Rethinking the design of the Internet: the End-to-End Arguments Vs. the Brave New World

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A Restaurant Scenario

Request

Response
A Web Scenario

All I did was type a URL!!!!!!!!!!!!!
By separating the pure communication aspects of the network from the application aspects (hosts) the complete network design is greatly simplified. (Computer Networks, Tannenbaum)
ISO OSI Reference Model

- Seven layers
Application and Physical Layers

- Application
  - Telnet
  - FTP
  - DNS
- Transport
  - TCP
  - UDP
- Internet
  - IP
- Host-to-network
  - LAN
  - Packet radio
With the world becoming Complex what should we do?
To have additional functionality for new requirements at the end points only thus keeping the inherent simplicity of the structure of Internet.
To have some or all of the new functionality as a part of the core.
End-To-End Arguments:
Application level functionality should be moved “up” and “out” of the core level

- Reduces complexity and cost.
- Upgrades are easier for end point applications.
- Adding new components is easier at the end points since its like adding a plug in.
- Components at end points, reduces the interdependence of the core and the end points.
Other systems using the E2E arguments

- Open operating Systems
- Client Server computing
  - Transition from 2 tier to 3 tier
  - Transition from web servers to application servers
- Databases (Data independence)
N-Tier System (Application Servers)

Ref: article on servlets by Vandana Janeja (Pursnani)
“Core” Kernel: OPEN Operating System

- Applications
- System Libraries (libc)
- System Call Interface
  - I/O Related
    - File Systems
    - Networking
    - Device Drivers
  - Process Related
    - Scheduler
    - Memory Management
    - IPC
  - Architecture-Dependent Code

Ref: www.cc.gatech.edu/classes/AY2001/cs3210_spring/Overview.ppt
Design Tradeoffs

- Butler Lampson: “choose any three design goals”
- efficiency vs. protection
  - more checks, more overhead
- clarity vs. compatibility
  - implementation of “broken” standards
- flexibility vs. security
  - the more you can do, the more potential security holes!
- not all are antagonistic
  - portability tends to enhance code clarity
Decisions to add to the CORE or E2E

- Application has more information about the data and the semantic of the service it requires.
- A lower layer has more information about constraints in data transmission (e.g., packet size, error rate).
- New functionality at a lower level should have minimum performance impact on the applications that do not use the functionality.
- Lower layer implementation improves performances of a large number of applications.
How will it affect the core?

- A guarantee for reliable data transmission
  - Selective redundancy in packet checksums, internal retry mechanisms etc-done by core communication system.
  - However the End application still has the liability for cross checking(Example ftp)
  - So This does not reduce the burden of the End application
Emerging New Requirements

- Untrustworthiness towards end points.
- More demanding applications requiring some intermediate processing point.
- Emergence of increasing control and say of the ISP’s.
- Third party involvement.
- Motivation for ease of use in applications.
Adding to the Core: Blocking applications

- Firewalls: To protect some part of the network from the rest of the internet

- Traffic filters: Preventing use of some applications, Blocking access to some pages

- Network address translation elements: Rewrite the IP addresses of packets leaving or entering a region
Design issues adding to the core

- Stream of data routed through the device
- Ability to see the data in the stream
  - Imposing a control element
  - What content the control element can see:
    Revealing or Hiding the content
Labeling

- Labels on information: to show the content without actually accessing it
  - Labeling by third party (Platform for internet content selection-PICS)
  - Metadata Tags

```html
<HTML>
<meta>........</meta>
</HEAD>
<BODY>
.. 
.. 
</BODY>
```
New demands from the applications

- What is leading away from a simple End to End design?
  - Anonymizing message forwarders: preventing traffic analysis
  - Helpful content filtering: removing spam, checking for viruses
  - Content caches: Using cached copies of web pages from intermediate servers
More complex application design: Using third parties

- Public-key certificates, Authorizing content by Signatures
- Examining content and verify that it is in the correct form
- Assurance to the identity or role- Eg: Voter registration(Labeling content and User)
Non Technical solutions: the role of the law

- Labeling technical, but enforcement that they are accurate is legal
- Federal trade commission: regulating advertising, endorsements and claims
- Securities and Exchanges commission: Financial claims
- FDA
- Anonymity in emails
  - But this could be an advantage for spammers

Some argue that Law has limited control, as Internet is truly transborder
Rise of new Players
The Changing role of the Government

- Govt. contribution to design of the internet is not as prominent
- Govt. attention to consumer issues has grown
- Areas of concern for govt. Antitrust vigilance, fraud detection / prevention, commercial code, taxation
ISP

- Providing a national and global infrastructure
- Adding services and restraints to part of network controlled by them.
- OPEN access debate: where ISP’s should share their resources
- Less emphasis on end – to – end simplicity but more on packaged look and feel
The erosion of trust

- Privacy
- Openness
- Third parties / Intermediaries
- Authentication of Intermediaries
- Online fraud
- Public Vs. Private Communication
The End – to End is a guideline for better Internet Design But not a law

Tradeoff between performance and Overhead