

Issues in Future Internet Design

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The Stanford
Clean Slate Program

<http://cleanslate.stanford.edu>



100x100 Clean Slate Program

<http://100x100network.org>



We have lost our way

- ❖ The simple default-on end-to-end network is long-gone.
 - ❖ It is hard to reliably identify users, to stop them from causing harm, and hold them accountable.
 - ❖ It is hard to support mobile users and data.
 - ❖ We are not enjoying the efficiencies of a lightweight, statistically shared infrastructure.
 - ❖ There are still many things we'd be frightened to do: *e.g.* air-traffic control, telesurgery.
 - ❖ The network is unreliable.
 - ❖ We are tweaking.
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- ❖ The research community has a lot to answer for: we've been stuck in incrementalism and backward compatibility.
 - ❖ There is change afoot ... NSF FIND and GENI.

A Future Internet

- ❖ Robust and available
- ❖ Inherently secure
- ❖ Support mobile end-hosts
- ❖ Economically viable and profitable
- ❖ Evolvable
- ❖ Predictable
- ❖ Anonymity where prudent ...
- ❖ ...accountability where necessary
- ❖ Improving the lot of the user

The list is simple, but getting there is not at all obvious.

Was: Non-issues

Became: What not to attempt

- ❖ Don't base research on guesses of what the applications will be: All previous attempts failed
- ❖ Ditto for physical layers
- ❖ Expect rampant and unpredictable innovation in both

Chronology

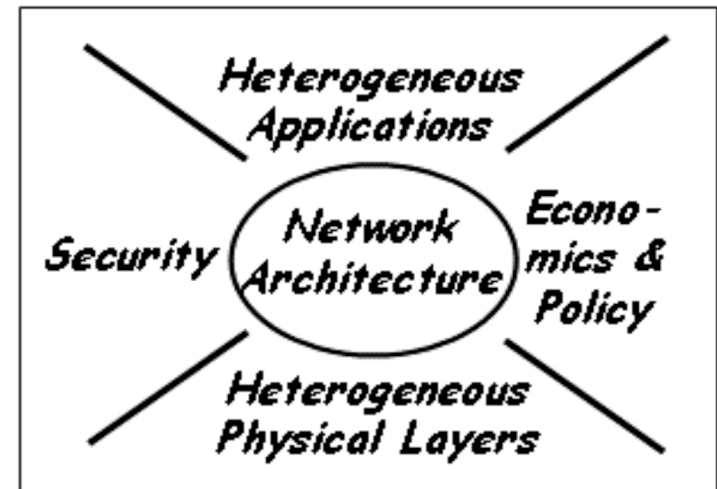
- ❖ 2005: A sea-change in the networking research community
 - Prompted by NSF
 - 100x100 Clean Slate Program
 - NSF FIND: Funding for architectural ideas
 - NSF GENI: Creating a platform for experimenting with new architectures, services and technologies
- ❖ 2006: A large community-wide effort
 - GENI planning process
 - Programs starting in Europe and Asia

100x100 Clean Slate program: How we are proceeding

- ❖ Clean Slate Approach
- ❖ Leverage Network Structure
- ❖ Holistic Design

Stanford Clean Slate Program: How we are proceeding

- ❖ Bring together a broad set of experts from different disciplines.
- ❖ Create new research programs in five areas.
- ❖ Include theory, architecture, and demonstration.



The Stanford Clean Slate Program

- ❖ Create a breeding ground for new collaborative projects across boundaries
 - ❖ Projects that will have significant impact in 10-15 years
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- ❖ Exploit Stanford's breadth and depth
 - ❖ Work closely with a focused group of committed industrial partners

Projects underway

Projects

1. Clean-slate approaches to security for private and public networks
Boneh, Mazieres, McKeown, Rosenblum
2. How to incorporate high capacity optics in the network core?
Kazovsky, McKeown
3. Theory: Flow-level models and scaleable queueing theory
Prabhakar, Saberi
4. Wireless & Economics: Cooperation and Competition in Wideband
Wireless Resource Allocation
Goldsmith, Johari

Other Stanford Clean Slate projects

1. Clean Slate design of predictable, resilient backbone networks
2. Clean Slate congestion control to minimize download time
3. Programmable nationwide backbone network

An Illustrative Example: Clean Slate Approach to Security for Enterprise/Private Networks

- ❖ Centrally administered
- ❖ Network security is important
- ❖ Someone has a security policy in their head or on paper

Problem

- ❖ “Default-on” communication model
- ❖ Access control filters (ACLs) implemented in every router/firewall to determine which flows are allowed (based on <src IP, dst IP, src Port, dst Port, Protocol> tuple)
 - Often misconfigured or incomplete
 - When paths change, easily circumvented
- ❖ Access control tied to packets, not services, users, end-hosts
- ❖ Therefore: fragile; “choke points”; hard to tell if security policy is implemented correctly.

Approach

- ❖ “Default-off” Communication
- ❖ To communicate:
 - User authenticates with network,
 - Asks for permission to communicate
 - Network compares request against security policy
 - If allowed, install state in network for this dialog
 - Route controlled by security policy
 - Permission not checked against policy for each packet
- ❖ Topology opaque

Ethane

- ❖ Prototype to test/use SANE ideas
- ❖ Interoperates with unmodified clients
- ❖ Ethernet version of SANE
- ❖ Based on custom “Domain Controller” and custom Ethernet switches