GENI and Security

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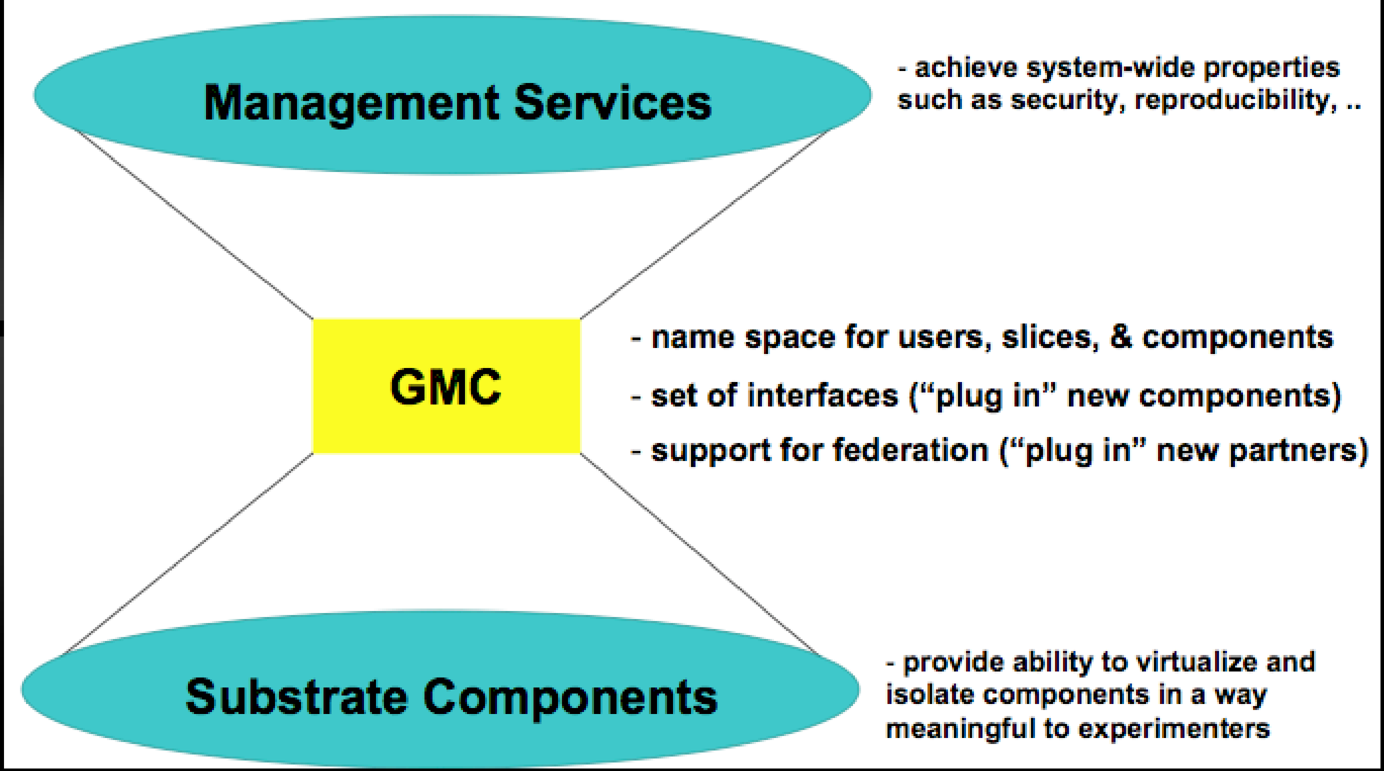
Introduction and Charge

- Our Focus:
  - Potential Uses: Security-related experiments to run on GENI
  - Necessary Components: Required instrumentation for GENI
  - Designing Security In: Security of GENI itself
- Our challenge for you:
  - Input, lots of input!
  - Your ideas for how to maximize GENI’s usefulness to the security community
    - Access, architecture, guarantees, etc.

GENI Architecture



- achieve system-wide properties such as security, reproducibility, ..

- name space for users, slices, & components
- set of interfaces (“plug in” new components)
- support for federation (“plug in” new partners)

- provide ability to virtualize and isolate components in a way meaningful to experimenters

— from Tom Anderson’s talk

What It Means

- ✓ GENI *manages* resources
  - ✓ Slices
  - ✓ Other objects (files, firewalls, monitors, ports)
- ✓ Manager *has* APIs
  - ✓ Users
  - ✓ Resources
  - ✓ Other networks such as ORBIT, DETER/EMIST, CENS, ESNET
- ✓ Manager *does* access control
  - ✓ Access determined by policy

Threats to GENI

- ✓ Exploitation of a slice
  - ✓ Runaway experiments
    - ✓ Unwanted Internet traffic, exhausting disk space
  - ✓ Misuse of experimental service by end users
    - ✓ eg, 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 system
  - ✓ DoS or compromise of GENI management infrastructure

Build Security In From the Start

… critical for good security!

Experiments (Discussed)

- Threats to the core
  - Bad/malicious routers (black holes, etc.)
  - Worms propagating through routers
  - “Captured” routers
  - Lifecycle attacks on routers
- Threats to the end points
  - DDoS attacks

Instrumentation (Discussed)

- ✓ Extraction of data
- ✓ VM with ability to capture all traffic
- ✓ Hooks for digital forensics (traceback, etc.)
- ✓ Tools for experiment-specific monitors
- ✓ Controls over who can view data
- ✓ Ability to monitor any resource—CPU usage, memory usage, slices, etc.
- ✓ Highly instrumented, controllable testbed

GENI Security (Discussed)

- ✓ Access control
  - ✓ A decentralized framework based on credentials and formal logic
  - ✓ Focused on implementing least privilege with a small, assured TCB
  - ✓ Will be sufficiently flexible to regulate access to wide range of resources; have not identified the full list yet (but don't need to)
  - ✓ Will be available to GENI and applications alike
  - ✓ Can be used to implement slice "kill switch" and audit trail
  - ✓ Eventually incorporating attestation ala TCG
- ✓ Key management
  - ✓ Public key certification encompassed by access control framework
    - ✓ GENI will have a PKI
  - ✓ Private key protection optionally supported via capture-resilience protocols or hardware tokens

Experiment Ideas and Issues

- ✓ How do we scale experiments to reflect the larger networks?
- ✓ How fast could a worm really spread in the face of infrastructure and/or end host controls?
  - ✓ How do homogeneity and/or diversity affect this?
  - ✓ Create libraries of worms for use on GENI
- ✓ What protocols for protecting infrastructure are or can be made practical by augmenting infrastructure?
  - ✓ WATCHERS (routers monitor each other), others
- ✓ How do we use the infrastructure to help handle DDoS attacks?

More Experiments

- ✓ Use GENI to test Internet voting
- ✓ Test software, run time monitoring security
- ✓ Evaluate Internet threats to SCADA, power grid, other critical functions
  - ✓ Running a backup demo for power grid
- ✓ Disaster management and survivability
  - ✓ Graceful degradation
  - ✓ Containing the failures or attacks
  - ✓ Collaborative sensors to provide early warning
  - ✓ Priority of jobs, traffic to properly allocate scarce resources
  - ✓ How many failed nodes can be tolerated?

Instrumentation Ideas and Issues

- ✓ Monitoring
  - ✓ What layer(s) of network
  - ✓ What aspects of hosts
  - ✓ What attributes (routing, performance, etc.)
  - ✓ How much data to collect
  - ✓ Where to collect it
  - ✓ Where to store it
- ✓ Dissemination
  - ✓ Privacy issues leading to data sanitization
  - ✓ Access control

More Instrumentation

- How to demonstrate GENI results can be applied to Internet
  - How do you compare networks
  - What attributes are important
  - Is experiment repeatable
- Forensics
- Deceptive technologies
- Performance issues

GENI Management Support

- ✓ View GENI as resource manager
  - ✓ Slices, systems, routers, etc. all objects
  - ✓ API for experimenters to access GENI
- ✓ Access control
  - ✓ Formal logic to prove what accesses allowed
  - ✓ Combine it with certificates for identity management
- ✓ Privacy
  - ✓ Protect privacy of experiments, data used and derived

More GENI Management Support

- ✓ GENI's insider problem…how do *we* solve it?
  - ✓ Attacker masquerades as experimenter, uses that to compromise GENI, other experiments
- ✓ Vulnerabilities in the GMC
  - ✓ How do we find, mitigate them?
- ✓ Interaction with edge networks (eg, wireless)
  - ✓ Define the interface between GENI and other testbeds (ORBIT, DETER/EMULAB, CENS)
  - ✓ Determine what guarantees (if any) they provide when combined with access controls in GENI

Other Security Ideas and Issues

- ✓ ***Critical and key problem:***

Build security into GENI

… this **includes assurance**

- ✓ Risks to GENI
- ✓ COTS, not COTS systems
- ✓ Heterogeneity vs. homogeneity
- ✓ PKI management
- ✓ Virtualization of resources
- ✓ Availability issues
- ✓ Legal issues
- ✓ Generally: advance the state of the art and science of security

See you in the breakout session!

Remember:

Build security into the GENI architecture