

The making of Internet: Challenges and Opportunities

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Who made Internet happen?

- The “fathers” of Internet
 - ▣ Vint Cerf, Bob Kahn
 - ▣ Kleinrock – packet switching theory
 - ▣ Al Gore
- People who deployed Internet - ISPs
- People who implemented protocols and equipments
- “Architects” and designers who specify protocols

The role of academic research

- At times, it seems too theoretical and detached
- But, it produces
 - ▣ **Revolutionary ideas:** packet switching, random access algorithm, WWW, network coding (CUHK)
 - ▣ **New technologies:** wireless, fiber optics, fast switches, batteries and portable devices...
- Important impact on Internet's architecture
 - ▣ End-to-end principle
 - ▣ Debates on QoS, how to do multicast...

What it takes to architect?

- Engineering Astuteness
 - ▣ Technical tradeoffs
 - ▣ Social issues
 - ▣ Economic issues
 - ▣ Cultural issues

Example 1: mobility

- Current Internet architecture does not support mobility well
 - ▣ Packets delivered to “subnets”
 - ▣ A host needs address in destination subnet to receive
 - ▣ Mostly engineering trade-off

Example 2: security

- Current Internet architecture emphasizes simple interface and open access
 - ▣ Fast growth in Internet applications
 - ▣ Anonymity
 - ▣ Many security problems in today's Internet
 - ▣ Even threatening national security: recent incident in Estonia
- The trade-off is not only technical
 - ▣ It involves **social** and **cultural** considerations

Example 3: ISP peering

- Currently, internetworking is based on ISP peering and inter-domain routing (BGP)
 - ▣ Source routing allowable?
 - ▣ P2P routing allowable?
 - ▣ Do peering and settlement models allow fair competition, and incentive to upgrade?
- These are **economic** considerations for architects

Example 4: environment

- The current network architecture gives no considerations for environmental issues
 - ▣ Some switching centers consume vast amount of power, causing environmental concerns
 - ▣ How can we build networks and route traffic that save energy?
- Environmental issues will soon become architectural considerations as well

Global village

- Future Internet architecture and standards need to be accepted internationally
- Many International efforts
 - ▣ E.g. in US, NSF has a **Future Internet Network Design (FIND)** project
 - What are the requirements for the global network of 15 years from now?
 - How would we re-conceive tomorrow's global network today, if we could design it from scratch?

The current impasse

- New user demands -> new protocols specified
-> but not getting deployed
- Maybe something wrong with the current architecture
- Need an architecture that promote innovation

Virtualization

- One of the projects in FIND
 - ▣ Virtual machines: vmware
 - ▣ Virtual LANs: vLAN
 - ▣ Virtual networks: ?
- Internet = a set of networks running in parallel (potentially using the same routers and links)
- Benefits:
 - ▣ allow diversity, evolution
 - ▣ bring out new technology incrementally

Our “white paper” to FIND

- Need to architect a few **building blocks** for evolution:
 - Virtualization, parallel networks
 - Best effort network for legacy applications and signaling
 - New data-planes and networks allowed to run in parallel
 - A new socket interface for diverse networks
 - Use signaling to agree on the network to use
 - Parallel stacks
 - A unified accounting and charging architecture
- FIND invited us to participate

Concluding remarks

- China is a major player in Internet
 - ▣ Deployment: ISPs and subscribers
 - ChinaTelecom, Netcom, CERnet...
 - ▣ Implementing protocols (routers/switches, IPv6):
 - Huawei, ZTE, Bitway...
- Contributing to the architecture for the future Internet is also very important
 - ▣ Require academic and engineering collaboration
 - ▣ Require international collaboration
 - ▣ China is in a great position to contribute

Who are we?

- A research group at Chinese University of Hong Kong (CUHK)
 - DM Chiu: co-director
 - John Lui: co-director, chairman of CS Dept
- To become part of
 - ▣ Research Institute of Theoretical Computer Science and Communications (ITCSC in CUHK)
 - Andrew Yao: director
 - DM Chiu: associate director

“Quote”

Do ask what the internet can do for you;
but also ask what you can do for the internet.