft of experimenter's credentials or compromise of slice software

Exploitation of GENI itself

- Compromise of host O/S
- DoS or compromise of GENI management plane

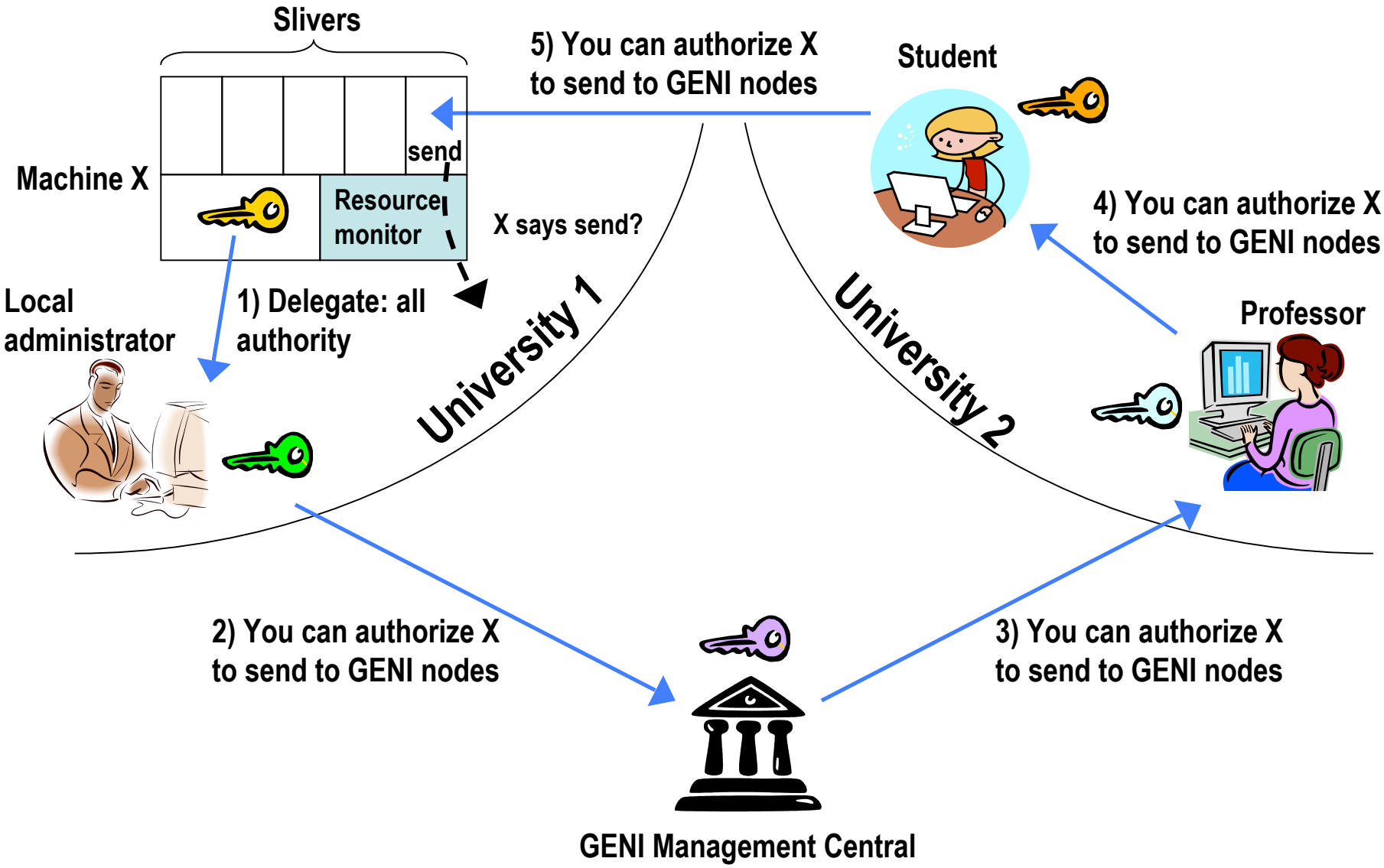
Requirements: Do no harm

- Explicit delegations of authority
  - Node owner → GMC → Researcher → students → …
- Least privilege
  - Goes a long way toward confining rogue activities
- Revocation
  - Keys and systems will be compromised
- Auditability
- Scalability/Performance
- Autonomy/Federation/Policy Neutrality
  - Control ultimately rests with node owners, can delegate selected rights to GMC

Access Control Requirements

- Arbitrarily flexible
  - Did not want to “hard code” policy into the system
- Dynamically extensible
- Verifiably sound and principled
  - Avoid ad hoc approaches
- Auditable
  - Must be able to determine why an access was granted, and who was responsible

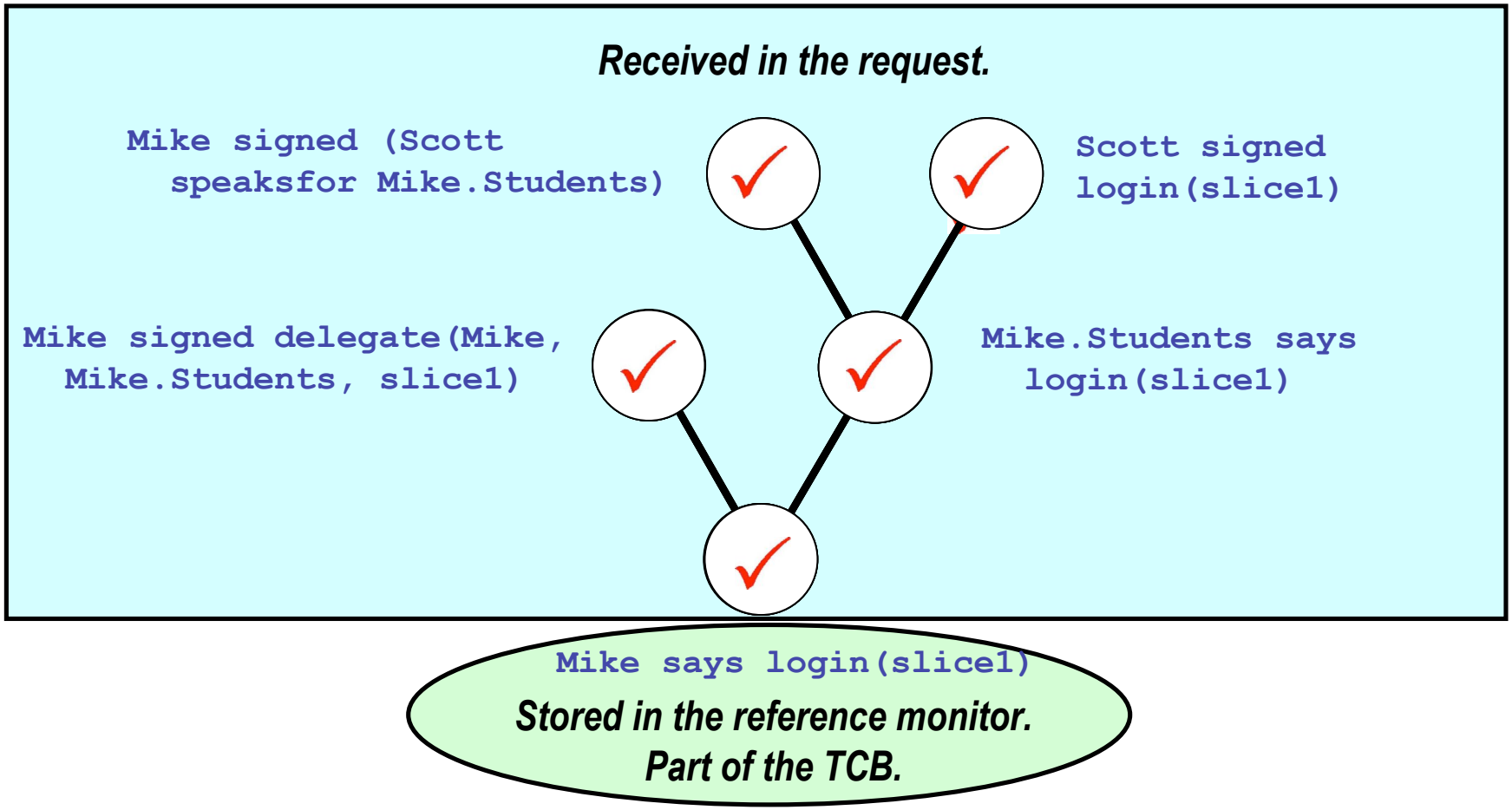
Authorization Example



A Proof-Carrying Approach

- Encode access control decision procedure in a formal logic
  - Can be used to express groups, roles, delegations, and new constructs
  - Can encode other, specific access-control mechanisms
- Digitally signed statements (e.g., certificates) used to instantiate logical statements
- Client submits a proof that its request complies with access-control policy
- Reference monitor checks that the proof is a valid proof of required policy

A Tiny Example



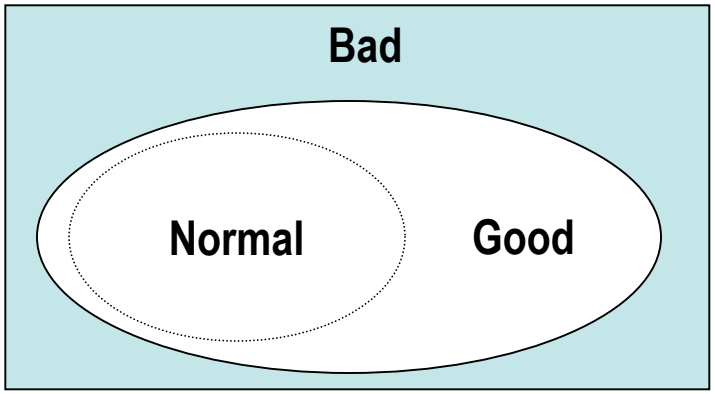
Authentication and Key Management

- GENI would have a PKI (as a corollary of the authorization framework)
  - Every principal would have a public/private key
    - E.g., users, administrators, nodes
  - Certified by local administrator
  - Keys sign certificates to make statements in the authorization logic (identity, groups, authorization, delegation, …)
- Private key compromise an issue
  - Encrypted with user's password? Off-line attacks
  - Smart card/dongle? Most secure, but less usable
  - Capture-resilient protocols: A middle ground
    - An (untrusted) capture-protection server can disable use of a key, e.g., when observing a password-guessing attack

Intrusion Detection

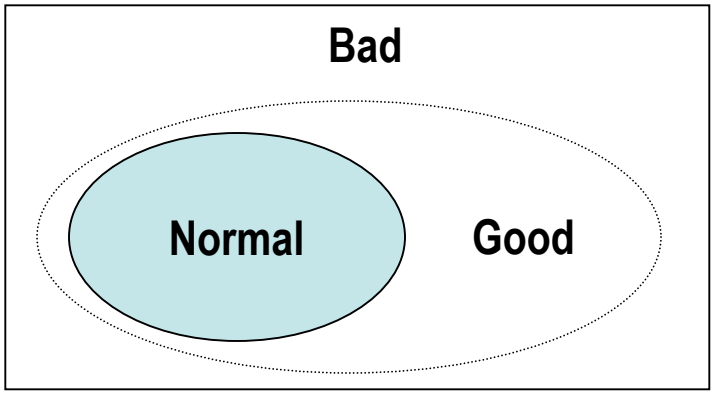
- Traditional intrusion detection methods may not suffice *for monitoring experiments*

Misuse detection
Specify bad behavior and watch for it



Problem: Experiments do lots of things that look "bad"

(Learning-based) Anomaly detection
Learn "normal" behavior and watch for exceptions

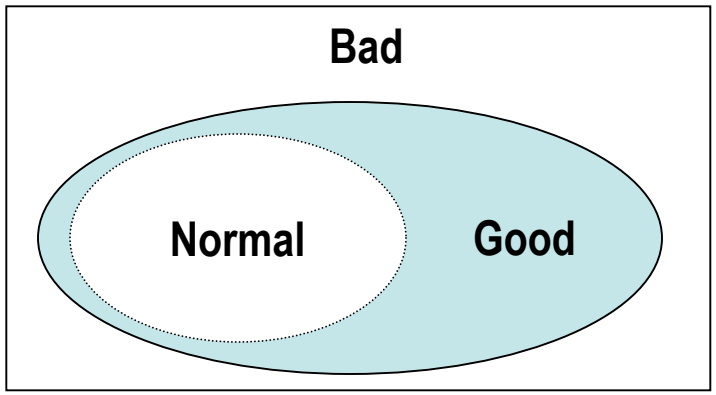


Problem: Experiments may be too short-lived or ill-behaved to establish "normal" baseline

Intrusion Detection

- Specification-based intrusion detection is more appropriate for monitoring experiments
  - Fits in naturally with authorization framework, as well

Specification-based intrusion detection
Specify good behavior and watch for violations



Audit Log Prototype: PlanetFlow

[Huang et al.]

- PlanetFlow: logs packet headers sent and received from each node to Internet
  - Enables operations staff to trace complaints back to originating slice
  - Notify experimenter; in an emergency, suspend slice
- All access control decisions can be logged and analyzed post-hoc
  - To understand why a request was granted (e.g., to give attacker permission to create a sliver)

Issues Left Open

- DoS-resistant GENI control plane
  - Initial control plane would employ IP and inherit the DoS vulnerabilities thereof
  - GENI experimentation may demonstrate a control plane that is more resistant
- Privacy of operational data in GENI
  - Could be a great source of research data
- Operational procedures and practices
  - Central to security of the facility