Managing Security in Dynamic Networks

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Overview

1. Dynamic Network Example
2. Automating Network Configuration
3. NESTOR Architecture
4. Example Revisited
5. Future Work

Dynamic Networks

- *Network*: elements, services, and policy
- *Dynamic Network* : components may change

Goal : manage configuration to maintain policy through change

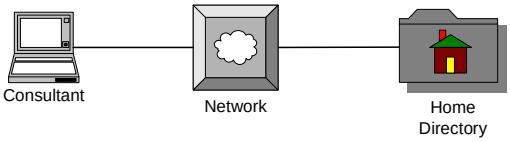
Configuration Mgmt is Difficult

- Human-intensive
- Distributed heterogeneous data
  - Single task involves multiple elements
  - Duplication & dependencies
- No verification of integrity rules
- Manual recovery

→ Static configuration & network failure

Dynamic Network Example

- Consultant visiting client needs to access home directory
- *Goal*: Plug laptop & double-click on home folder



Example Security Policies

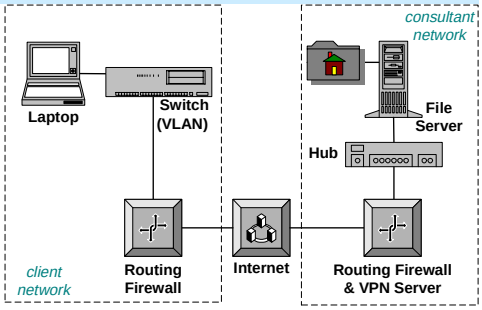
Client

- No visitor access to internal hosts
  - *switch, router, physical configuration*
- Restricted visitor Internet access
  - *firewall configuration*

Consultant

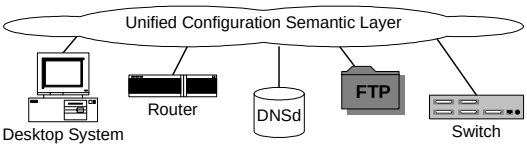
- VPN clients obtain restricted file access
  - *file, http, ftp server configuration*

Example Network (Detail)

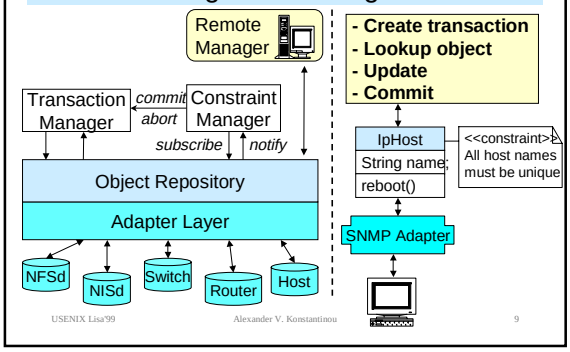


Solution : Unified Configuration Semantic Layer

- Unified object-relationship configuration model
- Consistency rules
- Change propagation
- Rollback and recovery



NESTOR: An Architecture for Network Self Management & Organization



Integrity Constraint Example

- Constraints expressed in OCL (Object Constraint Language -- part of UML)
- Example : "All nodes connected to an internal VLAN port should be *trusted* "

```
EthernetVlanSwitchPort->allInstances
->select(port | port.isEnabled)
->forAll(port |
 if (port.securityMgr.isTrusted(port.vlanID))
   port.forwardsNodes->forAll
     (node | node.securityMgr.isTrusted(node))
```


Policy Script Example

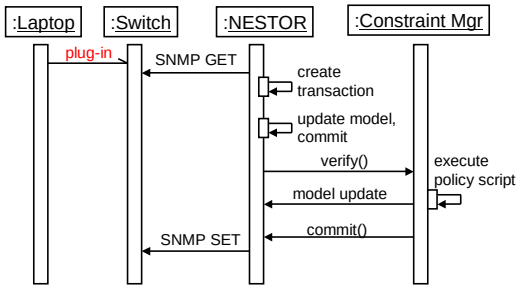
- Constraint violations handled by policy scripts (Java methods)
- Example (cont.): policy script changes the VLAN id of the violating port

```
public void constraintHandler
  (Object[] stack, Transaction trans) {
  EthernetVlanSwitchPort port =
    (EthernetVlanSwitchPort) stack[1];
  port.vlanID =
      port.securityMgr.getPublicVlanID();
}
```

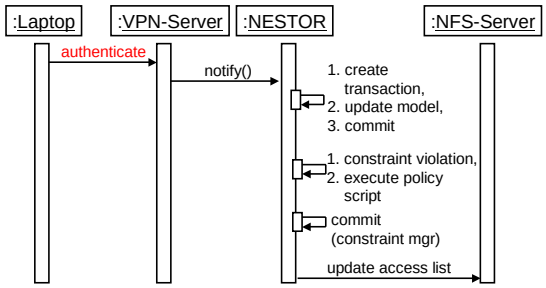

Dynamic Network Example Revisited

- High-level security policies
- Model network elements & services
- Instrument model interfaces
- Policies as constraints on configuration
- Policy scripts for change propagation
- Deploy and populate NESTOR server

Laptop Plug-In Interactions



Laptop Plug-In Interactions (2)



Summary

- Dynamic network challenges
- Solution: unified configuration semantic layer
- NESTOR architecture
- Policy-based dynamic network configuration

Future SA role: defining policies for change propagation

Future Work

- Translating high-level security policies to constraints on configuration (Telcordia)
- Model evolution (Telcordia project on reconfiguring networks of firewalls)
- Scalability
- NESTOR security model
- Distributing NESTOR/pushing down to device

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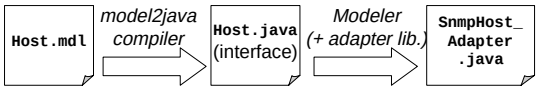
Backup Slides

Configuration Modeling

- Model expressed in the MODEL language (SMARTS)
- MODEL extends IDL with relationships, problems ...

```
interface nestor::IpHost : nestor::ManagedObject {
    attribute String hostname "Name of host";
    relationshipset interfacedThrough,
                    IpNetworkInterface, partOf;  }
```



NESTOR Transactions

- Proxy repository objects
  - Implement model interfaces
  - Log all access
  - Updates not pushed to device
- Transaction commit
  - Effect all changes on proxy objects to adapter objects (same order)
  - On failure, roll-back
  - On roll-back failure, note in recovery log