

Leveraging and Layering: Making Sense of Telecom, Computing and Data Market Structures

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Schumpeter - Gilder Hypothesis: "Silicon and Sand will Set Us Free"

- The secular religion of the '96 Telecom Act (and the MFJ)
- Creative destruction of vertically integrated natural monopolies
- Driven by entrepreneurial innovation, unleashed by exponentially decreasing costs of silicon and sand

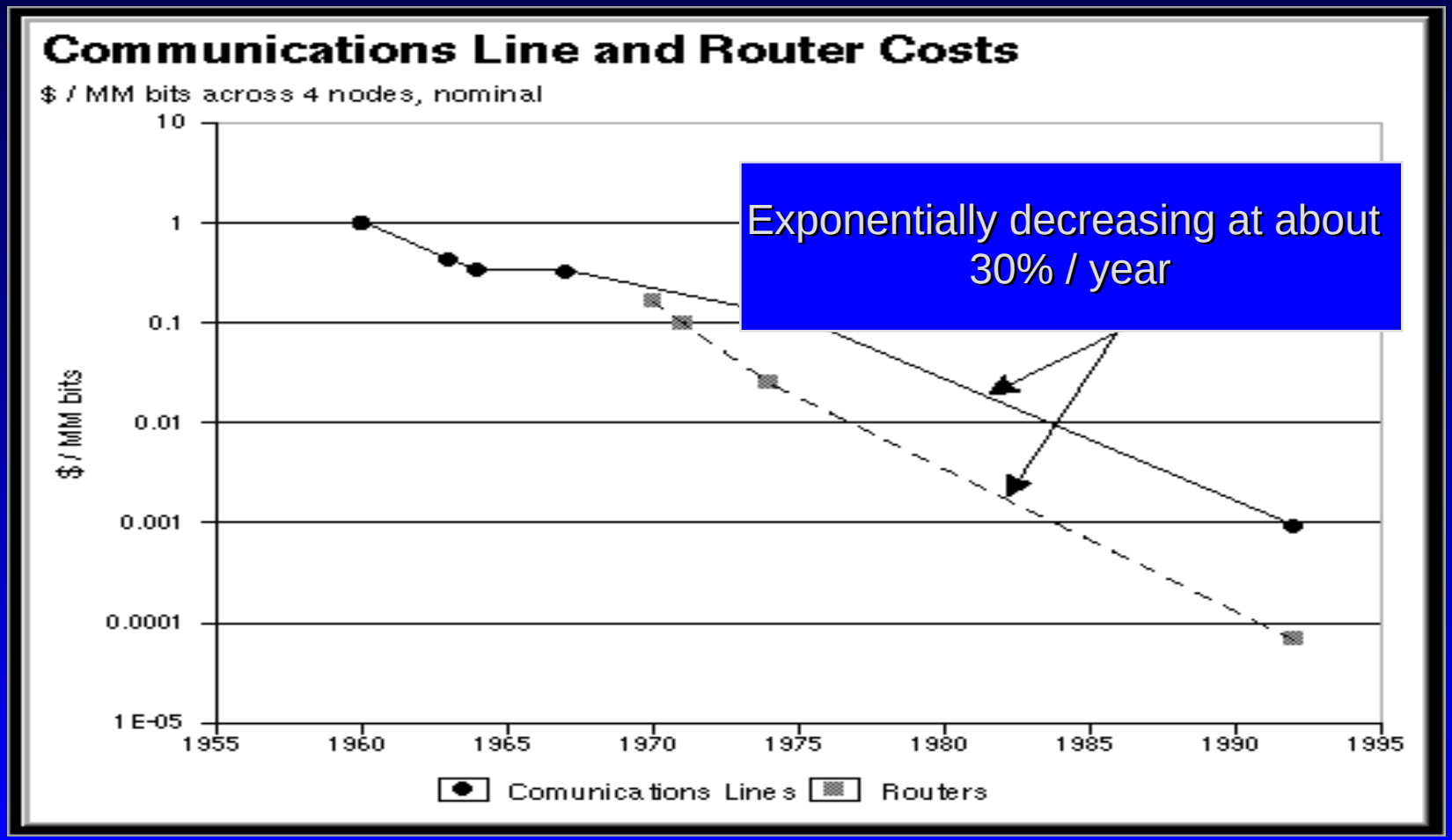
Schumpeter: The Prophet Isaiah

- Growth is driven by technological progress induced by bursts of creative, entrepreneurial activity
- Led by courageous knights, perhaps unscrupulous but daring to innovate and take risks in search of profits
- Creative fires of each wave wane as the dashing knights are replaced by dull managers and bureaucrats
- Schumpeter was of the Austrian school: free markets and libertarian freedom

Gilder: George the Baptist

- "Hollowing out of Everything"
  - Netscape will hollow out the OS
  - Sun/Java will hollow out the PC
  - Netcom will hollow out the regional phone companies
- More Austrian than Schumpeter: the knight errant takes on the corporate bureaucracies -- the faceless managers "just don't get it"

What miracles inspire our faith?



Link and switch costs declining 30%/year

- Huber's geodesic: switches now cheaper than links, so switching intelligence moves to periphery: many switches, fewer lines
  - PBXs, mainframes, packet switches, mobile switches, multiple IXCs, &c.
- in 1975, every phone in a company had a direct line to local office
  - now co. has PBX
  - 1/3 of calls never leave company
  - most handsets usually quiet, so aggregate and need fewer than 2/3 of the line capacity from PBX to LEC

Fiber capacity

Current Internet backbone: 155 Mbps

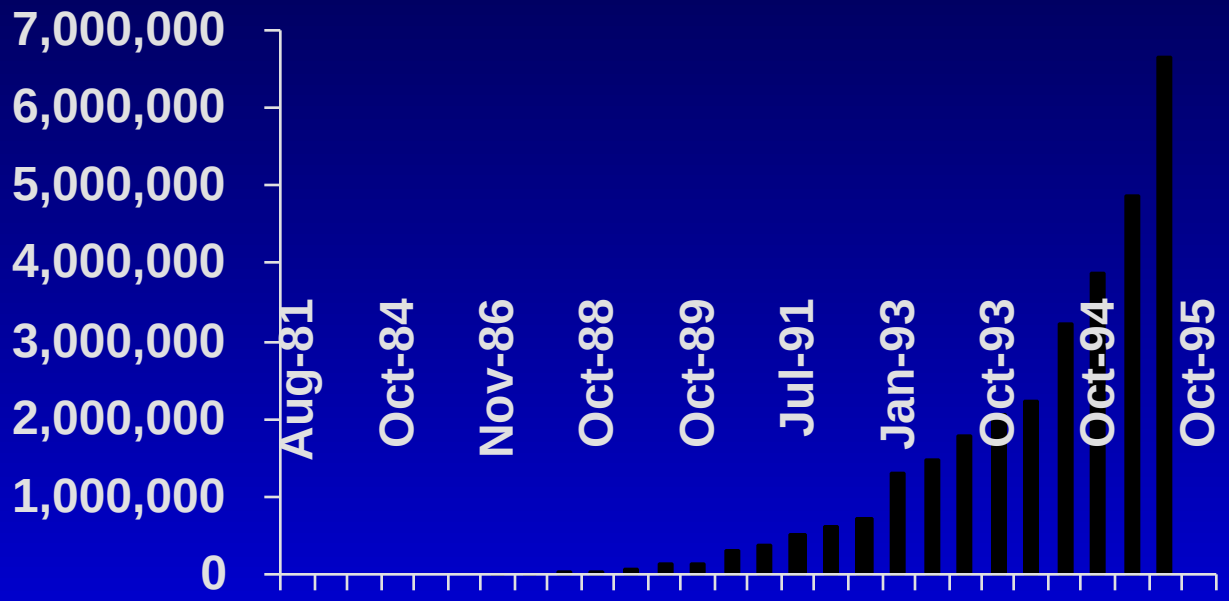
Single thread of fiber:

- 75,000,000 Mbps (theoretical)
- equiv. 4-5 billion AM radio stations
- more than all current airwave transmission of radio + TV + microwave + satellite comm

Moore's Law

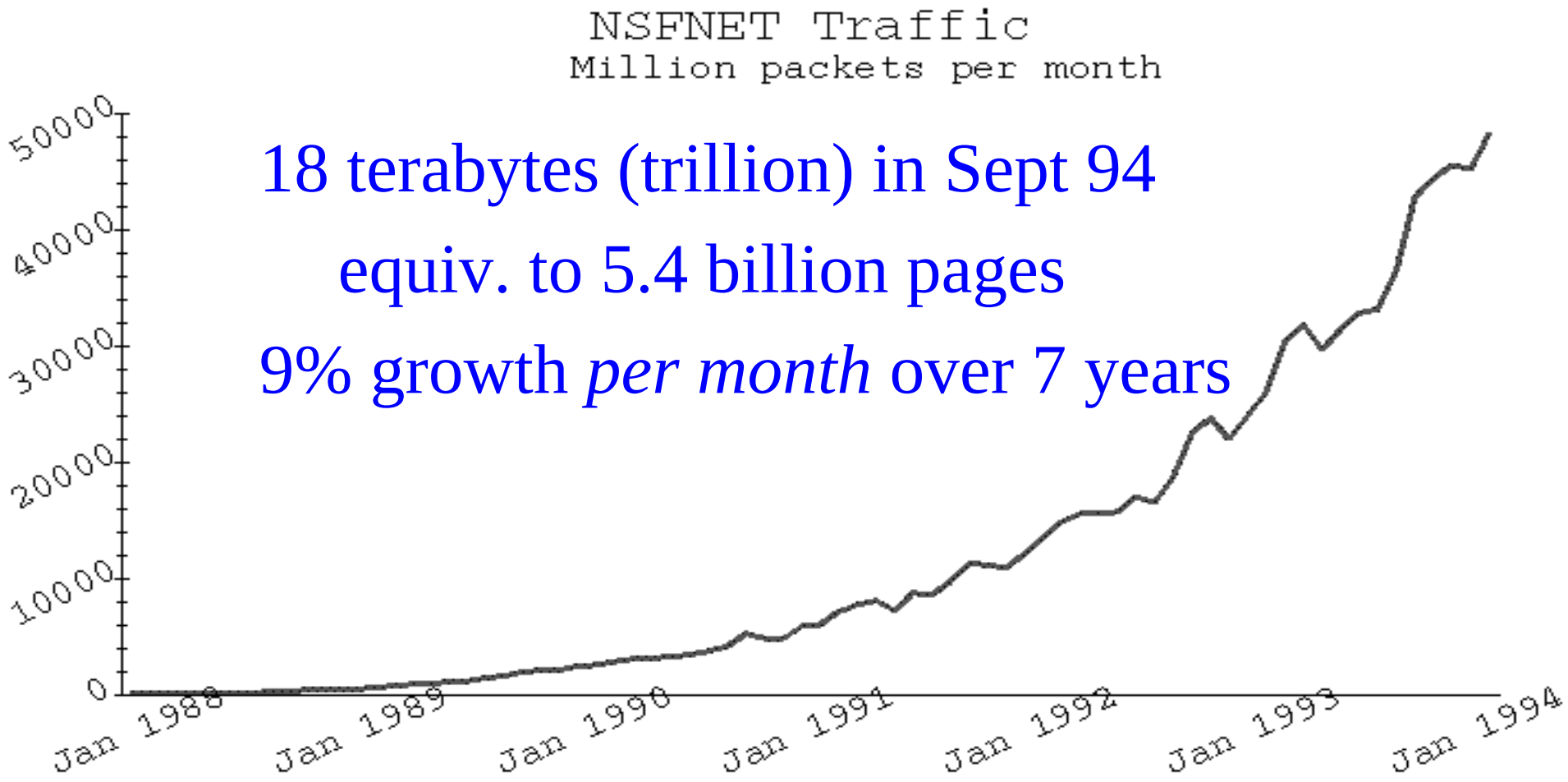
- Chip density doubling every 18 months
  - 1971: 2300 transistors, 1K DRAMs
  - 1995: 35,000,000 transistors, 64,000K DRAMs
- 1995 Pentium about 4X power of 1985 IBM 3090 mainframe

Internet Hosts: 1981-95



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Traffic Growth

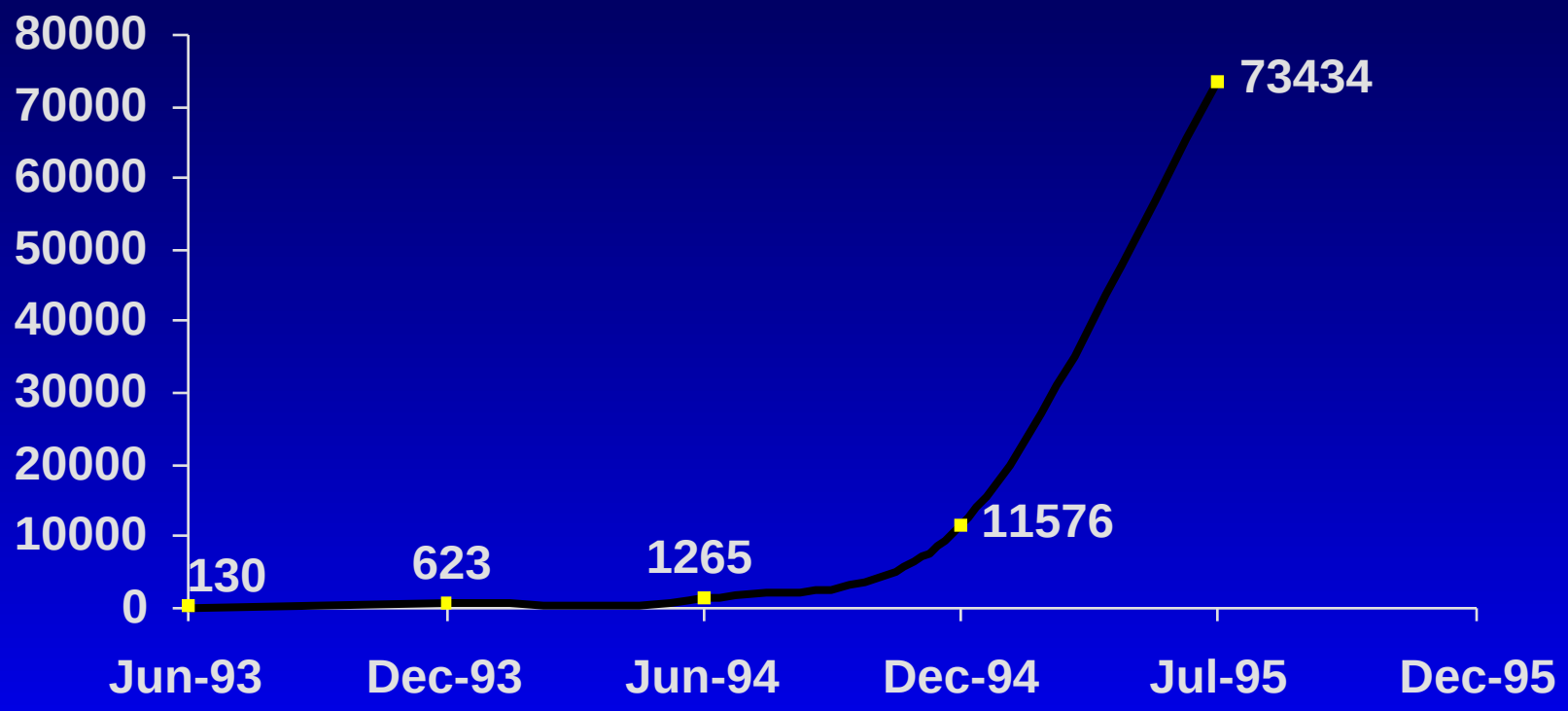


18 terabytes (trillion) in Sept 94

equiv. to 5.4 billion pages

9% growth *per month* over 7 years

Number of Web Servers: 1993 - 1995



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Revelations: The Judgement Day

Gilder: “the law of the microcosm requires decentralization of both business and government . . . . Long expected to favor large capital-intensive bureaucracies, the new technology in fact implies a global revival of entrepreneurship”

We are all Austrians now: “government intervention in the market process is always and everywhere destructive” (Llewellyn Rockwell, Jr.)

It is finished: go in peace

- Long distance is competitive
- Local telephony is (soon) competitive (cellular, PCS, Internet)
- Cable (coax) will be competitive (twisted pair, satellite)

Is it written?
Vertical reintegration

bottlenecks remain (number portability, local loop in some places)

new bottlenecks have emerged (SS7 passthrough, smart terminal OS)

will it ever end?

Another prophet cries from the wilderness: Huber as Mohammed

"As networks expand horizontally the companies that manage them grow vertically . . . . not-withstanding divestiture, the geodesic network will end up managed by a small number of giant, vertically integrated firms, AT&T among them." (Geodesic I)

- reintegration will be driven by consumer demand for a single provider of integrated service package

but as Noam and others note, in a world of compatible, interconnectable components we see service integrators who are not vertically integrated

Alternative explanation for reintegration: Network externalities

Defn: value to a user increases in the number of other users

key feature: critical mass (SHOW CHART)

Net externalities increasingly important in telecom

as microchip costs plummet, intelligence is distributed outwards in the network (Gilder's law of microcosm)

vast increase in the number of ways that network devices and links can be interconnected and employed to create new services

e.g., Internet telephony, email-to-fax, email-to-pager, pbx-to-bypass, virtual private networks, &c.

proliferation of interconnections and overlapping services require standardized interfaces

Examples

LEC-IXC interface (equal access rules, co-location)

NANP

SS-7 (CPN, Callback, ISDN, &c.)

TCP/IP (vs. OSI, &c.)

Ethernet (vs. Token Ring, &c.)

Windows OS (telecom: CTI for Caller ID, ACD, voicemail, fax, &c.)

Standards provide consumer benefits, but also *lock-in*

- Sutton: endogenous sunk costs
  - consumer investment in technology and adaptation to the standard
  - prediction: when ESC high, then industry will be concentrated
- Why are standards valuable? Windows OS
  - more applications written / peripherals designed for standard OS
  - learning curve faster (“guy down the hall”)
  - compatible data formats
  - mobility
- once standard obtains critical mass, tends to be excess inertia (Katz and Shapiro 1994)



Lock-in creates the opportunity for vertical leveraging

Suppose two candidate protocols for a new service, one more compatible with the standard for your existing system: which do you choose?

Microsoft controls the desktop; has (attempted) to leverage:

- desktop applications
  - in 1991, was second or sorse in word processing, database, spreadsheet
  - by 1994, was dominant seller
- network operating systems (NT)
  - Dataquest (1996) predicts that by 1999 NT will have 41% of OS market vs. 2% for UNIX (today: 1% to 2%)
- personal financial networks (Intuit)
- network computing (ActiveX, Visual Basic, Explorer/NT tools vs. Java/Netscape)
- videoconferencing (Tuesday NYT)
- proprietary online services (MSN):
  - "Microsoft's strategy is brilliant. By bundling MSN with Windows95 they are extending the operating system to include the entire network infrastructure." (Interactive Week, 12 Dec 94)

How to obtain critical mass?

- be smarter (and beat the stock market at the same time)
- buy it
  - penetration pricing (CD players, Netscape, MS Internet Explorer)
  - bundling (MS Office)
  - foreclosing compatibility (raising rivalsÕ costs)
  - vaporware (Windows NT, MSN)

ATT and Electronic Caller ID

- CPN available since 1991
- ATT stripped CPN from setup signal on all calls it did not terminate -- no long-distance caller ID available unless purchased leased line
- Why?
  - lost call minutes
  - *leverage into local calling market*
    - ATT has 60% of IXC calling minutes
    - if you could get 100% CPN coverage from ATT Local PhoneCo, 40% or less from Bell Atlantic, which would you choose?

Why would a firm want to vertically extend?

- Win the spoils: rents to controlling the new architecture
- Protect original turf:
  - innovation markets are dynamic
  - controlling network OS market helps MS protect dominance of Windows
- Price discrimination
  - *metering*: measure intensity of use at one layer through controlling another layer
    - e.g., revenues from MSN were to be dominated by transactions charges on commerce
  - *market segmentation*: value of Windows is dfferent to standalone desktops than to networked desktops

Closed versus open system competition

Farrell, Monroe and Saloner provide an alternative, cost distribution explanation of vertical organization

doesn't necessarily imply integration

ambiguous implications for policy

with enough firms (3?), cost motive biases towards socially inefficient closed architectures

How can we make sense of all this?

- Gilder's vertical implosion, Huber's integrated phoenix
  - what are the enduring principles?
  - what is common across telecom restructuring, computer hardware, computer software, Internet?
- If net externalities are here to stay, and they provide levers for market power extension, what are we to do?
  - What should be regulated, and what should be not?
  - How should it be regulated?
  - How can the answers keep up with changing technologies and market structures?

Framing the questions

Huber: focus on links and nodes

but too much going on in the nodes

Alternative: *service layering* -- idea borrowed from computer network and software theory



Layering

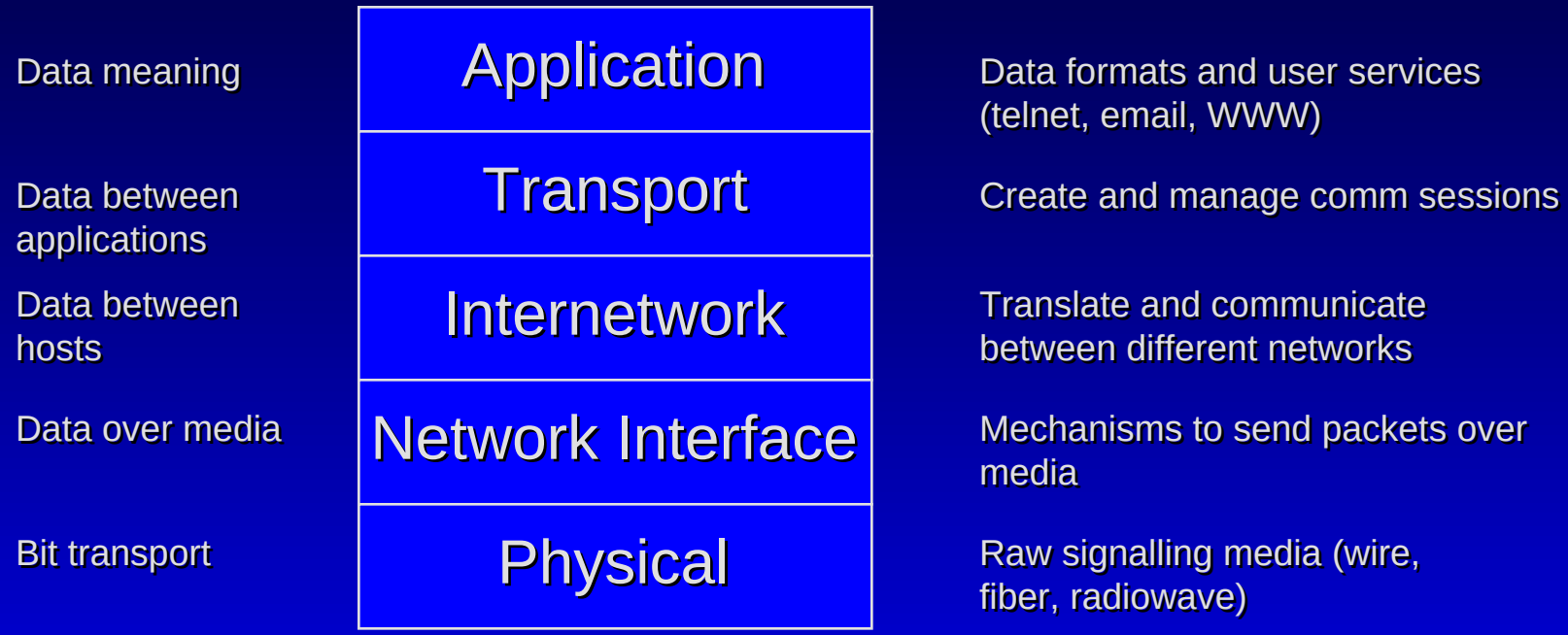
Network architecture theory

- organize the complex set of services into layers
- purpose of each layer is to offer services to next higher layer
- each layer shields higher layers from implementation details
- to succeed, each layer must recognize well-defined inputs, and perform well-understood functions to generate outputs: clean interface

Example: phone call layering

- e.g., I lift handset and dial 10 digits
- I don't need to know whether network uses SS7, or how switches do their job to open the circuit
- don't need to know if all landline, or some microwave; don't need to what part is copper, fiber, air

Example: TCP/IP layering



Example: Software layering

client application	cc:Mail
client network software	PC-TCP
network link	Internet (MCI, &c.)
server network software	UNIX TCP
server application	SunMail

Layering is an “object-to-think-with”

We approach unmanageable problems not with complete theories but with metaphor and representation in terms of familar objects

The turbine, smokestack, pipes and conveyor belts of the late 19th and early 20th centuries were powerful objects-to-think-with for imaging the nature of industrial modernity

Freudian objects-to-think-with

"Freudian ideas became well known and gained wide acceptance for reasons that had little to do with their purported scientific validity. Ideas about the importance of dreams and slips of the tongue became part of the wider psychological culture not because they were rigorously proven but because they were evocative objects-to-think-with. As people looked for slips and started to manipulate them, both seriously and playfully, the psychoanalytic concepts behind them began to feel more natural -- for people who never say a psychoanalyst and who never read a word by Freud."
(Sherry Turkle)

Why an object-to-think-with?

As McCloskey argues, “modernism [logical positivism] promises knowledge free from doubt, free from metaphysics, morals and personal conviction.”

- Yet falsification is not cogent (does the test reject the hypothesis of interest, or one of the legion of ancillary maintained premises?)
- And prediction is not possible
- These failures are especially true when technology, tastes and market structure are rapidly transforming
- What we need is a good, evolving conversation, which is immeasurably aided by evocative objects-to-think-with

Thinking with layering

operationalizes the notion of arms-length transactions

everything within a layer is encapsulated, only interaction is through published interface

thus, exchanges between layers are the transactions of classical, Walrasian markets

Implication: layer interfaces should be open

public specification of inputs, outputs and quality specs

uniform application of interface (same for all users including “owner”)

uniform availability of interface (same time for all users)

Example: Intuit acquisition

- layers (subset)
  - client Quicken
  - network interface
  - network
  - bank systems
- If communications function is incorporated into proprietary Windows, and Quicken interface to communications is not published, then Quicken users can be foreclosed from using financial service providers that are not on MSN (Quicken only “talks” to MSN)
  - forecloses competition in network service provider market
  - buys critical mass for MSN



Remedy

open the interface between Quicken and the network software -- then competing network providers can write their own network interface software

Example: ATT and Caller ID

SS7 header transport service provided by ATT:

- input: MTP (header packet including CPN) from link connected at inbound network access point (NAP)
- output: MTP at outbound NAP

layering policy:

- all inbound and outbound links should have access to same SS7 *specification* (including ATT leased-line links)
- all outbound links should be provided the same MTP header info -- no special treatment for ATT links

This is technology neutral: from service layering viewpoint, it doesn't matter whether local access is provided by leased line (ATT) or switched access (Bell Atlantic)

Principles for defining the layers?

Toward an "Open Interface Guidelines"

each layer should perform a well-defined function that services higher layers

layer boundaries should minimize information flow across the interfaces

should be defined in terms of services provided, not technologies

- e.g., same rules for phone and cable when they offer the same services
- policy should apply uniformly to, e.g., the "physical layer", not differently to fiber, coax, wireless

Layering principles, cont.

- should not be substantial cost efficiencies from expanding the boundaries of a layer
- should satisfy Katz's "regulatory principles for competitive markets"
  - competitively neutral
    - too broad favors critical mass owner
  - investment neutral
    - not picking technologies
    - should not induce cross-subsidies

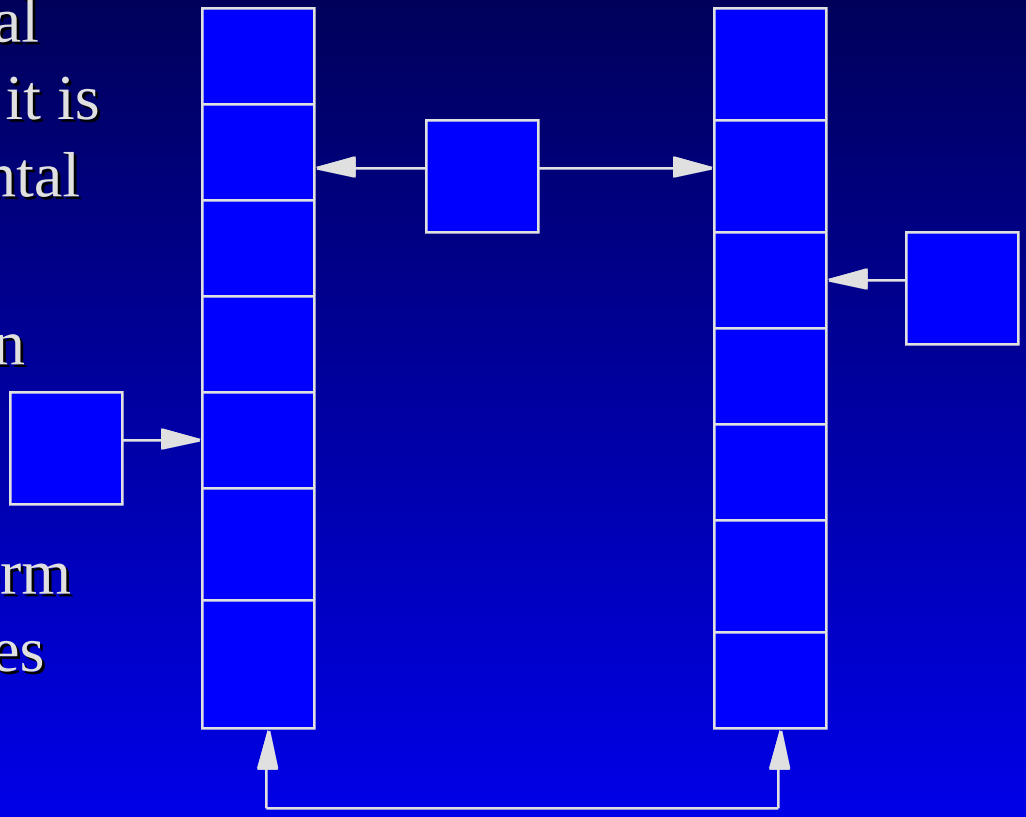
Example: Number Portability

- in strongly layered Internet, *numbers are portable*
- the Transport layer sets up host-to-host communication sessions (voice phone call, email delivery, terminal session)
- Transport hands off traffic with destination identifier to Internetwork layer
  - the information handed to Internetwork should be independent of how Internetworking is implemented
  - namely, ID number should not depend on who is providing the internetworking, or how
  - non-portable numbers violate layer boundaries

Layering and leveraging

we can tolerate vertical integration as long as it is disciplined by horizontal competition

horizontal competition against vertical firms requires clean layer boundaries, and uniform treatment at boundaries





Layering isn’t especially novel

implicit in some MFJ restrictions

the layer interfaces are the potential bottlemarks

Layering is step towards a general framework

an object-to-think-with

for identifying important bottlenecks

a guide to efficient, non-distortionary intervention

Layering unifies understanding of several industries

layering encompasses the experience and needs of not just telecom, but computing hardware, software and networks, which are rapidly converging into a single industry with telecom

the same theory that worked well for ATT in 1984 can be made to work well for the RBOCs in 1996, and for Microsoft, &c.