Beyond Unbundling

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My talk is entitled "Beyond Unbundling," and it proposes to take an initiative to modularize the network system as a way of dealing with the unbundling question. I've been writing for four years about ONA, so I am happy to see how things have progressed and that we now have meetings like this. Unfortunately, though I am part of the hosting PSC, I won't be able so stay for the entire event, since I am leaving later tonight to present talks in Hong-Kong and Beijing, by way of a San Diego conference on costing issues. But I am glad for the opportunity to talk about unbundling, which I consider to be the heart and soul of ONA in terms of long term significance.

To me, ONA must be seen in the context of America's rapidly declining international position in advanced electronics technology. We may have gotten used to the decline of traditional industries such as textiles, or steel, or automobiles, as long as there was at least the promise of the information-based high technology industries. But a look at Chart 1 shows the many critical elements of an information economy in which the American presence has declined.

In just 6 years the trade deficit in electronics has become huge, from a $6 bil surplus to an horrendous $15 bil deficit. [Chart 2] In telecommunications, trade moved from a positive $800 mil to a negative $2.7 bil. And this will get even worse, as the statistics for registration for new terminal equipment indicate. [Chart 3]

Information Industries with Small or Declining American Presence

Television sets

Memory chips

Super-computers and next generation computers

Video cassette recorders

Small and medium sized copiers

Facsimile machines

Expert systems

High definition television

Video Cameras

Printers

Telephone handsets

Answering machines

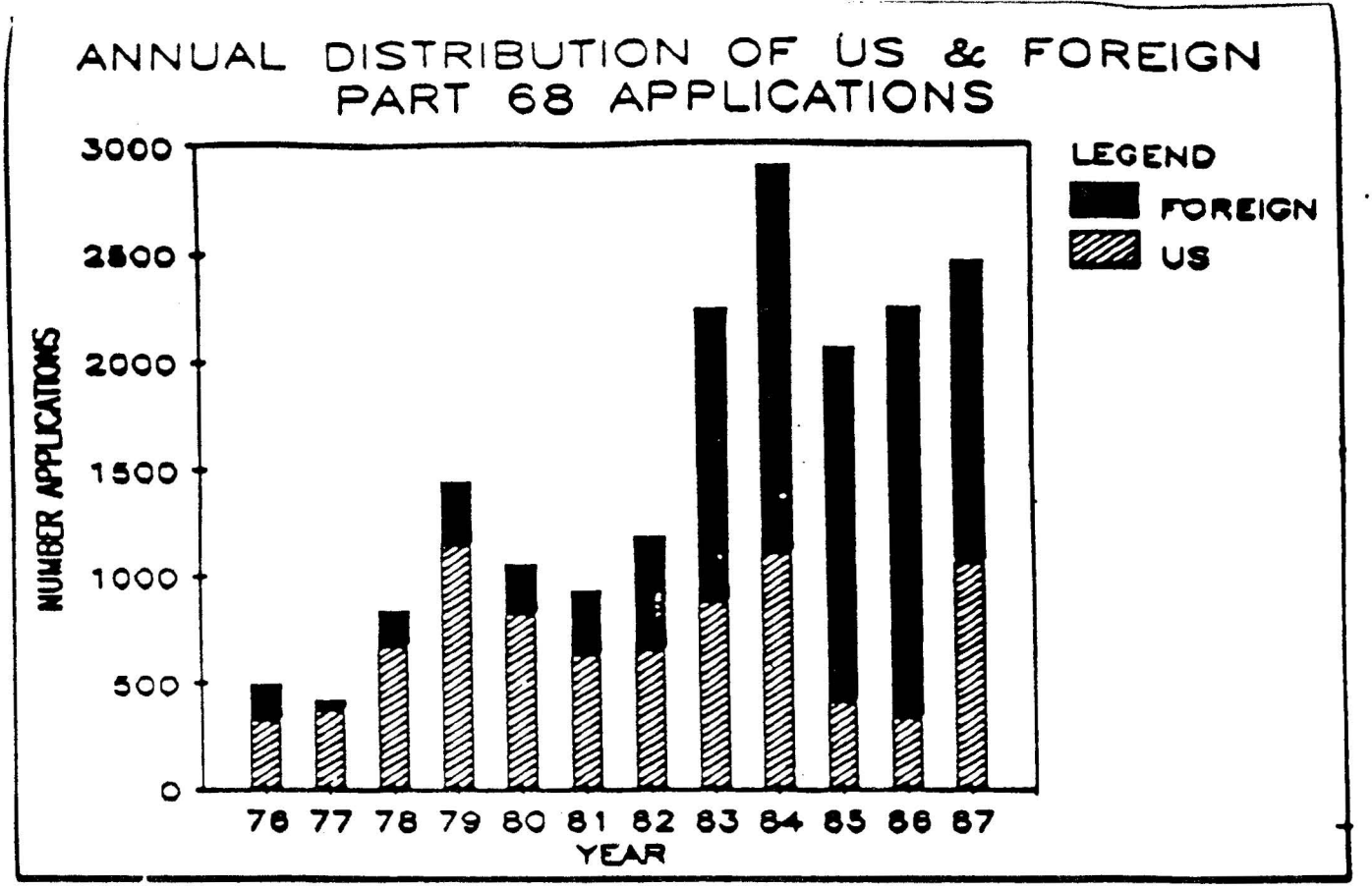
Computer storage devices

Laser disks

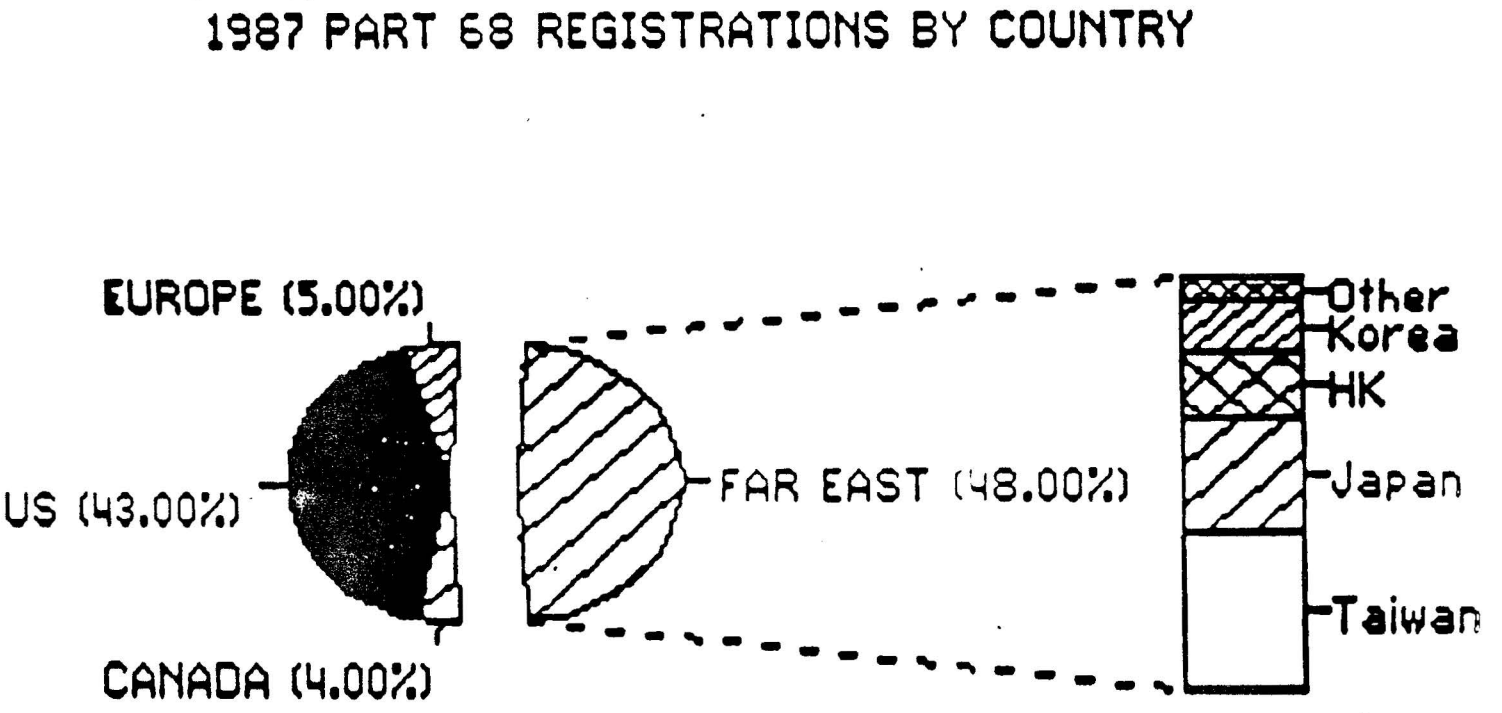
TRADE DEFICIT:

	1981	1987
ELECTRONICS	+ $6.04 bil	- $15.01 bil

	1981	1986
TELECOMMUNICATIONS EQUIPMENT	+ $817 mil	- $ 2.5 bil



18,471 applications since 1976



W. Von Alven, FCC, Washington D.C., 1988.

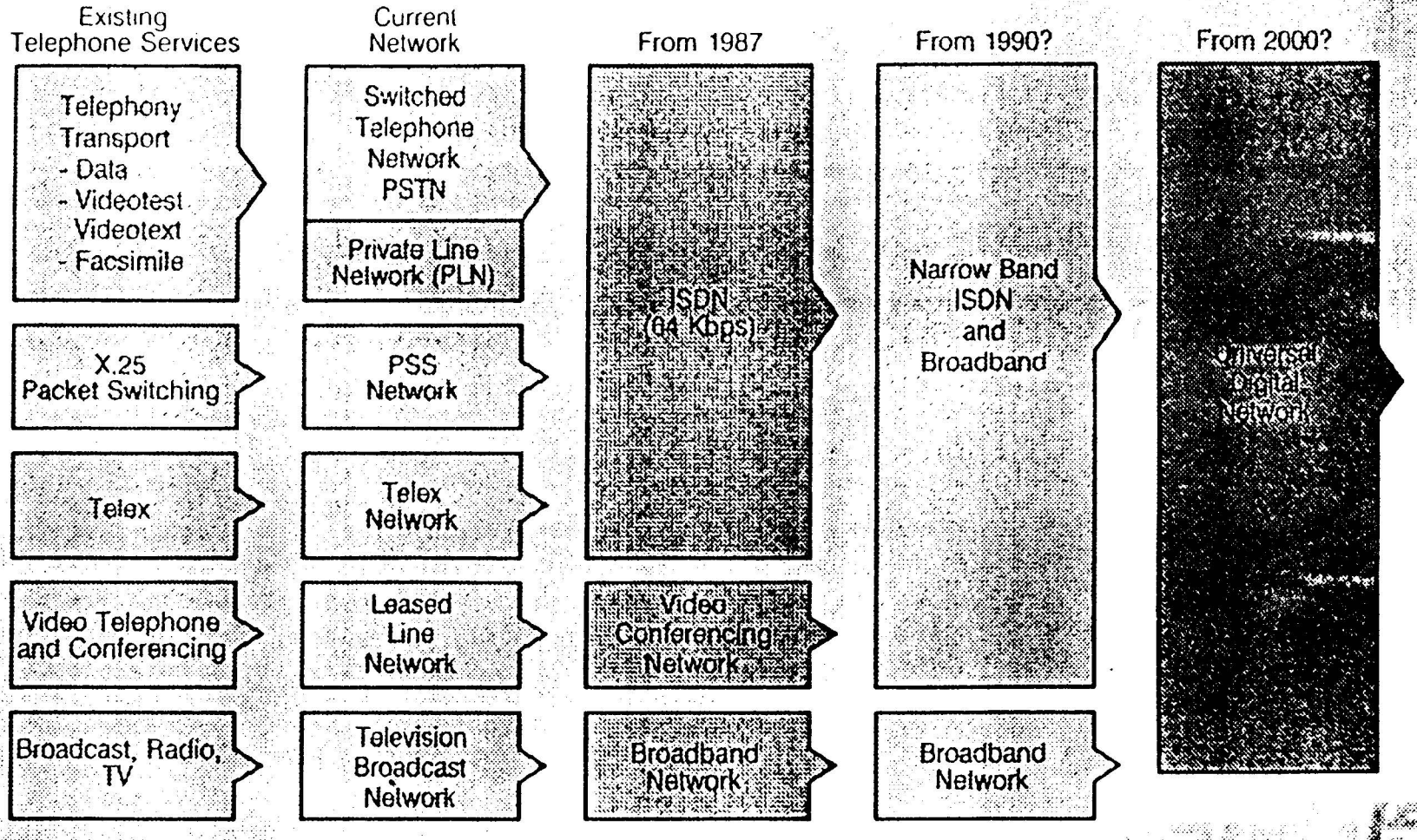
For network equipment, in a few years, according to a study cited by NTIA, the BOCs will be buying 58% of their equipment from abroad.

And while American electronic industries are burning, much of the policy response is to fiddle the old tunes. Washington is hopelessly split along half a dozen government institutions, and the FCC still seems to believe that if it does not take an active role, technology standards will be set by market forces rather than by Tokyo and Brussels.

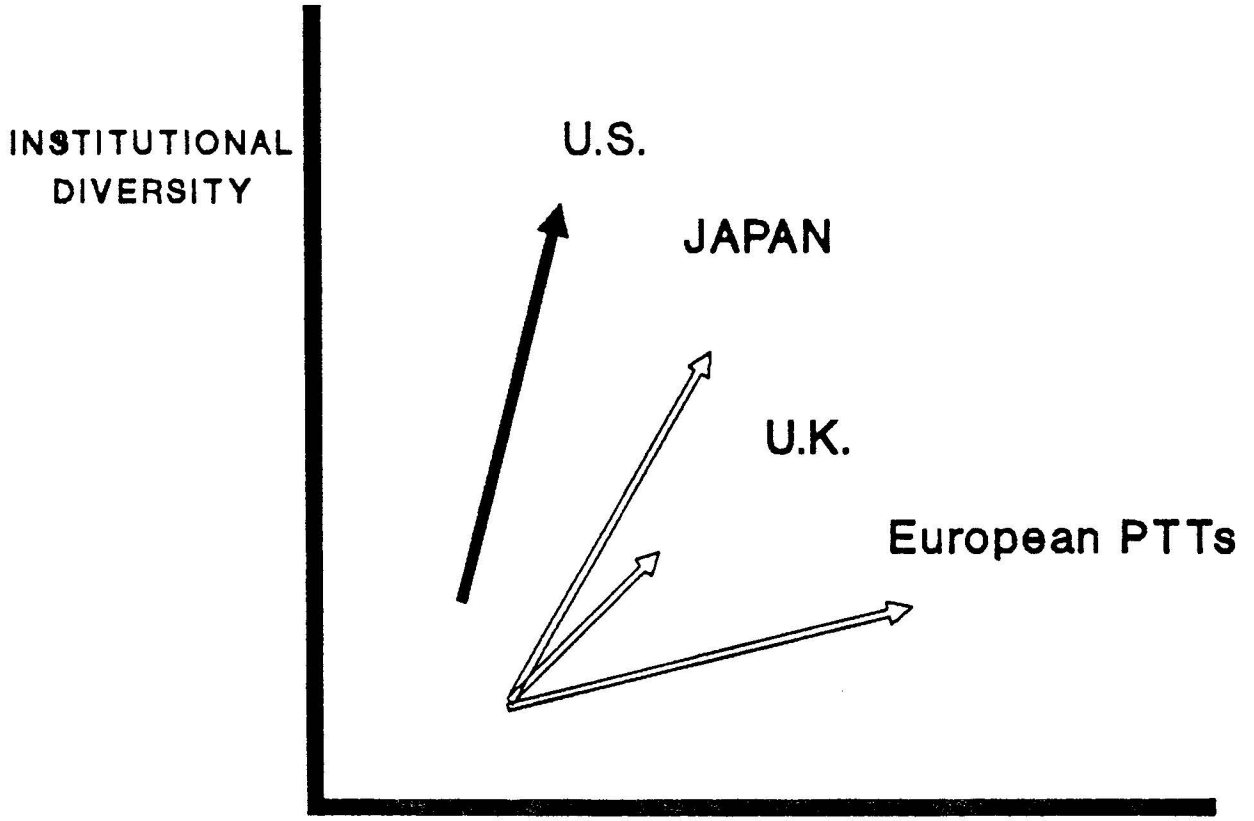
Just as alarming is the absence of a response by State regulators. It seems as if we simply don't connect this problem to our public interest responsibility, maybe because they are non-traditional concerns and less familiar than the good old turf issues. Sooner or later the public will hold us, too, accountable as part of the problem.

Now how does Open Network Architecture fit into this? It helps if one understands that telecommunications are today shaped by two basic but conflicting tendencies: the trend towards technical integration on the one hand, and the trend towards institutional and business diversity on the other. To some extent these two are substitutes for each other. To advance technologically, you can upgrade your network by more powerful integration, such as through ISDN or IBN. [Chart 4] Or you can bet on the impact of more competitive diversity. Chart 5 maps the strategies of several countries over the past few years. The European PTTs stress ISDN and integration. The US mostly goes

ISDN TECHNICAL EVOLUTION



NATIONAL STRATEGIES FOR NETWORK EVOLUTION



for institutional diversity. Not surprisingly, Japan is the most balanced in combining a major push for both in terms of diversity and integration. There is probably some form of efficiency frontier there, and while I don't know where it is, I am sure the U.S. is not on it.

ONA type unbundling is for the United States one way of dealing with diversity. It permits to tie together and make more vigorous the great number of providers of communications services. It would be nice if we could also make a big push in terms of integration. We are falling behind in ISDN. Nynex, for example, waits for ISDN demand like others wait for Godot; it is supposed to appear somehow, without the underlying service being offered that would generate applications. It's a classic chicken-and egg situation. That's why I've been pushing a proceeding to provide incentives and a move towards some more serious trials that would provide hands-on experience.

Now to a certain extent, the provision of more diversity is a partial substitute to technical integration, and it is probably the comparative advantage of American society which always thrived on diversity rather than on fostering large public systems. That's why the U.S. should play the strong suit and make rapid progress on ONA and on unbundling. And I will argue that this will not only give us a network of substantially more power and usefulness, and at a lower cost to users, but that it can and should also be used as a lever in a policy that encourages the domestic industry of electronic equipment and

applications. But to do so, it requires a more proactive technology policy for telecommunications in Washington and among the states, and this in turn requires some conceptual thinking about the network system, and about who has to make these policy calls.

In preparing this talk I started looking around for any such conceptual way of going about unbundling. It was Nobel laureate George Stigler who demonstrated that bundling could be used as a way of price discrimination; several antitrust decisions also struck down various forms of tie-ins, as restraints of trade. On the other hand, there obviously must be such a thing as excessive splintering the network in ways that are technically and economically inefficient. Or unbundling at the wrong places. Or unbundling in a way that reduces national compatibility. But it seems that very little analytical contribution has been produced in the millions of pages on ONA. So far, the issue has been dealt with largely ad hoc. Users wanted certain services in the various RBOC regions, and the RBOCs set out to offer them some of these elements and not to offer others, in an often inconsistent pattern. Some of these service elements were labelled BSEs, some BSAs, still others CNSs and ANSs under differing conditions and statuses. The States also served notice that they will be involved. The FCC has clarified some of the issues, sent others back, but essentially is going along with the proposed filings of the basic RBOC model, while acknowledging that modifications will be needed in the

future. This, of course, is a sensible and pragmatic course. Very reasonable, very safe. Take a first step, see what happens, and resolve the next set of problems and inconsistencies in the future. The problem with such an approach is, however, that one easily ends up with a system that is not based on any criteria except minimizing conflict. Somehow there must be a basis for evaluating the question whether a service element ought to be provided, how unbundled it should be, and how varied it can be across the country. If you don't have an explicit or implicit model in your head to answer such questions as they come up, and if you ad hoc it year-in, year-out, you can easily end up, after a while, with a national networks that proudly proclaims: Rube Goldberg was here.

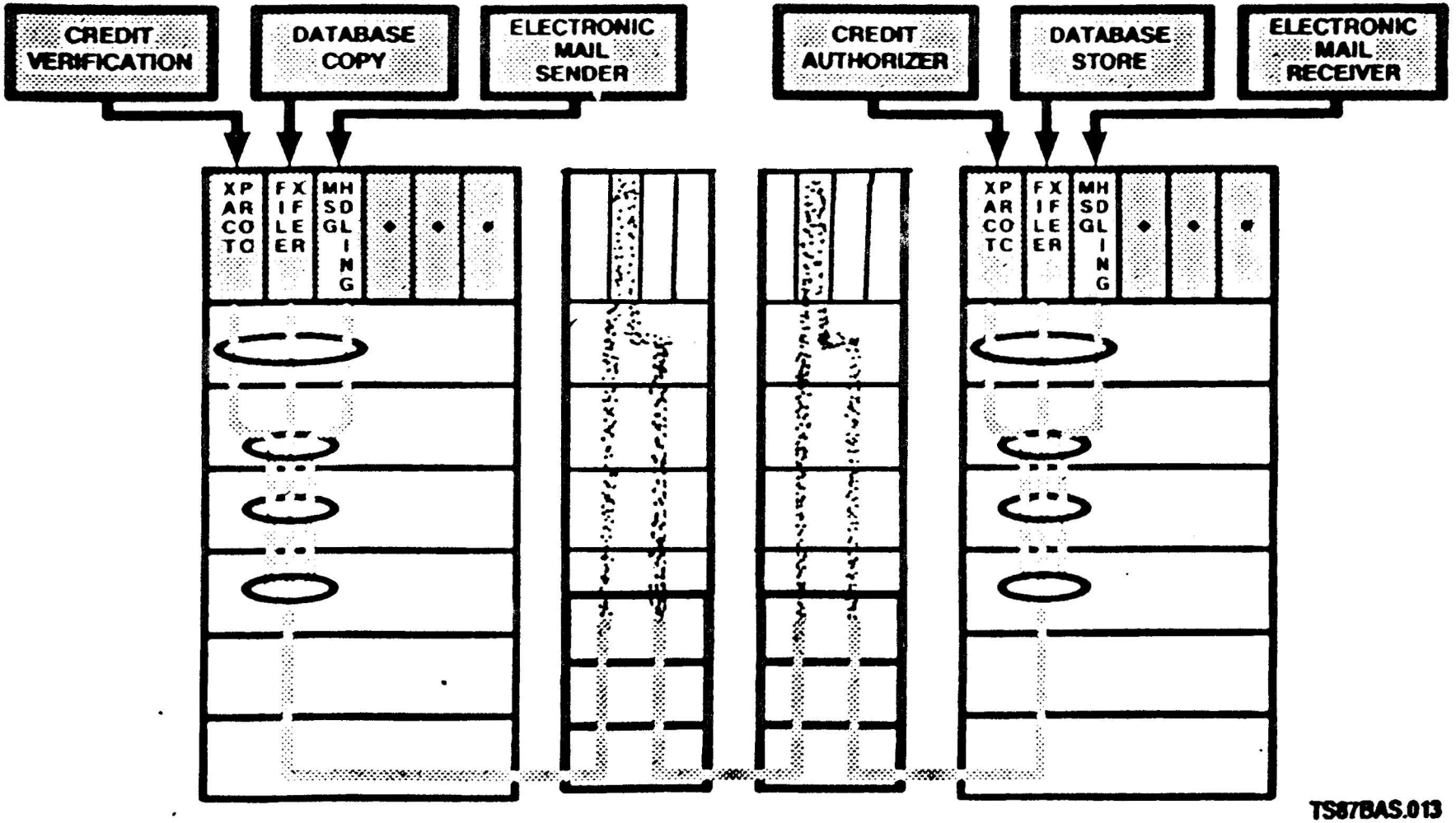
And to unscramble the omelette later is always much more difficult than to have some basic blueprint to begin with. So I'd like to make some beginning in this.

It is helpful to think of a network as consisting of hardware and software functions. The software functions are, to a certain extent, modular. Or rather, the tendency at least in data transmission is in that direction, and will in time in an ISDN network also apply to voice. That modular software architecture is based on something called the OSI hierarchy which stands for Open Systems Interconnection, and was developed by the International Standards Organization (ISO). OSI is based on a hierarchy of seven layers, each of which has defined functional responsibilities. An upper level layer is reliant on

the lower layers. But they are, in principle, independent modules, and one can rewrite the software protocol for any layer, and stick it back in without having to change any of the other layers. [Chart 6]

[Chart 7] is an example of an OSI operation. Here you have on the left and on the right the OSI stacks of two users' on-premises equipment such as two micro computers talking to each other. In the center you have network functionalities. The basic network would be only the lower three layers. But if the central office does more, such as storage or call rerouting, it would have all seven layers. The top layers are application, or more accurately so-called application macros. Examples in the graph are transaction processing, file transfer, or message handling. These application macros are independent software modules, although they can have also common elements. Communications are routed through the hierarchy, down and up and down and up and down and up, to reach the applications layer and module at the other end of the communication. So you can describe the software aspects of communications in this fashion. Now some modifications may be necessary to deal with voice and smart voice, and there are instances in which software still deals in an unmodular way with two layers together, or only with one half. So one should not take the OSI layers at full face value yet, but rather it is, with its internationally agreed upon modularity, a handy way to think about software protocols that drive telecommunications.

OSI Example


CREDIT VERIFICATION
DATABASE COPY
ELECTRONIC MAIL SENDER
CREDIT AUTHORIZER
DATABASE STORE
ELECTRONIC MAIL RECEIVER
XPARCOTO
FXFLEER
MHSDGLING
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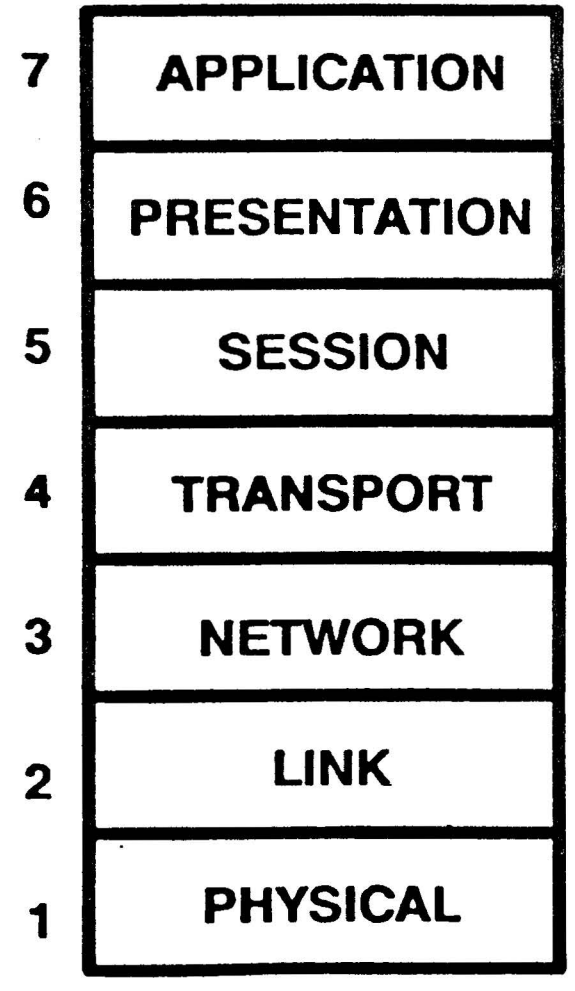
OSI Model



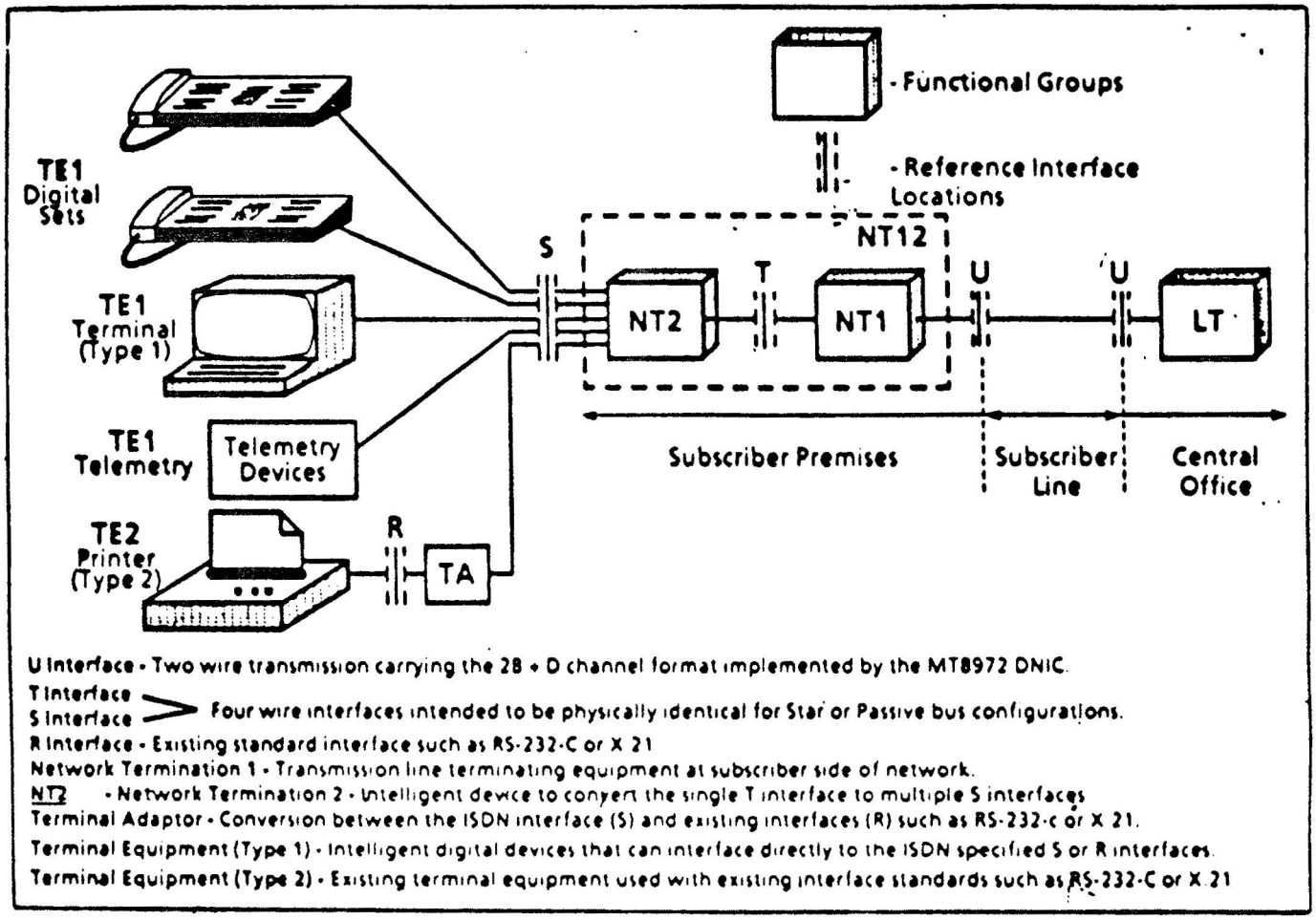
- User application process and management functions
- Data interpretation, format and code transformation
- Administration and control of sessions between two entities
- Transparent data transfer, end-to-end control, multiplexing, mapping
- Routing, switching, segmenting, blocking error recovery and flow control
- Establish, maintain and release data links, error and flow control
- Electrical, mechanical, functional control of data circuits

TS87BAS.004

Now let us move to hardware. Here, it is helpful to think of a network architecture as a sequence of segments. For example, the terminal itself. Or the inside wiring from it to the network termination point. Or from there to the serving area interface and the end office. Or the trunk between the local office and the tandem office higher up in the switching hierarchy. Now in the context of defining ISDN standards, the international standards body CCITT defined these segments, at least those close to the user, very carefully, and separated them with demarkation points known as the R, S, T, U, etc. [Chart 8] These are well defined points. You can use the same technique for segmentation throughout the network. [Chart 9] The consultant to one of the parties, Dale Hatfield, in fact argued that these segments ought to be available as service elements. My purpose here is not so much to deal with the dispute, how far ONA ought to go, but rather to map the network.

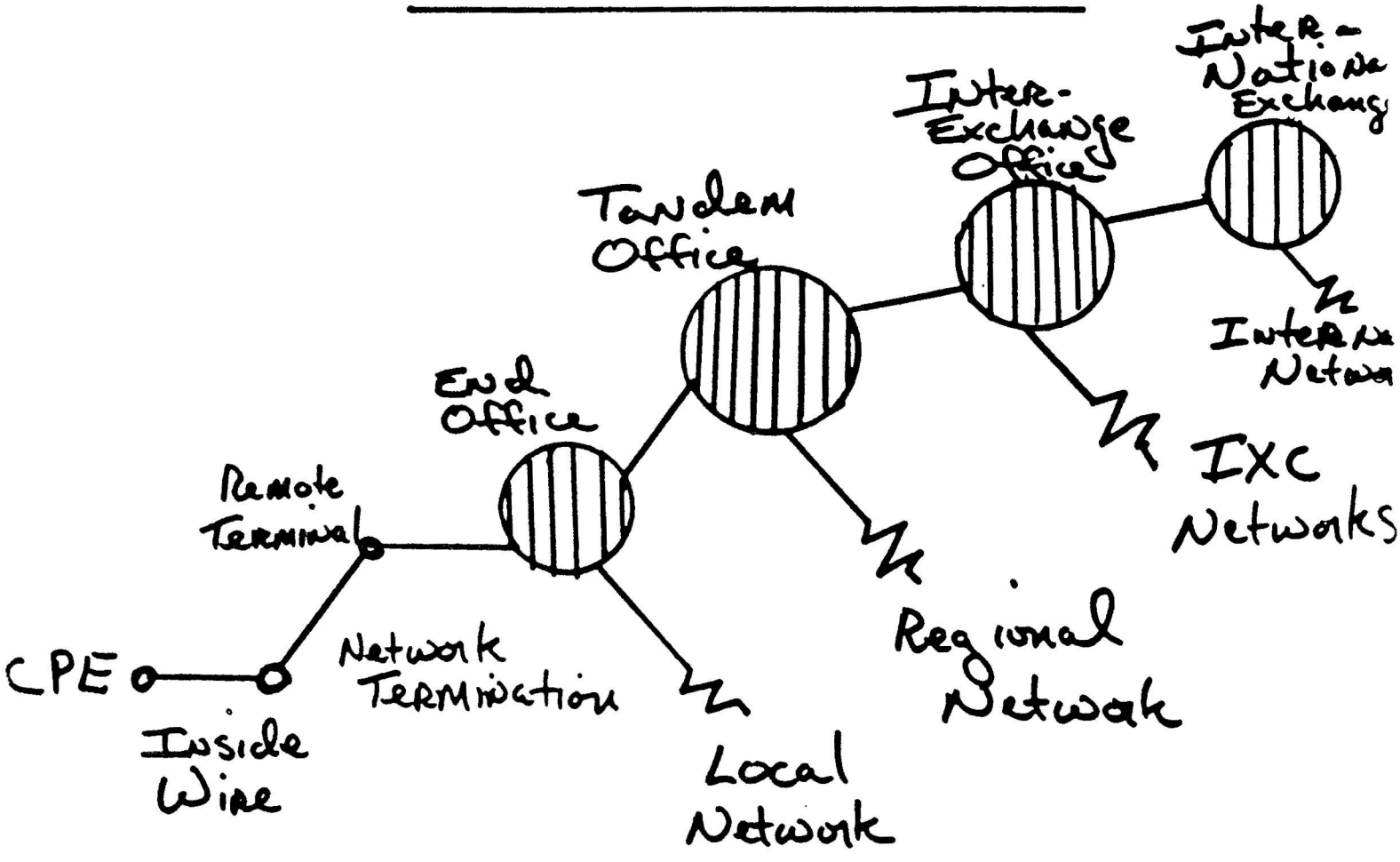
Now suppose we put together the software and the hardware presentations into a system of coordinates. [Chart 10] On the horizontal axis, we get the physical segments, from the periphery of the end user [Point Z] through the hierarchy to A and back to an end user [another Z]. On the vertical side, you have for each physical segment the software hierarchy of a model such as OSI. Now I know, not all physical segments would have all seven layers, but that does not make much difference here. The chart thus maps the network schematically. Each section is defined by a set of coordinates. Now when we talk about service elements,

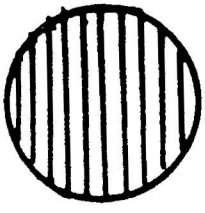
Figure 6.



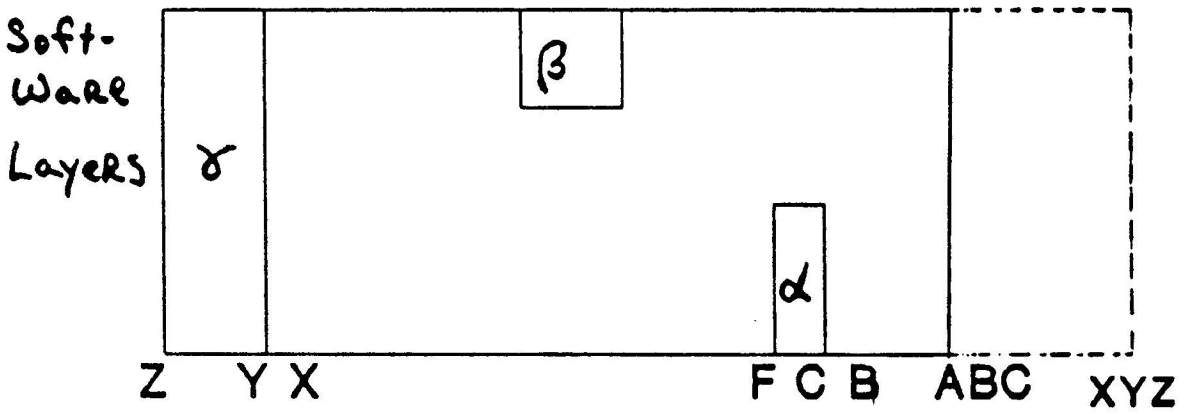
Source: Eli M. Noam, Telecommunications in Europe, Vol. 2, forthcoming. Chart from Telephony, 6/17/85, p. 31

Physical Network



 = Multiple Functions

MAPPING
the NETWORK



Hardware Segments

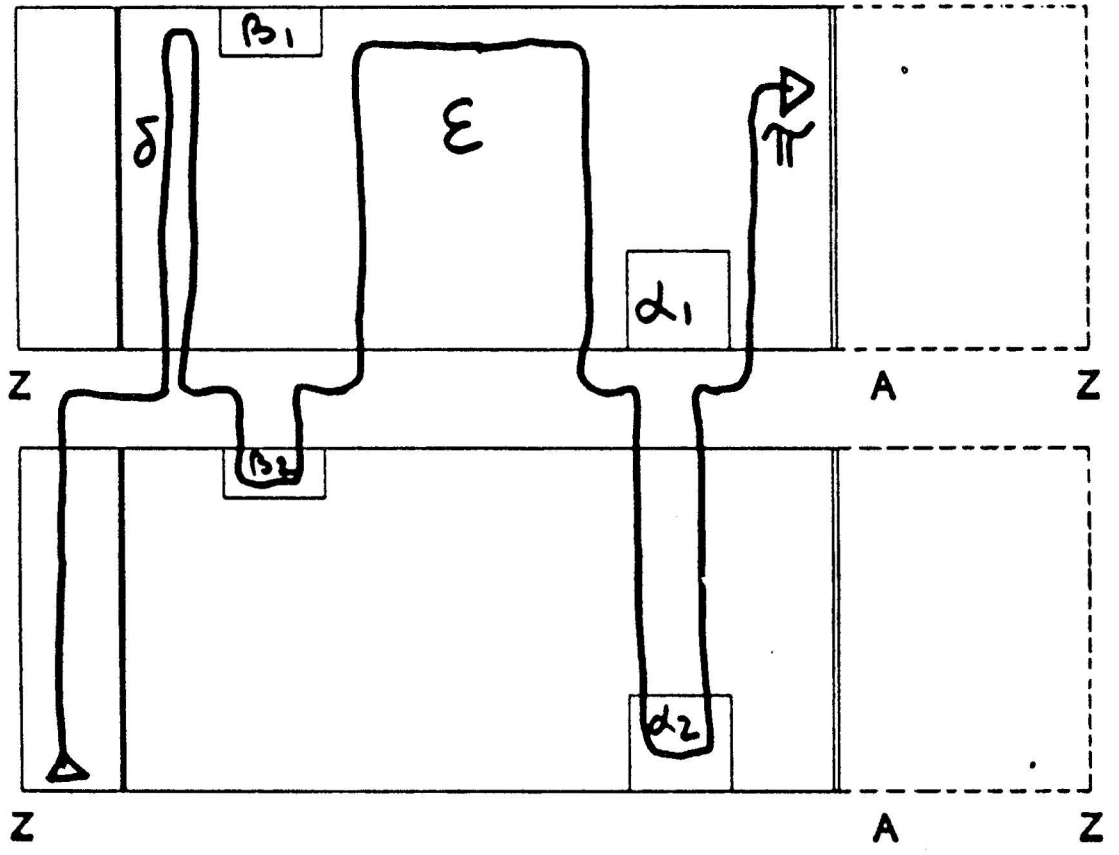
they can be graphed into the map, such as alpha, beta, and gamma. Alpha, for example, could be an interoffice transmission trunk. Beta is an applications module. Gamma is CPE. Etc. etc.

Now almost all of this territory used to be occupied by AT&T, but the development of the last two decades has been for others suppliers to enter, too, and most actively at the ends, where the CPE is located. This is schematically graphed in [Chart 11], which shows that some alternative supply exists. But the blocks that are offered usually lack the connecting physical and software elements that are necessary for an end-to-end connection with users, and which the traditional carriers possess. This is why, if we want to encourage the supply and creation of alternative service elements, we must provide a framework of interconnection with the other elements of the network. And this is the major rationale for ONA. Eventually we want the islands to grow larger and larger and fill the entire map and to make much of regulation unnecessary, so that the PSC can do something more productive with its time, such as regulating Shoreham. In the meantime, however, we and the FCC can liberate the islands of competition from regulation. But that may mean that the ferry service to these islands need to be assured.

As these islands grow and hopefully proliferate, it is essential that they all can all interrelate in a sensible manner in terms of technical standards, protocols, and boundaries. This is why it is essential to establish some form of a network

INTERCONNECTING THE COMPETITIVE ISLANDS

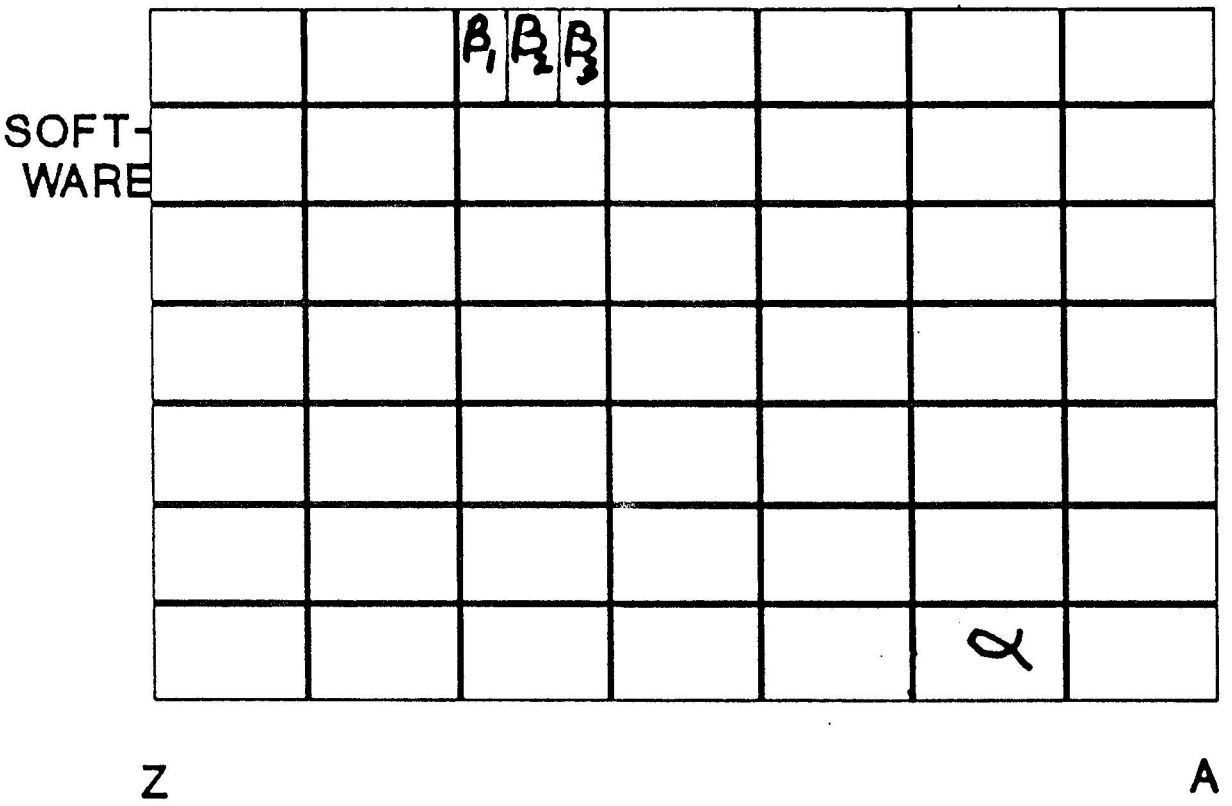
TRADITIONAL CARRIERS



NEWCOMERS

blueprint. And I think that this should be a policy priority if you want to be proactive rather than reactive. To make an analogy: lower Manhattan is a jumble of streets, because it is not based on any design but probably on the path chosen by Peter Stuyvesant's cows. Further uptown, however, there is a grid system, which was put on the maps many decades before any streets were actually laid or houses built. Can you imagine Manhattan traffic if all of its streets were designed like in the Wall Street area? It's bad enough as it is! And there would certainly be no Central Park. What in my view must be done is for a similar grid system to be defined for the network. It would define vertical and horizontal coordinates, and the technical standards of interconnection between them. In this fashion it would set out a system of <u>modularity</u> which would make possible an interconnecting modular network system. [Chart 12] Within the modules people could do whatever they wanted. and of course they could connect modules together. But you could replace one module, and it could interact with the others. It is easiest probably to set the physical coordinates in spatial terms. But it is also probably necessary to deal with the central office functions, and here the dividing lines may be more complicated and controversial. At present, the stored program control switch generics combine functions of access, features and functions, and transport. And COs combine several physical as well as software segments. This is a complicated but manageable issue.

A GRID OF NETWORK MODULES

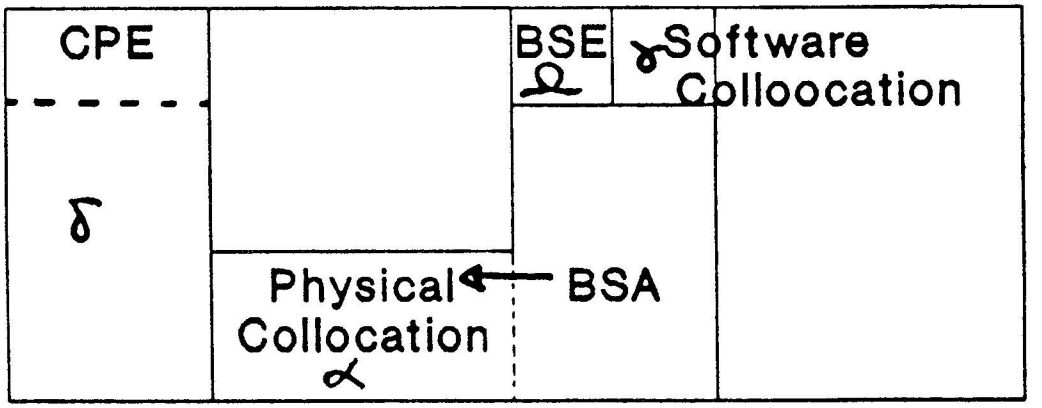


HARDWARE

It is not necessary to have all modules in place right now. Some embedded technology may straddle several modules, and separation today may be impractical, even as it is phased in. In other instances, a module may be an empty box, because nobody offers it. But one must have an eye to the future. Nor must each module be offered on an unbundled basis forthwith. That is a regulatory policy decision which will have to take into account also the cost of such unbundling.

The map can show what some of the fights over ONA are all about. The RBOCs plans essentially creates so called basic service elements, or BSEs, which cover essentially part of the region such as omega [Chart 13], mostly applications. But to get BSEs one needs also so-called Basic Serving Arrangements (BSAs), which you can think of as some territory alpha to the left and right of omega, including all the way to the user. In other words, without alpha there is no omega. The ESPs, on the other hand, don't want alpha, thank you very much, or rather they don't want to pay much for it. So they want to provide their own alpha, which means that they want to bring in their own wire and their own black boxes right into the LECs exchange, and this is called collocation. I should mention here that the New York PSC, in its competition docket, has discussed this matter, and as the public discussion and various press releases indicate, we are inclined to grant such collocation for private line type interconnection, while looking at switched type collocation later. I should also mention, at least parenthetically, that collocation makes

COLLOCATION



obsolete the regulatory distinction between CPE--customer premises equipment--and network equipment. It also raises questions of then what exactly a BSA is as distinct from a BSE, if you can get a BSE without the precondition of a BSA through collocation.

Now what's good for the goose is good for the gander. That's why we would require reciprocal collocation also at the collocators themselves, and also want to have an equality of burdens as well as an equality of rights, by having collocators contribute to something like a universal service fund that would go toward supporting social goals such as lifeline, service for the hearing impaired, coin phones at dark and distant corners, etc. This type of fund could also potentially contribute to some of the costs of unbundling.

Now who should set the network grid? The possible actors are the FCC, the States, the industry narrowly defined, the industry broadly defined, the National Institute of Standards of the Commerce Department, other national standards bodies, or the international CCITT in Geneva, the European PTTs coordinating body CEPT, or the Japanese and European industry.

In my view, it has to be an American initiative. The evolution of the American network system with its diversity of players is many years ahead of those of other countries, and to wait for them to catch up makes no sense. Secondly, the modularization of the network should be part of an effort in strengthening the American telecommunications equipment,

software, information, and network industries, without protectionism and artificial barriers, because modularity makes sense in terms of American network policy. But once in place, such a system has trade implications. Modularized American equipment and software could still be sold bundled abroad, while bundled foreign equipment would need to be unbundled to be useful here. Perhaps more importantly, the greater competitiveness that would be possible through the greater openness created by modularity could in time make American suppliers more competitive internationally.

Modularity would also make the service providers and carriers less dependent on any particular equipment manufacturers since there will likely be more competition to supply any specialized module than to provide a whole big central office switch, which is a multi-billion effort now and where the PTT countries with their targeted domestic procurement will increasingly have the edge. Just think of how ITT was expelled from Europe. Also, the modularity of software will make carriers less dependent on the switch manufacturers and their complex multi- million line programs. They can encourage the development of software applications by outside suppliers, just like IBM did with its software applications for the PC.

This gets us to the question who should be responsible in the United States for the setting of such a grid. In my view, there is the need for a proactive role for government in these standards and definitions areas, in collaboration with industry.

This may be one of the major remaining roles for the future. Indeed, the main carriers and their competitors have the interest and the expertise that is necessary, and they have worked reasonably well together in ANSI and its T-1 and X-3 committees, and in IILC on ONA issues. But experience, as well as the theoretical economic literature on standard setting and game theory shows that standards do not necessarily evolve optimally, nor smoothly, nor speedily, in a purely voluntary setting. You are asking for strategic behavior, and it's a firm's strategy, not a national one. And there is a strong need for national compatibility. This suggests to me that the best institutional set up would be energetic FCC leadership with an inter-industry task force on its side. In New York, we established two weeks ago a system of ONA inter-industry task forces to get a first crack at technical issues, under the chairmanship of PSC staff, and under very short deadlines to prevent dilatory behavior. I believe that the FCC should appoint an internal task force that is heavier on technologists than lawyers and economists (I am not parochial) to look into this in a speedy fashion.

Now where are the States in this? In my view, while the states have a role, they should not contest the FCC's predominance, but rather put forward the states position in a cooperative way. And I am speaking as someone who initiated the ONA issue on the agenda of the PSC through a proceeding, and who defended the ONA rights of the States before a Senate subcommittee and before the FCC in a filing. But in the

unbundling issue, there is also a clear need for national technical compatibility that far overrides sensitivities of turf.

It would be a truly terrible idea if States were to have differing interconnection and segmentation requirements that lead to differing architectures in central offices or CPE. To tie up everything in long-drawn turf battles is not in the national interest.

This is not to say that the States should have no role. First, of course, a cooperative and advisory role before the FCC. Second, States should be able to have some blocks subdivided more finely than the FCC, within the FCC's unbundling grid. This way, if New York, or if Bell Atlantic, think that there should be more unbundling than provided in Montana or in Ameritech territory, this could be accomplished. In some circumstances, the FCC could even provide State-optional additional subdivision points. In other instances, a State could hold off the application of the intra-state part of the FCC grid to itself for a set and limited time, as long as it did not implement a conflicting set of coordinates.

And, of course, States would still price intra state building blocks, as long as this would not be done to stymie the unbundling scheme. Therefore, if they didn't like a particular technical unbundling, they could provide for a tariff option where they are also, and I stress "also," offered in a bundled fashion, and there could be even some form of a discount or incentive built in to strengthen the bundle, as long as there is

no clear penalty for choosing the unbundled option.

Suppose an ESP asks for the introduction of a new application module such as gamma on Chart 13. There are several scenarios possible:

First, the ESP shows up with its own private software, for use only by its own customers. Then in effect the ESP is asking for inclusion of its software among the central office software functions. I will call this "software collocation." I am sure that local exchange companies will shudder at the notion and consider this a socialization of the network, but it's not really a bad idea commercially for them, as long as its conforms with standards and protocols, doesn't displace anything because of limited capacity, and of course pays its way. Already, some of the LECs have been developing a software interface as part of their Intelligent Network/2 plans, as part of their business strategy. For them, it may be a much better idea, in comparison with having the ESP lodge its software functions in its own black box that's somewhere in the central office if you have physical collocation. In other words, if regulators permit physical or virtual collocation, software collocation by contract is really a logical and probably much more efficient way to go, for both LECs and ESPs. From the telco's point of view, at least they don't have to trip over other companies employees and equipment, because software collocation should be feasible antiseptically by electronic communication. And it would also open up a scenario of very exciting applications. In effect, the

telco could subcontract with software developers and ESPs for services under its own or under the ESPs imprimatur. It would offer some itself, but would also have to compete against software and physically collocating ESPs and non-collocating ESPs. Some of these ESPs in fact could be other LECs and RBOCs from across the river.

At present, most computer hardware is designed to accommodate an operating system such as DOS or UNIX with applications programs such as spreadsheets, and wordprocessing. Telephone digital switches, though similar to computers, in effect mix the operating system with the applications, so that it is difficult for telephone companies or independent software companies as opposed to switch manufacturers, to write the new applications software. However, this situation will not last too long -- soon switches will be much more hospitable to software customization.

Here, too, reciprocity must be one of the governing principles. If ESPs can locate software or hardware in RBOC network, then the RBOCs should be given similar rights in other networks. Interconnection goes both ways. Furthermore, if user software can move upstream into the RBOC network, then RBOC hardware should be able to move downstream to user premises, to be used with user software or with the RBOC-provided one. This is shown by 8 in Chart 13. In other words, reducing the restrictions on RBOC equipment activities is a symmetrical response to ONA and collocation.

Much of the new applications may at first go toward commercial customers; but there is no reason why one could not also encourage applications, for example for health or social services, by supporting their initial development through the Universal Service Fund mechanism I mentioned before.

I don't want to get into pricing issues, because they are the subject of another panel, except to suggest that any definition of cost in such or other ESP arrangements must include a measure for the externalities in terms of performance of the central office. That is, if an ESP's added functionalities lead to a slowing of the switching time for everybody, then this should be offset by increasing the capacity or speed of the switch, and the cost for that is part of the cost imposed by the ESP.

A second scenario is where an ESP wants a customized module. The ESP could subcontract with the LEC to have appropriate software developed and put on line. As long as the software collocation option is there, one could use software developed elsewhere, and LEC-customized software could be priced on the basis of a commercial contract and would need no regulation. There is no market power. If the telco could make this application also available to other customers, this would presumably be reflected in the contract price.

I must come now to the conclusion. In the future, it will become increasingly difficult to say what <u>the network</u> is, and it's better to think of it as a federation that must interact.

The distinctions of private and public, of CPE and network equipment, of national and international, will increasingly fade. The old arrangement was based on the notion of sharing in terms of technology, economics, social policy, and politics. To some extent we are moving away form this sharing arrangement, because of the entry of new suppliers, and, perhaps even more importantly, because of the exit of major users form the old sharing coalition. It may be more efficient on some level to share, but by the same logic one should not buy books but use the library, and one should not buy a car but take the bus or taxi. In other words, the efficiency of capacity utilization is not the only thing driving the economic system. What is important for us regulators is not to ban private cars, so to speak, but rather to make sure that there are basic rules of the road, rules of interaction, based on the principles of compatibility, interconnection, non-discrimination, and reciprocity, that make it possible for this quarrelsome network family to live and work together. It's true that in the short term revenues may be lost from the public network operator, and that costs may be incurred. But one must take the long view. First, cost will come down with competition. Second, network revenues will go up as utilization goes up, and new applications should increase utilization. Third, where there are still revenue losses, we should make them up rather than stop the evolution of the network. And contributions for traditional social services such as life line should also be made by the newer members of the network family.

And if things go badly, we can always reassess some of the questions -- hopefully in a nice setting such as this one.

But I do hope that the pleasantness of the surrounding does not detract from the seriousness of the situation. The American IT industry is falling behind. A push in telecommunications is important. And to that purpose, it is important to structure the network environment in a way that permits flexibility, competition, and innovation, and to do so, the establishment of a network system based on modularity should be a priority. I very much hope that the FCC will take the initiative in moving in this direction, by structuring its ONA unbundling in a systematic and consistent fashion, and by appointing a task force at the earliest opportunity to look into this matter.

Thank you very much.

Information Industries with Small or Declining American Presence

Television sets

Memory chips

Super-computers and next generation computers

Video cassette recorders

Small and medium sized copiers

Facsimile machines

Expert systems

High definition television

Video Cameras

Printers

Telephone handsets

Answering machines

Computer storage devices

Laser disks