SECTION 4

NETWORK CONTROL SIGNALING

INTRODUCTION

The control network signaling functions are associated with the initiation, placing, answering, and charging of calls over the switched network.

Malfunctions can cause incompleted calls, or calls completed to other than the intended terminal. Processing such imperfect calls reduces the capacity of the network to serve "normal" calls. The effects of these malfunctions, then, may be felt by all users of the system, not just those originating and answering imperfect calls.

The present state of the switched telephone network does not permit easy identification of the source of this kind of malfunction, that is, to locate it occuring as in the subscriber's station or in the central office. Maintenance personnel, tests, and administrative procedures become involved in the attempt to localize these malfunctions as they come to light.

CONSEQUENCES OF IMPROPER NETWORK CONTROL SIGNALING

The purpose of this section is to identify the consequences of improper network control signaling without attributing these consequences directly or indirectly to the interconnection issue.

The consequences of improper network signaling pervade the entire network and can be grouped into the following categories:

incorrect billing;

wasteful use of central office equipment;

wasteful use of transmission facilities;

annoyance to other users;

wasted testing and maintenance effort;

unnecessary administrative expense;

costs to remedy consequences.

The following are examples of each category:

Incorrect Billing

On a two-party line, the billing equipment at the central office recognizes which party is making a call because of a DC connection to ground from one side of the line. If the connection to ground is not made at the telephone, or if the telephone is installed or maintained improperly, the wrong party will be charged on some calls.

In individual line service also, there is a chance of incorrect billing. This can happen if the equipment attached to the loop is either deliberately or unintentionally designed to "fool" the central office equipment. The vast majority of existing central offices have no protection against this.

Obviously, some control over the equipment attached to the loop is required to avoid deliberate or unintentional billing errors. Loss of revenue seriously affects the carriers and their customers.

Wasteful Use of Facilities

Wrong numbers caused by faulty dial represent a waste of telephone lines and of switching equipment. Faulty switchhook operation is another source of trouble. If, when a call is completed, the switchhook contacts fail to open properly, or some extraneous impedance

remains bridged across the line, the connection will fail to release for about thirty seconds. This is thirty seconds during which the circuits are not available to other users.

Annoyance to Other Users

A wrong number produces obvious annoyance to the customer who is falsely called. Wrong numbers due to faulty dials can and do occur. Where the call is not released properly due to switchhook trouble, the customer himself will be unable to place calls during this interval and customers trying to reach him will receive busy signals.

Added Testing and Maintenance Effort

Another consequence of improper network control signaling is an added burden on testing and maintenance. Faulty network contact signaling often shows up as an intermittent trouble. These are the hardest to trace and to diagnose.

Added Administrative Effort

Improper network control signaling can result in customer demands for credit against his telephone bill due to false charges. Since the source of the trouble, as previously mentioned, is difficult to trace and correct, the added administrative effort required can be considerable.

Conclusions

Improper network control signaling leads to inaccurate billing, wasteful use of the telephone plant and administrative effort, as well as annoyance to other users. In planning for the use of customer-owned network control signaling devices, the quality of network control signaling must be preserved.

FAULTY NETWORK CONTROL SIGNALING WITH CUSTOMER-OWNED EQUIPMENT

It is difficult to evaluate the effect of interconnection on network control signaling, since it is not known at present what precise instrumentalities users will employ for this

function. Network control signaling performance is closely related to the very detailed design and performance of the device used (switchhook, rotary dial, touch-tone pad).

The best that can be done, therefore, is to cite present experience of the carriers using their own devices. It will be understood that, as a matter of necessity and economics, these have been developed to a state of high accuracy of performance and reliability. Starting from this point, it may be postulated that devices owned and used by customers will be either (a) as good as, or (b) poorer than, these carrier-furnished devices. The consequences of these assumptions are drawn in the following section.

ECONOMIC PENALTIES OF NET CONTROL SIGNAL DEVICE FAILURES

Data on Bell System rotary dial and ringer units show a mean-time-between-failures (MTBF) of twenty-six years. This is equivalent to a failure rate of 0.0385 per year. For a population of 10,000,000 net control signal units, this failure rate will require 385,000 trouble visits annually; these represent an average cost of $15 per visit or a total cost of $5,770,000 per year.

Most vendors and users, lacking the motivation that has impelled the carriers to extend the reliability of network control signaling devices, would be satisfied with a seemingly reasonable, though lower, MTBF. Assume, for example, an MTBF of five years. The impact on network operation and costs is profound. Now, the failure rate is 0.2 per year. A population of 10,000,000

net control signaling units will have 2,000,000 failures, and an associated maintenance cost of $30,000,000. This is an increase of 520% or $23,000,000 in maintenance expense.

More generally, Table I gives annual network maintenance cost for network control signaling units as a function of MTBF of a single unit. The sensitivity of maintenance costs to network control signaling unit reliability is clear.

TABLE I

MTBF	Annual Maintenance Cost
26 years	$ 5.77 M
20 years	7.50 M
15 years	10.00 M
10 years	15.00 M
5 years	30.00 M
1 year	150.00 M

A second type of cost associated with network control signaling unit failures is the result of wrong numbers, wrong toll charges, etc. Some of these costs are estimated as follows:

Wrong Number	$0.05/call
Refund Request	$0.10/call
Delayed Refund Request	$3.00/call

It is difficult to estimate the frequency of such occurrences as a function of MTBF. The costs incurred would, for any MTBF, be a small fraction of the costs listed in Table I.

A third type of cost associated with net control signal unit failures is that due to false calls for assistance by the user. Where free interconnection has been permitted in the past (with governmental agencies, for example),

it has been the experience of the carrier, that he is frequently called to perform maintenance when, in fact, the interconnecting equipment is at fault. This phenomenon can be expected to persist with any form of interconnection where a specific interface between vendor equipment and the telephone company is not clearly defined as it is with an interface box. Costs for false calls of this kind can be expected to be a significant fraction of the costs in Table I, and will add to those costs.

The three types of costs described are a function of the MTBF of the net control signal unit. The costs are very significant when evaluated in terms of a large number of subscribers. Any excessive costs will be borne by both users and the carrier, since some costs cannot be properly allocated. Manufacturers and users do not have the motivation to achieve the excellence in quality which common carriers obtain. To keep total network costs at a

reasonable level, therefore, it is necessary that stringent control be applied to all net control signal units for direct interconnection.

TOUCH-TONE (MULTIFREQUENCY) SIGNALING

Available evidence indicates that there will be a substantial reduction in the frequency of wrong numbers with the increasing use of touch-tone network control signaling. Failure of the touch-tone (multifrequency) unit, unlike the rotary dial (d-c pulsing) circuit, is not interpreted by the central office as a wrong number. However, as has been pointed out, the costs associated with network control signaling failures which produce wrong numbers are relatively small.

SECTION 5

PROTECTIVE DEVICES

TARIFFS AND PROTECTIVE DEVICES

Unrestricted interconnection of customer-owned communications devices or of privately-owned unregulated communications systems to the public telephone network, as discussed in detail in Section 3, introduces the possibility of harm to the users of the networks in the form of degraded performance or an increase in the hazards of exposure of carrier personnel to dangerous voltages and currents.

As a safeguard against these potential harmful effects, AT&T has incorporated in FCC tariffs 259, 260, and 263, not only protective criteria relating to levels,

bandwidth, and signaling frequencies, but, in some cases, a requirement for carrier-furnished and installed protective and coupling arrangements to be placed between the telephone network and customer-owned and maintained equipment and systems. Certain classes of customers, who previously had interconnection rights without a requirement for protective devices, are permitted a choice between the new offering or continuation of previous arrangements. Private-line customers obtaining service under FCC tariff 260 are not, in all cases, required to obtain protective devices.

At the present time, the selection of devices and priority of design and manufacture rests with the carrier. Systems innovation and development of customer-owned devices may be influenced by the willingness of the carrier to produce specialized interface units and the extent to which customers can exert influence over new designs. This approach will be discussed in depth in later portions of this section.

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PROTECTION AFFORDED BY PRESENT CARRIER-FURNISHED DEVICES

Description of Devices

At the present time, the number of different types of coupling devices is limited. The available types are intended to fill immediate-known requirements. They are to be followed by additional types as needs are identified, economics are justified, and as development is completed.

It is not intended here to provide a detailed description of every coupler. Each is described in detail in a Bell System Technical Reference.

The couplers are similar in their basic functions, which are:

- to isolate the line from hazardous voltages;
- to limit signal levels;
- to preserve longitudinal balance;
- to protect the network control and signaling functions.

In its simplest form, the coupler is designed around an isolation transformer which interfaces directly, via a jack, with the customer-owned equipment. This transformer serves three functions:

1. it ensures longitudinal balance on the loop regardless of any in the customer's equipment;

2. it isolates D. C. currents in the customer's equipment from the loop;

3. it prevents hazardous A.C. voltages from being impressed on the loop by virtue of its saturation capability.

Varistors, shunted across the line side of the transformer, limit peak signal voltages. A capacitor in one side of the line blocks line current from saturating the transformer core. Some of the more complex forms of coupler include a more sophisticated signal limiter designed to reduce distortion of data signals. Others include arrangements for signaling and supervision, either manual or automatic, answering only or answering and calling. Couplers for interfacing customer-owned PBX equipment are more complex units.

Degree of Protection

Hazardous Voltages

The protection provided is excellent in the carrier-furnished units. A saturable transformer is an effective

method of protection. Fuses and circuit breakers rated for equipment protection cannot provide personnel protection because of the relatively small, but dangerous currents involved.

Signal Amplitude

The protection provided here also is excellent. The various types of limiter all ensure that proper levels are not exceeded.

Unwanted Frequencies

No attempt is made in any of the couplers to limit signal spectrum. The couplers provide no protection against unwanted frequencies.

Longitudinal Unbalance

The isolation transformer provides excellent protection against any defects in the customer's equipment, which could cause unbalance on the subscriber loop and consequent hazard of crosstalk and noise.

Improper Network Control Signaling

The subject of network control signaling and the consequences of improper control are dealt with in some detail in Section 4. In this section, conclusions are reached as to the effectiveness of the current carrier-provided interface arrangements in preventing improper network control signaling.

The degree of protection afforded to customer-generated network control signals is minimal. D.C. isolation is indeed provided between the customer's equipment and

the loop, but since signals are usually merely repeated, there is no protection against dial pulse speed variation, make-break ratio (in most cases), or repetitive dialing from a malfunctioning auto calling device. In certain cases, particularly with relays that repeat dial pulses, the coupling device can, in fact, degrade the dial pulses by superior timing characteristics of the relay.

IDENTIFIED ISSUES

Reliability

The protective arrangement or coupler introduces another electronic box into the system. Some have argued that the coupler can, itself, fail and degrade the system. What are the chances of failure occurring in a coupler? The answer, of course, depends on the complexity and soundness of design of the coupler. In the very simplest

type of voice coupler, several solid state diodes and an isolation transformer are all that is involved. Since all elements are solid state, life under normal operating conditions is pratcially indefinitely long. Transformer insulation failure at telephone line voltage is extremely rare unless the quality of the insulation is initially poor.

At the next higher level of coupler complexity, the diodes are replaced by amplifiers and an AGC circuit with power supply. Additional resistors, capacitors, transistors, and diodes are introduced. Under normal conditions, the life of this sort of coupler should be comparable to the life of the attachment. Certain of these couplers use relays for dial pulse repeating. Relays are notably poorer in reliability than solid state devices and can, therefore, be expected to have a somewhat higher, but still acceptable failure rate.

Redundancy

Redundancy, for purposes of this discussion, means that essential functions are unnecessarily duplicated in the coupler and in the devices attached to it. An example of redundancy occurs where a CDH-type coupler is used with a PBX. In this case, all functions of the coupler are repeated within the PBX itself from transformer isolation to regeneration of subset dial pulses which themselves meet the dial criteria. The redundant features could, of course, be deleted from the PBX. The manufacturer, on the other hand, maintains that this would mean that he would have to supply two types of PBX, one to interface with the CDH unit and another where a coupler is not required.

Redundancies can be reduced or eliminated by cooperative action of the carrier and the suppliers of attachments, or by the establishment of standards and by decree.

Transparency

Ideally, the protective device should be "transparent"; that is, its presence has no effect upon normal system functions.

"Transparency" has another, and somewhat different, meaning to the designer of the equipment attached to the telephone network. The ideal protective device to him is one that does not require that he make design changes in his equipment. For example, the AT&T CDH coupler for PBXs presents the non-telephone company PBX with a ten-terminal interface, whereas his PBX is designed for a two-terminal connection direct to the carrier's line.

Certainly, the greater the transparency of the protective device, the fewer the problems there will be in its utilization. Again, transparency can be assured by cooperative action by the carrier and the supplier of attachments, or, of course, by fiat.

Availability

Certain types of protective devices are said not to be available -- a coupler that will operate in a touch-tone system is one example. The problem of availability, however, appears to be easing. The most frequently-required types are available and the carrier is proceeding with the development of other varieties. The suddeness of the tariff filing created problems with regard to the supply of protective devices. A minimum number of types were ready for distribution at the time of, and shortly after, the filing. A number of users have complained about lack of availability of announced units. Some have complained that, due to the difficulty in defining all protective requirements in advance, design and production of devices by the carrier could unduly delay installation of systems. At this time, availability is further complicated by a lack of a firm interpretation

of tariff language. A lack of uniform interpretation among the many telephone companies and the various state Public Service Commissions is a factor.

Power Supply Dependence

Protective arrangements (above the simplest level) require a source of power. Commercial A.C. power is used. In the event of a power line failure, therefore, the protective arrangement becomes inoperative. Communications within the customer's site can continue if the customer has provided emergency power for his own equipment, but communications with the outside world, where it is most needed, is cut off. This problem must be resolved and, fortunately, many solutions exist. Automatic means for bypassing the coupler in the event of an emergency is one possibility. The problem disappears, of course, if the protective device is incorporated within the COAM equipment.

Glare

"Glare" is a condition that occurs on trunks or lines when the circuit is seized at both ends at, or nearly at, the same time (or during what is called the "ungarded interval"). When this happens, the switching machines at each end of the circuit are confused, each fruitlessly waiting for an answer from the other end. Early-type CDH protective couplers were designed to a 1.5 second unguarded interval. This arrangement introduced a three-fold increase in potential glare with customer-provided PBXs. The carrier, however, has issued a field change order for all CDH units which reduces their unguarded interval from 1.5 to .5 seconds.

The risks of glare with this change, are no different with the protective coupler and customer-provided PBX equipment from that with carrier-provided PBXs.

The increase in glare incurred by the addition of the protective arrangement would, therefore, appear to be a minimal problem at this stage.

Transmission Degradation

The ideal protective arrangement, as has been pointed out, should be "transparent" -- this is not practical. There is, however, usually no problem in compensating for this relatively small loss. Most modems and other attachments have adjustments or taps by which these losses may be fully compensated at the transmit end. Coupler losses at the receiving end amount to 2 db to 3 db. Normal attenuation at the receive end of the line can vary from 0 db to 35 db. Therefore, losses induced by the coupler are small compared to normal circuit variations.

Tolerances

This section discusses the effects upon the tolerances of the telephone system with the insertion of the protective device. One user complained that the dial repeating function in one of the protective devices was less tolerant to dial pulse variation than if no protective device was used.

AT&T reports that the device in question is an interim device designed for a specific computer application. It is being redesigned and will be replaced by another data coupler to be available in July 1970. With this device removed, there are no other know carrier-provided protective devices that will limit tolerances to anything less than what the unprotected loop would provide.

Packaging

The carrier-supplied protective device now appears as a separate entity in its own cabinet or box. While clean-cut from the carrier's point of view, it represents to the

user just another box that has to be put somewhere. Presently, the protective device cannot be physically located in the customer's equipment, although the carrier indicates it is willing to discuss this issue.

Other factors, however, must be considered if the manufacturer is to include the protective arrangement within his cabinet.

1. Redundancies can be removed in various ways and one way is through repackaging. The manufacturer, having complete control over both the protective device and his own attachment, will tend to eliminate all redundancies in order to get the best cost advantage.

2. There may be small maintenance advantages. An interface of two wires is easier to maintain than the interface of eight or more wires of the more complex couplers.

3. There are fewer hardware variations. The manufacturers of the customer's equipment will build the protective arrangement from the same hardware building blocks as are used in the rest of this equipment. The number of types of spare assemblies needed for maintenance is consequently reduced.

4. The appearance of the installation is enhanced if there is one less box to contend with. The space

occupied by the protective arrangement within the COAM equipment should be considerably less than as a free standing box. The sharing of common facilities (power supplies, framework, etc.) will contribute to the better packaging efficiency.

5. No conclusions can be drawn with regard to manufacturing cost advantages. While it appears that a large volume manufacturer would have a manufacturing cost advantage through elimination of redundancies and the sharing of common facilities (as discussed in 1 and 3), a smaller manufacturer

would have a handicap in higher compo:.ent cost because of low-volume production.

6. A built-in protective device has greater potential for mobility where that feature is important. Carrier-supplied protective devices would otherwise be required at each point of use of the portable attachment.

7. Is the protective device physically separate from the remainder of the customer's equipment?

8. Is it accessible so that it may be removed and separately checked out?

Cost

The general question of cost is considered in Section 8. In this section, we consider only certain questions of cost relating to protective devices.

The additional cost introduced by the requirement for protective arrangements has been discussed at some length. If the coupler and the attachment contain redundancies, then certainly the extra costs borne by the user are unjustified. If there is an opportunity for cost savings by better packaging; for example, by physically integrating the protective arrangement into some other equipment (see Packaging), this, too, must be considered. Take the case of a telephone answering service. Many lines must be brought into the one private switchboard -- perhaps hundreds. Hundreds of couplers would be required at the one location under existing tariffs. There are other situations of the same sort

One suggestion is that the carrier offer couplers for direct sale to users. Users may prefer to pay a one-time charge than to rent. Ownership should include freedom in packaging not currently available.

PROTECTION AT THE TELEPHONE CENTRAL OFFICE

This section discusses the feasibility of transfering the protection function to the telephone central office itself.

What Parameters Can Be Protected?

Perhaps the most significant observation to make about providing protection in the central office compared to protection of the customer's station is that no protection can be provided in the central office for certain effects. Protection at the central office cannot

ban high-level signals which cause crosstalk in exchange cable, foreign voltages that may be hazardous to those working on the loops, or unbalance which destroys the inherent balance of cables. Protection in the central office could, in principle, prevent excessive levels on carrier systems in the trunk plant. Present central office designs, however, do not provide facilities to limit signals to the levels required to prevent overloading carrier systems or to prevent crosstalk in loops or on voice-frequency intertrunks. In any case, such facilities, if provided, would also have to be provided on a per-loop basis.

Future Possibilities

The economics of protection at the central office compared to protection at the station involve factors which are not well understood at this time.

At this writing, the Panel does not have enough information to make recommendations.

OTHER PROPOSED PROTECTION ARRANGEMENTS

Another approach proposed by one manufacturer provides partial protection. The exact nature of the protective device, which uses solid-state elements, is not disclosed by the manufacturer. Its virtue is apparently low cost. The device does not use transformer isolation, yet appears to guard against hazardous voltages and signals. The protection, however, is not complete. Capacitive unbalance can still exist. The omission of the isolation transformer appears to us to invalidate the effectiveness of this protective arrangement approach.

MISCELLANEOUS

The Panel has considered such questions as:

- Whether or not the carrier is the only possible supplier of protective arrangements?

- Whether others than the carrier can properly install and maintain such devices?

- Who should assure responsibility for injury and harm? etc., etc.

These questions, however, are broader than the protective arrangements. They are treated separately elsewhere in this report.

CONCLUSIONS

The need for some forms of protection is well established. The question is; how much? where? and in what form? Clearly, there must be protection against harmful voltages, excessive signal amplitudes and longitudinal unbalance introduced by attached equipment. We draw the following conclusions:

- Existing carrier-provided protective devices are indeed effective in providing protection for hazardous voltages, excessive signal amplitudes, and longitudinal unbalance.

- Existing carrier-provided protective devices provide, on the whole, minimal protection against faulty network control and signaling.

- A protective device obviously introduces another potential point of failure. Reliability of the protective devices under normal operating conditions, however, should be comparable to the attachment and should, therefore, present no great concern.

- There are redundancies between the functions of the protective devices and those of certain customer-provided equipments; e.g., PBXs.

- Some carrier-provided couplers are not inherently transparent.

- Long delivery schedules and lack of needed types of carrier-provided couplers present a problem.

- The present dependence of some couplers on commercial power is not tolerable.

- Protective arrangements do not contribute to any significant performance degradation. Increase in glare is minimal. Transmission loss is a small effect.

- Central office protection cannot provide the same degree of protection as customer-site protection.

SECTION 6

CERTIFICATION PROGRAM

It is the purpose of this section of the report to review the alternative kinds of certification programs and to describe the basic steps required in each. The information gathered and analyzed in this study leads to a number of conclusions regarding certification programs in this application.

A certification program for telephone interconnection must be made up of three principal functions. These cover the areas of:

- standards development;
- equipment certification;
- certification of installation and maintenance.

ALTHOUGH EACH TELEPHONE INSTALLATION IS, TO SOME EXTENT, CUSTOMIZED BECAUSE OF DIFFERENCES IN LOOP AND SWITCH CHARACTERISTICS, NEVERTHELESS, THERE IS SUFFICIENT COMMONALITY TO ALLOW STANDARDIZATION.

THE PANEL CONCLUDES THAT THE STATE OF KNOWLEDGE AS TO THE CHARACTERISTICS OF THE TELEPHONE PLANT AND THE DEMONSTRATED CAPABILITY OF REPUTABLE MANUFACTURERS AND USERS WILL ALLOW THE DEVELOPMENT AND CAREFULLY PHASED-IN IMPLEMENTATION OF A CERTIFICATION PROGRAM.

STANDARDS DEVELOPMENT

No certification program, whether it be for equipment or for services, will work unless the proper standards have been established. These standards must include both performance and safety. In the case of telephone

interconnection, standards must be developed to cover certification for installation and maintenance of equipment and facilities, as well as for equipment manufacture, since all of these combine to determine the net effectiveness of the program.

The standards, which must be developed for equipment performance, need only cover those factors relating to protection of the telephone network and to personnel safety. While many would claim that broad performance standards for equipment and facilities and for personnel qualifications could be devised, the certification program under consideration aims at a more limited, clearly-defined goal. These limited performance and safety standards would not guarantee the performance which the use of customer-owned and maintained equipment would receive. Programs for this area could be

developed; however, they are not within the realm of this study which is limited to the issues involved in the "Carterphone Decision."

Private industry can contribute to the development of standards, but the final authority should remain with a government agency. The standards cannot be entirely voluntary, and enforcement will require that the standards be referred to in the tariffs of the carriers.

As stated earlier, the committee feels that there is a sufficient data base of information if carefully applied to allow the selective generation of standards in this area.

A standards development program requires the resouces of a qualified standards organization to provide co-ordination, structural guidance and staff services to

those writing the standards. Such organizations exist within both the private industry and government.

Standards cannot be prepared by staff personnel in organizations chiefly skilled in the preparation and review of standards, although these personnel are essential elements in the process. Instead, the standards development program requires the work of knowledgeable people with sufficient training and experience in the design, manufacture, installation, operation, and maintenance of modern complex communication equipment and systems. Without this depth of practical technical knowledge, the resulting standards will fall short of the requirements for a workable certification program.

The technical expertise in this area resides with the carriers, users, and manufacturers and these must all be involved in this program. In this connection,

several organizations are now active in the United States in the preparation of standards for communication equipment, systems, and interfaces. They can contribute knowledge and experience toward the establishment of the larger effort needed in the program being considered. These groups are made up of people from private industry, common carriers, government and consumer organizations who have pooled their capabilities for the development of standards similar to these now sought. These experienced groups and individuals must be identified and their relationships and responsibilities in the necessary standards development program must be defined.

Technical expertise in standards preparation is exemplified by the American National Standards Institute (ANSI), formerly known as the U. S. A. Standards Institute (USASI). This is a non-profit membership organization with members from trade, technical, and professional

groups, industrial and commercial companies, government agencies, and consumer groups. It serves as a clearinghouse for standards in the United States and also provides the machinery for developing and approving standards. ANSI has many successful standards programs in operation today.

Many trade associations work on the development of standards required in their business or industry. In some cases, these are independent programs of the associations. In others, a trade association serves as sponsor for a particular ANSI standards program in a relevant area. Examples of trade associations with currently-active standards programs in data and voice communications are Business Equipment Manufacturers Association (BEMA) and Electronic Industries Association (EIA).

Working today under the direction of the EIA Communication Terminals and Interface Section, are three active technical standards committees. Standards prepared, or in process, include those for data transmission and facsimile interfaces and for connecting arrangement interfaces. EIA Standard RS-232, first issued in 1961, covers the interface between data sets and data terminal equipment. It has found wide acceptance from both terminal manufacturers and from common carriers. Another is EIA Standard RS-366, which describes the interface for automatic calling equipment used in communication systems.

In most standards committees, standards are prepared by members, appointed by the chairman because of their technical qualifications, who attend regularly-scheduled meetings to discuss, prepare, and review draft standard proposals. When the committee has

reached agreement, a standards review board arranges for its publication to a broad cross-section of producers, consumers, and other interested parties. Comments are invited and received. These are considered in the final review and editing of the standard proposal, before it is published as an official approved standard. After publication, standards are periodically reviewed and updated according to an established schedule.

As stated earlier, Federal Government participation will be essential in the establishment and conduct of any standards development activity for telephone interconnection certification programs. This participation must take several forms:

1. The Federal Government must establish the line of authority which gives weight to the

enforcement of the standards. Cooperation between Federal and State Governments will be most important in this.

2. The Federal Government, as a large user of communications facilities and services, should be invited to send qualified personnel to participate in the committees developing new standards. Their experience will be helpful in the development of proper standards.

3. The Federal Government must establish priorities and schedules to ensure that an orderly and expeditious development program proceeds.

Development of proper standards will take time. Even with qualified personnel working on their preparation, some standards have required more than a year before agreement could be achieved. If the program is recognized to be sufficiently urgent, the time required for development will be shortened. The importance of each standard influences the manner in which necessary qualified personnel are made available and the willingness of affected organizations to work out compromise agreements, and this, in turn, determines the time needed to arrive at an approved standard.

EQUIPMENT CERTIFICATION

Every certification program must have, in addition to standards, procedures which ensure that equipment meets those standards. The degree of inspection performed as a part of equipment certification determines the probability that the equipment will meet the requirements.

In order to assure the successful operation of an enforced certification program, distinct separation must be maintained between the testing organizations and the manufacturing companies. The testing laboratories must be independent of the equipment manufacturers.

Each equipment certification procedure should have two parts. One involves the evaluation and monitoring of the manufacturer. The other relates to inspection of the actual part or unit being made. Therefore, equipment certification procedures do not apply simply to equipment. They must always combine the equipment and the manufacturer who produces it.

In setting up an equipment certification procedure, the company organizational structure is examined by those responsible for the certification program. Functional separation of manufacturing and quality assurance

organizations is believed to be essential. Proper test equipment and evaluation facilities must be made available, along with the trained and experienced personnel who operate them. Since many manufacturing plants are, to a large extent, assembly operations, procedures for receiving and inspecting incoming material, parts, and subassemblies are important to certification of the final units. In addition, internal specifications, which control purchasing, vendor quality assurance, and the manufacturing process, must be examined.

Next, the products themselves must be tested and evaluated and the proper controls must be set up to ensure that equipment produced continues to meet the standards. This includes a thorough review of the design and the performance specifications, as well as the fabrication methods and control. Test methods and sampling techniques used by quality assurance personnel are important in the certification of each product.

In setting up a certification program, overall organization responsibilities and relationships need to be considered. There are advantages in separating central management and administration of the certification and standards program from the day-to-day operation of test and inspection facilities. A separate management organization will be continuously responsible to the government agency granting its authority. At the same time, performance of equipment testing and inspection can be a competitive business handled by either government facilities or by many relatively samller competing firms looking for more cost effective methods of performing their tasks. There are a number of these independent test laboratory companies in the United States today. They should be used to form the nucleus of a certification activity which would grow as the demand rises.

SELF-CERTIFICATION

If a manufacturer sets up his own program for equipment certification and verifies that he, in fact, meets all the stated requirements of a producer of specific product, and that the finsihed product has been inspected according to published standards, the resulting program would be called self-certification. In general, this approach to certification is less likely to produce satisfactory results than a program of equipment certification and inspection by an outside, disinterested concern. An enforced certification program separates the responsibility for inspection from the manufacturing and distributing organizations which have a direct financial involvement in the outcome.

Self-certification has, however, proved to be satisfactory in several related areas. The FCC requires that manufacturers of radio transmitting equipment mark all such products in a way which certifies that particular standards are met. The units are not tested by a third party. Instead, an agreement between the FCC and the manufacturer suffices. In a similar way, the U. S. Coast Guard requires that standards be met in the manufacture of equipment and accessories for small craft used in specified areas. Again, the manufacturers' own certification is sufficient.

For the situation under study by this Panel, however, where direct electrical connection is involved, and where severe and, in many cases, intractable harm can be done, self-certification would be too risky. This is particulary so in the case where a large

group of small users with little knowledge and economic incentive to buy quality equipment could cause severe harm to the rest of the using community.

Customer self-certification allows the user to test and approve his own system without inspection by an outside organization. The Panel does not recommend a program of self-certification, even if the necessary interconnection standards can be developed. There are four principal reasons:

1. Information on the regulations and technical requirements for protection will not be directly available to all customer personnel. Many service craftsmen will not be familiar with the technical information.

CERTIFICATION OF INSTALLATION AND MAINTENANCE

After a user obtains his certified terminals or other equipment, he must assume responsibility for their operation. As discussed earlier in this report, it is essential that the equipment must be installed and connected to the telephone facilities correctly, and it must be maintained in a way which will not cause future harm to the telephone network. A certification program must be established to cover installation and maintenance, as well as manufacture, of the user-owned equipment.

An installation and maintenance certification program must include standards for, and inspection of, the equipment connected to each telephone line. In addition, consideration must be given to the qualifications and responsibility of the personnel who do the work. Minimum standard requirements will specify whether a given individual is

authorized to carry out installation and maintenance of the equipment and certification that the work has been properly completed.

The certification program for installation and maintenance will require training, testing, and licensing procedures. Licensing will follow examination under rules developed in the standards program. Every license certificate will be endorsed to indicate its applicability to equipment of one or more classes.

The procedure for installing user-owned equipment will require close cooperation with telephone company personnel, since each case will require some degree of customer adjusting or fitting. This cooperative action will need to be recognized in a standard through the establishment of guideline procedures for installation and checkout.

In its simplest form, installation and maintenance certification would apply to a protective coupling unit designed to prevent harm to the public telephone network. If a physically separate protective coupling unit cannot be identified, then these procedures must apply to pertinent parts of all equipment and facilities in the customer system connected to each telephone line.

In actual practice, the telephone company personnel will probably not complete installation of the telephone line and connection to the customer equipment until a properly signed and dated certificate of inspection has been executed by an authorized inspector, who has, himself, been certified.

Inspection at the time of installation will not certify the installed user equipment indefinitely. Periodic inspection with appropriate documentation by licensed personnel must also be required by the standards for installation and maintenance.

Another area which needs careful consideration is the certification of equipment for resale to a second user. After connection and use at one installation, it must be serviced and inspected by authorized personnel before it can be sold to a second user.

Maintenance requirements will include both routine and emergency service of the user's equipment. The correct type of routine or preventive maintenance can protect the network by preventing trouble before it starts. After trouble has been observed or

suspected, optimum methods for fault isolation will help greatly in reducing the time needed to correct the touble and to return the system to satisfactory operation. Responsibility and duties of those on each side of the common carrier - user interface must be spelled out in sufficient detail.

A maintenance organization, in order to secure certification, should carry the necessary stock of replacement units, spare parts, and other material needed for service of the equipment. Training programs for service personnel should also be implemented in a way which meets or exceeds minimum standard requirements.

Several different approaches to maintenance can be suggested. All of these can be successful if a certification program is adapted to their specific needs. The

manufacturer, vendor, or a service organization might offer a service contract to the customer in which it assumes responsibility for all aspects of installation and maintenance and guarantees proper certification of those employees who complete and inspect the work. The customer may choose, instead, to take whatever action is necessary to obtain certification of his own employees. In larger companies, this may be the most appropriate method.

Different levels or classes of licensing for personnel might be required. As an example, craftsmen working on installation and maintenance of certified equipment would have, as one requirement, current employment in a job which requires their licensing. Those engaged in management positions would need to possess a high level of competence in order to obtain their class of

of license. Those at all levels must have sufficient knowledge and understanding of the customer responsibility for protection of the telephone network.

Some examples of related certification procedures in other industries help to demonstrate how the technique would work for telephone interconnection. Before an electric power utility company will allow connection of its power lines to a new home or business building, certification of satisfactory inspection is required. Inspectors themselves are tested and certified through authority of the local or state government. The standard which usually specifies minimum performance and safety requirements is the National Electrical Code, an ANSI Standard prepared and updated by ANSI Standards Committee C1 under the sponsorship of the National Fire Protection Association. The building owner is responsible for reinspection and certification whenever future changes are made.

The Federal Aviation Agency (FAA) regulates private flying under a similar program calling for certification of equipment and maintenance through inspection by authorized persons. Engine overhaul and other routine or preventive maintenance is performed under a strict schedule specified by the FAA. Failure to comply with the standards results in revocation of the owner's license. Compliance with the standards is certified only by FAA licensed and authorized inspectors.

The Federal Communications Commission (FCC) regulates the operation of radio and television broadcasting stations through the issuing of station licenses and personnel licenses for operation and maintenance of the station equipment. These licenses represent an authorization granted because of demonstrated need and capability. Failure to operate station equipment in a prescribed manner may result in loss of both station and personnel licenses.

One of the key factors in the practicality of a program of this sort is the availability of a trained pool of manpower to carry it out. The technical capability to install and maintain private communications and computer systems offers a competent manpower base with which to start. The organization responsible for development of equipment and interface standards must work in close relationship to the group developing personnel certification as part of an integrated certification program.

PHASE-IN PROGRAM

In the Applicable Experience Section (Section 10) of this report, we point out that there has been considerable successful experience of U. S. carrier interconnection of large-scale organizations such as the government and the "right-of-way" companies. However, this

experience is limited in scale relative to the overall telephone plant and detailed data on the degree and specifics of this interconnection was not gathered. The past experience has been with large and technically-capable organizations. There is no such equivalent experience with the larger volume/smaller user type of customer on a direct interconnection basis. As a matter of fact, since this whole area is so new, there is no large-scale experience of interconnection using the carrier-supplied connecting arrangements. As discussed earlier in this report, those elements are also new, relatively untried, and already some deficiencies are evident. All this leads to the caution that if a program for direct interconnection by the customer via a certification program is to be carried out, it should be done carefully and in a way planned to minimize risk to the carrier net and the success of

the program. This program must be set up to gather data to provide feedback to the standards organization for further development of the program.

The Panel feels that, as a first step of implementation, the more complex and smaller number configurations, such as PBX, should be certified. A ready technical base of servicemen exists which could be certified. The equipment manufacturers and users are already familiar with telephone practices. This application would not represent a significant volume impact so that if errors are made and lessons are learned, they can be remedied. Following this, the next most complex and widespread area can develop, probably data terminals, and then proceed to the remainder of the field. It must be emphasized that the development of the certification program for both equipment and personnel must procede apart.

A number of installations, primarily the "right-of-way" companies, are presently directly interconnected with the carrier system. Over a period of time, these interconnections should be certified or access arrangements used. The Panel has not investigated a schedule for this, but it should be considered as an element in the overall certification program. New interconnections should be in accordance with the tariffs with either certification or access arrangements.

CONCLUSIONS AND RECOMMENDED ACTION

The Panel concludes that:

PRESENT TARIFF CRITERIA AND CARRIER-PROVIDED CONNECTING ARRANGEMENTS ARE AN ACCEPTABLE WAY OF ASSURING PROTECTION FOR NETWORK PERSONNEL AND PROPERTY.

AN ACCEPTABLE ALTERNATE WAY IS THROUGH THE DEVELOPMENT OF STANDARDS, COMBINED WITH ENFORCED CERTIFICATION OF EQUIPMENT AND PERSONNEL. THIS REQUIRES:

THAT AUTHORITY FOR STANDARDS AND THE CERTIFICATION PROGRAM RESIDE WITH THE FEDERAL REGULATORY AGENCY:

THAT THE PROGRAM BE UNIFORMLY APPLIED TO ALL CLASSES OF USERS:

THAT THE ENFORCED CERTIFICATION PROCEDURES BE TAKEN AS A WHOLE:

THAT A CAREFULLY PLANNED AND TIMED STEP-BY-STEP EFFORT BE SET UP TO ENSURE THE SUCCESSFUL IMPLEMENTATION OF THE PROGRAM.

SELF-CERTIFICATION BY MANUFACTURERS OR USERS CANNOT ASSURE AN ACCEPTABLE DEGREE OF PROTECTION.

The full-certification program, with inspection by an independent authorized organization, was investigated by the Panel. In its opinion, the necessary standards for safety, protection of the telephone network, installation, and maintenance can be developed. Needs of the communications system and its limitations are known and understood. Organizations exist which can set up and operate the necessary standards bodies with qualified people which could be made available. In addition, independent commercial test laboratory companies, which are in operation today, could serve as the nucleus of an expanding test, inspection, and certification operation.

The Panel recommends that serious consideration be given to the establishment of a certification program covering equipment and service personnel. Many

questions must be investigated and many decisions made before a successful certification program can be set in motion. Typical tasks which must be undertaken are listed below:

- The chain of delegation and authority must be made clear. Specific organizations which will make important decisions must be selected.

- Specific equipment to be covered in a certification program must be defined. Those functions considered basically important to personnel safety and network protection must be identified.

- Cost of the program, in terms of incremental increase in the amount paid by the customer, must be determined. A figure of $1000 has been suggested for test and evaluation of the production run for one manufacturer's small product. This might mean an increase of less than one per cent for a large quantity item. However, for a special unit made by a small manufacturer, the added cost might be prohibitive. Realistic estimates need to be established.

- Licensing procedures must be established in many area, including manufacturers, vendors, service personnel, test labs and training schools.

- A specific channel for review of procedures and disputes must be defined and established.

- A program of planned phasing is needed, in which results are measured at each step before the next is undertaken.

- The roles of government and private industry must be defined and agreed upon.

A certification program of the type described in the foregoing section might solve, in an optimum way, the relationships and responsibility questions at the interfaces between telephone companies and their customers. One added benefit is almost certain to result. Common

standards for physical interface characteristics and functional performance would be a most beneficial outcome. The interfaces might then become standard, regardless of the customer's geographical location. All telephone line interfaces in a given location might meet the same standard. Terminal equipment designed to meet the standard requirements could be expected to match the telephone lines anywhere in the United States.

SECTION 7

RESPONSIBILITY

The argument has been made before this Panel by the telephone companies and by the NARUC that the carriers are now responsible for end-to-end service, and that this single responsibility cannot be fragmented without serious consequences which would be contrary to the public interest.

As a substitute for the limitations which would be imposed on carriers by a free market, regulation by one or more agencies of government is provided by law in 49 of the 50 states, and is practiced by local government in the 50th state (Texas). These regulatory commissions have authority to specify

or approve: a) the types of service which shall be provided; b) who shall provide them; c) where or within what limits they shall be provided; d) what charges shall be made for each service and each location; and e) the rules and other conditions under which service will be provided, special charges assessed, service terminated, etc. It is through the exercise of such authority that regulatory commissions exert a large measure of control over the quality of telephone service.

As long as the carriers remain in full control of their facilities, commissions can, through the exercise of their authority over the carriers, greatly influence the quality of service. To the extent that carriers lose such control, the commissions themselves will lose the ability to fulfill their responsibility with respect to network service,

for the commissions lack effective authority over individual users. It is for this reason that state commissions have been hesitant to support the principle of widespread interconnection. The protective interface units required under the present tariffs are viewed by many commissions as isolating devices, the chief virtue of which is to enable commissions to continue to hold telephone carriers responsible for end-to-end service.

When a user takes service from a common carrier under present tariffs, the carrier has a statutory responsibility for protecting network service and an unequivocal responsibility for the safety of the personnel and equipment of the carrier. When a user interconnects his own equipment directly with the network, he assumes a share of that same responsibility, relying upon standards, certifying

agents, and personnel not under the control of either the user or the carrier. Unless these standards, agents, and personnel are under the control of a commission, centralized authority over service and safety will have been lost. Standards and certification procedures for equipment sold in interstate commerce must be uniform. A high degree of uniformity in personnel qualifications is desirable, but the work will, in general, be performed locally and may be supervised, inspected, and policed locally. Such work will be performed for the user, often at the user's request or direction. The user, therefore, should be required to acknowledge his responsibility for abiding by rules which he understands.

The authority for the approval of standards to be used for the purpose of equipment certification should be reserved for the government agency to which the carriers are responsible, and any independent testing laboratories authorized to certify equipment derive their authority from the FCC and must hold that authority at the pleasure of the FCC. Authority for the certification of craftsmen must be reserved to the FCC and state commissions, as appropriate.

A high degree of uniformity with respect to technical standards and rules of interconnection under all regulatory jurisdictions appears to be essential in the public interest. It is widely recognized that most interconnections will actually be made under state rather than interstate tariffs. The desired uniformity of standards and rules is not likely to

be achieved unless responsibility for the total end-to-end service can be confined within reasonable limits. Commissions may be expected to act individually to assure that someone is accountable, unless that assurance is given through the adoption of standards on interconnection at the federal level.

The traditional responsibilities of the telephone carriers, for which they are held accountable by regulatory commissions, include at least the following:

a. Provide basic service of good quality to all.

b. Meet customer needs which are economically justifiable.

c. Protect both quality and continuity of service.

d. Protect safety of employees, users and public.

e. Keep costs as low as is consistent with other obligations.

f. Distribute the cost burden fairly in the public interest, as determined by regulators.

g. Avoid unreasonable discrimination among users with respect to price, service, and privilege.

The impact of interconnection on each of these must be considered to assure that the authority of regulators to carry out their public responsibilities is not diluted to an unreasonable degree.

Responsibility for public and employee safety presents some difficult questions with important legal implications.

The exposure is great and the risk is life itself. The precautions which need to be taken can be defined, but it is less clear how liability would be changed if users own their own terminal equipment without protective interface devices provided by the carrier.

It has been suggested to this Panel that standards for interfacing with the telephone network should be prescribed, and it is thought that such standards will provide a measure of protection against personal hazards which might otherwise be caused by direct interconnection.

It is also thought that such a program would provide a measure of safety against the impairment of telephone service to the general public. A standards program, however, will have the effect of distributing the responsibility for end-to-end

service among a large number of organizations unless special precautions are taken to prevent such a result. If the preparation and definition of standards falls to some other organization than the telephone carrier, then a large measure of responsibility for network service may be transferred thereby to that other organization. Whatever company or organization is responsible for the enforcement of standards will also assume a significant measure of responsibility for network service.

The development of standards requires the cooperation of the technical expertise in the area being standardized, the expertise required in the standardization field, and the necessary authorizations and responsibility to ensure responsiveness.

Government must assume the leadership and carry out delegation of authority to a body qualified to conduct this task, including the standards development program. Private industry can contribute to the development of standards. In any case, the developed standards cannot be entirely voluntary standards and any attempt to enforce standards will require definition of the authority represented in these standards.

It has also been suggested that some method of type-approval or equipment certification should be employed to protect the network against interconnected equipment of inferior design or manufacture. This approach to a solution involves a shift of responsibility from the carrier to the manufacturer of its equipment and also to the certifying authority, whoever or whatever this may be.

Responsibility does not end with the selection of equipment, for the proper installation and maintenance is of equal importance. Unfortunately, this presents a far more subjective problem. Users who interconnect their own equipment with the network may elect to contract for the installation and maintenance of that equipment, either from its supplier, from the carrier, or from some other organization. In each case, such election passes on some of the responsibility for system performance from the customer to the contractor. If contractors and suppliers, as well as equipment, are also certified as to competence, then responsibility for network service is further diluted to include the certifying authority.

Technological changes raise an additional question of system design responsibility. Alternative designs

may be expected to shift future costs from cable plant to terminals, from switching systems to cable plant, from interoffice trunks to local exchange plant, or the inverse of each of these. If, for example, future events should lead to large-scale user ownership of terminal devices, an important question of responsibility is raised, for who will determine which of two alternative system designs will be employed when one of them makes terminal devices more costly and local cable plant less costly? Presumably, if this occurs, it will fall to the commissions to assure that the public's interest in lowest total cost is recognized.

Summary and Conclusions

Responsibility for end-to-end system performance now rests with the telephone carriers and with

their regulators. Enforcement beyond that provided by the carrier's sense of public responsibility comes, when necessary, from the influence and authority of regulatory commissions.

The widespread interconnection of user-owned terminals and systems, without isolating protective interface devices, could cause the dispersal of responsibility for service to include, in addition to the carriers, one or more of the following:

a. Users who own their own equipment.

b. Manufacturers who assure that standards are met.

c. Those who prepare standards.

d. Those who test or certify products.

e. The source of certifying authority.

f. Those who certify the competence of individuals or organizations for installation and maintenance.

g. Inspectors.

h. Commissions (directly, in contrast to present back-up responsibility) for system design.

The Panel believes that any significant dispersal of responsibility for service and cost would be seriously detrimental to the public interest. The Panel also believes that this can be prevented by so structuring a program of standards and certification that the final authority for each segment of the program rests with the same regulatory commissions having jurisdiction over the carriers.

the network should be required, in the process of applying for such privilege, to affirm their acceptance and understanding of the provisions of the tariffs governing such interconnection.

A question of jurisdiction among the several commissions, federal and state, must be considered, but the answer seems evident to the Panel. Equipment manufacturers cannot deal with a multiplicity of standards, and centralized authority is thus essential. Minimum standards for the certification of craftsmen will be a by-product of the setting of standards for equipment, and the same uniformity is needed as to these. However, it appears to the Panel that the administration and enforcement of the program might be handled on a local level.

SECTION 8

COSTS

The Panel has been given the assignment of considering the technical aspects of interconnection with the telephone network, and of making recommendations on the basis of those considerations. Every technical conclusion has costs associated with it, and any recommendation which ignored cost would be without value.

On the other hand, many of the presentations made to this Panel have included protestations that this or that solution entailed an unnecessary cost burden. Consideration of any one cost by itself is easily transformed into a debate about who should bear the cost, or of how costs should be distributed among users and suppliers of telephone service. Such a debate is beyond the scope of the assignment given to this panel.

Under regulation, the rate-making process distributes to users all costs of utility operations. In an open market, it has become axiomatic that one pays for what one gets. The assertion that some particular cost is the responsibility of a utility, or of a manufacturer, or of a supplier, and not of the ultimate user, is academic insofar as the deliberations of the Panel are concerned. What matters is that all costs which result from interconnection be recognized, and that they be held to a level which is reasonable in relation to the benefits which are expected to follow. The allocation of those costs among users is a matter best left to regulatory commissions and market forces.

Prohibitions against interconnection with the network, ruled improper by the FCC in its Carterphone Decision, placed a cost burden -- directly or indirectly -- on users of the system. The granting of interconnection

privileges reduces or eliminates those "costs" and substitutes others, including one or more of the following:

1. (a) Purchase of terminal equipment and systems;

   (b) Installation of terminal equipment and systems;

   (c) Maintenance of terminal equipment and systems.

2. (a) Purchase of interface devices for protection or signaling;

(b) Installation of interface devices for protection or signaling;

(c) Maintenance of interface devices for protection or signaling.

3, (a) Construction of telephone company plant;

(b) Maintenance and repair of telephone company plant;

4. (a) Preparation, publication and maintenance of standards;

(b) Equipment certification

(c) Certification of people or firms qualified for installation and maintenance.

5. (a) Administration and record keeping, to keep track of user-owned terminals and systems connected to the system;

(b) Administration associated with the application of interconnection restrictions, inspection, and verification.

6. Costs to user, contractor, and telephone company associated with divided responsibility for testing, maintenance, and repair.

7. Costs of service impairment, or more frequent interruptions.

The apparent waste which is involved in requiring the use of protective interface devices in all cases, even when they are unnecessary for protection of the network, may be offset, more or less, by the reduction or elimination of other costs which are less visible, but just as real. The Panel did not attempt to analyze this area in depth.

It should be noted that the whole subject of rates has been outside the scope of this Panel's consideration. Nevertheless, rates are basic to this entire issue, as they will determine the degree of interest on the part of users in any alternative method beyond that presently authorized by the tariffs. Since there is as yet no experience with direct interconnection, no conclusions are possible. It may well turn out that the regulatory

agencies will conclude that the direct interconnection of user-owned equipment does, in fact, result in increased operating cost to the carriers, sufficient to require rate adjustments. While the Panel does not believe this to be probable under the proposed certification program, the possibility, and the consequences concerning the validity of this alternative approach, should be recognized.

SECTION 9

INNOVATION

INTRODUCTION

For the purpose of this section, the term "Innovation" will be taken to mean the introduction and use of new equipment, new uses of equipment, or new services. We are not concerned here with inventions or ideas per se, but rather with the ability to put inventions or ideas to practical use by the telephone companies or those who wish to interconnect.

The principal consideration here is interconnection with the DDD network, although some of what is discussed is obviously applicable to the question of interconnection with private lines as well.

The impact of innovation has not been presented as a major issue before the Panel, but some concerns have been expressed. It is clear that many of those concerns are the result of interconnection itself and the fact that interconnecting parties and the carriers will have to cooperate in some way to reach solutions to problems when their interests do not coincide. The amount and kind of protection required for the network and the method of providing it tend to change the nature and degree of the problems, but do not solve them. Few, if any, of the problems are entirely technical in nature, although technical factors should be considered in any policy decision.

Although the discussions before the Panel have been addressed primarily to problems that might limit innovation, it seems clear that interconnection will have a positive influence on innovation in some cases.

The Panel has made no systematic attempt to survey new technology and potential new developments. For our purposes, the material presented to the Panel in response to our inquiries seems adequate. For this reason, the references to new technology and new developments cited below should be considered only as examples of things that are reasonably well understood and which may have some impact in the not too distant future.

The incentive to innovate is usually economic, either directly or indirectly, whether it be to provide an existing service at lower cost or to provide a new service. The increasing dependence of the business community on communications in a variety of forms will provide ample incentive for continuing innovation in an era in which technology is likely to advance rapidly.

It seems likely that business will want fast response to its communication needs and will want customized services to optimize its own operation. To the extent possible, no technical barriers in the interconnection policy should prevent such innovation so long as new things are not allowed to interfere with other uses. Neither should technical barriers prevent telecommunication carriers from innovation in the network, where it is in the public interest.

BACKGROUND

New Technology

The development of integrated circuits to the point where cost and reliability expectations are realized will certainly have an impact on innovation. Existing functions will be performed at lower cost and new functions not practical

with older technology will become economically attractive. In addition, it seems likely that in attempts to optimize overall systems (common carrier systems, user systems, or a combination of the two) there may be a tendency to shift functions between different parts of the system. For example, with low cost, small size, and high reliability, there may be future tradeoffs that suggest putting more functions in terminal equipment in order to make savings elsewhere in the system.

For many years, the trend in transmission technology has been toward larger and larger systems. In the long-haul transmission plant, each new system carries larger numbers of voice band circuits or equivalent and at less cost per circuit mile. This trend seems certain to continue, using waveguides, perhaps within a decade,

and still wider band systems, using optics in several decades. As now understood, these latter systems will likely use digital modulation techniques and will tend to promote more widespread use of digital facilities in the network feeding into those systems.

NEW DEVELOPMENTS

New Telephones

The Bell System has indicated that the next generation of telephones will use active electronic devices to improve transmission quality and to help overcome some of the technical limitations of loop characteristics. It will also likely include tone ringing using tones in the voiceband. When that telephone is used, customer equipment that is acoustically coupled to the telephone will have to be modified, and inductively coupled devices

probably won't work at all. The new telephone is not expected to be in production for several years and will not be in widespread use for quite some time. It does, however, illustrate how new system tradeoffs by the carrier could impact on customer-owned equipment.

New Terminals

Very little has been said before the Panel about the character of future terminal development. This is not surprising, considering the competition in this field. It seems safe to assume, however, that with the ability to interconnect, this will be an attractive field and new ideas may spring from a variety of sources. It also seems safe to assume that terminals will become increasingly sophisticated. In fact, future terminals will most likely be small

"computers" in that logic will be programmable by the user. In such cases, the terminal might be able to match changes in central offices by changes in terminal "software," if a standard interface has been established.

The rate of innovation of data users will likely exceed that of the switched network with the largest and fastest growing segment in the low and medium data rate areas.

Digital Transmission

The telephone companies are now using large quantities of PCM carriers in their exchange trunking plant. The Bell System version is called T1. A second system, T2, with more capacity and usable for short- and medium-length toll circuits is under development by Bell. This

trend toward systems that carry signals in digital form seems likely to continue through larger long-haul systems. In particular, as noted earlier, the system using waveguide as the transmission medium will be a digital system. The prospect then is toward an increasing percentage of the DDD transmission plant being digital leading eventually perhaps to a predominantly digital plant. Special networks will likely grow much sooner.

In an all digital DDD long distance plant, the loading and interference characteristics will be somewhat different from those in frequency division analog carrier systems. While one would expect that some of the details of the signal criteria might change, the changes are not likely to be large and, in any event, will not occur for some years to come.

The availability of a substantial amount of digital transmission will very likely result in new tariff offerings for digital data services. The Panel believes that protective criteria for those services should be consistent with the need to protect the specific facilities used.

New Switching Systems

The move toward all digital transmission in the long distance plant will lead also to the switching of signals in digital form. Such switching already exists in special networks like that of Western Union. Since such a switch looks essentially like another digital transmission link, it would have no additional effect on the criteria for interconnection.

In the local or exchange switching plant, the desire to go to solid state electronic crosspoints in the switching

network has been thwarted somewhat because of the need to pass the high voltages required for ringing the telephone. This is one example of a situation where the system balance may change with integrated electronics. It may be that by putting a tone ringer and perhaps tone transmission of off-hook/on-hook signals in the telephone, even at added expense, the resulting impact on the local office which might then make extensive use of electronics in the switching path would more than offset the additional costs, if any, in the telephone. Such swap-offs could, of course, have a significant impact on interconnection and the interface between user and carrier-owned facilities.

New Signaling Systems

Currently, signaling in the DDD toll plant includes the use of a 2600 Hz tone to indicate the busy or idle status

of trunks. The tariff criteria are set up to protect this 2600 Hz signaling system. The future direction of signaling appears to be toward systems that are separate from the voiceband path. Hence, with such systems, the protection of 2600 Hz will no longer be necessary, but because of the very widespread use of the present system, it will be a significant factor for years to come.

NEW SERVICES

PICTUREPHONE

The Bell System has conducted trials of a switched see-while-you talk service called PICTUREPHONE and has announced that a commercial service offering will be made in 1970. It has also advised the Panel that interconnection arrangements will be

available at, or soon after, the introduction of the service.

This service will have, in addition to the normal audio pair in the loop, two pairs of wire for the video (one for each direction), with a transmission capability approaching 1 MHz. In the digital toll transmission plant, the voice and video will be multiplexed on a 6.3 MB/s bit stream. The system clearly has capability for high-speed data.

Since the interconnection arrangements have not been announced, the Panel has no basis on which to make detailed comments. One observation, however, can be made. The audio pair is used for network control signaling. The question of interconnection to the two video pairs should then be limited, in the technical sense, to transmission and physical protection criteria.

DATA-PHONE 50

The Bell System has recently begun a 50 kilobit service called DATA-PHONE 50. No provisions have been made for interconnection and a few parties have suggested that interconnection be allowed. Although the Panel has not studied the characteristics of this service, it sees no technical reason why interconnection should not be permitted, consistent with the final decisions regarding interconnection for voice-band circuits. The use of this service will likely be primarily for computer-to-computer data transmission in load-leveling, national data banks, national network access for remote access users, etc. It will be desired to incorporate into computer communication hardware all automatic functions as opposed to manual functions most used today in voice band data transmission.

OTHER NEW SERVICES

Other new services are likely to be offered in a way and form that can only be estimated at this time and which will depend not only on technical factors but also on actions by regulatory agencies. The offerings of the types recently proposed by MCI and the DATRAN service are examples. We have grouped such services under the general heading of customized common carriers. They will, in general, we believe, aim their offerings at the business community and perhaps especially at users of data services where the rate of innovation will be high. While we do not attempt to judge whether or not a proliferation of such services is in the public interest, we do observe that from a technical point of view, many of them will depend on interconnection with the common carrier.

POTENTIAL RESTRICTIONS TO INNOVATION

Problems of Information Transfer

The need for more information to be exchanged between suppliers and users on the one hand and the carriers on the other was evident in the presentations before the Panel. Users suggested arrangements to the Panel which the Bell System had already provided for, but about which the user was unaware. Other cases came up where the Bell System stated its intent to the Panel to provide for connecting arrangements, but that intent was unknown to suppliers and potential users. Regardless of the procedures finally adopted for providing protection to the network, whether by interface boxes, by standards, or some other arrangement, some method should be worked out to allow for better interchange of information. Some of this will come naturally with time as all parties gain experience

with interconnection, but the problem will remain to some degree. Further, it is evident to the Panel that many customer systems have or will have terminal points in independent companies, as well as Bell System territory, and better communication with the Bell System is not sufficient. This issue will be addressed further in Section 11.

Questions of Timing

Perhaps the most significant question of timing is that of the response time of carriers to new user requirements. Users have found that arrangements which are nominally available are not actually readily available in all Bell System companies when they want them and not available at all in some independent companies. This is inevitable in the initial stages of a change as significant as interconnection. Nevertheless, many people feel that the carriers will not be able

to respond rapidly enough with new protective arrangements and that they could innovate faster if they included the protection in their terminals. They could then make it available on their equipment regardless of the location or company.

A second question of timing has to do with the changes in the carriers' system which might make user equipment obsolete. The Bell System has expressed concern that if a user has just purchased new equipment, he will be reluctant to accept a change in the telephone system that would require substantial change to his equipment.

Several users, especially those in fast-moving fields like computer communications and those who have historically interconnected with the carriers' private

lines, suggest that the rate of innovation in the DDD network will pose no problem to them.

Questions of Cost

An important cost question from the suppliers point of view is the cost of a new connection arrangement for some new service or use he may want to offer. If he included the protection in his own design, he would be able to determine the total cost himself. If he must wait for a carrier tariff, the total cost of his service will be uncertain until the tariff is filed.

Another criticism of the present arrangement is that suppliers fear that the carriers can compete unfairly because, in their opinion, the added protective box makes customer-owned systems more expensive and less reliable than comparable carrier-owned

systems. The Panel recognizes that the question of actual overall cost is a complex one and has made no evaluation of costs including those of administration, etc., as they relate to different approaches. Section 8 discusses some of the general cost trade-off areas in greater detail.

Restriction of Use

Present connection arrangements are on a per line basis and are tailored to a specific terminating arrangement. Some users may want to use a line for one purpose at one time (e.g., during the day) and something else at another time (e.g., during the night). This argues, in their opinion, for an arrangement that is physically a part of the terminal rather than the line. The Bell System has agreed that this may be possible using carrier-owned protective devices which are integrated into the customer equipment.

In a different vein, the carriers point to a potential use of characteristics of specific designs in the network that are incidental to its normal use and that may be different in subsequent generations of equipment. An interconnecting arrangement which takes advantage of such arrangements may unknowingly be made obsolete by new designs. An example brought before the Panel involved the use of single tones produced by pressing two touch-tone buttons simultaneously. The new integrated circuit version of the touch-tone generator does not produce the single tone since that feature was only incidental to the original design.

SUMMARY OF ISSUES AND CONCLUSIONS

The carriers have said that widespread interconnection will tend to impede innovation in the network, because, among other things, users will tend to oppose changes by

the carriers that make the users' equipment obsolete or require it to be modified. They have also said that direct interconnection without carrier-owned interconnecting arrangement will further impede their innovation because it removes the carrier-controlled buffer with known characteristics between the network and the interconnected equipment.

Some users, especially the large ones and those in fast moving fields such as computer time-sharing, have expressed the opinion that, with the necessarily deliberate rate of innovation expected in the network, there will be no major problems in keeping up with network innovation. They do not agree with the carriers' concerns regarding the need for a carrier-controlled buffer.

Some suppliers of equipment and services have expressed the opinion that the presence of the carrier-owned interconnecting arrangement will impede innovation on the user side of the interface where the goal is to optimize the users' system or use of equipment. Further, and perhaps more importantly, they question the ability of the carrier to respond rapidly enough to new situations where new interconnection arrangements are required.

While there are limited data on which to base conclusions, it is the opinion of the Panel that:

1. The advent of widespread interconnection itself, regardless of how it is implemented and controlled, may indeed have some effect on the rate of innovation by carriers, suppliers, and users. In some cases, it may impede innovation in

the network and, in others, it could conceivably promote innovation because of the pressures of demand from users. It will certainly tend to increase the rate of innovation by suppliers and users.

2. The introduction of a certification program for direct interconnection will not significantly restrict carrier innovation if there is effective information exchange between carriers, suppliers and users. On the other hand, the suppliers and users will have more freedom to innovate.

3. On balance, the negative effects of the certification program, innovation in the overall system of carriers, and users of interconnected equipment, is likely to increase.

SECTION 10

APPLICABLE EXPERIENCE

COMMON CARRIER APPLICABLE EXPERIENCE

The common carriers have had extensive experience with interconnection between carrier systems and with non-carrier customer-owned and maintained equipment and systems.

Interconnecting with Each Other

Communications carriers are extensively interconnected with each other. There are approximately 1900 independent telephone systems connected with the Bell System. The Western Union Telegraph Company is interconnected with the Bell System and many of the independent telephone

companies. The international communications carriers, including COMSAT are interconnected with the Bell System. The Bell System, the international carriers, and COMSAT are interconnected with foreign carriers.

These interconnections are all arranged on a contractual basis with standardized interface arrangements developed by extensive inter-carrier committees and consultative groups. The Federal Communications Commission and forty-nine state regulatory commissions act as referees, or courts of appeal, if difficulties arise over the interconnection interface. However, the fifty or more years of experience the telephone industry has had in arranging interconnections from simple interfaces involving manual plug and jack telephone switchboards to the complex automatic systems providing for nationwide (and now international) Direct Distance Dialing (DDD) have resulted in a surprisingly small number of appeals to these commissions.

Design procedures and the authority for interconnection have been formalized between the carriers and the regulatory commissions, such that these practices are well established and thoroughly understood throughout industry.

Equipment standards and practices are based on voluminous documentation prepared by joint industry committees and largely issued as Bell System Technical Manuals. Equipments and practices developed by the Western Electric Company are made available throughout the industry and many manufacturers substantially duplicate this equipment for use by the independent telephone companies.

Standards for maintenance and repair and standard practices for installation and preventive maintenance have been established by the industry through experience

with extensive analysis of equipment failures and faults. Technical equipment and system innovation promoted by both the carriers and the manufacturers of communications equipment is pursued on an industry-wide basis with extensive consultation through the many joint committees between the Bell System and the independent carriers. New services, when requiring new technical equipment, system practices, transmission standards, etc., are developed jointly between the AT&T and the independent companies. After new services have been tested experimentally, standard operating procedures, inter-company tariff agreements, and revenue sharing arrangements are established.

The assignment of cost burdens between the several carriers is established on the basis of the current separations formulas, or through negotiation and action with the responsible regulatory commissions.

The experience of inter-carrier interconnection arrangements has applicability to the present study to the extent that two organizations operating on the opposite side of an interconnection interface can perform successfully when both operate to compatible or the same standards and are technically and operationally qualified and their motivation is to provide efficient, economical service with minimum disruption due to interconnection difficulties.

Authorized Non-Carrier Interconnections

There has been experience with a very considerable number of accepted, if not specifically authorized, non-carrier interconnection arrangements. The largest of these users are the United States Government agencies, particularly the Department of Defense, which, for many years, has made extensive use of common-carrier systems often providing its own terminal equipment, including PBXs. Another class

of users has been the so-called right-of-way organizations (railroads, pipelines, electric utilities) who have operated their own communications systems with varying degrees of interconnection with the telephone carriers. Aeronautical Radio Incorporated (ARINC), serving the air transport industry, has operated an extensive network and many localized interconnection arrangements. Most of these are on an allocated circuit (leased line) basis, but there has been some use of interconnection with the switched network, theoretically only on an emergency basis.

The authority for these various interconnection arrangements has been agreement between the user and the carrier with the user satisfying the carrier that his technical equipment adequately protected the network and performed the functions of network control and signaling.

User systems were designed, in most cases, with extensive consultation with the carrier involved and often with installation of test equipment and practices to protect the network which were approved by the carrier.

In many cases in the past, the equipment employed has been Western Electric-manufactured or manufactured by other concerns on the basis of Western Electric's specifications and designs. Currently, equipment is being manufactured in accordance with accepted national or international standards by competent manufacturers and many satisfactory interface arrangement have resulted.

In most cases, the organizations concerned are adequately competent technically and motivated to maintain equipment to high standards of performance, and interconnection problems have been manageable.

There is applicability to the present study in these non-carrier interconnection arrangements, both from the standpoint that several have been highly successful and trouble free, while others, where motivation may not be to maintain high standards of technical, operational, and economic performance, have resulted in troubles. Both of these cases will be discussed in greater detail later in this Section of the Report.

Experience of Right-of-Way Companies with Carrier Interconnections

The right-of-way companies, including railroads, pipelines, electric utilities, to which might be added ARINC, have had extensive experience using carrier circuits as part of their systems.

Procurement of Equipment

In many cases, right-of-way companies own and operate private communications systems (microwave relays being the most important, but other systems are also included) which serve their principal operational locations. These locations include railroad switchyards, terminals, pipeline pumping stations and control centers, utility generating and distribution systems, substations, and and other installations. In the case of ARINC, circuits are used to interconnect transmitter and receiver or transceiver sites with communications and control centers.

Interface Problems - Trouble - Responsibility

Much of the equipment used by the right-of-way and similar utility companies has been developed and procured in accordance with specifications or practices developed by carriers or manufacturers who are skilled in providing equipment for the telephone utilities.

Interface problems have developed from time-to-time, but these are generally worked out amicably between the user and the carrier with satisfactory settlement of areas of responsibility.

One submission by such a user summarizes its experience with interconnection. It has nearly 500 unattended stations controlled over Bell System circuits by operating centers sometimes located several hundred miles away. The user also has an Electronic Switching System interconnected with over 800 Bell System circuits. This user has no knowledge of dangerous voltages or currents having been introduced into the carrier system through its operations, and, from the user's standpoint, service has been entirely satisfactory without the necessity of interface devices between the user and the carrier facilities. The user has extensive procedures and facilities for monitoring the nature of the signals introduced by it into the carrier

network. It has also established rigorous preventative maintenance procedures with about sixty maintenance men and thirty fully-equipped maintenance trucks constantly visiting and checking facilities throughout the United States.

Experience of Foreign Communications Carriers

Foreign communications carriers have been concerned with the problem of interconnection of non-carrier equipment in varying degrees. The extent of the problem depends upon the policies of the carrier, the extent to which the carrier is able to meet urgent demands for switched telephone services, and the nature of its organization.

Limited Applicability of Experience of Foreign Carriers

The applicability of the experience of foreign carriers to the specific problems facing the FCC and the U.S. carriers varies, both because of the widely differing circumstances under which different foreign carriers operate and the lag in the development of pressures for the use of the carrier networks for many non-telephone purposes.

In general, the carriers in the developed industrial countries have a monopoly of telecommunications services. This is achieved by the carrier, either being a ministry of government -- as in the case of the Bundespost and the PTT's in various countries -- or a chosen instrument government-chartered corporation, such as the Nippon Telephone and Telegraph Public Corporation or the British Post Office Corporation. The

extent of the monopoly varies but, in general, it is quite complete and to challenge it is, in effect, to challenge a basic function of government.

Most of these foreign carriers are responsible for the total of domestic (and, in many cases, foreign as well) telecommunications services. This includes message telephone service, telegraph services including TELEX, the provision of leased lines for all services from narrow-band telegraph to television program relay. There are exceptions to the provision of television program distribution, such as the separate network of EUROVISION in Europe, but such exceptions are limited. In the case of the communications systems operated by government ministries, the ministry is, in effect, the FCC, the AT&T, the independent telephone companies, Western Union, private microwave services, etc., all

incorporated in one organization. In general, the policies of such an organization can only be challenged through the national parliament. In the case of the recently established British Post Office Corporation, one of the objectives was to remove the carrier from detailed political surveillance by parliament and permit it to concentrate on the technical, operational, and business management aspects of a major service business. In this case, to provide for customer or public influence or guidance in the operations of the carrier, several Councils and a National Council have been established.

In many countries, the primary orientation has been almost exclusively toward public message telephone and telegraph services and financial and plant resources have been inadequate to fulfill the demands for these services; hence, the carriers have been slow in permitting

any extensive use of their facilities for other services. This has been particularly true of certain countries of Western Europe which have been loathe to commit transmission facilities to private line services when they are sorely needed for public message telephone service.

An advantage a government ministry or chosen instrument corporation has, is the ability to rank order subscribers or using agencies giving preference to those adequately qualified. These include other government departments and agencies, the railroads or other right-of-way companies, and large technically-qualified industries. The government department, or government-backed corporation, is in a strong position to discontinue service if established specifications, practices, or standards are not adhered to.

These "monopoly" carriers can, and do, establish and enforce rules ensuring adherence to high standards in the procurement of customer equipment. They can establish specifications, require type approval of all equipment -- even to the extent of testing it in their own laboratories -- before manufacturers are permitted to sell to prospective users for interconnection. The British Post Office, for example, has long avoided the investment in large PBXs by requiring the user to procure his own, but it has type approved only a few models manufactured by British manufacturers who supply equipment to the Post Office and manufacture in accordance with Post Office specifications, practices, and standards. The PBX is then installed in accordance with the Post Office-established specifications and then maintained by Post Office personnel. The Post Office permits interconnection of automatic dialers and other

devices for fire, burglary, high water, and other alarm services. However, these must be connected in parallel with a standard telephone installation, the device must pass a Post Office qualification test, and be maintained in accordance with established standards.

The ministry of telecommunications or a national telecommunications corporation can make any necessary decisions as to the placement of economic burden for provision of non-standard services for any interconnection arrangements or for other costs occasioned by user-provided equipment. The British Post Office requirement that the user provide large PBXs is a good example of this.

Experience with Extra-Legal Interconnections

Prior experience with unauthorized interconnection has given some indication of problems which might develop with formal arrangements for interconnection of user-provided equipment without some protective interface between customer-owned and maintained equipment and the carrier facilities.

Amateur radio operators have long used "phone patches" for connecting amateur radio telephone stations to the switched network in order to permit their friends to communicate with distant parties through amateur radio. Most of the telephone companies have countenanced this "illegal" use of the system as a service to the amateurs and the public and relatively few cases of trouble have been experienced. In general, an amateur operator is a competent technician who understands the telephone

network, the amateur's carrier-provided telephone is used to perform the signaling functions and the phone patch is only connected while the call is in progress.

There is a considerable body of experience of difficulties with user-installed extension telephones which usually shows up only when the telephone is defective or the mismatch between the characteristics of the "foreign" telephone and the requirements of the loop are such as to result in a report of poor service or a failure of service.

A survey of state regulatory commissions indicates a limited accumulation of knowledge concerning troubles from interconnection of user-owned equipment, but a considerable number of examples were cited where such equipment had been interconnected with telephone company facilities resulting in service calls and difficulties in

clearing the trouble. One Commission cited fifty-four trouble reports during a recent, but unspecified, period where user-owned equipment was involved, of which forty-five were found to be faults in the user equipment. A second Commission cited an example of computer time-sharing terminals connected through a local central office which contributed to a serious overload condition. In this case, the holding time per call on the terminals was approximately ten times the holding time on regular business telephone lines. A number of other specific examples were cited by this Commission.

The experience here is applicable to the present study to the extent that it indicates that, in many cases, a customer with inadequate technical and operational competence may create difficulties in the common-carrier network.

Experience in Other Areas

There is experience in other technical and service enterprises where interconnections between systems or system components may be pertinent to the study of interconnection with telephone systems.

Computers (Main Frames and Peripheral Equipment)

A good example is the interconnection of peripheral equipment of one or several manufacturers with a computer main frame of another manufacturer.

The computing industry had to face the "foreign attachments" issue years ago. The large computer main frame manufacturer maintained a strong sense of overall systems responsibility very similar to the common carrier's position which has been altered by the Carterphone decision. The manufacturers maintained that they could not be responsible for the

performance of the system if the customer uses other than the manufacturer's equipment and supplies. The issues are comparable in certain respects to those posed in the common-carrier interconnection case. Who is responsible for maintenance and installation? Will the attachment harm the system? The foreign attachment has greater capability, lower cost, etc.

The first departure from the entrenched position of the main frame manufacturers in the computer field occurred over ten years ago in the magnetic tape area. Computer manufacturers sold their approved magnetic tape, but the users started buying from other independent suppliers. In general, the tape worked quite well and it represented an appreciable cost saving to the user. Customers were warned, however, that they had now transferred the responsibility for tape handler performance to themselves. When there was doubt as to

whether the tape handler or the tape was at fault, the manufacturer's serviceman used a "good standard" tape to prove the case one way or the other. Even though the responsibility for tape performance was thus assumed by the user, he was willing to take this responsibility judging by the amount of magnetic tape being purchased from independent manufacturers today.

Within the past few years and with the fantastic growth of the computer industry, many independent peripheral device businesses have spawned. More are being born each day. There are now a large number of organizations providing peripheral devices like punched card readers and punches, high-speed printers, tape handlers, and disc handlers to customers in competition with computer main frame manufacturers.

Interconnection of these "foreign attachments" raised grave concerns on the part of the computer main frame manufacturers. The complexity of the interface between the peripheral device and the control unit or computer is such as to make the telephone interconnection interface seem much simpler in comparison. Signal frequencies are in the megacycles rather than cycles, levels are in the milli or microvolts, crosstalk problems are fierce, and timing control sequences are infinitely more complex and precise than the dial pulses or tones used in the telephone network control system. Yet, users of their own volition have decided to risk the interface problem and incur the division of responsibility to accrue cost savings. The independent peripheral manufacturers have lobbied so heavily that GAO, after due consideration, in June 1969 issued a directive to all Government agencies employing EDP

equipment strongly advising the use of plug-to-plug compatible components to replace the original system-supplied equipment when there is a cost advantage.

As far as is known, the use of such foreign attachments, especially disc and tape units, has been successful despite the complexities of the interface. The user will undoubtedly experience greater difficulty and delay in resolving a malfunction, but he apparently feels it is worth the cost differential. In the event of malfunction, the user will, in most cases, have to call the computer main frame maintenance man to diagnose whether the problem is in the peripheral or in the system. If the problem is in the peripheral, he then has to call the peripheral service company, thus paying a double maintenance charge and incurring extra delay. If the problems are obviously in the peripheral, he need call

only the one company. The same maintenance philosophy can apply to the interconnection of foreign attachments to the telephone lines.

It appears that foreign attachments will be a way of life for the computer industry. The weakness of the analogy pointed to above is that only the user may be harmed in the case of the computer attachment while many, who are generally unknown, may be harmed with a bad telephone attachment, although with the advent of computer time sharing, this may become less true, but here again, it is the user or provider of the particular computer time sharing service who accepts the degradation in service to reduce costs. Further, there is no comparable problem of hazard to personnel or property of other than the user of the computer through interconnection of foreign equipment or systems.

Broadcast Interconnection Arrangement

There is considerable experience which has some relevance in the broadcasting industry (sound as well as television) in the interconnection of user-owned equipment with the carrier facilities. These are almost exclusively leased-line situations with full-period or temporarily-allocated circuits in use for broadcast purposes. These systems are operated without complex interface devices between the user and the carrier facilities.

Experience with Government Networks and Equipment

The largest single class of interconnected communications systems and terminals in the United States are those of U.S. Government agencies -- the largest being the Department of Defense.

Defense Communications Systems

There is a long complex history of a partnerhsip between the Department of Defense and the U.S. domestic and international common carriers. In general, this arrangement has been beneficial to both sides, but particularly to the U.S. Government in that wide latitude of interconnection of Government-owned equipment and systems has been permitted by the common carriers as exceptions to normal tariff arrangements. Last year, the Government obtained approximately one-half billion dollars of telecommunications services and facilities from these carriers. The largest single aggregation of such facilities is the Defense Communications System (DCS) which is being evolved from the systems of the three military services. When put together with systems of the other principal departments and agencies of the Government, the whole becomes the

National Communications System. Leased carrier facilities (particularly in the continental forty-eight states) comprise the bulk of the National Communications System (NCS). Major components of the NCS are:

> The CONUS AUTOVON system, a leased telephone network classified as a CCSA system provided by AT&T and the independent telephone companies. AUTOVON provides the backbone voice network for national security command-control communications.
>
> A companion to AUTOVON is CONUS AUTODIN, a leased system provided by the Western Union Telegraph Company, providing record communications for the Department of Defense and certain other associated activities.

Government Systems Other Than Those Operated by Defense

There are a number of Government systems other than those operated by Defense. Principal among these are:

The FTS (Federal Telecommunications System), a CCSA voice network administered by the General Services Administration and providing service to all Government agencies, but primarily service to agencies other than DoD.

The ARS (Advanced Record System), a GSA administered record communications system leased from Western Union, provides these services for Government agencies other than the DoD. These are also components of the NCS.

DCS Specifications

The Defense Communications Agency, with the advice and assistance of other agencies, has developed DCS and NCS specifications (in many cases, substantially equivalent to those governing the relationships between the Bell System and the independents) to guide the evolution of the Defense Communications System and the National Communications System. These specifications include interface specifications for interconnection of the Government-owned equipment with carrier facilities.

Preferential Treatment by Common Carrier

Because of the nature of Government requirements, particularly those associated with national security activities, the space program and other critical government activities, the carriers have afforded the Government special treatment in regard to interconnection, the

use of customer provided equipment and the provision of special telecommunications arrangements to meet unique requirements. As was demonstrated to the Panel, these arrangements have not been without cost and difficulty. Although the DoD is probably the largest technical organization in the world with extensive capabilities for procurement, installation and operation of telecommunications type equipment, many problems have developed as a result of interconnection arrangements without interface devices to shield the common carrier network from failure, malfunction, or deliberate misuse of user facilities.

It has been shown that DoD interconnection of user-owned and maintained equipment with the Bell System accounts for a disproportionate share of the troubles in terminal equipments and transmission arising through interconnection. DoD has approximately

200 posts, camps and stations with user-owned telecommunications equipment interconnected with carrier facilities. In many cases, the carriers have been called in or volunteered their assistance to correct difficulties with customer-owned facilities. However, in certain instances, the installations on the post, camp or station are in such a serious state of disrepair, with hazards due to power cables in the same conduits with communications cables, with circuits improperly installed on joint use poles, etc., etc., that the carrier has issued instructions that no carrier personnel should be permitted to perform any function relating to the maintenance of telecommunications facilities on these bases.

Conclusions

The review of the practices of certain foreign carriers and the experience of U.S. carriers with interconnection

provides many lessons germane to the recommendations of the study team. The most comprehensive experience is that derived from interconnection of Government-owned equipments and systems (primarily those of the U.S. Department of Defense) with carrier systems.

There is also a large background of experience with interconnection of systems and equipments operated by the right-of-way companies, including the railroads, pipelines, electric utilities, etc., and with communications service organizations such as ARINC. There is also some applicable experience with the connection of user-owned telephones and other terminal devices to carrier networks. There is, however, no experience applicable to large scale interconnection of small, individual users, and the Panel concludes that it must be approached with great care.

The Panel also concludes that:

Interconnection without special interface devices is possible without service impairment or hazard to carrier personnel only under favorable conditions;

Such interconnections without restriction could cause substantial service impairment;

Favorable conditions are necessarily associated with incentive, ability, responsibility and user resources.

SECTION 11

INFORMATION AND ORGANIZATION

The need for improved information transfer among carriers, users, and sponsors was demonstrated on numerous occasions during the study. This lack of information is felt by all parties and will grow more serious as the interconnection area evolves. This lack of information exhibits itself in the improper design of equipment, confusion as to rules, rates and procedures, and a certain rigidity in the approach to mutual problems. As we have noted in the discussion on Certification (Section 6), there is a dearth of hard information in this area and a successful phasing-in of such a program requires knowledge and care. At present, no formal organizational structure

exists to implement this program. It is the feeling of the Panel that formal organizational structures should be established in this area to cope with the problems that are sure to develop.

Industrial trade organizations exist today whose function is concerned with writing or discussing standards for a particular industry. In the computer industry, several groups (SHARE, GUIDE, COOP, UNIVAC Users) are comprised of member corporations who meet to discuss the use of a computer. Standard programming languages such as FORTRAN, COBOL, PL/1, etc., are of prime importance to these users with respect to "standards" of the languages themselves. Thus, a standard COBOL implemented on various computers allows an interchange between various manufacturers' computers and models within a given manufacturer. The communications industry is represented in various

organizations (again members are corporations), such as International Communications Association, sections of the IEEE, etc. These organizations sponsor meetings of communications managers for various corporations at which specific problems are compared and discussed.

This section deals with an organizational requirement whose structure may be similar to others, but which emphasizes a difference, i. e., that of responsibility. The FCC is responsible to the public for the integrity of the national telephone network; thus, an organization reporting to the FCC must be true to that same responsibility. The new organization should be formally recognized by the FCC to ensure that proper weights are attributed to its recommendations. The purposes of the organizations should be to:

1. Promote a two-way exchange concerning problems of interconnection interfaces between the common carriers and the user suppliers. This exchange is vital to the problem of possible liberalization of interconnection and the resulting integrity of the public telephone network.

2. Promote and establish working groups that will be concerned with standards development, certification programs for equipment, licensing programs for installation and maintenance procedures and finally, with the data gathering and analysis of

technical interfacing problems. The various users groups need a common, authoritative forum to which data is fed and reacted to in the coming decade. Other trade and industrial organizations would welcome an independent atmosphere for discussions related to their specific positions on interconnection policy from a technical standpoint.

3. Develop recommendations to FCC as to the timing of the elements of a phasing-in process if a certification program is established. These recommendations should specify specific changeover interim

periods for certain classes of users by equipment to minimize the impact of the new standards and certification programs.

4. Promote a workable atmosphere concerned with innovation problems in interconnection on a continuing basis. There are three areas of concern: (a) interchange of ideas and information before new concepts and equipment developments are implemented; (b) interchange of ideas and new approaches before installations are made [by the carrier or user]; and (c) inter-

change of problems data after new services are installed in which unforeseen problems sometimes arise.

Proposals can be evaluated in the FCC authorized organization and brought together with TELCO and user positions. As changes occur in central offices, for example, relevant technical issues can be discussed in the forum as to the impact on the various user categories. New ideas by equipment suppliers can be evaluated in terms of particular common-carrier facilities that are ever changing.

A possible structure of a possible new organization is noted in Figure 1. This structure is purely an example and is by no means meant to be that simple. Various standing committees on continuing problems

would be organized and short range ad hoc groups would function on specific problems such as the phasing-in period for the proposed standards and certification program for direct connection equipment. Another important area is that of coordination with the State regulatory agencies to foster a more workable cohesiveness between these agencies and the FCC.

The NAS itself is an example of how the FCC might consider chartering the new organization. Funding and staffing criteria of the NAS are proper guidelines to the structure. Members must be individual (as opposed to corporate) and must be recognized as technically competent and dedicated professionals. A major activity of the organization must be oriented to collecting and managing a common data base of

interconnection activity. Access to this data base is reserved to the FCC and the organization and would be a valuable history file for the coming decades of expansion of the use of the public telephone network.

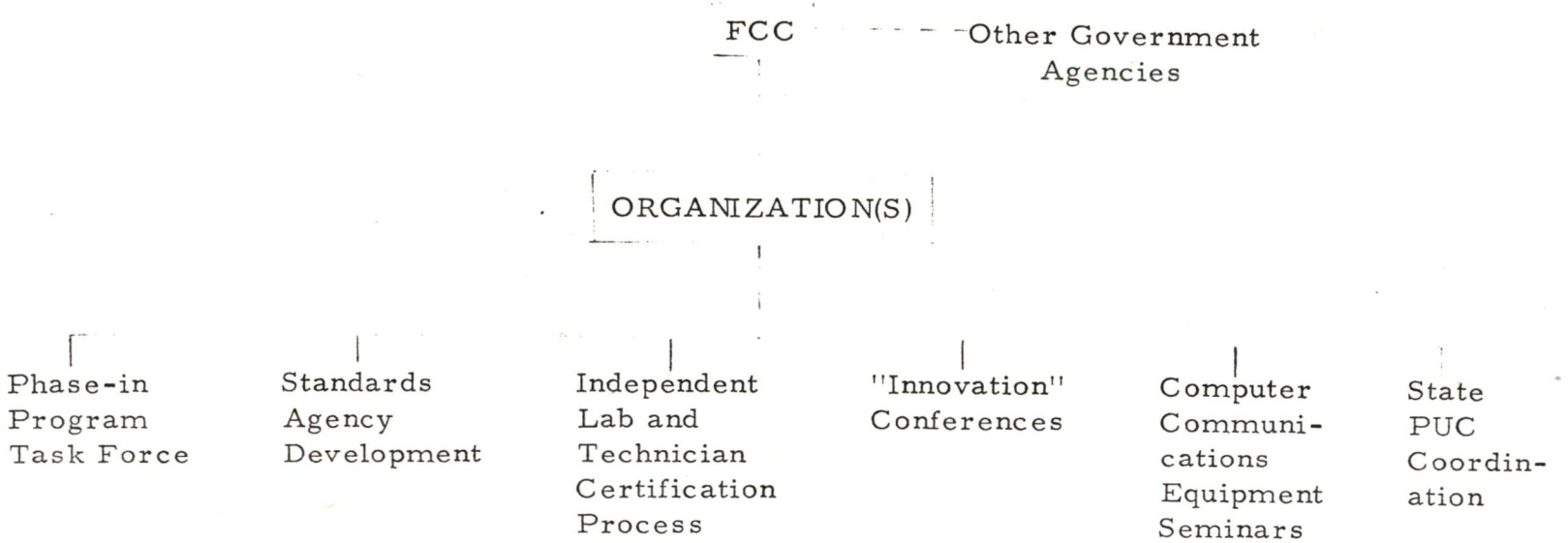

Figure 1