

CS 268: Future Internet Architectures

Ion Stoica
May 1, 2006

Key Question

- How can we as researchers/engineers influence the evolution of the Internet again?

istoica@cs.berkeley.edu

2

How to Answer this Question

- Understand the new realities and try to predict where the Internet is heading to
- The two papers
 - The days when all players had a common goal are gone, and that the new environment where different players have often conflicting goals is here to stay
 - Internet should provide only one basic service: connectivity for which there is no business model, hence treat the Internet as a publicly supported & controlled utility

istoica@cs.berkeley.edu

3

Tussles

- The process by which players with different interests act to achieve those interests
- Accept the reality that the players have often conflict interests and try to leverage or at least accommodate it

istoica@cs.berkeley.edu

4

Design Principles

- Design for variation in outcome not for a particular outcome
 - Modularize the design along tussle boundaries
 - Design for choice

istoica@cs.berkeley.edu

5

Modularize along Tussle Boundaries

- Functions that are within a tussle space should be logically separated from functions outside of that space
- Examples
 - DNS, QoS

istoica@cs.berkeley.edu

6

Design for Choice

- Design protocols such that to allow parties to express preferences about the parties they interact with
- Examples
 - Mail server

istoica@cs.berkeley.edu

7

Design Implications

- Design open interfaces – allow different parties to compete providing the same interface
- Desirable properties of open interfaces
 - Visible exchange of value → allow parties with compatible interests (e.g., provider/customer) to achieve equilibrium
 - Exposure of cost of choice → allow parties to make “intelligent” choices
 - Visible (or not) of choices made → realize that choices made public can be different from choices made in secret
 - Tools to isolate and resolve faults/failures

istoica@cs.berkeley.edu

8

Economics

- Goal: create premises for investment
- Drivers of investment: greedy and fear
 - Greedy: invest in the hope to maximize revenues
 - Fear driven by the competition, which in turn is driven by the ability of customers to have choices

istoica@cs.berkeley.edu

9

Examples

- Lock-in from IP addressing
 - Solution: made it easy for a host to change addresses and use multiple addresses
- Value pricing
 - Solution: aid consumers to bypass the controls of the producers
- Residential broadband access
 - Solution: design residential access facility that supports competition. Who is going to deploy this facility?
- Competitive wide area access
 - Solution: allow consumers to control the path of their packets at the level of providers. Need payment mechanisms?

istoica@cs.berkeley.edu

10

Trust

- Users should be able to choose with whom to interact, and the level of transparency they offer to other users
- Question: who is controlling the policy? Users or network administrators?
- We cannot fully address this question but we should
 - Provide maximum flexibility to users in setting policies
 - Allow users to select third party entities to mediate the interaction (e.g., PKI)
- Recognize that technical solutions are not enough!
 - E.g., how to avoid eavesdropping?

istoica@cs.berkeley.edu

11

Openness

- We need to strive for open interfaces → lead to competition, innovation
- In Internet this means simple service, i.e., transparent packet carriage → allow to deploy new protocols without having to modify the network

istoica@cs.berkeley.edu

12

Important Side Discussions

- Mechanisms vs. policies
- The role of identity
- The future of end-to-end arguments

istoica@cs.berkeley.edu

13

Internet as Public Utility

- Assumption: Internet should provide basic connectivity → no business model for this
- Conclusions/Solutions:
 - Evolve internet into a publicly supported & controlled utility (e.g., postal system, power grid distribution, public roads)
 - Grant monopoly subject to regulatory contracts
 - Universal service → reach everyone
 - Common carriage → common interface
 - No bundled services

istoica@cs.berkeley.edu

14

Discussion...

istoica@cs.berkeley.edu

15