

Today's Agenda

A proposal for a new Internet architecture

- The NewArch Project

The NewArch Project

Main question:

If we could design the Internet from scratch, given what we know today, how would we go about it?

- This question makes the problem “easier” (no migration problem)
- On the other hand, it frees ourselves from short-term constraints

What do we want to retain?

- Openness of the architecture
 - Allow free-market competition
 - Encourage independent innovations, especially innovations that promote users' goals
 - Support freedom of information exchange
- Robustness, flexibility, evolvability
 - Accommodate a wide range of new technologies
 - Keep the core as simple as possible, but not simpler

New requirements

- Internet as a commercial undertaking
- Deal with the erosion of trust, need for security
- Deal with the tussles in cyber-space
- Embrace a broad base of users
- Support new application requirements
- Support new technologies

Internet as a commercial undertaking (1)

- ISPs emerged in the 90s
- Structure of the industry is induced by the network architecture
 - At the points where open interfaces are specified
- Openness makes market more competitive
- Packet-carriage will become a commodity product
 - Initial investment is high for ISPs
 - Prices in commodity markets are driven by incremental costs, but incremental cost of delivering packets is 0
 - This leads to bankruptcy, mergers, low rates of investments, and monopoly

Internet as a commercial undertaking (2)

- To avoid bankruptcy and monopoly, ISPs will want to avoid commoditization:
 - Provide higher-level, user-level services
 - Lead to product differentiation and higher profits
 - Move functionalities into the core (more “middle-boxes”)

- New architecture has to
 - Allow great innovations within the network also
 - So long as it does not inhibit vigorous innovations at the edge

Deal with the erosion of trust, need for security

- Original Internet design:
 - Transparent: what goes in comes out
 - Oblivious to packets' contents
 - Transparency is the greatest contributor to the success
- Drawbacks of transparency:
 - Facilitate delivery of un-welcomed data (viruses, worms, spams, etc.)
 - Erosion of trust → users & ISPs install packet filters → no more transparency
- Solutions?
 - Trust-modulated transparency!
(Good problem to do research on!)

Tussles in cyber-space

- The Internet has all the dynamics and conflicts of interests of a modern society
 - **Players**: users, ISPs, governments, IP right holders, content providers, private sector network providers, ...
 - **Tussle spaces**: economics, trust, power, fame, ...
- New architecture has to
 - Be able to accommodate this reality
 - Better yet, use it to strengthen the architecture
- Devise new design principles
 - Design for variation in outcomes
 - Design for choice
 - Modularize along tussle boundaries

Tussle Spaces: Economics

- Provider lock-in from IP addressing
 - ISPs want to lock-in their customers (to some IPs)
 - Customers want to freely change ISPs yet keep IPs
- Value Pricing
 - ISPs want to categorize customers and charge accordingly
 - Customers circumvent this restriction
 - Question: value-pricing is not morally wrong, should users be helped in bypassing control imposed by ISPs?
- Residential broadband access
 - Users don't have many choices of access networks
 - Economists and users want a more "open market"
- Competitive wide-area access
 - Internet should support a choice for source routing (users want)
 - Carriers do not want that

Tussle Spaces: Trust

- “Bad” users vs. good-old Joe Ordinary
- Firewalls could support good users, but in tussle with transparency
 - Too much control of the network will inhibit innovations and freedom
- Who get to set policy in firewalls?
 - Users vs. administrators
 - Citizens vs. governments
 - [should firewall’s policy be transparent?]
- Anonymity vs. accountability
 - What do we mean by identity?
 - Need a framework for identification

Embrace a broad range of users

- Balance the following goals
 - Open for innovations and novel uses
 - Not demanding technical virtuosity in users

Support new application requirements

- Best effort isn't sufficient anymore
- Balance between the following goals
 - Keep the Internet's ability to operate over a wide range of communication technologies and operating conditions
 - Provide a predictable and uniform set of operating conditions for the applications run on top of the Internet
- In some cases, it might be impossible to reconcile
 - Inter-planetary networks
 - Multimedia applications

Support new technologies

- The Internet have dealt with many new technologies fairly well
 - ATM, MPLS, WDM, etc.
- Wireless and mobile networks have challenged the current architecture
 - **Wireless**: higher loss rates distorts RRT estimates, for instance
 - **Mobility**: effects to routing, addressing, security, variation in services, ...
- Sensors, PDAs, DTNs, ... and more to come

NewArch's Proposal: Knowledge Plane

- Internet = Data Plane + Knowledge Plane
- **Data Plane** keeps the basic network stupid and transparent
- **Knowledge Plane**, running on top of the Data Plane, makes it very smart, helps manage it better
 - Gathers information from end nodes about what *should* be happening, and from network about what *is* happening
 - Integrate this information: detect and correct failure, interact with users, ...
 - A distributive *cognitive system*, because algorithmic solutions are not sufficient, due to incomplete, untrusted, inconsistent, malicious, misleading information