World Wide Web – History, Architecture, Protocols
Architecture of Web Information Systems

CS/INFO 431
Carl Lagoze – Spring 2006

Creating Order from Chaos

- Information universe is inherently disordered
- Cognition is order-making, pattern finding
  - Hawkins – "On intelligence"
  - Classification
  - Data mining
- Information management involves, then, putting layers of order on this chaos
  - policies, practices, standards, laws, architectures

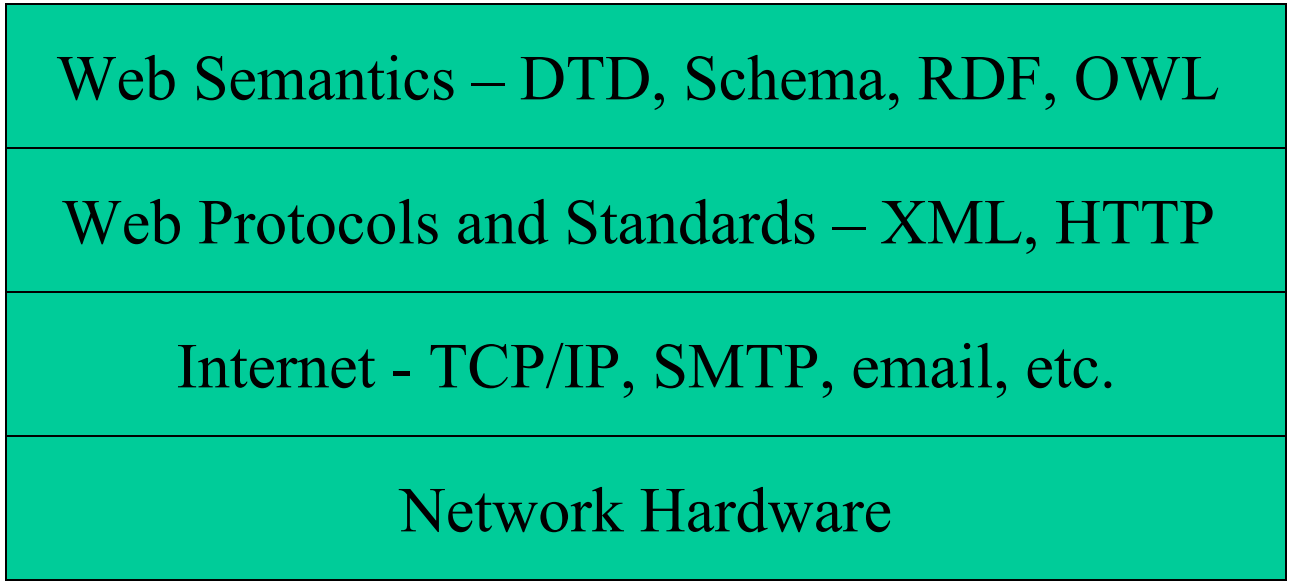
Standards in traditional information management

- Evolved in slow transition from elite culture to democratic culture
- Professional Culture controls adaptation
  - Shared culture through professional affiliation, ALA, IFLA
  - Shared culture through training, MLS
- Codes
  - Library Bill of Rights
  - Privacy agreements
- Intellectual Standards
  - Dewey Decimal System
  - Taxonomies – LCSH, MESH
  - Cataloging Rules – AACR2, Name Authorities
- Architectures
  - Machine Readable Cataloging

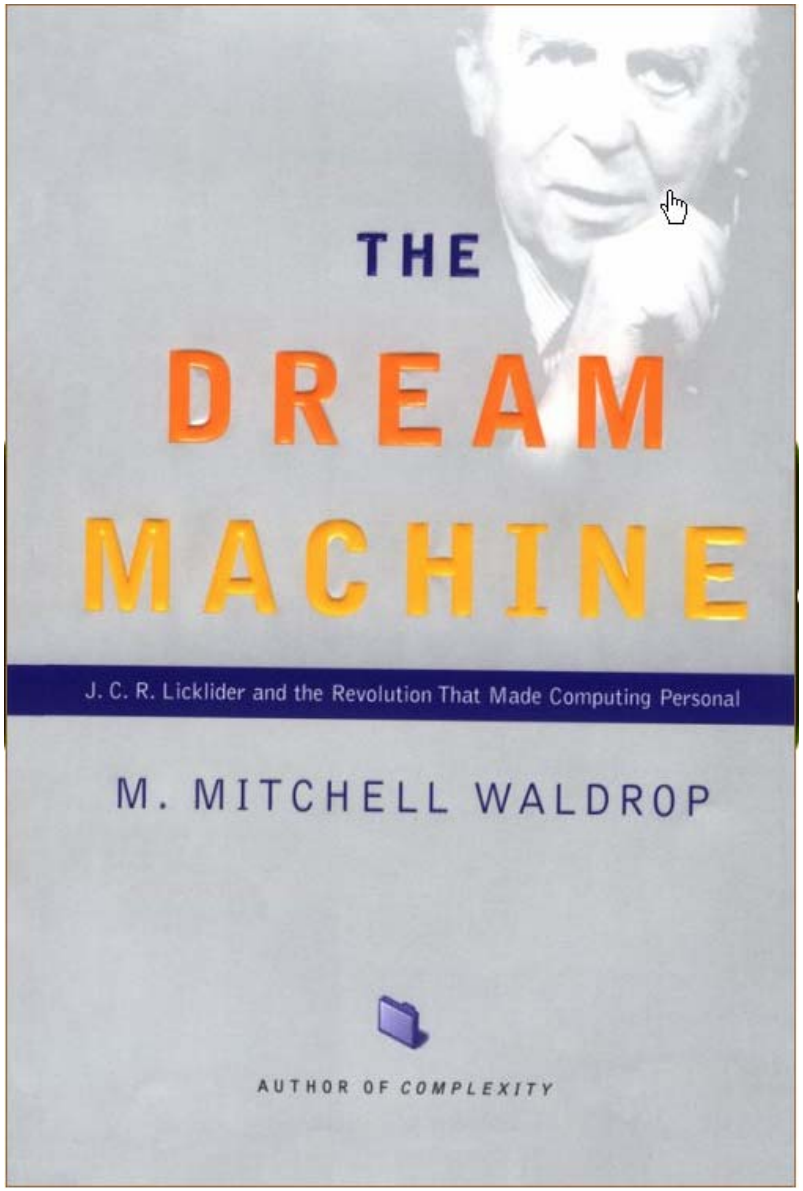
Standards in networked information management

- Roots in elite culture, revolutionary transition to democratic culture
- Complicated by profit/power potential
  - Political structures reflect this complication
- Based on code rather than human behavior
  - difficult transition from heuristic to algorithmic world – e.g., rights management
  - Larry Lessig "Code and Other Laws of Cyberspace"
- Opportunities to replace human effort with algorithmic and computational power
- "Good enough" principle

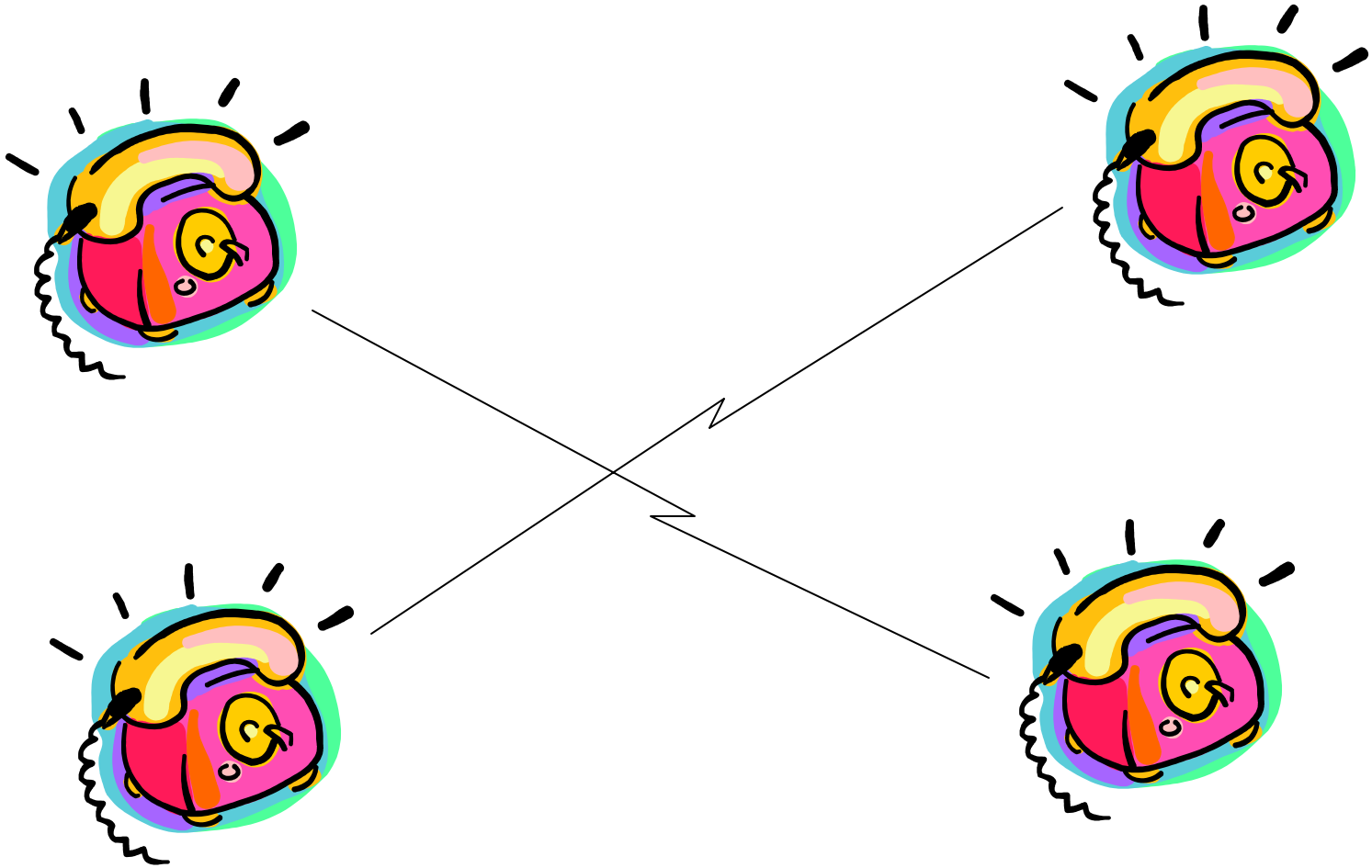
Architecture and Standards Layers



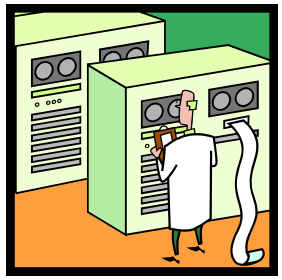
Upper layers operate within constraints and opportunities of lower layers

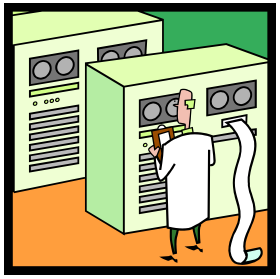

THE
DREAM
MACHINE
J. C. R. Licklider and the Revolution That Made Computing Personal
M. MITCHELL WALDROP
AUTHOR OF COMPLEXITY

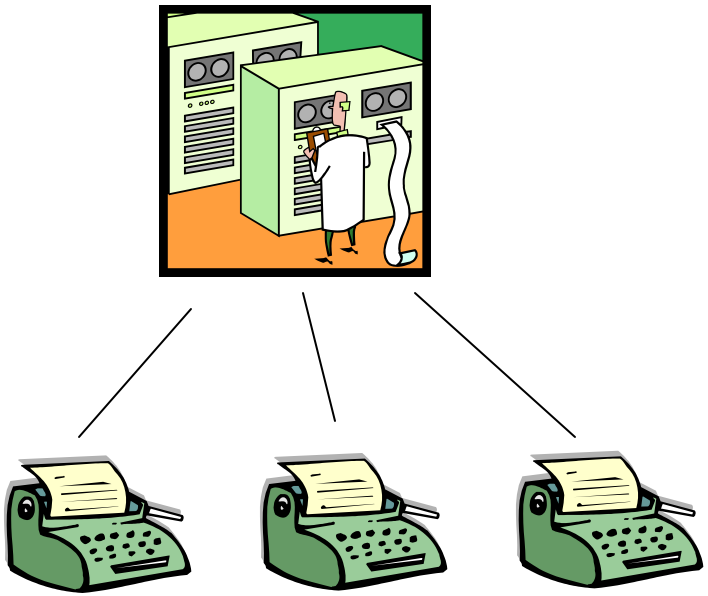
In the beginning….



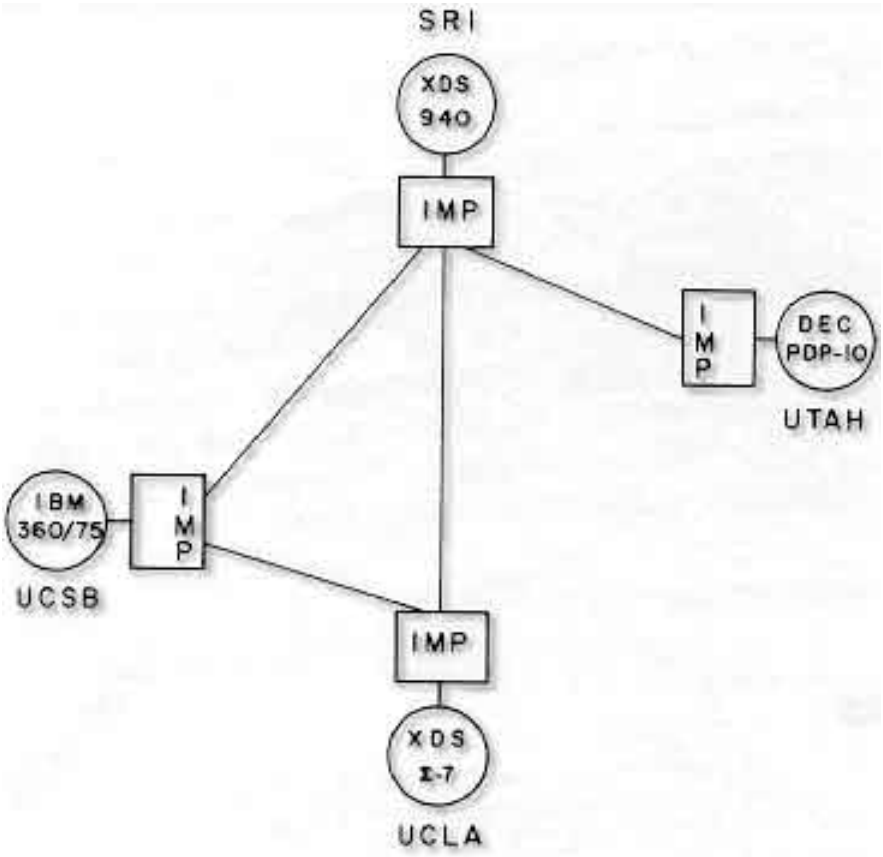
In the beginning…





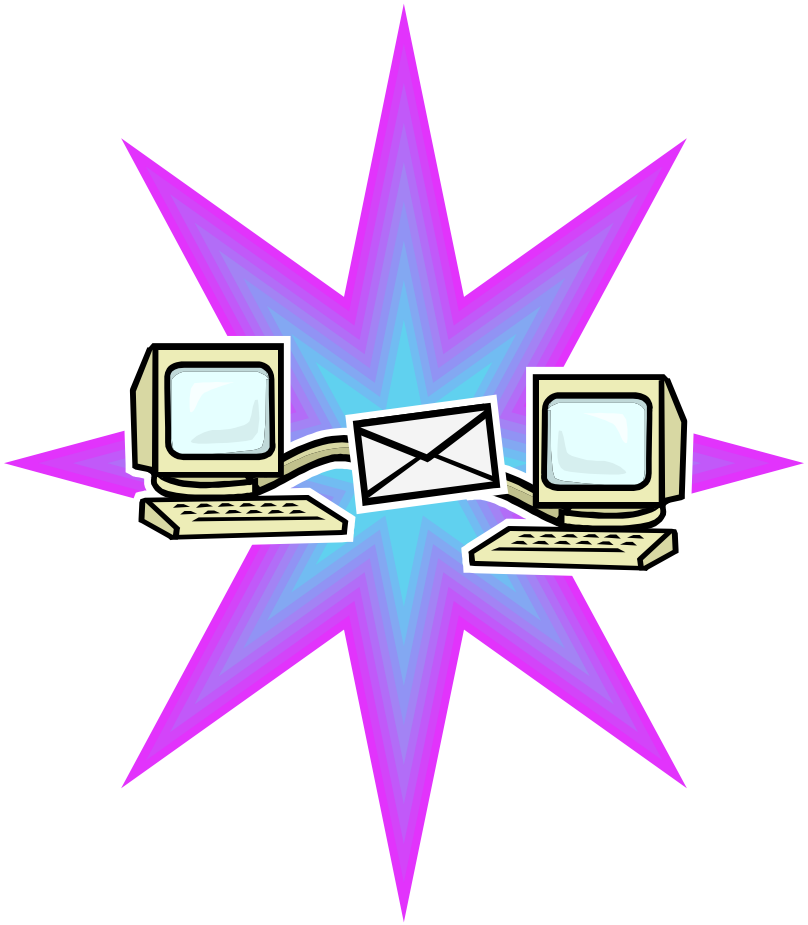


ARPANET



- DoD funded through leadership of Licklider
- Inspired by move from batch to timesharing
- Allowed remote login

Packet Switching

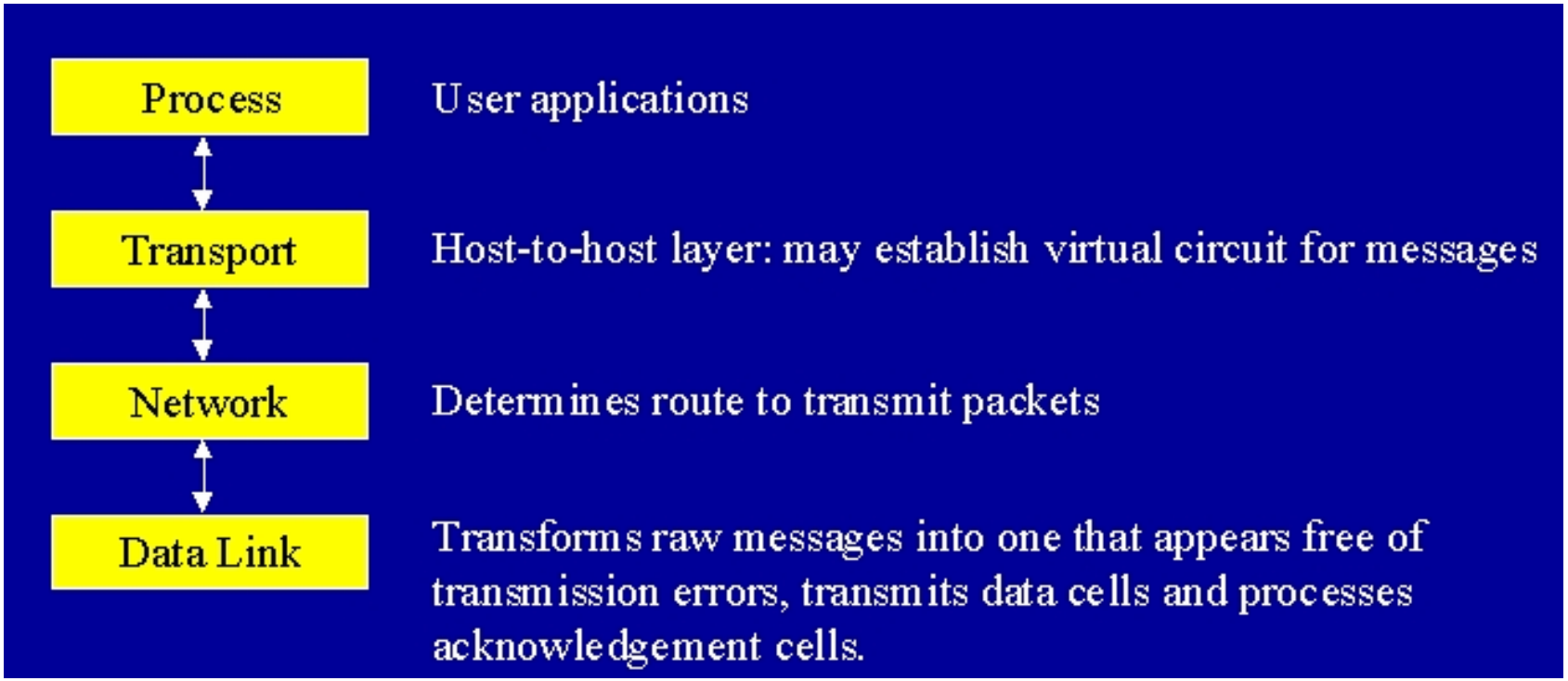


- Invented in early 1960's by Baran, Davies, Kleinrock
- digital, redundant, efficient, upgradeable (software)
- 1969 ARPANET first network implementation
- http://en.wikipedia.org/wiki/Packet_switching

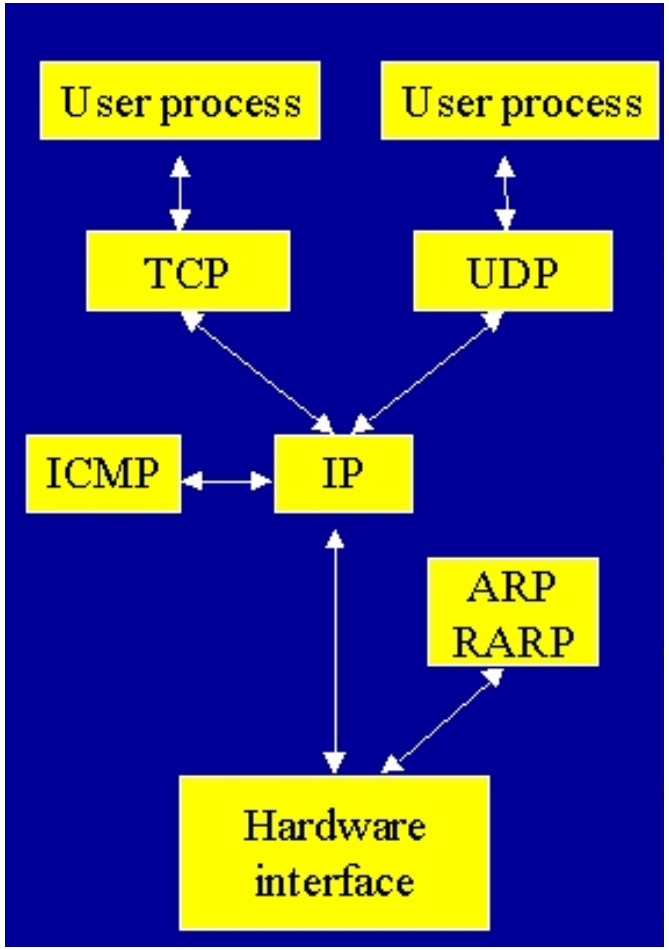
Packet Switching

- Network messages broken up into packets
- Each pocket has a destination address
- Pass and forward model – router gets packet, examine, decides where to send next
- Message reassembled on other end

Layered Protocol Model



TCP/IP Protocol Suite

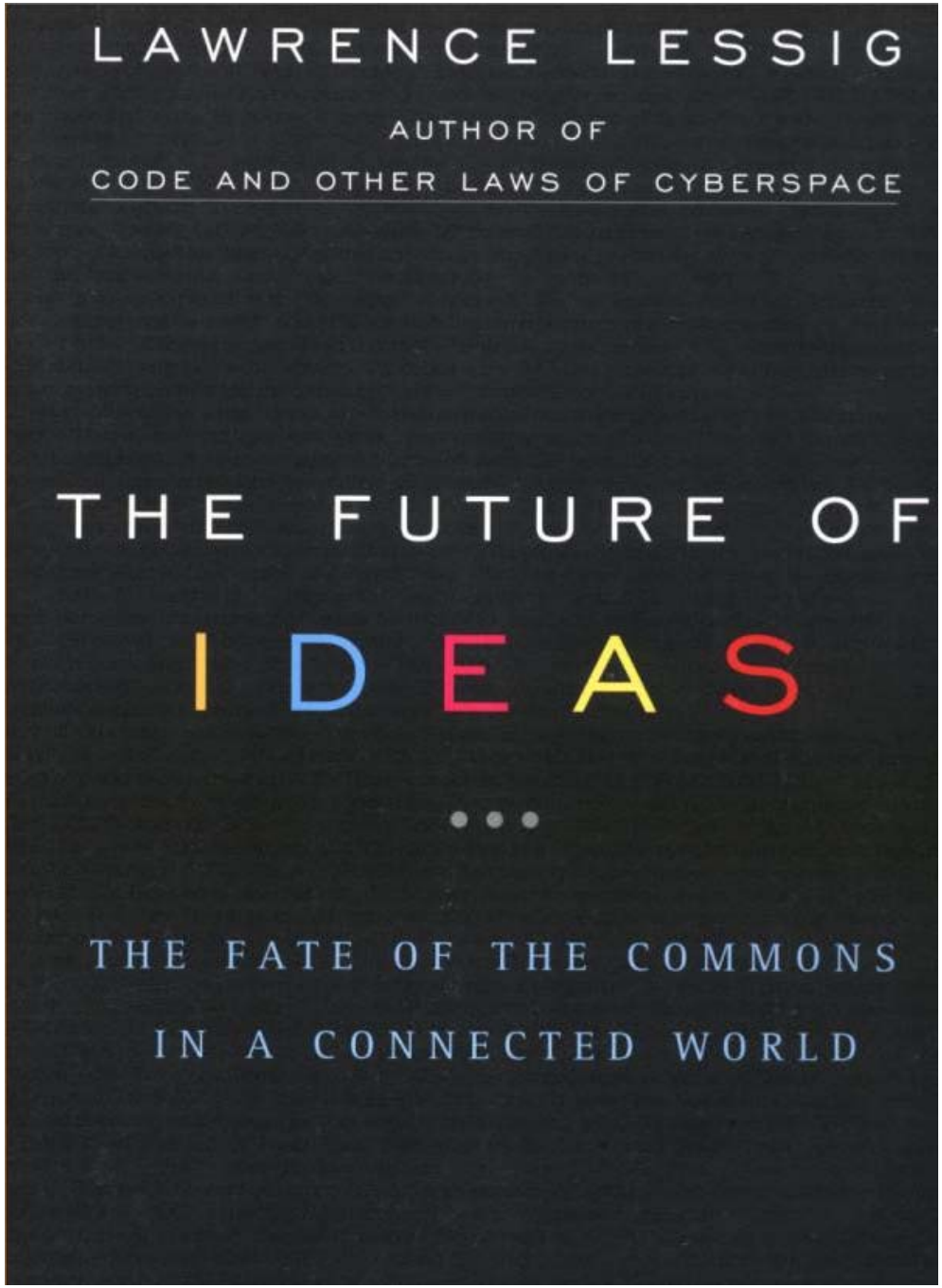


- IP – packet delivery
- TCP – virtual circuits, packet reassembly
- ARP/RARP – address resolution

Internet Issues – how to address them

- Demands of multimedia applications
- Virtual circuit reservations – bandwidth and quality of service guarantees
- Real time streaming protocols
- State saving

- Political Comment
  - Increase in functionality has implications
    - Democratization of the Net
    - Privacy
    - Vulnerability


LAWRENCE LESSIG
AUTHOR OF
CODE AND OTHER LAWS OF CYBERSPACE
THE FUTURE OF
IDEAS
THE FATE OF THE COMMONS
IN A CONNECTED WORLD

Infrastructure and Standardization

- Complex legal, economic, social, and technical process
- Wasn't invented in the information age
  - Railroad track gauge and tariffs
  - Telephone and telegraph
  - Banking
  - Power and Light
- Not for the faint-hearted

Internet Governance

- Internet Society (ISOC) – Evolution, social & political issues
  - http://www.isoc.org/
- Internet Architecture Board (IAB) – Oversees standards process
  - http://www.iab.org/
- Internet Engineering Task Force (IETF) – standards development
  - http://www.ietf.org/
- Internet Corporation for Assigned Names and Numbers (ICANN)
  - DNS administration
  - IP # assignment
  - Protocol #'s
  - port #'s
  - http://www.icann.org/
- World Wide Web Consortium (W3C) – web standards and evolution
  - http://w3c.org

Internet Documents

- RFC's – "Requests for Comments" to IETF community for information, standardization
  - http://www.ietf.org/rfc.html
- STD's – Official IETF Internet standards
  - http://www.rfc-editor.org/rfcxx00.html
- Internet Drafts – IETF working documents
  - http://www.ietf.org/ID.html
- W3C Reports (recommendations, drafts, notes)
  - http://www.w3.org/TR/

Well-Known Protocols

- Telnet – external terminal interface, RFC 854 (1983)
- FTP – file transfer, RFC 959 (1985)
- SMTP – mail transport, RFC 821 (1982)
- HTTP – distributed, collaborative hypermedia systems, RFC 1945 (1.0 1996), RFC 2616 (1.1 1999)

Short History and Premises of the Web

- Information sharing in a fluid context
  - CERN 1989
  - Reality
- Relationships are not hierarchical
- Non-centralized management
- Structure can be modeled as a graph
  - Typed nodes (text, graphics, people, software modules)
  - Type relationships (depends on, refers to, made)
- Hypertext (after Ted Nelson)
  - Human-readable information linked together in an unconstrained way.
  - Extend to Hypermedia and network
- Clean division of document display and format (browsers and HTML) from access (HTTP)

Basic Web Technologies

- Document layout
  - HTML → XML
- Document formatting
  - CSS
- Document naming
  - URL's
- Document typing
  - MIME
- Document access
  - HTTP

HTTP

- HTTP is…
  - Designed for document transfer
  - Generic
    - not tied to web browsers exclusively
    - can serve any data type
  - Stateless
    - no persistent client/server connection
  - Defined at ftp://ftp.isi.edu/in-notes/rfc2616.txt

HTTP Example

```
-bash-2.05b$ telnet google.com 80
Trying 72.14.207.99...
Connected to google.com (72.14.207.99).
Escape character is '^]'.
GET index.html HTTP/1.1
Host: lagoze.com

HTTP/1.1 200 OK
Cache-Control: private
Content-Type: text/html
Set-Cookie: PREF=ID=c9f0e0565db57456:TM=1138635078:LM=1138635078:S=H-BsvXLg58YkL
114; expires=Sun, 17-Jan-2038 19:14:07 GMT; path=/; domain=.google.com
Server: GWS/2.1
Transfer-Encoding: chunked
Date: Mon, 30 Jan 2006 15:31:18 GMT

bd8
<html><head><meta http-equiv="content-type" content="text/html; charset=ISO-8859
-1"><title>Google</title><style><!--
body,td,a,p,.h{font-family:arial,sans-serif;}
.h{font-size: 20px;}
.q{color:#0000cc;}
//-->
</style>
<script>
<!--
function sf(){document.f.q.focus();}
// -->
</script>
</head><body bgcolor=#ffffff text=#000000 link=#0000cc vlink=#55la8b alink=#ff00
00 onLoad=sf() topmargin=3 marginheight=3><center><table border=0 cellspacing=0
cellpadding=0 width=100%><tr><td align=right nowrap><font size=-1><a href="/url?
sa=p&pref=ig&pval=2&q=http://www.index.html/ig%3Fhl%3Den">Personalized Home</a><
/font></td></tr><tr height=4><td><img alt="" width=1 height=1></td></tr></table>
<table cellpadding=0 cellspacing=0 border=0><tr><td align=right valign=bottom><i
```

HTTP Session

- An HTTP session consists of a client request followed by a server response
- Requests and responses are sent in plain text

HTTP Request Methods

- Methods include
  - GET: retrieve information identified by the URL
  - HEAD: same as get but don't get message body (content)
  - POST: accept the request content and send it to the URL
  - PUT: store the request content at the given URL

HTTP Request

- Start line
  - Consists of method, URL, version

    `GET index.html HTTP/1.1`
  - Valid methods include:
    - GET, POST, HEAD, PUT, DELETE
- Headers
  - HTTP/1.1 requires a Host: header

    `Host: www.google.com`
- Body content

HTTP Response

- Start line
  - consists of HTTP version, status code, and description

  ```
  HTTP/1.1 200 OK
  ```

  ```
  HTTP/1.1 404 Not Found
  ```
- Headers

  ```
  Content-type: text/html
  ```
- Content

HTTP Response Codes

- Response coded by first digit
  - 1xx: informational, request received
  - 2xx: success, request accepted
  - 3xx: redirection
  - 4xx: client error
  - 5xx: server error

HTTP Content Body

- Header fields can affect content interpretation
  - required header field: Content-type
  - others: Content-Encoding, Content-Length, Expires, Last-Modified