"Realizing the Information Future: A Recent National Research Council Report"

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10 November 1994
Bartos Theatre
Massachusetts Institute of Technology

The following is an edited summary, not a complete transcript of the remarks made by the speaker.

David Clark (DC): I would like to discuss a recent report by a study committee of the National Research Council (NRC) on "Realizing the Information Future: the Internet and Beyond". I was a member of the committee that produced the report, which came out last May. The NRC is a private corporation chartered by the federal government for the purpose of giving advice to the government. In this case, our committee presented the report to many government agencies such as the Department of Commerce, the Office of Management and Budget, and the FCC. We also did a lot of industry briefings, because we thought the conclusions were very relevant to the private sector. For example, we presented our findings to the National Cable Television Cable Association and will be briefing a number of telephone executives next month.

The National Science Foundation asked for this report to be written because they understood that with the transition of the Internet from a public good provided to the scholarly and scientific community to a commercial offering, some important changes were happening. Now that the Internet is successfully migrating to a commercial environment, the government recognized the need to think about how to deal with the communities it had traditionally and substantially supported.

When we (the committee) looked at the information world, we saw a tremendous amount of turbulence going on. Some of it is technical, in terms of changes in technology enablers and drivers. All the technology which in the past has been special-purpose analog technology is now moving toward a digital model which has a great deal of commonality. We found increasing network commonalities for TV distribution, computing and telephony. Overall we saw a blurring of a lot of boundaries that used to be crisp, for example the boundary between entertainment and information services. Another part of the turbulence that we found involved changing market conditions. These conditions include a rapidly growing and diversifying user population; an increase in private investors and investment levels; a proliferation of information providers; and an enormous growth of network-based applications and services.

Our committee's report had three sections. The first section constructed a technical framework in order to make sense of the turbulence we saw, and to help people understand what the National Information Infrastructure (NII) might be. We called this the Open Data Network, or the ODN. The second section addressed the experiences and perspectives of the research, education and library communities that have been traditionally served by government. In particular, we considered what the needs of these public interest constituencies

might be in the future. The final part of the report dealt with the role of the government in developing and deploying an NII based on an ODN architecture.

We wanted to present a picture of what we felt the NII should be. The key characteristics we identified — attributes we felt were desirable for an NII — were openness, technology independence, scale and decentralization, security, flexible basic service, heterogeneity, and cost recovery. "Openness" of the NII is especially important to users, to network providers, and to service providers. It is also important in the sense of openness to change and evolution. "Open to users" means that the network does not partition us into closed user groups. "Open to network providers" means anyone who is technically qualified should be allowed to attach to the network in order to serve a group of customers, regardless of the size of the provider. "Open to service providers" refers to high-level service — information providers, for example. There ought to be a level playing field for people with something to market, such as an interesting data base. "Open to change and evolution" is especially critical. Infrastructure to me means that we are building some sort of enduring base which can serve a variety of applications, but that we do not know what the range of successful services will be.

The technical framework section of the report comes up with a specific architecture for an ODN, which has four layers. From the top, these layers are: 1) applications, 2) middleware services, 3) transport and format services, and 4) a technology independent bearer service. All of these layers sit on top of the network technology substrate. The bearer service, the bottom layer, is particularly important because it decouples network technology from application development, allowing the two to evolve separately. This decoupling maximizes the potential for innovation. The bearer service provides a demarcation between network provider and service provider. It is a point of unbundling, in the sense that the bearer service has to be made widely available and cannot be bundled with the higher levels of service. This allows the network to be open to all service providers, since everyone can get at the bearer service and can then sell higher-level service.

I have said that the NII must be open. It must also have the right features. For example, the bearer service cannot be unidirectional or else it is not possible to do interactive and transactional services such as video originating from the home. It cannot be too general because that would add an unacceptable cost and nobody would install it. It is necessary to balance the level of generality of the bearer service. It must be general enough but not so general that it costs too much.

The Internet is a good example of an ODN. Although it has flaws and limitations, it embodies the ODN architecture. The Internet has a bearer service in it, and this is the reason why it is successful — not just because someone invented the World Wide Web and Email. These are applications which people like and which make them want to buy the Internet. But what makes the Internet really work is the IP layer in the middle, which defines the Internet bearer service.

The point about the Internet is that its architecture makes it open to all sorts of new services. How do you build such a successful bearer service? The answer is by minimizing what goes into that layer of the architecture. The Internet bearer service has only two features: the addressing plan and a simple delivery service. These minimal requirements make evolution easier.

But our report did not just describe the Internet and say that it alone is the future of the NII. This is the wrong way to look at the NII. The NII is much broader than the Internet. There are all sorts of constituencies such as cable providers or the phone companies who barely know the Internet exists today. Or else they see it as a threat rather than as a business opportunity. These larger sectors have very specific requirements. These requirements may be in conflict with the requirements of the Internet or maybe they can be harmonized. But we must be sensitive to these requirements because if the Internet is to grow, we have to deal with the communities which do infrastructure in the United States right now. The Internet makes certain technical assumptions which may not be appropriate to meet the needs of these sectors.

The idea that the Internet can run on top of everything has been very powerful for us in the Internet community. But I have sometimes called the Internet a hostile overlay, because it

runs on top of a variety of infrastructures which do not know about us or else are not very happy about us. In the long run it is not stable to run invisibly on top of other services. We want to build a system that moves down into the infrastructure and becomes part of what the infrastructure providers sell. In doing so, the Internet cannot continue to be a hostile overlay. It will have to mutate or else deliberately marginalize itself.

I keep focusing on access circuits — the last mile, the subscriber loop, the subscriber drop. I am concerned about access circuits because they are a key issue if you want to reach not just the large businesses and university campuses but also the ordinary citizen. If you want to reach the citizen and the home with an open data network, there is no way of doing that effectively today. A major investment would be necessary to upgrade U.S. subscriber drops. But it is not clear that market forces will get us there. Our committee looked at this situation and said that maybe there is a potential role for the government. I will come back to this point later.

The report also addressed the issue of setting standards. One of things we noticed is that the number of players on the standard scene, who are jockeying for turf, is out of control. We suggested that the government might watch this process, but we specifically said the government should not set standards. That is much too vigorous a role. But representing the public interest or convening meetings (of standard setters) is okay. Our committee also invented a concept called NII compliance, which relates to standard setting. If the NII is not just a marketing slogan — if it is a vision that we are trying to achieve — then there must be a definition of what it is and what it does. There must be a test of whether some capability is part of the NII or not. Compliance would almost certainly be defined in terms of whether you conform to certain standards. Whichever organization gets to write the NII standards would be in a position of tremendous power.

Regarding research and development, there is a need for strategic research on topics such as addressing and routing, resource management, network control, and mobility. Network architecture studies are crucial for tying all the pieces together. Today we need an architecture study to take a fresh look at what the bearer service is. We also need a study in terms of security architecture, to put the bits and pieces of security technology we now have into a coherent whole. Bad security is the enemy of the open network. Key security architecture goals should include assuring high reliability, protecting against system-wide failures, and addressing the vulnerabilities inherent in wireless technologies.

The second part of the report addressed the government's continued role in supporting the the scientific research, education and library communities. The government made a decision in the 1980's to demonstrate the Internet as a viable technology by making it available to the scientific research community which it had traditionally served. This experiment was a tremendous success. But it has been suggested that the experiment was a little like giving away drugs, because the users become addicted and then are faced with the problem of how to pay for the service once government support disappears. What kind of approach to payment to pursue in the future is a serious policy question which the report discusses. For now, though, I want to address another question which came up in our discussions. This was whether there are other sectors, in addition to the research community, that should be the target of a experiment similar to the original demonstration of the Internet. I want to focus on the K-12 educational community, another public sector institution which the government has traditionally supported. Recently in Texas, for example, there was an experiment which put their elementary schools on the Internet. The consequences were tremendously empowering for both the students and the teachers. There is great national interest in expanding the experiment more fully to the educational community at the K-12 level. But there are issues of financial costs. Local school districts do not have the money. We have to think of education in a global way, in terms of financing widespread networking within the educational community.

The whole issue is the NII's cost and how to keep the cost down. People think the Internet is free. This is untrue. It's just that somebody else paid for it and you didn't notice. Pricing has two roles here: recovering costs but also shaping user behavior. The nice thing about the Internet is that because users pay a flat fee, it encourages use. But we are going to go through a

big struggle in the next five years over whether this pricing system which encourages usage will continue.

The final section of the report dealt with the role of the federal government in realizing the information future or an NII. The vision is only the first step. It must be translated into a technical framework; corresponding technology must be developed or improved, and it must be expressed as detailed standards. Products based on these standards must be produced and deployed. The government must be a player in all these steps. What should the role of the government be? First, it must provide leadership, which means having a vision, as Vice President Al Gore does. It also means articulating and sustaining that vision. Second, the government must identify, listen to, and speak for under-represented interests. Every citizen must be thought of as a potential user and information-producer. Finally, the government must influence the shape of the NII. It must work with industry to promote optimal deployment, foster open data network architecture and standards, and support fundamental research and development. Federal procurement or tax depreciation can be used as a lever.

Our committee made five major recommendations to the government. The first was that the government should keep technology policy as part of its focus. This means establishing a better balance between the technical, economic, and social policy elements of NII evolution. The second, as I just mentioned, was that government should work with industry to develop incentives for engineering access circuits supporting an ODN architecture — but not by regulating or mandating. The third was that the government should consider transitional support for education and research institutions where there is an economic hardship in terms of Internet commercialization. The fourth was that government should facilitate Department of Education leadership in network-based education content, curriculum, methods and practice. The last recommendation was that since network research is still important, government should continue to fund it, focusing on emerging issues at the both the lower and higher levels of an ODN architecture.

The central dilemma in the realization of the information future is that the bulk of the money will be spent at the lower layer of the ODN (below the bearer service level), while most of the money is made at the top layers — in applications and middleware services. $50 billion is expected to be spent at the lower layer. But those costs must be recovered somehow. How can this tension be resolved? There are several possible solutions, none of which I think will work. One is not to bother with homes and schools. But this fails to meet important societal needs. Another is to link products at the top to providers at the bottom through bundling or vertical integration. But bundling goes against the whole point of making the architecture open so anyone can go on top of the bearer service. Another solution is to sell network connectivity in a competitive market. But this may not work since most costs are fixed and cost recovery would be obstructed. A fourth solution is to provide facilities through a monopoly. But this is unpopular because providers hate regulation.

What then is the answer? One answer is to allow a mix of open and closed systems. For example, video-on-demand could be closed and an open system (an ODN) allowed to coexist on the same infrastructure. In a way, this is bribing the people who are spending the $50 billion on infrastructure by letting them bundle video on demand or provide other services to make money. But at the same time there would be an open system next to the video on demand which would be used to address societal needs. Will this work? I don't know.

Beth Rosenson, Rapporteur

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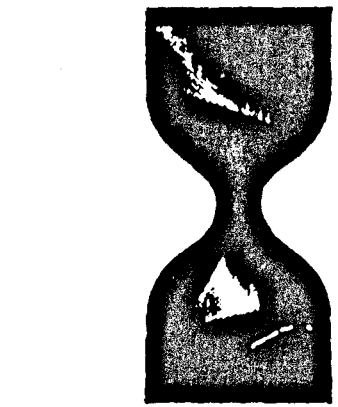
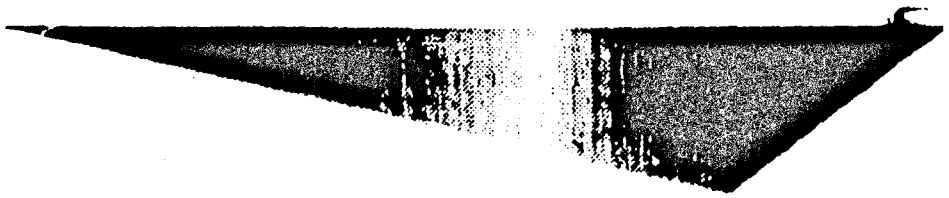
Realizing the Information Future

The Internet and Beyond





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REALIZING . . . A BROAD DEBATE

- MARCH 1993 LAUNCH . . . MARCH 1994 ACADEMY SIGNOFF TRANSMITTAL
- MAY 1994 RELEASE . . . PUBLIC BRIEFING, CONGRESSIONAL TESTIMONY
- *FEDERAL BRIEFINGS*

  ARPA, CIC, DOC (NIST, NTIA, OPSP, TA), ED, FCC, NEC, NSF, OMB, OSTP, TPWG

- *TECHNICAL SESSIONS*

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FERTILE CHAOS OR ENTROPY?

- TECHNOLOGY ENABLERS/DRIVERS--
  - NETWORK COMMONALITIES FOR TV DISTRIBUTION, COMPUTING, AND TELEPHONY;
  - DIGITAL TRANSPORT AND SWITCHING OF VIDEO AND OTHER FORMS OF DIGITAL INFO;
  - LAST-MILE ECONOMICS;
  - BLURRING ENTERTAINMENT-INFO BOUNDARY;
  - TRUE INTERWORKING OF DIFFERENT TYPES OF DIGITAL APPLIANCES

- MARKET CONDITIONS--
  - RAPIDLY GROWING/DIVERSIFYING USER POPULATION;
  - INCREASE IN PRIVATE INVESTORS AND INVESTMENT LEVELS;
  - PROLIFERATION OF INFORMATION PROVIDERS;
  - ENORMOUS GROWTH OF NETWORK-BASED APPLICATIONS AND SERVICES

- POLICY-MAKING CONSEQUENCES
  - ALMOST UNIVERSAL SET OF STAKEHOLDERS FROM MANY CONSTITUENCIES;
  - DEMAND MAY BE LATENT, UNEXPRESSED, OR HARD TO READ;
  - STAKEHOLDERS VOICE CONFLICTING VIEWS OF THE IDEAL ROLE FOR GOV'T AT ALL LEVELS;
  - POLITICAL ACTIVITY RELATING TO AN NII IS INCREASING

THREE MAJOR SECTIONS

I. FRAMEWORK FOR AN INTEGRATED INFORMATION INFRASTRUCTURE--AN *OPEN DATA NETWORK*--CHAPTERS 1-2

II. EXPERIENCES, NEEDS, AND PERSPECTIVES OF THE RESEARCH, EDUCATION, AND LIBRARY COMMUNITIES--CHAPTERS 3-5

III. ROLES FOR THE FEDERAL GOVERNMENT IN DEVELOPING AND DEPLOYING AN NII BASED ON AN OPEN DATA NETWORK ARCHITECTURE--CHAPTER 6

WHAT IS THE NII?

THE REPORT ARTICULATES A SPECIFIC VISION FOR THE NII

KEY CHARACTERISTICS:

- OPENNESS, TECHNOLOGY INDEPENDENCE, SCALE AND DECENTRALIZATION, SECURITY, FLEXIBLE BASIC SERVICE, HETEROGENEITY, ACCOUNTING

OPEN NATURE IS CENTRAL:

- TO USERS, TO NETWORK PROVIDERS, TO SERVICE PROVIDERS, AND OPEN TO CHANGE AND EVOLUTION

WHY THIS VISION? TO ADDRESS THE CENTRAL TENSION IN THE NII

- THE NII IS INFRASTRUCTURE--IT MUST BE STABLE AND LONG-LASTING

- WE DO NOT KNOW WHAT THE RANGE OF SUCCESSFUL SERVICES WILL BE

THE OPEN DATA NETWORK ARCHITECTURE

A SPECIFIC ARCHITECTURE IN 4 LAYERS:

- APPLICATIONS
- MIDDLEWARE
- TRANSPORT AND FORMAT
- TECHNOLOGY INDEPENDENT BEARER SERVICE

ALL OF THIS SITS ON TOP OF THE NETWORK TECHNOLOGY SUBSTRATE.

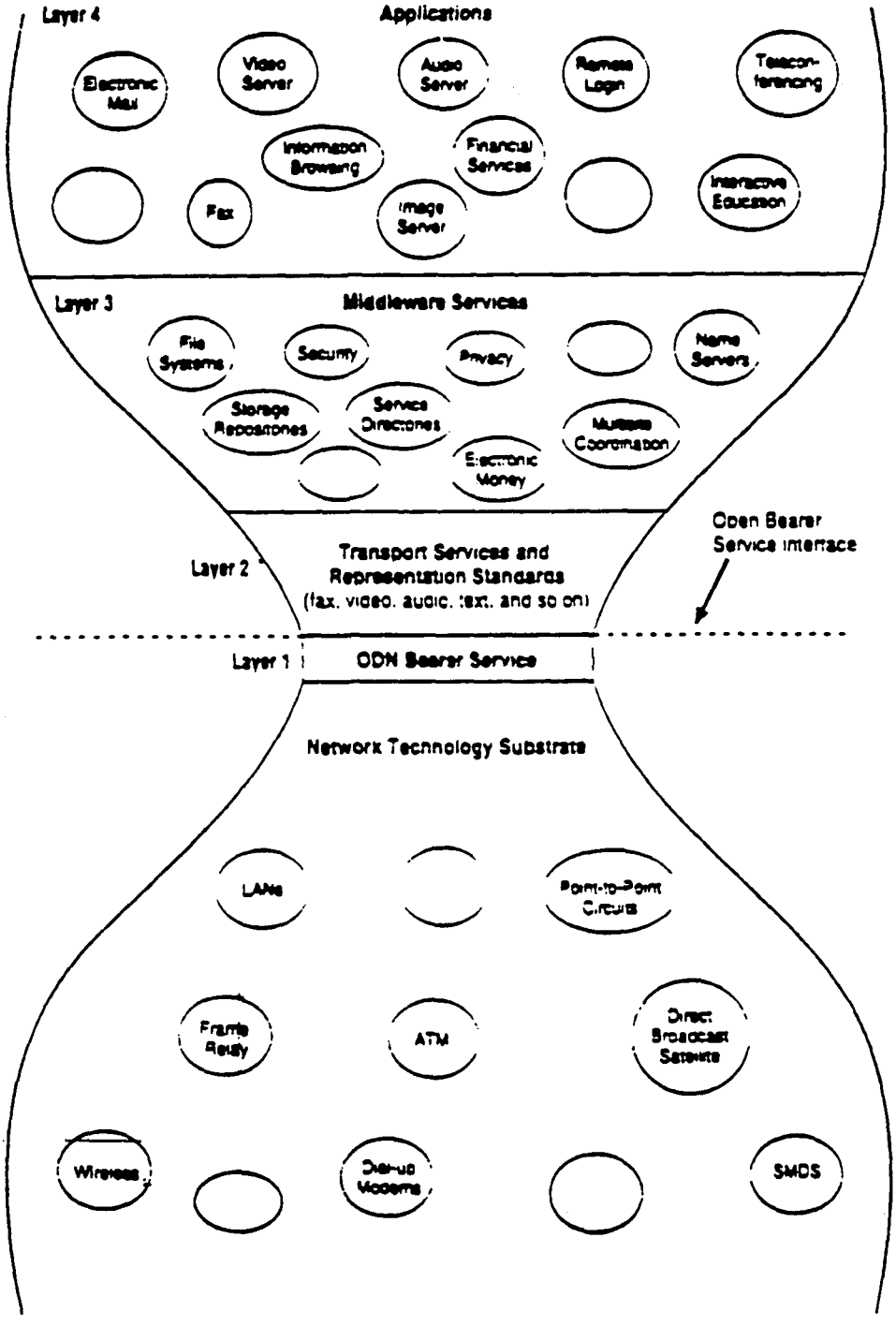


FIGURE 2.1 A four-layer model for the Open Data Network.

THE CENTRALITY OF THE BEARER SERVICE

DECOUPLES NETWORK TECHNOLOGY FROM APPLICATION DEVELOPMENT

- ALLOWS BOTH TO EVOLVE SEPARATELY
- MAXIMIZES POTENTIAL FOR INNOVATION
- PROVIDES A DEMARKATION BETWEEN NETWORK PROVIDER AND SERVICE PROVIDER--A POINT OF *UNBUNDLING*

KEY ISSUES IN THE SHAPING NII:

- IF NOT OPEN, NO EASY ENTRY FOR HIGHER LEVEL PROVIDERS
- IF WRONG FEATURES, WHOLE CLASSES OF SERVICES PRECLUDED
- IF TOO GENERAL, ADDS UNACCEPTABLE COST

DEFINE THE LOWER LAYER, SO THE UPPER LAYER CAN GROW

THE DEPLOYMENT OF THE BEARER SERVICE IS THE KEY POINT WHERE MARKET FORCES ALONE WILL NOT BE SUFFICIENT TO MOVE US TO A PARTICULAR OVERARCHING VISION.

THE INTERNET A$ AN ODN EXAMPLE

The Internet embodies an Open Data Network architecture

- IP layer defines the Internet bearer service
- TCP and UDP protocols implement the transport layer
- So far, the Internet has had limited middleware

The Internet is open to all sorts of new services

- WWW and Mosaic as latest examples

The Internet operates over all sorts of technology

- Predated LANs
- Moving to new technologies--e.g., Frame Relay, ATM

The Internet involves a wide range of service providers

- Runs over local exchange and long-haul telephone links
- Accessible through growing range of for- and non-profit network service providers
- Provides access to for- and non-profit info resources/services

IP: A VERY SIMPLE BEARER SERVICE

IP has two essential features

- A *common addressing plan*
- A simple delivery service: "Best effort" Quality of Service

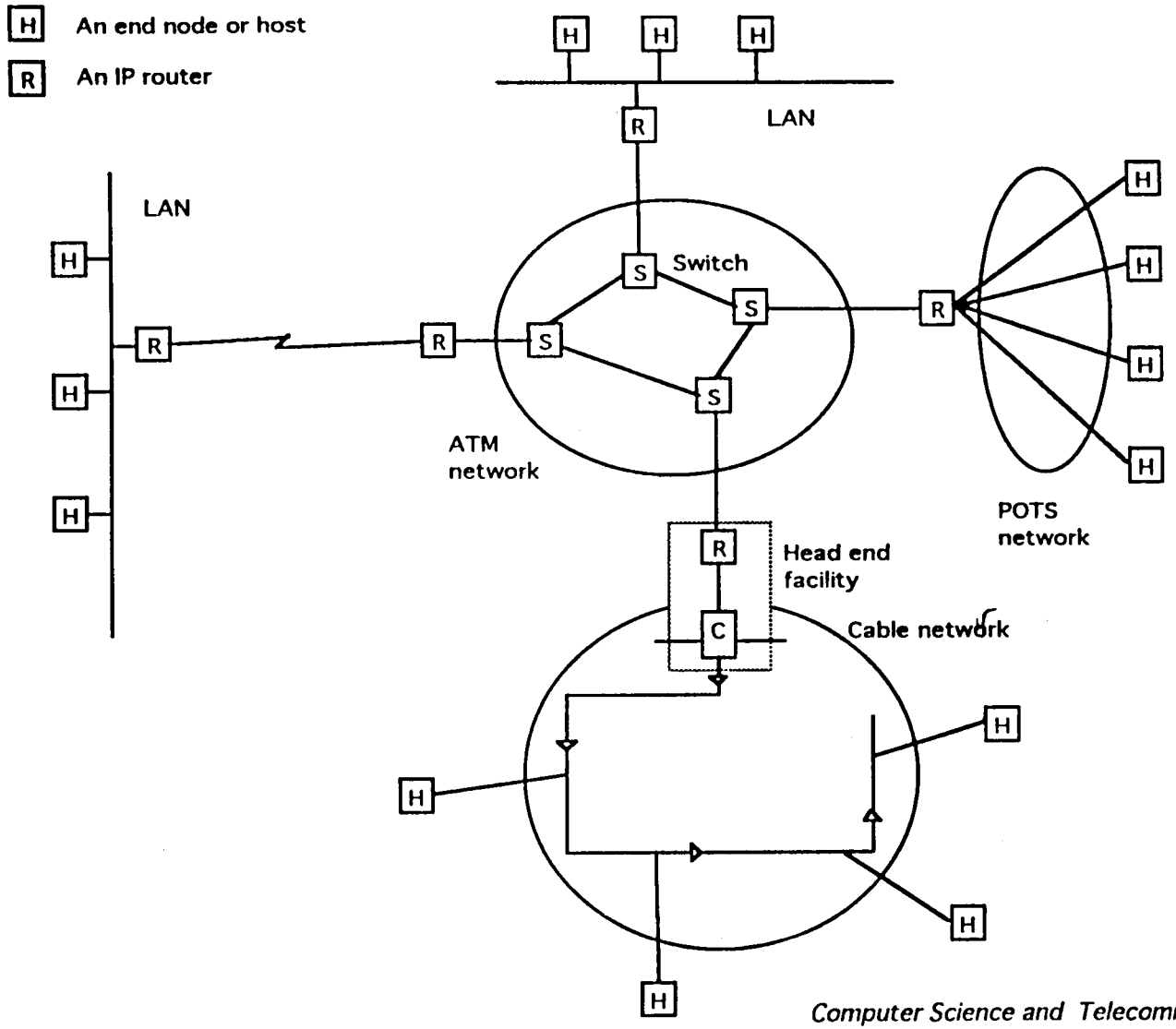
What is IP in concrete terms?

- A layer of software that runs on all the connected routers or end nodes
- Everyone who plays in the Internet has to implement IP
- Unifying veneer over collection of network technologies that provide slightly differing capabilities--hence labeled "abstract"

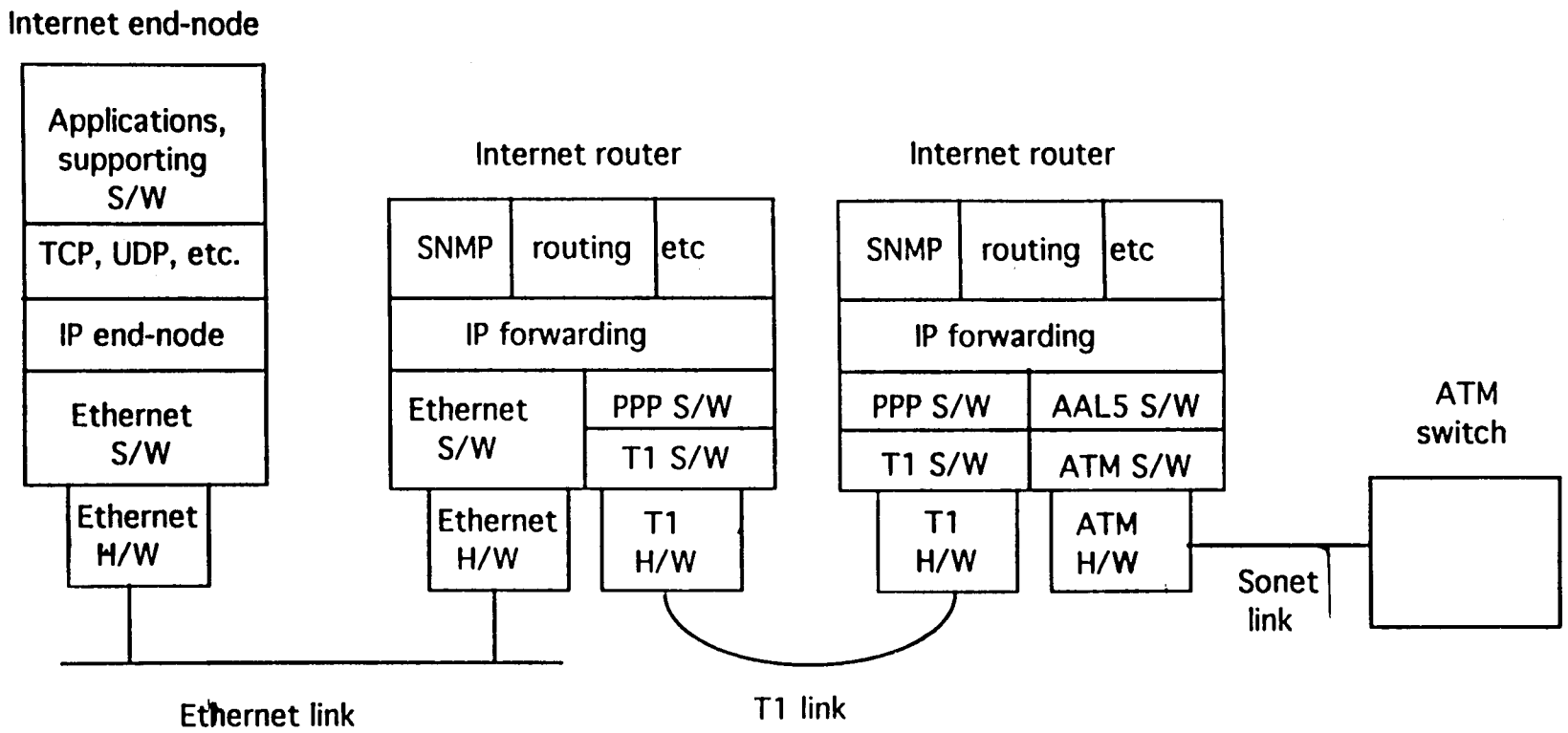
Minimal requirements mean evolution is easier

- Audio and video delivery being added--adding necessary tools to IP, need supporting capability in the underlying technologies

A TYPICAL INTERNET TOPOLOGY
SHOWING IP AND LOWER LEVEL TECHNOLOGY



SOFTWARE MODULARITY IN INTERNET ELEMENTS



WHY DIDN'T THE REPORT JUST DESCRIBE IP?

1) The NII is much broader than the Internet.
   - Other communities--cable, telephony--have other requirements

2) The Internet has assumed certain technical approaches--though these are changing
   - Packet switching
   - Best-effort delivery

3) There may be other candidates
   - The Internet community is developing one option--IPng
     - Multiple QOS, easy configuration, security, and so on
     - Advanced thinking--broaden out from just packet switching

4) The ODN should be "a part of" the system, not "on top of" the system
   - Will require changes/extensions for O&M
   - The Internet as a "hostile overlay" (or "permissive service")

ACCESS CIRCUITS: KEY DEPLOYMENT ISSUE

MAJOR INVESTMENT OVER NEXT DECADE TO UPGRADE U.S. SUBSCRIBER DROPS

WHAT VISION(S) OF THE NII WILL THESE UPGRADES SUPPORT?

- 500 CHANNELS OF ON-DEMAND TV?
- AN OPEN MARKET OF IDEAS, PRODUCTS, AND SERVICES?

WHAT WILL MAKE THE ANSWER COME OUT ONE WAY OR ANOTHER?

- AN OVERARCHING VISION IS NEEDED BUT IS NOT ENOUGH
- MARKET FORCES DO NOT OFFER PROPER INCENTIVES
- SOME ECONOMIC INCENTIVES REQUIRED (DOES NOT IMPLY REGULATION!)
- SOME RESEARCH AND DEVELOPMENT
  - PROVE CONCEPTS, REDUCE COST, DEMONSTRATE MARKET

CONVERGENCE EXAMPLE: VIDEO AND THE OPEN DATA NETWORK

Several options for integrating a general bearer service into a video delivery drop

1) *No support*: Some systems today are so specialized to analog video broadcast they cannot incorporate other services at all.

2) *Separate services*: Minor extensions to today's systems (e.g., up-channel amplifiers) can support services in addition to basic video delivery.

- "Ethernet modems"
- Time division multiplexing for POTS
- One or more of these could be enhanced to deliver a version of an ODN service (e.g., provide bi-directional capability)
- Separate services are enough to meet ODN objectives
  - No requirement for the video to use the bearer service
  - No requirement for the video business to be unbundled

3) *Digital encoding of video*: Example of a step toward realizing an open and flexible NII.

- ODN bearer service is still separate from video delivery
  - Engineer video coding and delivery in whatever cost-reduced manner industry prefers
  - Define one video representation separating video info from delivery details
  - Simultaneously supports a general bearer service and provides a way to move the video into that more general format as needed at the end node

- Digital video can be processed by both TVs and general purpose processors
  - Can convert video to other representations at end point
  - Support applications beyond simple TV viewing

CONVERGENCE EXAMPLE CONTINUED: VIDEO AND THE ODN

4) *Further integration*: The bearer service could be used for the delivery of video itself. General network technology (ATM) could be used for video transport.

- Not necessary for our vision--report is neutral
- Recognize that full integration raises concerns about efficiency of video delivery

5) *Next generation systems*: Current examples of advanced systems were not designed for goal of ODN plus efficient video.

- R&D might demonstrate better cost implications for supporting ODN services
- Flexible bi-directional capacity is a desired feature
- In long term, open service will benefit from increased bi-directional capacity
- Must take into account evolving user needs as well as cost

STANDARDS AND STANDARD SETTING

STANDARDS BRIDGE VISION AND IMPLEMENTATION... INTEROPERABILITY AT DIFFERENT LEVELS, NII COMPLIANCE

DIFFERENT SECTORS "OWN" NII PARTS...MANY COMMITTEES, CONSORTIA, OTHER PLAYERS

- LINK STANDARD SETTERS AND PRODUCT DEVELOPERS VIA SHARED FRAMEWORK FOR INTERACTION
- STANDARD SETTING IS A POLITICAL PROCESS UNDER INCREASING PRESSURE

NII STANDARD SETTING CALLS FOR GOVERNMENT PARTICIPATION, NOT MANDATES

- SUPPORTING STANDARDS IS NOT JUST ATTENDING STANDARDS MEETINGS

- SEVERAL ROLES AND OBJECTIVES:

  - MANAGE THE VISION
  - BROADEN CONSTITUENCY
  - SUPPORT CONSORTIA, COMMITTEES
  - ACT INTERNATIONALLY
  - FUND RELATED R&D
  - SUPPORT REFERENCE IMPLEMENTATIONS
  - MAP VISION TO STANDARDS
  - REPRESENT PUBLIC INTEREST
  - REPRESENT PUBLIC-SECTOR INSTITUTIONS
  - REPRESENT OWN INTERESTS AS USER
  - LOWER COSTS OF GENERAL TECHNOLOGY

NII COMPLIANCE

IF THE NII IS NOT JUST MARKETING, THERE MUST BE A DEFINITION OF WHAT IT IS AND WHAT IT DOES

THE REPORT DEFINES THE CONCEPT OF "NII COMPLIANCE"

- BASED ON THE OBJECTIVE OF MAXIMIZING INTEROPERATION
- COMMITTEE'S APPROACH PERMITS A RANGE OF FUNCTIONALITY

MUST EVALUATE STANDARDS--ASSESS WHETHER THEY ACCOMPLISH THE NII FUNCTIONALITY

STRATEGIC RESEARCH AND DEVELOPMENT: PREREQUISITE TO NII SUCCESS

STRATEGIC TOPICS--*DERIVED* FROM ODN ARCHITECTURE, SCALE, DECENTRALIZATION, EVOLUTION

- ADDRESSING AND ROUTING
- RESOURCE MANAGEMENT
- NETWORK CONTROL
- ISSUES IN MOBILITY
- TECHNOLOGY FOR ACCESS CIRCUITS
- INFORMATION NAVIGATION AND FILTERING
- INTELLECTUAL PROPERTY RIGHTS MANAGEMENT
- SECURITY AND PRIVACY

ARCHITECTURE STUDIES ARE CRUCIAL

EXPERIMENTAL TESTBEDS ARE ESSENTIAL--ADVANCE NETWORK AND SERVICE TECHNOLOGIES, ASSESS OPTIONS FOR POLICY-DRIVEN MECHANISMS RELATING TO RIGHTS AND RESPONSIBILITIES

- STRONG EXPERIMENTAL COMPONENT, REFLECTING SYSTEMS ASPECTS
- INVOLVE ACADEMIA AND INDUSTRY . . . CROSS-FERTILIZE BASIC AND APPLIED RESEARCH EFFORTS
- BEARER SERVICE COULD BE EXPLORED VIA TESTBED . . . POSSIBLY USING NSF vBNS, ARPA NII INTEROPERABILITY TRP

NSF, ARPA, OTHER AGENCY OPPORTUNITIES TO BUILD ON STRENGTHS AND ONGOING PROGRAMS

SECURITY ARCHITECTURE

GOVERNMENT SHOULD FOSTER DEVELOPMENT OF A *SECURITY ARCHITECTURE*

- KEY SECURITY ARCHITECTURE GOALS:
    - ASSURE SUFFICIENTLY HIGH RELIABILITY
    - PROTECT AGAINST SYSTEM-WIDE FAILURES
    - ADDRESS VULNERABILITIES INHERENT IN WIRELESS TECHNOLOGIES
- MECHANISMS--PROTECT AGAINST CLASSIC THREATS (TO CONFIDENTIALITY, INTEGRITY, AND AVAILABILITY OF DATA AND SYSTEMS) AS WELL AS VIOLATIONS OF INTELLECTUAL PROPERTY RIGHTS AND PERSONAL PRIVACY
- DOD'S CLASSIFIED INFO PROTECTION ARCHITECTURE BEST-DEVELOPED--BUT MODEL NOT ADEQUATE FOR FULL RANGE OF NII PROBLEMS

PROGRESS CALLS FOR *EDUCATION AND PUBLIC ATTITUDES* RE RESPONSIBLE, ETHICAL USE OF INFORMATION, PLUS ASSOCIATED REGULATION AND POLICY

- COMBINE TECHNICAL FACILITIES, RECOMMENDED OPERATIONAL PROCEDURES, AND MEANS FOR RECOURSE WITHIN THE LEGAL SYSTEM
- SECURITY ARCHITECTURE/STRATEGY STRENGTH FROM COMMUNITY ACCEPTANCE

RESEARCH, EDUCATION, AND LIBRARY OVERVIEW

- *WHY?* ESTABLISHED PUBLIC INTEREST, TRADITION OF GOVERNMENT SUPPORT
- *WHAT?* EXAMPLES OF WHAT REL ARE DOING, WOULD LIKE TO DO, PROBLEMS EXPERIENCED/BARRIERS TO DOING MORE
- *HOW?* NREN-NII TRANSITION PRESENTS BOTH RISKS AND OPPORTUNITIES
  - TRADEOFFS IN COSTS, BENEFITS OF ACCESS AT INSTITUTIONS V. HOMES
  - KEY PARAMETER IS COST . . . LIMITED ABILITY TO PAY AND STRONG NEED FOR PREDICTABLE BUDGET REQUIREMENTS
  - TRANSITION ANXIETY . . . YET EXPECT MORE EVOLUTION THAN REVOLUTION

RESEARCH AND HIGHER EDUCATION COMMUNITIES

- RESEARCH HAS DOMINATED--YET EXPERIMENT HAS JUST BEGUN
- MANY/VARIED USES (E-MAIL, DB ACCESS, INSTRUMENT CONTROL)
- REMOTE COLLABORATION (CROSS-COUNTRY, COUNTRIES, DISCIPLINES)
- REMOTE AND SELF-DIRECTED LEARNING--BRIDGE TO LIFE-LONG LEARNING APPLICATIONS
- SOME SEGMENTS OF SCIENTIFIC RESEARCH IN VANGUARD; OTHERS--AND HUMANITIES--LAG IN CONNECTIVITY AND APPLICATIONS
  - LEADING-EDGE SCIENTIFIC RESEARCH HAMPERED BY LACK OF BROAD, RELIABLE ACCESS TO HIGH-BANDWIDTH, MULTIMEDIA COMMUNICATION (DOE EXAMPLES)
  - NETWORKED FILE SYSTEMS, INTERACTIVE GRAPHICS, AND MULTIMEDIA DOCUMENTS SPUR DEMAND

K-12 EDUCATION

K-12 EDUCATION LACKS:

- ACCESS
- COMFORT WITH ELECTRONIC TECHNOLOGY
- FINANCIAL RESOURCES and
- INTEGRATION OF NETWORKING AND INFORMATION ACCESS INTO CURRICULA

K-12 EXPERIENCES UNDERSCORE CRITICALITY OF HUMAN ELEMENT, TRAINING, LOCAL/INTERNAL INFRASTRUCTURE

NATIONAL INTEREST IN EXPANDING THE EXPERIMENT MORE FULLY TO EDUCATION, ESPECIALLY AT K-12 LEVELS

GREAT EXPECTATIONS FOR CHANGES IN PROCESSES OF TEACHING AND LEARNING

FINANCIAL ISSUES: MANY COSTS

INTERNET NOT FREE, BUT MOST COSTS PAID BY INSTITUTIONS

- REL APPREHENSIONS

DIFFERENT KINDS OF COSTS: (1) LOCAL ACCESS, LONG HAUL; (2) INTERNAL INFRASTRUCTURE; (3) INFO RESOURCES

- NET ACCESS COVERS ONLY A PIECE OF THE COST PROBLEM

- CONGESTION COMPLICATES--RISES WITH VIDEO, MULTIMEDIA, ETC.?

  - EXTRAPOLATING IS RISKY

FINANCIAL ISSUES: PRICING RATIONALE

INFRASTRUCTURE IS SHARED--SHAPE USER BEHAVIOR BY TECHNICAL MEANS OR PRICING

- BETTER CHOICES WHEN SEE ACTUAL COSTS OF ALTERNATIVES
  - HOW MUCH OF REL BUDGETS SHOULD GO FOR NETWORKING?
  - WHO SHOULD DECIDE?
- SUBSIDIES USEFUL UNTIL VALUE CLEAR. REL PROVIDE NO-FEE RESOURCES TO OFFSET

FINANCIAL ISSUES: PRICING APPROACHES

FLAT-FEE PRICING FEASIBLE . . . IT EXISTS TODAY AND IT SUPPORTS EXPERIMENTATION

- INTERNET COSTS ARE LARGELY FIXED (ROUTERS, LINES)--*INDEPENDENT OF USAGE*
- FLAT FEE PRICING PREFERRED BY REL--PREDICTABLE, ALLOWS HEAVY USE--AND SHARES RISK

COMMITTEE ASSUMES *VARIETY* OF PRICING SCHEMES

- MULTIPLE SERVICE PACKAGES WITH DIFFERENT FLAT FEES AND LEVELS OF SERVICE

IDEAL PRICING STRUCTURE *WILL CHANGE* AS TECHNOLOGIES, APPLICATIONS, AND DEMAND MATURE . . . AND AS *INTERCONNECTION CHARGES* FOR NETWORKS, HOSTS EMERGE

PRINCIPLES AND PRACTICE

POLICY CONCERNS DRIVING TECH DECISIONS OR ARISING FROM NEW TECH

BROAD PRINCIPLES FOR UBIQUITOUS ACCESS PLUS TERMS AND CONDITIONS OF USE (PRIVACY, SECURITY, FIRST AMENDMENT, IPR)

SUBSTANTIAL COMMONALITY ON GENERALIZATIONS . . . DIFFERENCES ON SPECIFICS

- Who gains and loses? REL insights; balance legitimate business opportunities and individual rights
- REL users are the primary producers of info they transfer today--REL will continue to supply info resources and services

EMERGING NEED FOR BROADER CONSIDERATION OF ETHICS ON A SUSTAINED BASIS

- Cf. Ethical, Legal, and Social Implications (ELSI) program of Human Genome Project
  . . . analyze needs, develop policy options, public and professional education

INTELLECTUAL PROPERTY RIGHTS

GOAL: REFLECT RIGHTS OF CREATORS AND USERS AS WELL AS PUBLISHERS

NETWORKS CONFOUND IPR MANAGEMENT . . . BUT ROBUST MARKET FOR NETWORKED INFO AND RESOURCES FUNDAMENTAL TO NII SUCCESS

TWO FLAVORS OF IP CONCERNS:

(1) PROTECTION OF INTEGRITY OF A WORK--BROAD AGREEMENT

(2) ABILITY TO REAP REVENUE--DISAGREEMENT--ESP. ON LEVEL, MECHANICS

- CONTROVERSY OVER CHARGING FOR BOTH ACQUISITION AND EACH USE

IPR: CHARGING ISSUES

TECHNOLOGY MAY UNDERMINE TRADITIONAL MODELS FOR CHARGING FOR COPYRIGHT-PROTECTED WORKS

- RISE AND RANGE OF *CASUAL PUBLISHING*--LIBERAL ELECTRONIC MAIL, PUBLIC FILE REPOSITORY, GOPHER SERVER, AND MOSAIC/WORLD-WIDE WEB FEED THIS TREND
- MORE PUBLISHING *BY THE PIECE*--ARTICLES V. WHOLE BOOKS
- *"SYNTHETIC"* APPLICATIONS--SMALL ELEMENTS FROM MULTIPLE SOURCES
- VERY *HIGH VOLUME* ACCESS TO SPECIFIC INFORMATION RESOURCES
- MORE *SHORT-LIVED* USES OF INFO--E.G., INTERACTIVE, HOT LINKS, BROWSING
- *REPUBLICATION* POSSIBILITIES RAISE QUESTIONS ABOUT SHIFTS IN THE COSTS AND BENEFITS OF PUBLISHING
  - MECHANISMS FOR NEGOTIATING AND PAYING FOR PARTIAL OR COMPLETE COPYING, "REPRODUCTION" RIGHTS, AND SO ON STILL IN DEVELOPMENT (THEY EXIST IN CERTAIN CLOSED ELECTRONIC DELIVERY SYSTEMS) THOUGH TECHNOLOGY PROVIDES ULTRALOW COST REPRODUCTION AND COPYING.

DEVELOPMENTS CHALLENGE CONVENTIONAL PRICING AND BUSINESS APPROACHES

IPR: INFORMATION ASYMMETRIES

IMPLICATIONS FOR BARGAINING POWER AND FAIRNESS OF OUTCOMES:

- CAMPUS ENVIRONMENT: GENERAL LACK OF UNDERSTANDING OF CURRENT COPYRIGHT LAW, FAIR USE PROVISIONS, AND RAMIFICATIONS OF ELECTRONIC PUBLISHING

- COMMERCIAL PUBLISHING: MORE FORMAL TRANSACTIONS W/RIGHTS AND REMUNERATION

- AUTHORS MAY KNOW LESS THAN PUBLISHERS ABOUT OPTIONS FOR REPUBLICATION AND ASSOCIATED REVENUES THROUGH ELECTRONIC DATABASES AND OTHER ELECTRONIC VEHICLES

    - AUTHOR MAY FOCUS ON ORIGINAL PUBLICATION V. FAR BROADER PUBLISHING PROCESS THROUGH ELECTRONIC DATABASES AND SO ON

AUTHORS AND PUBLISHERS ARE EXPERIMENTING IN THE COMMERCIALIZATION, CHARGING FOR, AND CONTROL OF THE INTELLECTUAL MATERIAL FLOWING AND STORED IN ELECTRONIC FORM

REALIZATION TAKES MANY STEPS

THE VISION IS ONLY THE FIRST STEP:

- IT MUST BE TRANSLATED INTO A TECHNICAL FRAMEWORK OR ARCHITECTURE
- CORRESPONDING TECHNOLOGY MUST BE DEVELOPED OR IMPROVED
- IT MUST BE EXPRESSED AS DETAILED STANDARDS
- PRODUCTS BASED ON THESE STANDARDS MUST BE PRODUCED
- THESE PRODUCTS MUST BE DEPLOYED

ONLY IF ALL OF THESE STEPS SUCCEED CAN AN NII BE REALIZED

THE GOVERNMENT MUST BE A PLAYER IN ALL OF THESE STEPS

ROLE OF GOVERNMENT

- *PROVIDE LEADERSHIP* -- I.E., HAVE A VISION, ARTICULATE IT, AND SUSTAIN IT
  - NII OVERALL
  - K-12 EDUCATION OPPORTUNITY
- *BALANCE INTERESTS* -- I.E., IDENTIFY, LISTEN TO, AND SPEAK FOR/SUPPORT UNDERREPRESENTED INTERESTS
  - EQUITY . . . REL ILLUSTRATE ISSUES
  - EVERY CITIZEN A USER--WHO IS HEARD, BY WHOM?
  - LATENT/UNEXPRESSED DEMAND . . .
- *INFLUENCE NII SHAPE* -- I.E., WORK WITH INDUSTRY TO PROMOTE OPTIMAL DEPLOYMENT, FOSTER OPEN DATA NETWORK ARCHITECTURE AND STANDARDS, SUPPORT FUNDAMENTAL R&D, AND USE FEDERAL PROCUREMENT AS A LEVER
  - RESEARCH NETS . . . EXPERIMENTAL NETS
  - FIPS, REL SUPPORT, INTERNET SUPPORT/TRANSITION

RECOMMENDATIONS TO THE FEDERAL GOVERNMENT: REALIZING AN ODN-BASED NII

1) *KEEP TECHNOLOGY POLICY IN FOCUS* ... BALANCE TECHNICAL, ECONOMIC, AND SOCIAL POLICY ELEMENTS, RECOGNIZE LONG RANGE NATURE OF NII EVOLUTION

2) *WORK WITH INDUSTRY TO DEVELOP INCENTIVES* FOR ENGINEERING ACCESS CIRCUITS SUPPORTING AN ODN ARCHITECTURE

3) *CONSIDER TRANSITIONAL SUPPORT* FOR EDUCATION AND RESEARCH INSTITUTIONS WHERE EXTREME INTERNET COMMERCIALIZATION HARDSHIP

4) *ENABLE DEPARTMENT OF EDUCATION LEADERSHIP* IN NETWORK-BASED EDUCATION CONTENT, CURRICULUM, METHODS, AND PRACTICE

5) *CONTINUE AND EXPAND NETWORK RESEARCH SUPPORT* . . . MANY TECHNICAL CHALLENGES ARE FAR FROM RESOLVED, AT ALL LEVELS OF ARCHITECTURE

RECOMMENDATION 1: LEADERSHIP AND GUIDANCE

THE COMMITTEE RECOMMENDS THAT THE FEDERAL GOVERNMENT EXPAND ITS NII AGENDA TO EMBRACE THE OPEN DATA NETWORK (ODN) ARCHITECTURE AS A TECHNICAL FRAMEWORK FOR THE DESIGN AND DEPLOYMENT OF THE NII. REQUIRED IS A STABLE MECHANISM TO PROVIDE THE FOLLOWING:

- CONTINUED FEDERAL LEADERSHIP IN STIMULATING THE DEVELOPMENT AND DEPLOYMENT OF AN ODN ARCHITECTURE FOR THE NII, INTEGRATING THE TECHNICAL, ECONOMIC, AND SOCIAL CONSIDERATIONS BASIC TO ACHIEVING A TRULY NATIONAL U.S. NETWORKING CAPABILITY.

- CONTINUED FEDERAL INVOLVEMENT IN THE DEVELOPMENT OF STANDARDS FOR THE NII. THE COMMITTEE DOES NOT CONCLUDE THAT THE GOVERNMENT SHOULD SET THE STANDARDS, BUT RATHER THAT IT SHOULD SUPPORT AND PARTICIPATE IN THE ONGOING STANDARDS-SETTING PROCESSES MORE EFFECTIVELY, BRINGING TO THOSE PROCESSES AN ADVOCACY FOR THE PUBLIC INTEREST AND FOR REALIZATION OF AN OPEN AND EVOLVABLE NII.

TO THIS END, THE COMMITTEE FURTHER RECOMMENDS THAT THE FEDERAL GOVERNMENT DESIGNATE A BODY RESPONSIBLE FOR OVERSEEING THE TECHNICAL AND POLICY ASPECTS OF THE EVOLUTION OF THE NII AND ITS APPLICATIONS.

RECOMMENDATION 2: TECHNOLOGY DEPLOYMENT

THE COMMITTEE RECOMMENDS THAT THE GOVERNMENT WORK WITH THE RELEVANT INDUSTRIES, IN PARTICULAR THE CABLE AND TELEPHONE COMPANIES, TO FIND SUITABLE ECONOMIC INCENTIVES SO THAT THE ACCESS CIRCUITS (CONNECTIONS TO HOMES, SCHOOLS, AND SO ON) THAT WILL BE RECONSTRUCTED OVER THE COMING DECADE ARE ENGINEERED IN WAYS THAT SUPPORT THE OPEN DATA NETWORK ARCHITECTURE.

RECOMMENDATION 3: TRANSITIONAL SUPPORT

THE COMMITTEE RECOMMENDS THAT TEMPORARY SUBSIDIES OF EDUCATION AND RESEARCH INSTITUTIONS BE CONSIDERED IN CASES WHERE THE COMMERCIALIZATION OF THE INTERNET GENERATES EXCEPTIONAL FUNDING DISTORTIONS.

RECOMMENDATION 4: K-12 EDUCATION

- THE . . . DEPARTMENT OF EDUCATION SHOULD TAKE A LEADERSHIP ROLE IN ARTICULATING . . . THE OBJECTIVES AND BENEFITS OF NETWORKING IN K-12 EDUCATION. IT SHOULD DEFINE A NATIONAL AGENDA THAT CAN GUIDE EFFORTS AT THE STATE AND LOCAL LEVEL.

- . . . THE DEPARTMENT OF EDUCATION SHOULD, IN THE SHORT TERM, PURSUE COLLABORATIONS WITH THE NATIONAL SCIENCE FOUNDATION AND OTHER RESEARCH AGENCIES, BUT IN THE LONG TERM SHOULD ACQUIRE INTERNAL TECHNICAL EXPERTISE AT A SUFFICIENTLY SENIOR LEVEL.

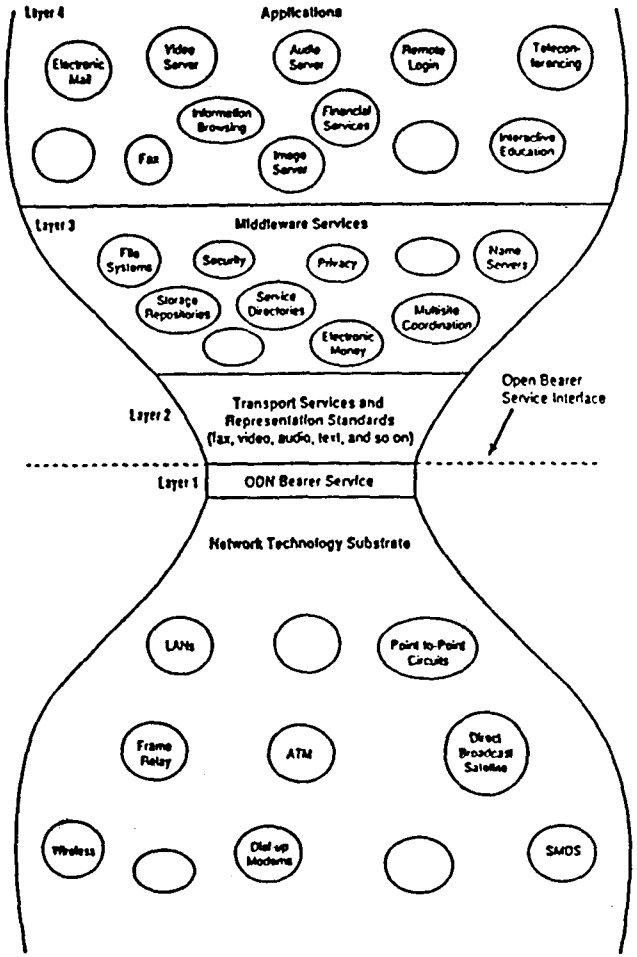
- THE DEPARTMENT OF EDUCATION SHOULD SET AN AGGRESSIVE AGENDA FOR RESEARCH ON TELECOMPUTING TECHNOLOGY IN EDUCATION . . . ADDRESS BENEFITS AND APPLICATIONS OF HIGH-BANDWIDTH COMMUNICATION AND SERVICES AND THE TRANSFER OF RELATED TECHNOLOGIES . . .

- THE FEDERAL GOVERNMENT SHOULD CONTINUE, AND IF POSSIBLE, EXPAND, FEDERAL FUNDING THROUGH MATCHING GRANTS, LEVERAGING STATE, LOCAL, AND INDUSTRIAL FUNDS, TO STIMULATE DEPLOYMENT OF NETWORKS IN THE EDUCATIONAL COMMUNITY.

RECOMMENDATION 5: NETWORK RESEARCH

THE COMMITTEE RECOMMENDS THAT THE NATIONAL SCIENCE FOUNDATION, ALONG WITH THE ADVANCED RESEARCH PROJECTS AGENCY, OTHER DEPARTMENT OF DEFENSE RESEARCH AGENCIES, THE DEPARTMENT OF ENERGY, AND THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION, CONTINUE AND, IN FACT, EXPAND A PROGRAM OF RESEARCH IN NETWORKS, WITH ATTENTION TO EMERGING ISSUES AT THE HIGHER LEVELS OF AN OPEN DATA NETWORK ARCHITECTURE (E.G., APPLICATIONS AND INFORMATION MANAGEMENT), IN ADDITION TO RESEARCH AT THE LOWER LEVELS OF THE ARCHITECTURE.

THE CENTRAL DILEMMA



<- MONEY GETS MADE HERE

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POSSIBLE SOLUTIONS

1) DON'T BOTHER WITH HOMES AND SCHOOLS, ETC.
   - BAD -- NO USERS

2) LINK PRODUCTS AT TOP TO PROVIDERS AT BOTTOM -- VERTICAL INTEGRATION
   - BAD -- NO LONGER OPEN

3) SELL NETWORK CONNECTIVITY IN COMPETITIVE MARKET
   - MOST COSTS FIXED -> SELL AT MARGINAL COST
   - BAD -- NO COST RECOVERY, SO ALL GO OUT OF BUSINESS (OR JUST ONE SURVIVES)

4) PROVIDE FACILITIES THROUGH A MONOPOLY
   - BAD -- PROVIDERS HATE REGULATION

AND THE ANSWER IS...?

ONE ANSWER: ALLOW A MIX OF CLOSED AND OPEN SYSTEMS
   - VIDEO ON DEMAND COULD BE CLOSED -- ITS ONLY MONEY. WHO CARES
   - AN OPEN SYSTEM (ODN) COEXISTS ON THE SAME INFRASTRUCTURE