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ISDN: Numbering, Addressing, and Interworking

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The factors that affect the design of a numbering plan for the Integrated Services Digital Network (ISDN) involved a complex interplay between existing plans, national priorities, and technical system limitations. These factors are the subject of this report. Desirable attributes of any numbering plan are explained, existing standards covering various plans are discussed and some actual plans currently in use are examined. The development of the Numbering plan for ISDN by the Consultative Committee for International Telegraph and Telephone is essentially complete. However there is still a need to understand and make sense of the relationship of all of the standardized plans and the implications on interworking as public networks evolve toward the ISDN concept and technology.

Key words: addressing; interworking; ISDN; numbering plans; telephony

1. OBJECTIVE AND SCOPE

There currently exists a number of worldwide public network numbering plans. For example, The Consultative Committee on International Telephony and Telegraph (CCITT) Recommendation E.163 specifies the International Telephone Number, and Recommendation F.69 a Telex Destination Code. With the emergence of Integrated Services Digital Networks (ISDN's) there exists a real need for addressing in this new environment. Recommendation E.164 has been developed for that purpose. Open System Interconnection (OSI) standards are also being developed by the International Standards Organization (ISO) including a standard for a global network addressing plan. Finally, there is a need for interworking between networks such as an ISDN subscriber's call to a public dedicated network subscriber.

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This report does not attempt to resolve any issues. The purpose here is to acquaint the reader with various numbering plan concepts, the attributes these plans have, and to indicate what standards currently exist. There is a need to understand relationship between plans, concepts, and standards and their impact on interworking as public networks evolve toward this new concept of integrated services using digital network technologies.

The emphasis today is on implementing the ISDN numbering plan (ISDN-NPs) in various countries. In the following paragraphs we introduce some basic concepts concerning ISDN and indicate how the evolution of ISDN in the United States may differ from other countries. In Section 2 we list and define several criteria that are pertinent to numbering plan developments for any network. These criteria have largely grown out of telephone requirements since this is the network from which ISDN is expected to evolve. In Section 3 we proceed with an overview of various "standards," including CCITT's recommendations which influence the ISDN numbering plan implementations. We include a comparison chart showing various plans that exist today.

Many items of information are used throughout this report that have been found in unpublished, and therefore unreferencable, CCITT literature, e.g., Temporary Documents. These are denoted by: CCITT. Other basic sources are given in CCITT (1985) the CCITT "Red Book" Series (also see and Appendies C, D, & E covering CCITT Recommendations E.163, E.164, F.69, and X.121.

1.1 The Integrated Services Digital Network

CCITT defines an ISDN as:

> "A network evolved from the telephone network that provides end-to-end digital connectivity to support a wide range of services, including voice and non-voice services to which users have access by a limited set of standard multipurpose customer interfaces."

The end-to-end digital connectivity eliminates the requirement for analog voice-band modems for data. However, some form of voice digitization is required.

The original ISDN concept was based on the premise that a digital public telephone network would be transparent to the type of information being transmitted whether speech, facsimile, or bulk data. It was assumed that the ISDN would be based on the public telephone network. This rationale implied that an ISDN network would be a digital successor to the public telephone network. In the United States, this led to the idea of "multiple ISDN's" with similar characteristics and interconnection of these networks. As CCITT studies have progressed, recognition has been made that this may be an over-simplified approach. It may be not be necessary for the carrier to always know the types of information being transmitted as in basic service. Now the concept has been introduced that a limited set of multipurpose user/network interfaces will be used to interconnect users with the ISDN. An ISDN would then be a conglomerate of mutually interconnected networks, not necessarily having the same characteristics, with subscriber access via standard ISDN interfaces.

The predominant characteristic in ISDN planning is that a broad range of voice and nonvoice services will be supported. These services will be integrated through digital connectivity between users. Services such as telemetry, security monitoring, electronic mail, electronic funds transfer, voice, facsimile, graphics, videotex, bulk data transfer between computers, and nonbroadcast video are intended to be available through an ISDN. The ISDN services are expected to use public and leased data channels, network interconnection, and circuit- and packet-switched facilities. Media will consist of wire pairs, coaxial cable, optical fiber cable, and satellite systems. Message-switching does not appear as part of the current planning.

A fundamental principle underlying ISDN service integration is that the interfaces between the user and the network will be defined and kept to a minimum. Currently, there are many interfaces that connect a customer's terminal to the network. Most of these interfaces would be eliminated as the ISDN interfaces become defined and implemented. Existing interfaces (e.g., RS-232-C) could operate in an ISDN environment using a special adaptor. Such an interim solution would eventually be phased out. Another key principle is that bearer services (facilities such as circuit- or packet-switched channels provided by a carrier) be limited. The premise is that the communication carriers would provide the user with a minimum number

of standard channel services over circuit- and packet- switched facilities. The basic user network interface will have two 64-kb/s (B) channels for information transfer and one 16 kb/s (D) channel for signaling and low-speed data. This is the 2B + D basic channel structure. Multiples and submultiples of these data rates are being studied by the CCITT. High-volume users will have available a 23B + D configuration at the user/network interface. This is a primary rate channel structure for a PABX or LAN connection to the ISDN.

The ISDN is being structured so that current service-dedicated networks may be integrated into "an ISDN" where appropriate and cost-effective. Dedicated facilities to be integrated are those of the telephone networks, circuit- and packet-switched data networks, and telex. Private line, PBX, and LAN networks are not expected to be integrated, although they may be interconnected to the ISDN as shown in Figure 1. The evolution is expected to take one or two decades and will probably take place according to national or geographic boundaries based on national priorities or needs. Facilities that are already in place are to be part of this transition. The present digital networks are to be the basis for the integration of services based on economic considerations and technological evolution. Equipment is not being discarded except through obsolescence. The 64 kb/s PCM digital signal, the T-carriers, stored program control, and user-network signaling are to be an integral part of the ISDN.

1.2 Regulatory Viewpoint In the United States

In August 1983 the Federal Communications Commission (FCC) issued a Notice of Inquiry to seek comments concerning ISDN including comments on the role of the FCC in ISDN standards development. The information obtained resulted in a First Report in Docket 83-841 issued in April 1984. This so called First Report set forth several principals that relate to the United States environment. They include:

1. The ISDN numbering plan must have sufficient flexibility to allow subscribers to specify their choice of carrier for long distance service. The current international telephone numbering plan precludes this feature.

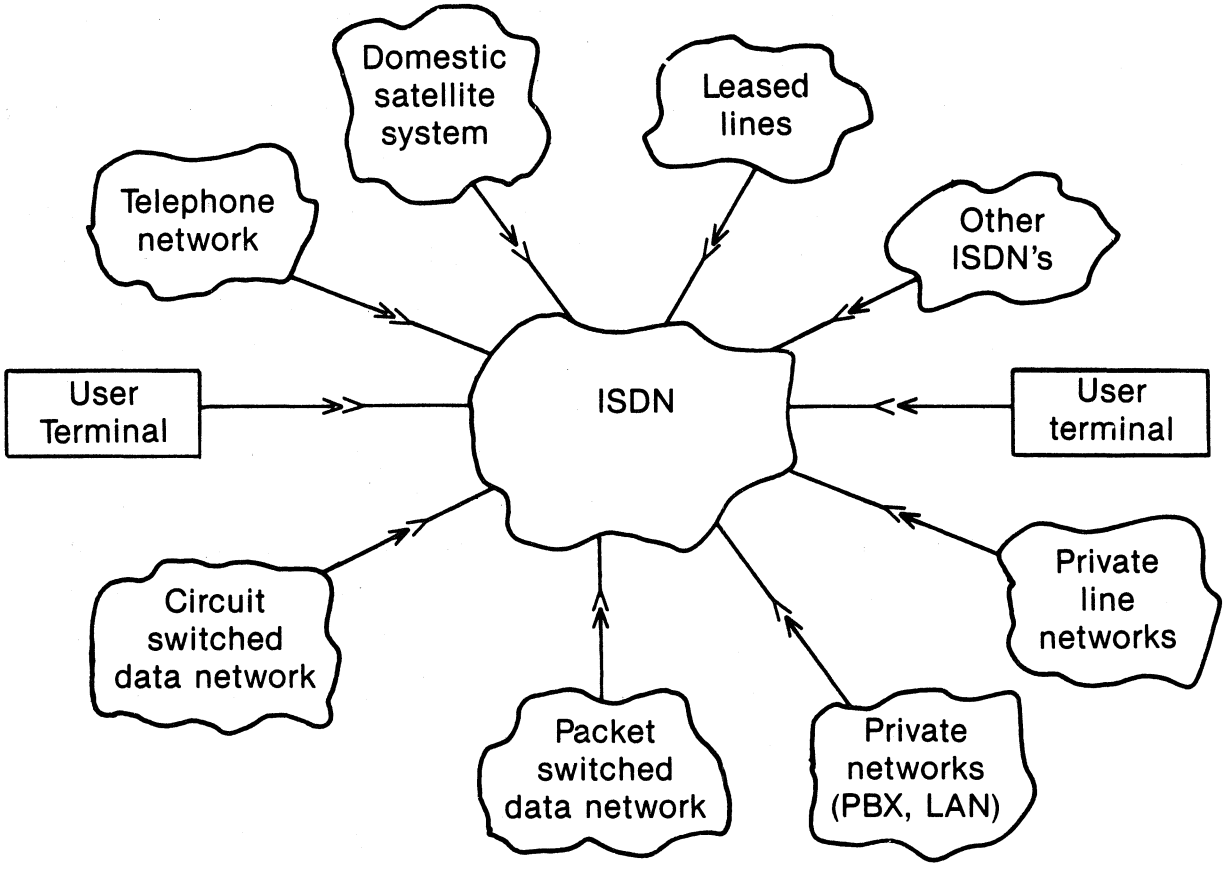

Figure 1. Interim interconnection of dedicated networks and ISDN(s) via interfaces.

2. Network termination equipment (NT1) is viewed as customer premise equipment that is supplied on a competitive basis in the United States This implies that the interface between this termination and the network (i.e., the "U" interface) is the connection between the customers' premises and the network and must be defined explicitly.

3. CCITT recommendation must be sufficiently flexible to accommodate the basic-enhanced dichotomy that exists between regulated and unregulated services in the United States.

In the United States, the National Committee of the CCITT is headed by a representative from the Department of State. The U.S. CCITT has been divided by subject matter into five groups as follows: A) regulatory matters, B) telegraph operations, C) telephone operations, D) data transmission, and E) the ISDN Joint Working Party. The ISDN Joint Working Party is the means by which the United States industry and Government agencies can coordinate their inputs relative to ISDN to the appropriate CCITT Study Group. An ISDN working group was formed a few years ago to conduct technical studies in assigned areas in support of the ISDN Joint Working Party. This group consists of industry and Government members working together to resolve many conflicting viewpoints. The work of this group has been taken by Working group T1D1 of the T1 standards committee that is an ANSI accredited committee sponsored by the Exchange Carriers Standards Association.

Contributions from the United States CCITT group to the CCITT are submitted via the U.S. Department of State. The process is intended to establish a unified U.S. position at the international meetings.

The development of any Recommendation in the CCITT is a complex and continuing process that often takes many years to complete. The process is exemplified by Recommendation X.121, The International Numering Plan for Public Data Networks. This Recommendation evolved from a Question first entrusted to Study Group VII in 1972. At that time the only numbering plans in existence were for telephone and telex networks, neither of which seemed to meet needs for interworking data networks on a worldwide basis. Study Group VII established a working party to concentrate on developing a workable plan. Canada subsequently submitted the first contribution during the 1972 to 1976 study period. This plan, to be administered by the CCITT,

provided for a 14-digit address including a 3-digit country code, a 1-digit network code, and a 10-digit network terminal number. Canada's contribution served as the basis for subsequent plan development. The working party, consisting of 15 to 30 members from 10 or more countries, met once or twice each year to review and discuss contributions and to amend the original Recommendation. Recommendation X.121 was finally adopted by correspondence in 1978. This adoption and subsequent publication of X.121 between the normal meetings of the plenary assembly was the result of the urgency expressed by a number of countries. Since that time, the working group has continued its efforts and is currently working on additional amendments to X.121 focusing on subaddressing including the allocation of subaddresses to terminals on the Public Switched Telephone Network (PSTN).

Figure 2 depicts the current U.S. view toward an ISDN. In this figure the customer-premises equipment is provided on a competitive basis. A telephone operating company provided local loop passes traffic off to any one of several competing long-haul networks. Most other countries do not have competition in their carrier industry but consider the network termination, local access, and long-haul carrier to be a single monopoly.

1.3 Environment of An ISDN Numbering Plan

Figure 3 depicts one view of a global ISDN addressing domain. In this scenario a subscriber at point "A" could reach a subscriber at point "B" anywhere in the world by dialing one number assigned out of the ISDN plan. Similarly, a computer at point "A" could communicate with another at point "B" by transferring one specific set of digits. In both of these examples, both terminals at "A" and "B" are attached to ISDN's. Other isolated networks could not be addressed.

The ISO portrays the environment for its end-to-end global addressing scheme differently. The ISO views an ISDN as a subdomain among many other subdomains within a global network addressing domain. This is depicted in Figure 4. All users are not connected to the ISDN but may be connected to other networks that are connected to ISDN.

The primary purpose of any numbering plan is just the identification of the end points involved in a connection. Thus neither service selection nor routing configurations are considered part of the plan. For ISDN subscriber

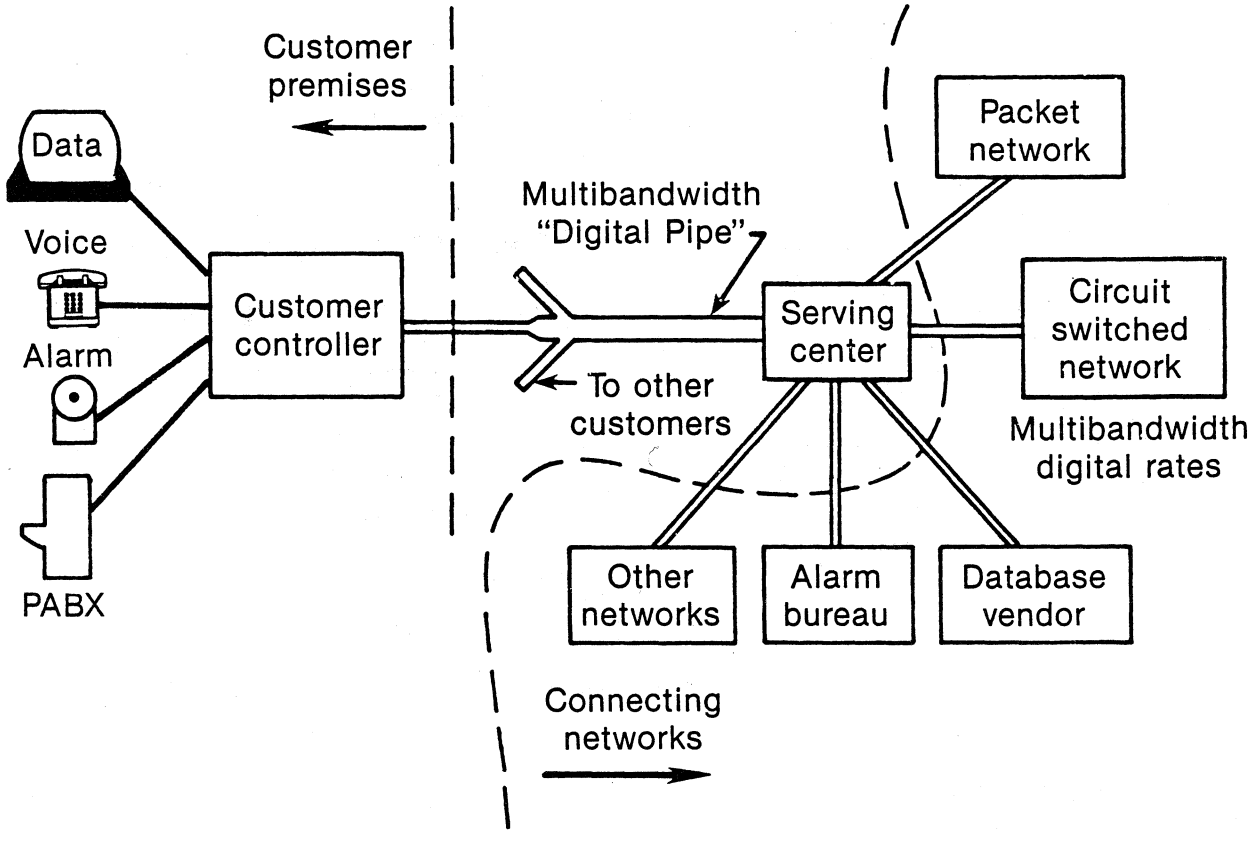

Figure 2. ISDN approach in the United States (after Dorros, 1983).

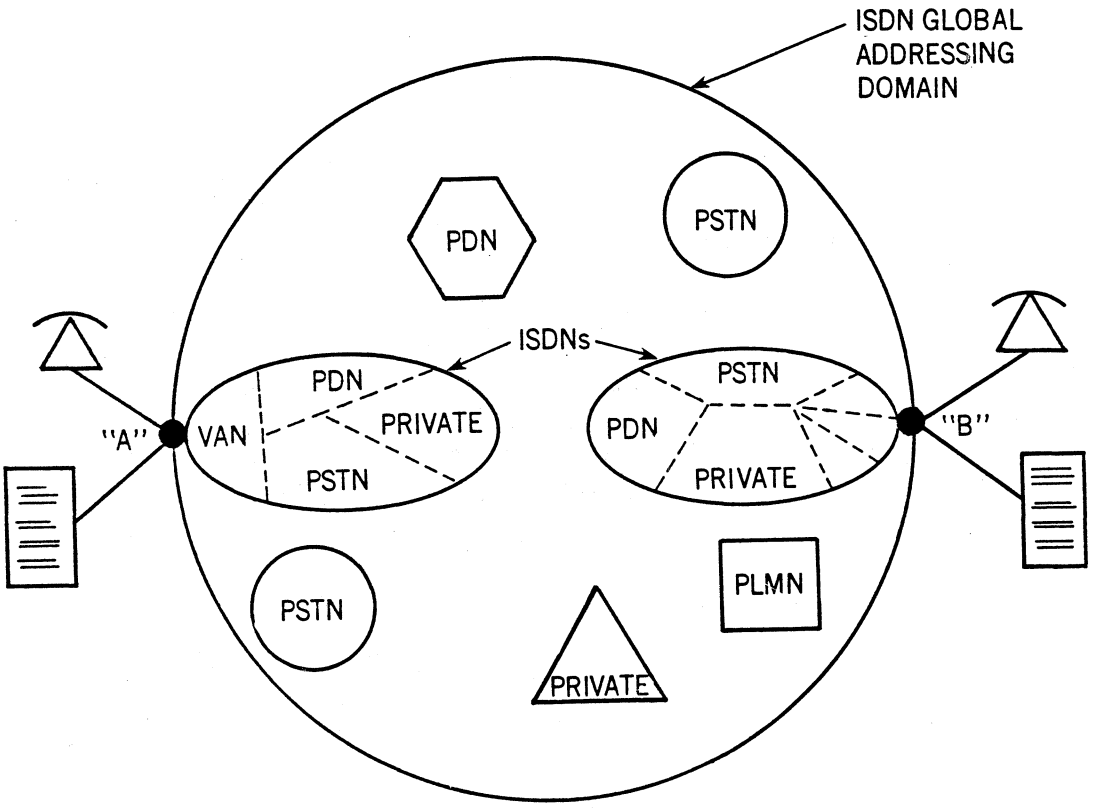

Figure 3. ISDN global addressing domain.

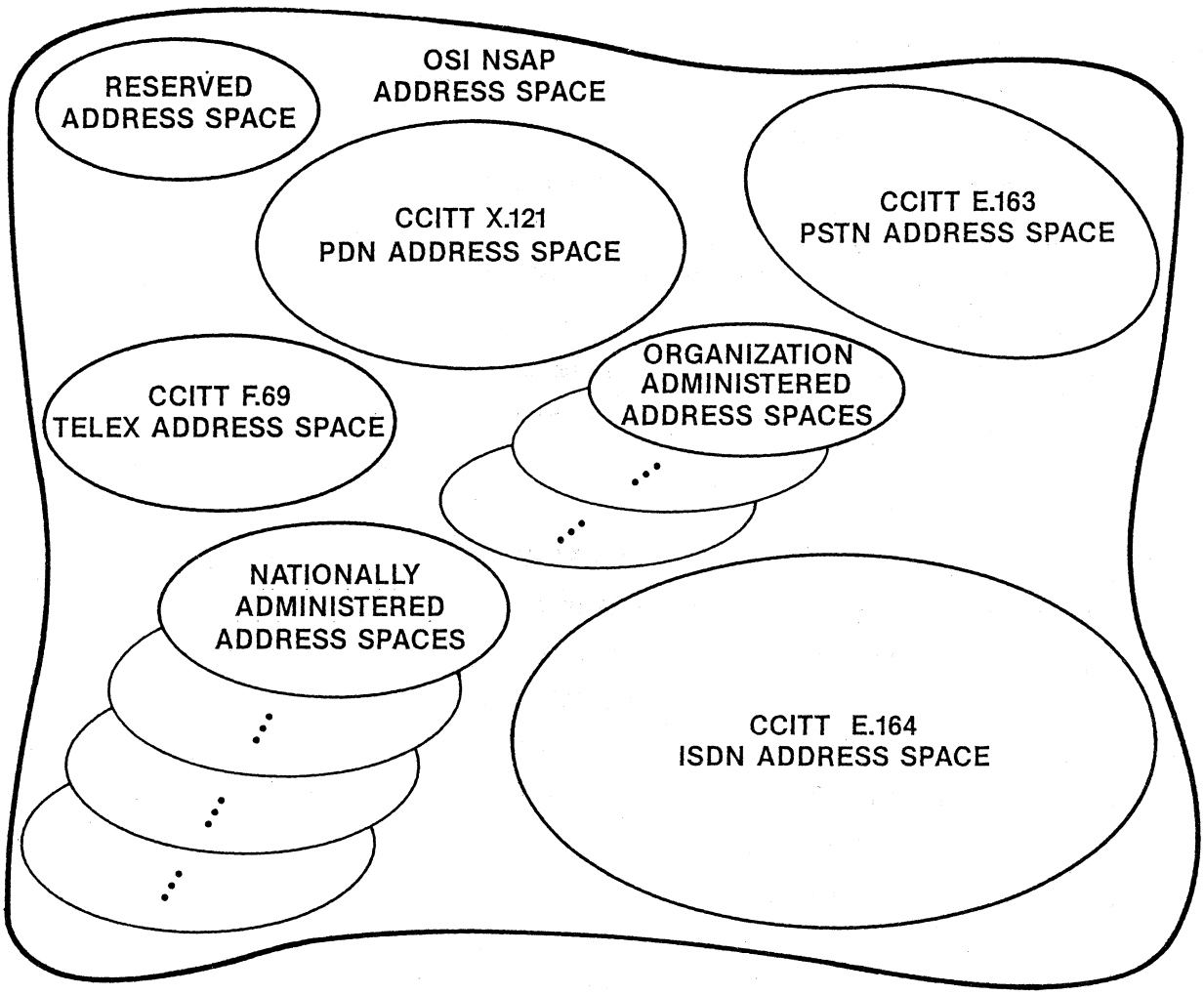

Figure 4. ISO global addressing domain.

to subscriber communications, the ISDN-NP assigns numbers to each. In the scope of a more global communication whereby an ISDN subscriber may connect to a non-ISDN subscriber, different views exist on how subscribers should be identified by each other and by the networks involved.

This report is intended to explore the many facets of ISDN number plan design and discover areas that require attention to successfully achieve interworking between evolving ISDN's and existing networks.

We recognize that ISDN will not emerge fully developed as a global system but will evolve from the existing telecommunications environment. The requirement for interworking with currently existing networks will be an important one for some time to come. This is the reason for discussing the dataphone, data, and telex standards for numbering plans in the next section.

2. NUMBERING PLAN DESIGN

In this section those criteria believed relevant to implementing any numbering plan are defined. The vital issues of network interworking are also discussed. The subject of continued study within both the CCITT and ISO, network interworking's importance, cannot be overstated. The entire premise behind the ISDN is based on two crucial elements, connectivity and interoperability[1] necessary for network accessibility, and consequently, interworking (private communication from J.A. Hull and D.V. Glen, "Impact of ISDN Standardizatin on Interoperability," NTIA 1984 informal report). This will be a topic of concern for many years to come since, not only during its growth and development (which could take decades) but even after it has "come of age," the ISDN may have to coexist and interwork with many non-ISDN networks, both data and voice, fixed and mobile.

2.1 Numbering Plan Criteria

While the structure and components of various numbering plans may be slightly different from each other to suit their intent, the major concerns of any telecommunication numbering plan are common. The issues that should be addressed must be, first and foremost, subscriber-oriented. For any

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[1]Connectivity is the existence of information paths among a population of users. Interoperability is the existence of interface and protocol compatibility among a population of users.

network, including an ISDN, it is important to answer such questions as: How many subscribers[2] must be uniquely identified? The answer to this directly affects the length and format conditions of the numbering plan. Additional questions that must be addressed are: How many switches or switchboards will form a switched network, and how many of the previously-identified subscribers should be handled by each switch?

At this point two terms must be defined that are used in this and subsequent sections. With regard to the ISDN, the terms numbering and addressing are used in this report as follows: A subscriber ISDN number uniquely defines that subscriber's T-reference point at the network termination unit, and the S-reference point at the terminal side of a PABX, LAN, etc. (These reference points are defined in CCITT Draft Recommendations I.310 and I.411, and further described in I.412. See Figures 5 and 6.) The subscriber ISDN number is the number by which the subscriber is identified in the ISDN Numbering Plan (e.g., the number that might be listed against the subscriber's name in the public directory). An ISDN address consists of at least the ISDN number, but may contain additional information (e.g., a subaddress), which may consist of the identification of a specific user on a private network or LAN; it may be the "extension" of a user on a PABX if the extension numbering scheme is not part of the ISDN Numbering Plan, or it could be a specific process address point inside a computer installation. More concerning the distinction between number, address, and subaddress will be discussed in Section 3.

An important consideration when studying a new numbering plan is the compatibility of the new scheme with national and local dialing plans, and any other dialing plans with which interworking is to take place. For the near and intermediate term, an ISDN Numbering Plan will have to operate within the confines of those address or numbering features that are intrinsic to the already existing systems with which it will operate. This is one of the primary reasons that such documents as CCITT Recommendation I.120 state: "ISDNs will be based on the concepts developed for telephone ISDNs and may evolve by incorporating additional functions and network features including those of any other dedicated networks such as circuit-switching and packet-switching for data so as to provide for existing and new services."

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[2]Here a subscriber is defined as any individual, or special feature, or function to which a unique station address or number is assigned.

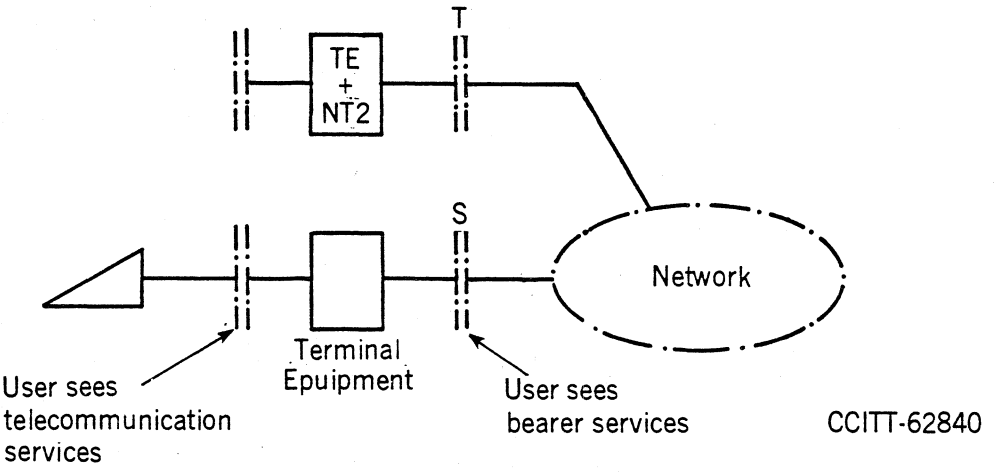
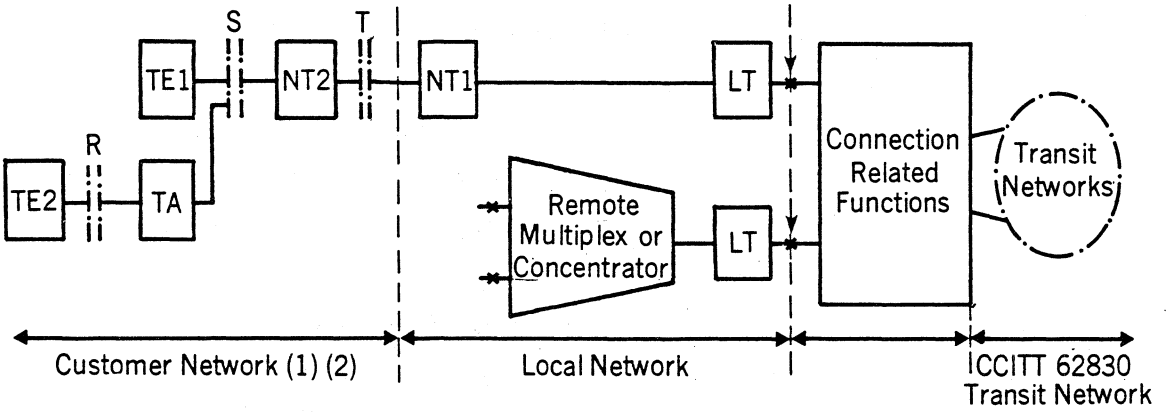


Figure 5. Reference for defining ISDN capabilities (after CCITT Draft Rec. I.310).



TE = Terminal Equipment
NT = Network Termination
LT = Line Terminal
CRF = Connections Related Functions

Note 1 - NT 1 functional entity could be located within the subscriber premises in some cases and outside the subscriber premises in other cases.

Note 2 - For some countries, the customer network could be connected to more than one local network and possibly more than one transit network.

Note 3 - Customer network, local network, serving local center transit network do not refer to functional groupings.

Figure 6. Typical examples of a reference configuration for the ISDN (after CCITT Draft Rec. I.310).

The following paragraphs present those characteristics considered necessary to the transition, maintenance, and common use of an international ISDN Numbering Plan (ISDN NP). These features, or criteria elements, are defined and their expected attributes are explained in terms of their relevancy to the overall issue.

2.1.1 Uniformity

This element may also be referred to as commonality or compatibility. It is the key to interworking networks and is defined as a degree of sameness with the numbering plans of other systems, existing and planned, with which the ISDN may have to interwork. Uniformity is of the utmost importance because it has the strongest influence on the number of subscribers with which a given subscriber can communicate. An emerging ISDN, wherever it may be, will have to coexist for some time with telephone and data networks, public and private, that are already in place. Uniformity of the ISDN-NP will allow greater network interworking, thereby affording a greater range of subscriber services to a greater number of subscribers. This will, in turn, lead to increased communications at all levels and greater user mobility.

2.1.2 Flexibility

Flexibility can permit a subscriber to maintain contact with other subscribers even when rapid changes are taking place with the network and its environment. Although many things may quickly come to mind when discussing flexibility, for a numbering plan it is primarily the capability of allowing unique identification of a wide variety of quantities, types, and groupings of subscribers and their mobility without alteration of the plan. In this way, the attribute of flexibility meets the objective of stability in the dialing plan. It does this by meeting long-range needs without major changes, thereby minimizing user reeducation (Muhlhausen et al., 1983). Another attribute of a flexible numbering plan is that no restrictions would prohibit increases in the exchange of information or in the mobility of the use. Flexibility also contributes towards a network's responsiveness or adaptibility to the needs of its users, thus making it more readily available and capable of keeping current with technological

advances. Flexibility is also the element that allows subscribers to maintain contact regardless of the turmoil of an emergency or during catastrophic failure situations.

2.1.3 Ease of Use

This feature enhances the ability of a subscriber to complete calls. A part of the measure of ease of use is the length and structure of a particular number or, how easy is the number remembered and used? In other words, a dialing plan should be "user friendly". This means minimizing normal dialing sequences while, at the same time, providing for user selection of frequently desired features in the dialed digits. It also means that critical timing or time outs in dialing data collection should be avoided (Muhlhausen et al., 1983) since they can cause customer irritation. A well-organized and easily utilized numbering plan can lend stability and dependability to a network. For an emerging ISDN, this can facilitate greater accuracy and eventual standardization of the numbering plan.

The benefits derived from this feature, as well as the previous two features, would greatly enhance the acceptability of the numbering plan and, consequently, bring about a wider distribution of the services offered.

In addition to user convenience and acceptance, the ISDN numbering plan implementation must be acceptable from a commercial and administrative viewpoint (e.g., costs, timescales). The management of the numbering plan by administrations or Recognized Private Operating Agencies (RPOAs) should be a simple process, and the numbering arrangements should permit the publication of easily understood instructions for users-CCITT. These instructions should be concisely spelled out in the published or stored Directory.

2.1.4 Explicitness (Nonambiguity)

This element has the greatest effect upon the mode and clarity of a number or address. With respect to a numbering plan, explicitness prevents users or network misinterpretation or confusion of the number coding. Explicitness does this by grouping digits so that their value and arrangement preclude errors in their meaning. A nonamibigious numbering

plan furthers the speed of identification and transfer of messages by reacting more accurately to the routing of those messages. For example, in a very large numbering plan such as in the North American area, explicitness, when used appropriately for destination routing, makes it possible to distinguish between Numbering Plan Area (NPA) codes and Central Office (CO) codes by examination of the second digit dialed.

It has been proposed that the method of specifying services required, interworking with other networks, and identifying destination subscribers within the calling network should be explicitly stated within the address or number. This, however, is a controversial issue that must be resolved.

2.1.5 Expandibility

The arrangement of digits, or dialing sequence, of a number influences the flexibility of a numbering plan. The explicitness, or nonambiguity, of the numbering plan depends upon the value of the digits used as well as their placement within the structure of the number. Expandibility addresses the issue of how many digits are available for use within the numbering plan and thereby, determines what the ultimate network capabilities are. While for ease of use it is desirable for an address or number to consist of the minimum amount of digits needed for a rapid and correct connection, several factors enter into the argument for an upward revision of the digit limitation. Study Group II, of the CCITT has investigated this issue, along with many other ISDN numbering plan issues. One of the address-length limiting elements in the past has been the digit capacity of international registers. Proposals for an increase in the digit capacity of international registers and an upward revision of the E.163 digit limitation of 12 were based on the following:

- Memory capacity is no longer very costly.
- Several CCITT Contributions have indicated a requirement for an increase in numbering capacity for the purpose of direct-inward-dialing (DID) and because the subscriber population including data terminals may soon exceed existing capacity.
- An increase in digits would also meet the requirement, in certain countries, to introduce network identification codes (NIC's) (without compromising the country code).

- The requirement for interworking with other networks may be facilitated especially if those networks employed a numbering plan such as CCITT X.121, which allows up to 14 digits.

- Mobile services (land or maritime satellite) numbering plans (CCITT Recommendations E.212 and E.213, E.211, E.210) require additional access digits.

Regardless of the maximum length of an international ISDN number, prefixes, language digits, etc., are not considered part of it, but must be included in the planning of digit capacity for the international switch register nonetheless.

2.1.6 Accessibility

The simple definition of this criterion is the capability of being reached. In a telecommunication network, however, there is more to the meaning of the word accessibility than is implied by that simple definition. Accessibility, in telecommunications, should be viewed from the point of a user-pair communicating with each other. Even in simplex transmission, the user-pair must first be connected by some physical information path; and second, the user-pair must be interface- and protocol-compatible. If an interworking unit exists to perform conversion, the interfaces and protocols do not have to be identical as long as the service semantics are maintained.

2.1.7 Deducibility

This characteristic could be of particular value in any network where subscribers may be in a fluid or mobile environment. In one sense, deducibility refers to the ability to derive a subscriber or his location from his number. This could also apply to an individual subscriber number if implemented properly. It could be used as an organizational unit locator and would eventually locate an individual subscriber. Deducibility is also another way of saying that a system (network) is capable of recognizing certain digit values and/or placement or traits (e.g., time outs) inherent to the numbering plan and, by inference, either anticipates a given response within a certain period of time, or responds immediately. This is

illustrated by any special prefix used, such as the international prefix 011, or a combination of prefix and time lapse, such as a 3-second lapse after either the first digit "0", or second digit "1". The North American Numbering Plan Area (NPA) code format, where the network equipment recognizes the second digit, distinguishes between an NPA code and Central Office (CO) code, and anticipates the number of digits as 7 or 10, is also such a form of deducibility. The human factor form of deducibility is sometimes applied on mobile networks where a subscriber's address is assigned using easily remembered, reproducible logic. Thus subscribers can deduce another's address without referring to a directory.

This list of attributes can be expanded further with lesser degrees of importance. Different administrations and different carriers view the desirable attributes from different perspectives. For example, the telephone carriers may want different characteristics than the data or telex groups. That is why there are three different numbering plans and dialing procedures for three different networks. They are:

1. Numbering Plan for the International Telephone Service (CCITT Rec E.163) Appendix C.
2. Plan for Telex Destination Codes (CCITT Rec F.69) Appendix E.
3. International Numbering Plan for Public Data Networks (CCITT Rec X.121) Appendix F.

It has become more and more desirable to provide interworking between these networks. Because the transition to a global ISDN is expected to take considerable time, it is essential that interworking arrangements be available during the transition period.

Another list of desirable features for the interworking numbering plan was submitted to Study Group II by Nippon Telegraph and Telephone (NTT) of Japan. The list contains the following six features:

1. Smooth transit to ISDN (Expandibility).

2. Maintenance of existing numbering plans for dedicated networks as long as they exist (Permanency).

3. Common use of supplementary service dialing procedures and prefixes for all the dedicated networks and ISDN as far as possible (Uniformity).

4. Little or no required changes to existing networks and existing exchange systems (Economy/Flexibility).

5. Address number dialing digits to be a uniform length and as short a possible (Simplicity/Ease of use).

6. Ability to dial the same address number for the same called terminal from all calling terminals whether the calling terminals are in the same network or not (Universality/Accessibility).

This list is included to show the diverse opinions that exist throughout the world concerning how the ISDN plan should be implemented.

2.2 Network Interworking

Recommendation I.330 states that "the ISDN number does not identify the particular nature of the service, type of connection, or quality of service to be used nor does it identify a transit RPOA/network."

This is an important point. It means that while a caller may specify where a call is to go, the network controls how it is to get there. It is generally agreed, however, that signaling procedures that are not part of the international ISDN number should be capable of carrying user-to-network information and carrier selection.

While the network switching hierarchy is responsible for routing message traffic, unless full-connection arrangements have been established, the message traffic will not arrive at its final destination and the communication user pair will not be accessible to each other. This concept is as important to subscribers within the same ISDN as it is from the ISDN to any other network with which it must interconnect, and vice versa, whether the other network is another ISDN or a public, private, or dedicated network of any type. For the network to route a call to a user-indicated destination subscriber is only part of the task. The called subscriber's switching interface must also recognize the incoming set of digits as being a valid directory number in that network and then take appropriate steps to allow access to the called subscriber, thereby completing the connection. All conditions of interoperability (e.g., protocol, language, format, data rate, synchronization) must be met on both sides of the call. Although the basic issue of interworking several networks is not peculiar to the ISDN,

accessing an ISDN by several specialized networks is unique. For the purpose of this report, the term specialized network can be taken to mean any of the following:

1. Circuit Switched Data Network (CSDN)
2. Packet Switched Data Network (PSDN)
3. Value-Added Network (VAN)
4. Local Area Network (LAN)
5. International Record Carrier (IRC)
6. Domestic Satellite Systems (DSS)
7. Mobile networks (maritime or PLMN)

The development of digital telecommunications networks is progressing far more rapidly in parts of the world than was originally conceived. Although this transition to Integrated Digital Networks (IDN's) is considered the next "natural" step in the evolutionary process between the Integrated Analog Network (IAN) and the ISDN, there is still expected to be some time before the implementation of ISDN's becomes widespread. It will be even longer before the ISDN becomes as ubiquitous as the PSTN is today, if it ever does. During this period of ISDN development, it is anticipated that public, private, and dedicated networks will have to coexist and interwork with those ISDN's for some time, as indeed they have had to coexist and interwork with each other. An outgrowth of this latter relationship has been the development of the international numbering plans (E.164, E.163, F.69, and X.121). With the imminent establishment of ISDN's it is important to study and define numbering and addressing methods of accessing the ISDN's, and ways in which ISDN's and other networks should interwork.

Based on the premise that an ISDN is an entity, there can basically be five separate and distinct sets of ISDN-related interworking circumstancees. They can be briefly described as follows (see Figure 7):

1. Participating specialized networks [SN(P)] and an ISDN making up a whole global network. This relationship, as envisioned by the Central European Post and Telephone (CEPT), is shown in Figure 8.

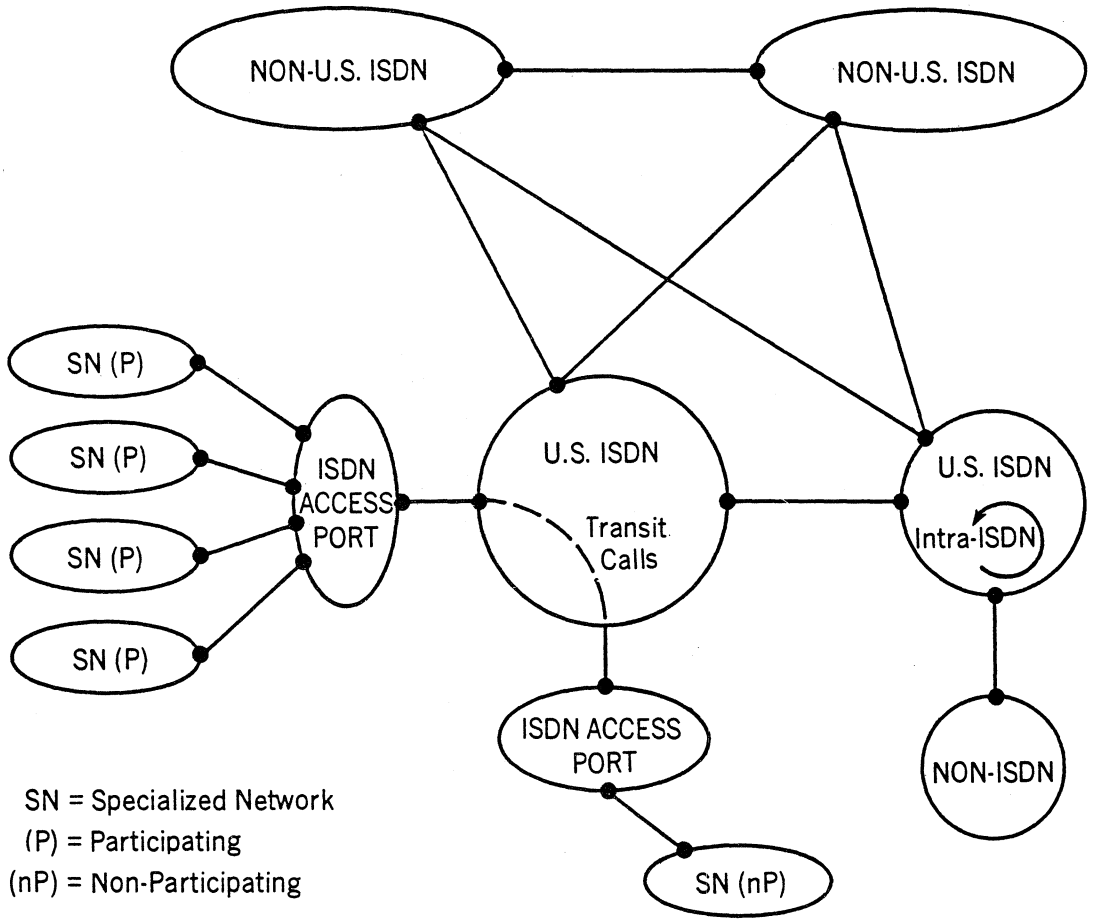


Figure 7. ISDN interworking possibilities

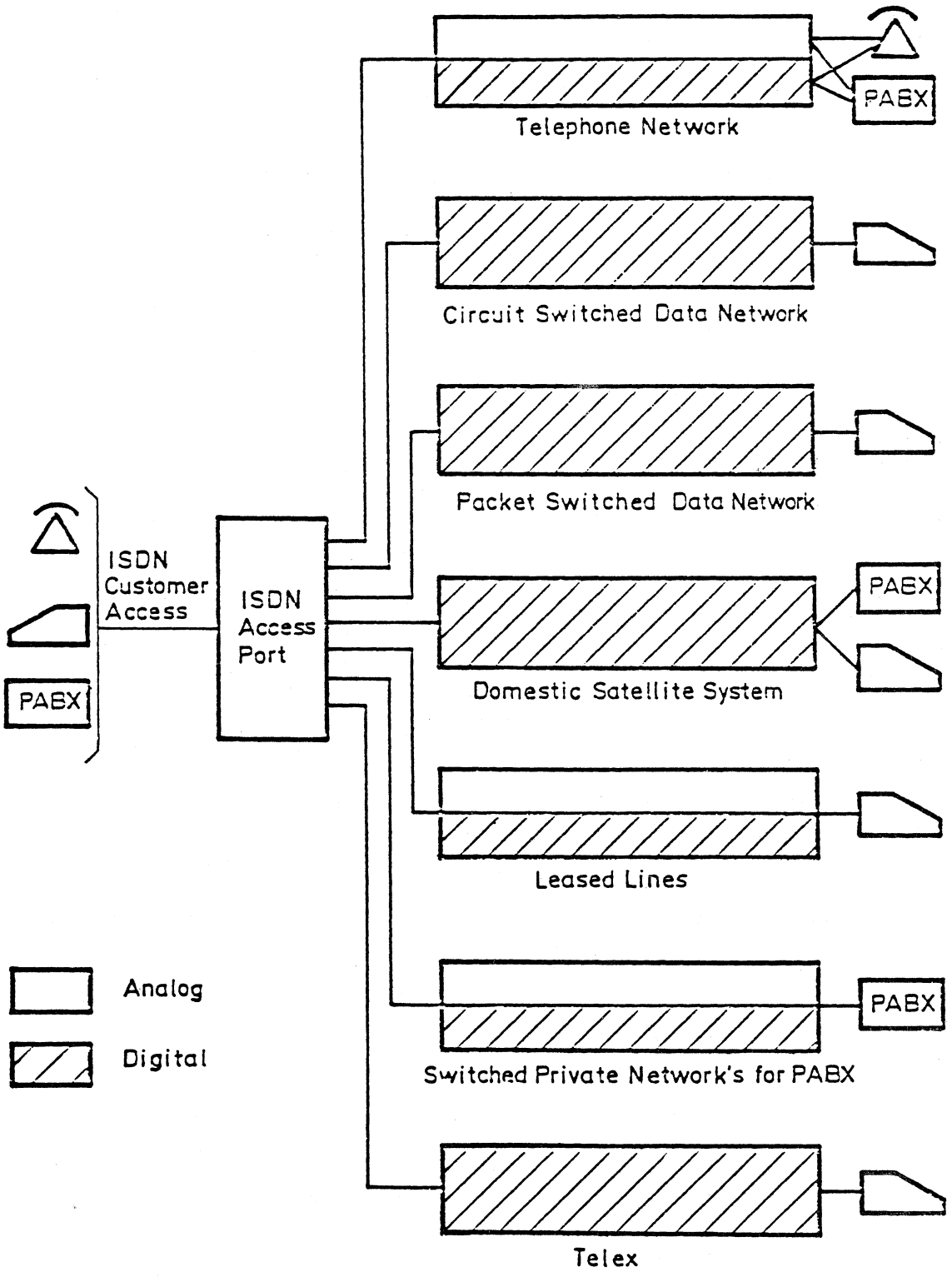


Figure 8. Interconnections between ISDN and various dedicated networks (CEPT, 1982).

2. Nonparticipating specialized networks [SN(nP)] and an ISDN operating on an occasional-access basis.

3. Domestic ISDN's within a multiple-ISDN administration (e.g., the United States).

4. A non-United States ISDN and United States ISDN(s).

5. A non-United States ISDN and another non-United States ISDN.

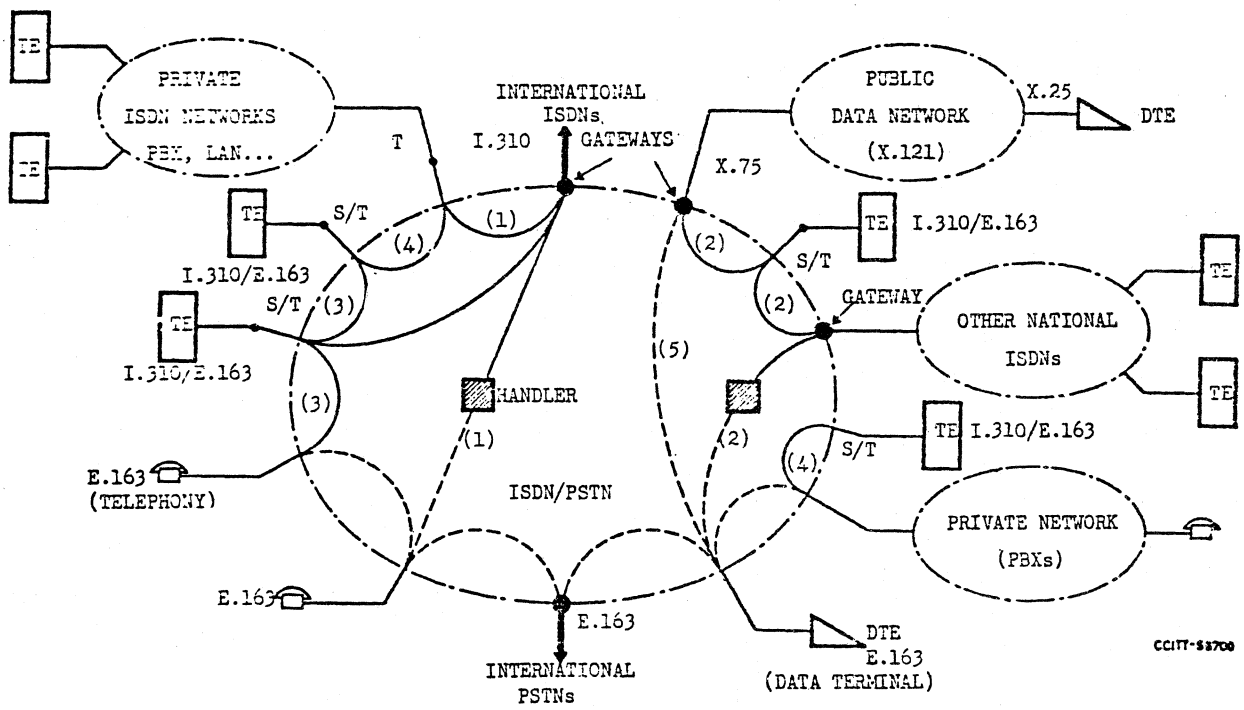
The distinction between United States and non-United States ISDN's is included because United States ISDN's are expected to evolve differently than in other countries. In the United States multiple carriers may be used to provide various ISDN services rather than a monolittic structure.

In addition to these five possible situations, there must also be considered the case of a transit network being capable of carrying and delivering traffic from one network to another, either of which may or may not be an ISDN. A contribution (COM II - No. 207) to the CCITT from Canada includes the illustration in Figure 9 which shows how many of the circumstances of network interworking. It also indicates the relevant Recommendations involved, and the various addressing methods required. This gives some idea of the magnitude of the problem and what can be expected during the near and intermediate term of ISDN development.

Standards groups are currently debating the selection of a standard method of numbering plan interworking so national ISDN's will be able to work internationally. Three basic types of methods for addressing in ISDN interworking situations have been identified. These methods are:

1. The use of a numbering plan Identification Code. This method could be used primarily when interworking from an ISDN to other numbering plans (e.g., E.163, X.121).

2. The use of a special prefix, or "escape code", which signifies that the digits to follow belong to a different numbering plan. This method, which is often referred to as the single-stage method, is presently used for interworking from X.121 networks to PSTN's (using the digit 9), and to telex networks (using the digit 8). It is also used when interworking from a PABX to a PSTN, FTS, or AUTOVON. this method could also be used for interworking from an ISDN to other networks instead of, or in addition, to method 1. A special prefix, outside the ISDN number format, could be used.



(1) INTERNATIONAL ISDN ADDRESSING : P, CC, NIC, NN
(2) NATIONAL INTERNETWORK ADDRESSING : P, NIC, NN (E.163, X.121 or F.69)
(3) INTRA ISDN/PSTN ADDRESSING : NN (E.163)
(4) NATIONAL ISDN/PRIVATE NETWORK ADRESSING : NN, TE or NN Shared Address
(5) NATIONAL PSTN/PDN NETWORK ADDRESSING : PORT METHOD

LEGEND : P : PREFIX CC : COUNTRY CODE NIC : NETWORK IDENTIFICATION CODE NN : NATIONAL (SIGNIFICANT) NUMBER

——— ISDN CONNECTION - - - - PSTN CONNECTION TE : TERMINAL IDENTIFICATION

Figure 9. Address for interworking between ISDN and other networks (CCITT, 1983).

3. The use of a two-stage, or port, method is currently used for interworking between PSTN's and other networks (e.g., SPRINT, MCI, AT&T). It could be used, in some cases, for interworking between an analog PSTN and an ISDN.

There may also be other methods not included here.

Under the Modified Final Judgment MFJ) entered in United States vs. Western Electric Co., et al., each Bell operating company (BOC) is required to provide equal access to all interexchange carriers (IC's). Equal access under this decree means "equal in type, quality, and price to that provided by AT&T and its affiliates. The MFJ defines strict areas of service responsibility for the BOC's and prohibits joint BOC/AT&T ownership of network facilities after divestiture. Intraexchange services are provided by the BOC's while interexchange services are provided by interexchange carriers: The decree does not define how equal access will be provided but permits each BOC to devise an appropritate plan to fulfill this requirement. Equal exchange access requires the use of a code (10XX) to designate the IC. In adddition each BOC must offer as a tariffed service, exchange access that permits each subscriber to automatically direct interexchange calls to the IC so designated by the subscriber. This is known as presubscription. (See Figure 10 for SCC connections to the U.S. PSTN before the MFJ.)

All of the different possibilities for numbering plans and addressing in the ISDN for interworking with many networks point out the pressing need for worldwide standardization, otherwise each countries implementation and interworking solution could seriously complicate the process of making international calls.

3. OVERVIEW OF NUMBERING PLAN STANDARDS

This section will present a broad look at the standards that heavily influence interworking considerations. Existing CCITT Recommendations will be viewed together, to allow an understanding of individual, and synergistic, effects. The following Recommendations are included:

E.164 Numbering Plan for the ISDN Era

E.163 Numbering Plan for the International Telephone Service

E.160 Definitions Relating to National and International Numbering Plans

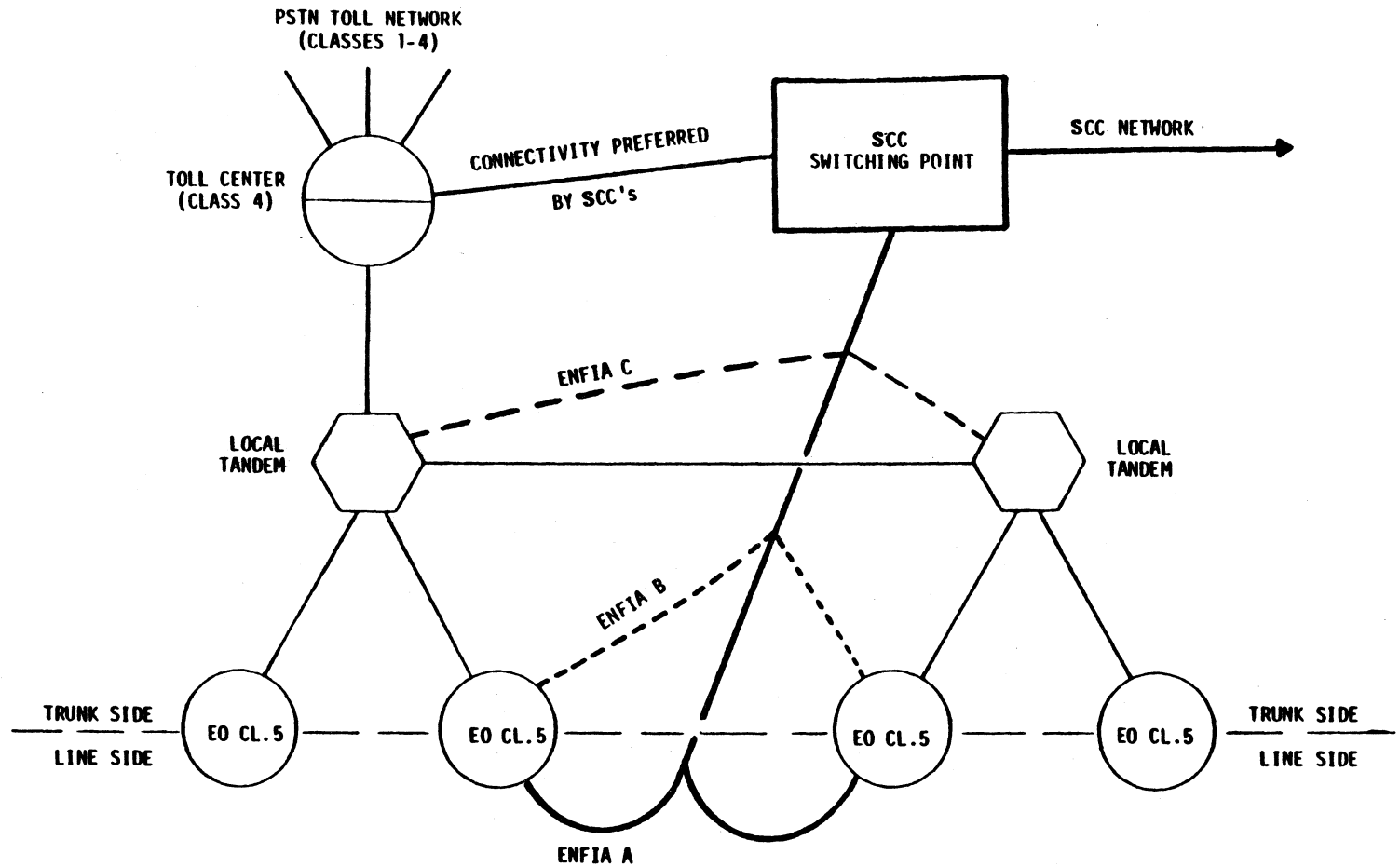


Figure 10. Specialized common carrier connections to the PSTN in U.S. (before equal access).

E.131	Subscriber Control Procedure for Supplementary Telephone Service
E.210	Ship Station Identification for VHF/UHF and Maritime Mobile-Satellite Services
E.211	Numbering and Dialing Procedures for VHF/UHF and Maritime Mobile-Satellite Services
E.212	Identification Plan for Land Mobile Stations
E.213	Telephone Numbering Plan for Land Mobile Stations in Public Land Mobile Networks (PLMN)
F.69	Plan for Telex Destination Codes
I.330	ISDN Numbering and Addressing Principles
X.121	International Numbering Plan for Public Data Networks

The guidance contained in these Recommendations will be shown as it relates to three general areas of ISDN network planning: numbering, addressing, and the actual provisioning of an ISDN connection. Recommendation I.330 best differentiates between the threee concepts. An "ISDN address" comprises an ISDN number and mandatory and/or optional addressing information. Providing an "ISDN connection" requires not only an ISDN address but also nonaddress information. The subsections below provide the logical buildup from the ISDN number (and its parts) to the provision of an ISDN connection.

3.1 Numbering

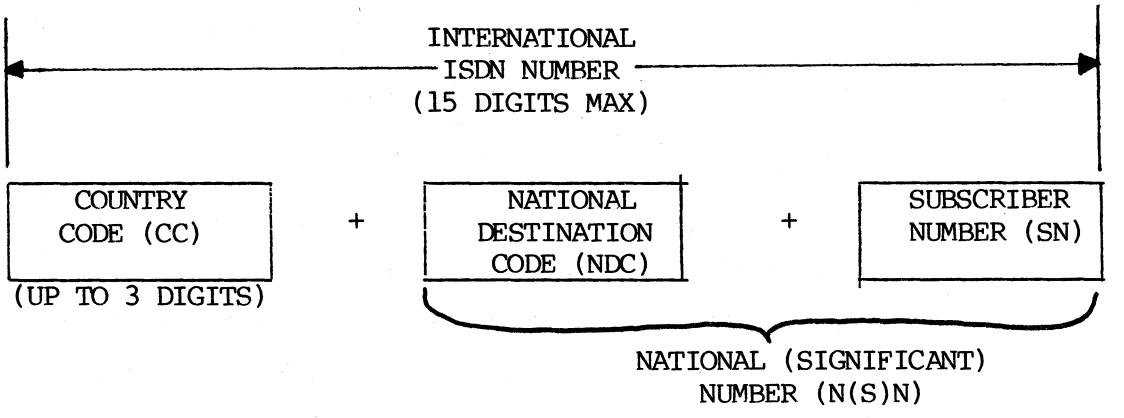
Because the ISDN will evolve (gradually in some cases), Recommendation I.330, states that all ISDNs should evolve toward a single ISDN numbering plan and that this plan should be developed by enhancing E.163. The "Numbering Plan for the ISDN Era", E.164, therefore, has been considered with that thought in mind.

Recommendation I.330 notes that some present data networks could retain X.121 numbering structure and interwork with ISDN's, or evolve from X.121 data networks to multiservice networks. The X.121 structure must also be examined for application to ISDN formats.

In the following subsections the pertinent recommendations are discussed in detail so that differences can be noted. We begin with Recommendation E.164 which describes the International ISDN Number.

3.1.1 The International ISDN Number (E.164) Appendix D

The International ISDN Number is illustrated below as described in E.164.



This 15 digit (maximum length) number is composed of the following parts:

- Country Code (CC): a combination of one, two, or three digits characterizing the called country. Nine digits (from 1 to 9) are CC's or first digits of a CC. These digits define "world numbering zones" (per E.163). Assignment of CCs is by the CCITT.

- National (Significant) Number (N(S)N) or National ISDN Number: the number used, following the trunk prefix, to obtain a subscriber in the country (or group of countries using one integrated numbering plan) but outside the same local network or numbering area. The following equations illustrate the N(S)N as defined in the respective documents:

  N(S)N = NDC + SN (E.164)

  N(S)N = Trunk Code + SN (E.160)

  National ISDN No. = NDC + ISDN SN (I.330)

- National Destination Code (NDC): one or more decimal digits characterizing a numbering area in a country (or group of countries using one integral numbering plan). The NDC varies in length to accommodate the requirements of destination countries. It can be used to select a destination network (e.g. an ISDN or public switched telephone network.) It may be used in a trunk code (TC), as defined in E.160, to route calls over a destination network. NDC's are assigned by countries.

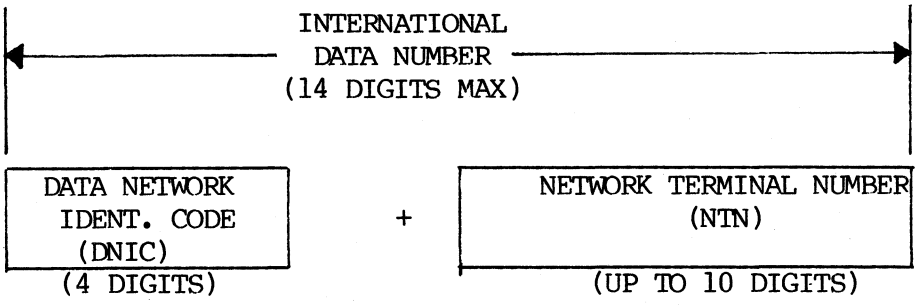
- Subscriber Number (SN): a number used to reach a subscriber in the same local network or numbering area. This number varies in length in accordance with the requirements of the destination country. It is the number normally found associated with a subscriber in the network directory. ISDN subscriber numbers may be allocated from the range of subscriber numbers available in the local ISDN exchange and may be assigned to customers who subscribe to only telephone service, one or more data services, or a mixture of telephony and data services. ISDN subscribers always are called by the same SN irrespective of where in the network the call originated. The assignment of subscriber numbers is a national responsibility.

3.1.2 The International (Telephone) Number (E.163) Appendix C

Recommendation E.163 portrays the "International (Telephone) Number" for basic telephone service in the same configuration as the "International ISDN Number," i.e., a CC plus an N(S)N. The primary differences between the two, however, are the absense of a defined NDC field in the standard plan and the maximum allowable digits to be dialed by subscribers in the automatic international telephone service (E.163) are 12 (excluding the international prefix.)

3.1.3 The International Data Number (X.121) Appendix F

The International Numbering Plan for PDN presented in X.121 is designed to permit identification of a country, a public data network located within it, and a data terminal operating in the PDN. An "International Data Number" is depicted below. This is the number that will allow a particular data terminal in one country to be reached from a data terminal in a different country.



A total of 14 digits are authorized for this number. Its structure is not unlike that of the International ISDN Number. The following elements exist within the International Data Number:

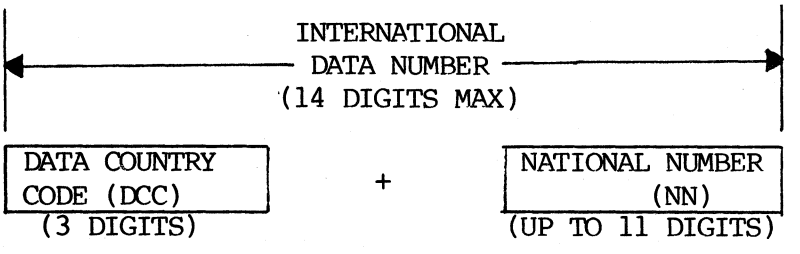
- Data Country Code (DCC): a combination of three digits characterizing the called country. The first digit (2 through 7) represents a designated world zone and is followed by two digits in the 0 through 9 range, completing the country's identification. CCITT-assigned DCC's are provided in Annex V to X.121. There is a potential for 600 different DCC's.

- Network Digit: one digit which immediately follows the DCC digits and specifies a particular PDN within the country. Because this digit may be in the 0 through 9 range, only 10 different PDN's may be designated for a DCC. (A country with more than 10 PDN's may be assigned more than one DCC.) Network digit assignments are made nationally.

- Data Network Identification Code (DNIC): formed by the DCC and Network Digit, this four digit number identifies a PDN anywhere in the world. In a country or area where all networks are contained within one integrated numbering scheme could be assigned to specific services. There are potentially 6000 DNIC's that may be assigned. The assigned DNIC's (DCC's + Network Digits) are published in the Operational Bulletin of the International Telecommunication Union (ITU).

- Network Terminal Number (NTN): analogous to the ISDN Subscriber Number, this number is used by a terminal to reach another terminal within the same PDN. Recommendation X.121 restricts the NTN to a maximum of 10 digits.

In a national integrated numbering scheme for PDN's, the network digits become part of the National Number (NN). The international number composed of a DCC and a NN is shown below.

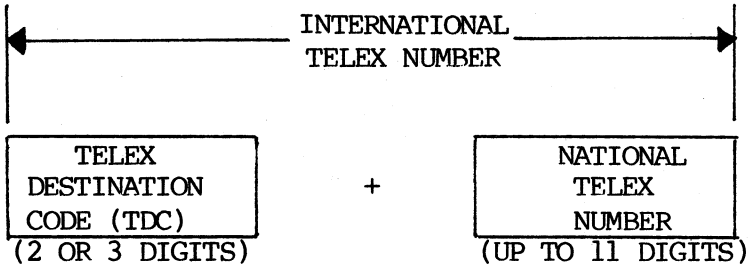


The DCC was defined above. The NN is defined as follows:

- National Number (NN): the number used to call a data terminal from another terminal within the national numbering scheme. The first digit of the NN is the last digit of the DNIC defined above, i.e. the network digit. The entire NN may not use more than 11 digits.

3.1.4 The International Telex Number

In 1980, the CCITT resolved that the control of international transit circuits for Telex required the selection of Telex Destination codes (TDC's) to identify countries (or networks) in a uniform manner. Recommendation F.69 was established, not as a comprehensive numbering plan for Telex, but as an aid toward having Telex fit into other numbering plans. Recommendation X.121 identified an "International Telex Number" as shown below. The format of the number is consistent with both the International Telephone Number and the International Data Number.



The TDC is defined in F.69 as follows:

> TDC a two or three digit number used to identify a country, geographical area, or network. A list of TDCs are provided in Annex A to Recommendation F.69. See Appendix E.

Table 1 illustrates the allocation for the first digit of the TDC. (The geographical boundaries of the continents have not been rigidly followed to permit the code system to be more flexible.) The last one or two digits may be in the 0 through 9 range. The number of two-digit codes available is rather restricted. The CCITT has stated that it is undesirable to allocate these to serve individual networks in countries where several networks exist but do not have a coordinated internal numbering scheme.

Table 1. Allocations for First Digit of TDC (F.69)

0	- not to be used as first digit
1	- available for additional destination codes
2	- North American and adjacent areas
3	- South American and adjacent areas
4	
5	- Europe, U.S.S.R., and adjacent areas
6	
7	- Pacific and adjacent areas
8	- Middle East, Far East, and adjacent areas
9	- Africa, Near East, and adjacent areas

3.1.5 Summary of Numbering Plan Observations

A review of the international numbering plans for the ISDN, telephone network, and the public data networks, leads to a few general conclusions relative to the basic numbering structures that exist and how E.164 might accommodate present designs into future integration efforts. These enclusions are:

- Some form of a country code is used in all networks to pinpoint a destination country or geographical area. The ISDN (E.164) limit of three digits is adequate for telephone (E.163) and data (X.121) concerns.

- Provision is made for identifying a particular network, numbering area, or trunk code within a country. The E.164 latitude of allowing one or more digits for a network destination code satisfies telephone and data requirements

- A large subscriber (terminal) number is permitted in E.164 to accommodate various national needs. ISDN network flexibility through E.164 is demonstrated by the theoretical potential to accept 13-digit subscriber numbers for voice or data service in countries with 1-digit country codes and 1-digit network destination codes.

- A size limit for the international number is provided that is commensurate with service needs. A 15-digit maximum allowable size still pertains for the ISDN number.

- National or international prefixes, language digits, address delimiters, etc. are not included in the international number. These fields are added during dialing or call processing in exchanges and are discussed below.

- The international number (ISDN, telephone, or data) does not identify selection procedures for network service parameters, e.g., nature of service, type of connection, transit network, or quality of sevice required. "Service identifiers" describing the requirements of the calling terminal will be in the signaling information.

- The maximum number of digits allowed in an international number e.g., 15 for the ISDN plan, is <u>not</u> the total capacity required in switch registers; for example, prefix digits, signaling, etc., may require additional digits.

Table 2 outlines and compares the numbering structures found in the ISDN, telephone, and public data numbering plans.

Table 2. Comparison of ISDN, Telephone, and Public Data Numbering Structures

International Number	ISDN (per E.164)	Telephone (per E.163)	PDN X.121	PDN Telex
Country Identification	CC= 1,2, or 3	TCC= 1, 2, or 3	DCC= 3 Note 1	TDC= 2 or 3
Network Identification or Numbering Area	NDC= 1 or more (e.g.,5)	NDC (Trunk Code) 1 or more (e.g.,5)	Network Digit =1 (integrated scheme =0)	
Subscriber Number	Subscriber No. varies = 4 to 13	Subscriber No. varies = 4 to 10	Network Terminal No. = 10 (integrated scheme NN = 11)	
Total Maximum No. of Digits	International ISDN No. = 15	International Telephone Number = 12	International Data No. = 14	

Note 1: More than one DCC may be assigned to countries or geographical areas having more than 10 PDN's.

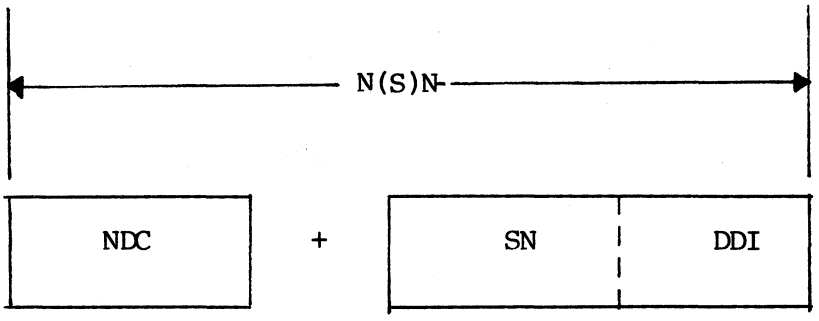
3.2 Addressing

Identification within a subscriber's installation of a point beyond the ISDN (telephone, data) number requires a transfer of address information from the public network to the subscriber's equipment. This can be accomplished through three techniques: direct dialing-in, subaddressing and a combination of these.

3.2.1 Direct Dialing-In (DDI)[1]

In DDI the last few digits forming the end of the Subscriber Number are transferred to the subscriber's installation as shown below. The number of digits varies depending on the requirements of the called subscriber's equipment and numbering plan limitations. (Note Table 2.) An address delimiter, "end of address", may be inserted at the end of the DDI to indicate the end of the subscriber's number.

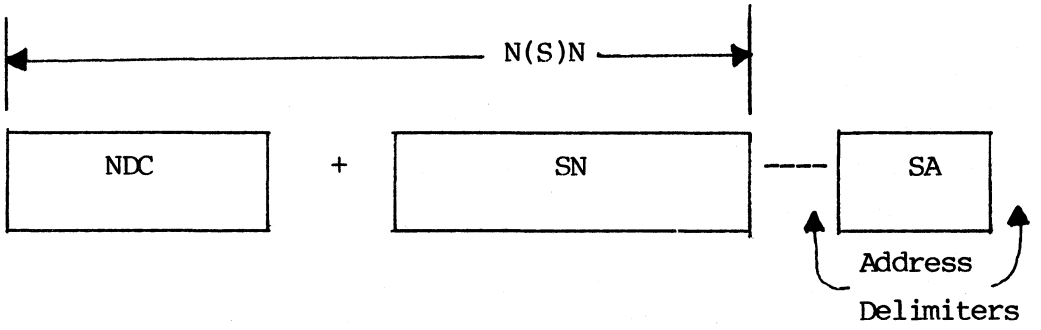
[1]Direct dialing-in (DDI) as defined in CCITT Yellow Book, Vol. II-Fascicle II.2, Sup. 1, has the same meaning as direct inward dialing (DID) as defined in Federal Standard-1037A (to be published).



3.2.2 Subaddressing

Subaddress is optional and in many cases may not be used. It may be added to an ISDN number to allow addressing beyond the subscriber network address.

The "ISDN Address" consists of an "ISDN Number" and an "ISDN Subaddress" (I.330). Depending on the different cases and stages identifiable within an addressing process, the ISDN Number may be an International ISDN Number, a National ISDN Number, or an ISDN Subscriber Number. The network address extension method, subaddressing (SA) is depicted below. The (SA) is sent by the calling party within the call setup procedure and passed transparently through the network separate from both the ISDN number and user-to-user information. The SA provides a unique identification on an end point that may reside in a terminal or private network.

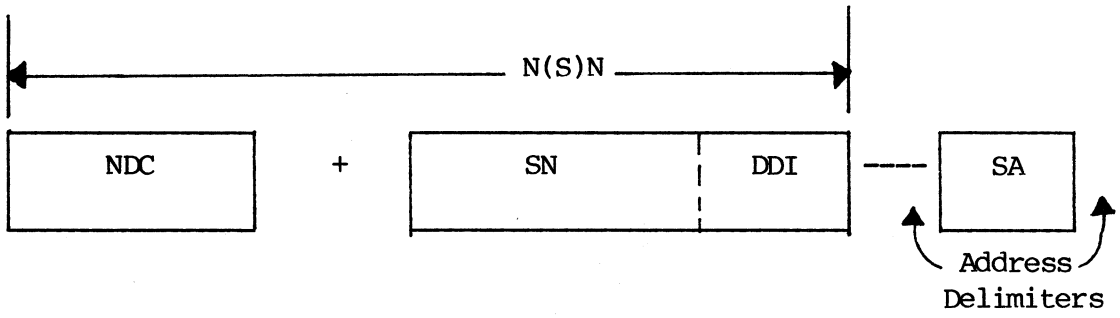


The SA field is provisionally limited to 32 decimal digits. Later proposals extended this to 40 decimal digits. Address delimiters surround the SA (i.e., "beginning of SA" and "end of address").

Subaddressing procedures are the subject of a separate CCITT Recommendation not yet approved.

3.2.3 Direct Dialing-In + Subaddress

This method combines the DDI and SA techniques described above. The structure is illustrated below.



3.3 Connection

Connection of one party to another involves access and routing, and if necessary, internetworking functions. These functions may be perceived directly from the standpoint of applicable CCITT standards (i.e., Recommendations E.164, E.163, E.160, E.131, I.330, and X.121) but should also be related to the Open System Interconnection Reference Model (OSI-RM). The subsections below provide insight through both perspectives. It should be noted that much work continues to be done by the CCITT in the area of "Connection" provision in interworking situations.

3.3.1 Access

Recommendation E.160 specifies two prefixes, which are not part of any national or international number or address, but which may be required by a subscriber to gain access to various networks:

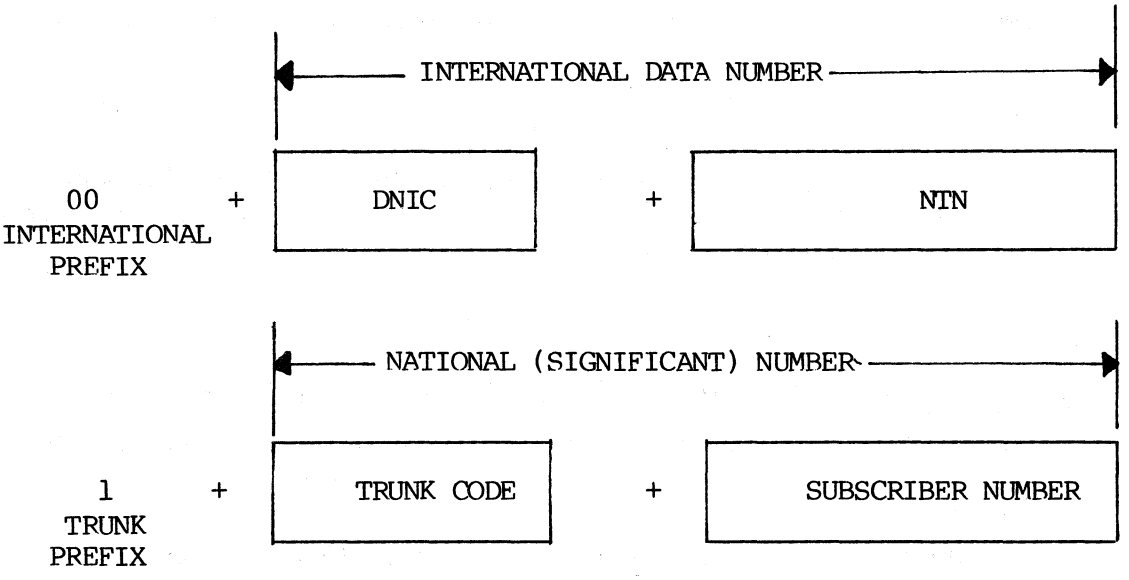
1. Trunk Prefix: digit(s) to be dialed by a subscriber to someone in his own country but outside his own numbering area. This prefix provides access to automatic outgoing trunk equipment. For countries tied together under one integrated numbering plan the trunk prefix is also used from one country to another. (e.g., North American) In the international service, the trunk prefixes of the destination country are <u>not</u> used [i.e., between the country ID and the N(S)N].

It is recommended by the CCITT that countries that have not yet adopted a trunk prefix for access to their national (automatic) network should adopt a single-digit prefix, preferably 0. Irrespective of what digit is chosen, it should be precluded from being used also as a first digit of the trunk codes (E.163).

2. International Prefix: combination of digits to be used by a subscriber in one country, making a call to a different country, to obtain access to the outgoing international equipment. This prefix is not used between countries using one integrated numbering plan.

Recommendation E.163 recommends that countries that have not yet introduced international operation, or that are revising their numbering plans, should adopt an international prefix of "00".

In some countries two or more international prefixes may be used (E.160). This procedure allows additional capability; for instance" (1) abbreviated dialing (i.e. shorter country codes) for calls to defined groups of countries, via different groups of switching equipment, and (2) ability to obtain different classes of call (e.g., station call or personal call for telephone service) for charging purposes. Illustrations of trunk and international prefixes are given below.



One other type of access that is important to remember, particularly in light of addressing, is access to supplementary telephone services. "Supplementary service" is any service provided by the telephone network in addition to the fundamental telephone service. Supplementary services include:

mobile radiotelephone services
radio paging
telephones on transport systems (air, rail, etc.)
direct dialing-in
abbreviated dialing

Recommendations E.131 and E.132 specify control procedures for not only these supplementary services, but also for services other than telephony that can be initiated with tone dialing. In the event that telephone sets used in a dedicated telephone network are used as subscriber instruments in service-integrated networks, "it is desirable that the procedures still apply." However, the fact that tone dialing can be used to generate requests for other services as well as address should not imply that such requests are part of the address.

Recommendation E.131 presents three code schemes for access to supplementary telephone services: an AT&T code scheme (USA), a CEPT code scheme (Europe), and an NTT code scheme (Japan). (Administrations are asked to apply one of the three schemes rather than establish a new one.) The basic fundamental elements for supplementary services access using any of the three code schemes are as follows:

AT&T: access prefix *. (Cusomters are permitted to dial the digits 11 in place of *)

CEPT: service code prefix * or #

NTT: prefix digit 1 for services available from both dial and push-button telephones, prefix # for services available from push-button telephones only.

3.3.2 Routing

Recommendation I.330 indicates that the routing of ISDN connections should take into account the following information, when supplied by the user:

- ISDN numbers, including destination network identification and digits for direct dialing-in, where applicable
- Service type and attributes, possibly including requested quality of sevice parameters such as transit delay, throughput, and security
- Multiple transit RPOA/network selection, when permitted by the originating ISDN.

In national networks, on a particular connection, the user may choose to specify some or all of this information at either subscription time or connection-establishment time. The principles of ISDN routing have not yet been determined.

3.3.3 Interworking

None of the CCITT Recommendations referenced above precludes any country's adminstration, or geographical area, from having single or multiple telephone, data, telex, or ISDN networks. In like manner, individual numbering plans may be utilized in a country for the individual PDN's, PSTN's, or ISDN's, or integrated plans may be used for single-service network categories (e.g, all PDN's), or multiservice networks (ISDN's). The world objective is that all ISDN's should evolve toward one numbering plan, the ISDN numbering plan. In the meantime, existing numbering plans may interwork/coexist with the ISDN numbering plan (Rec. E.164 or I.331).

"Interworking" (nationally and internationally) is an issue for CCITT further study. All interworking cases from ISDN to dedicated networks (and vice versa) have to be addressed by appropriate CCITT Study Groups. Although specific standards are not yet approved, broad interworking principles have been established (e.g., in CCITT Recommendations E.164, I.330, X.300). These will be presented below.

Interfacing networks adds requirements to monitor and ananlyze numbering for network management purposes. This will also be discussed below.

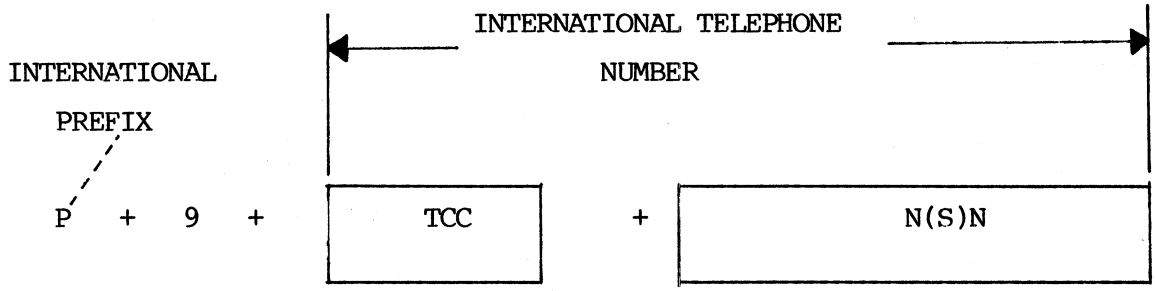
Basic Principle of Interworking

Two basic principles were stated in E.164 relative to interworking:

- The ISDN subscriber should be able to setup calls to subscribers, or services, terminated on "public dedicated networks"
- A single-stage selection procedure should be used for interworking wherever possible, however, a two-stage procedure can also be employed where necessary. The selection procedures will be explained first.

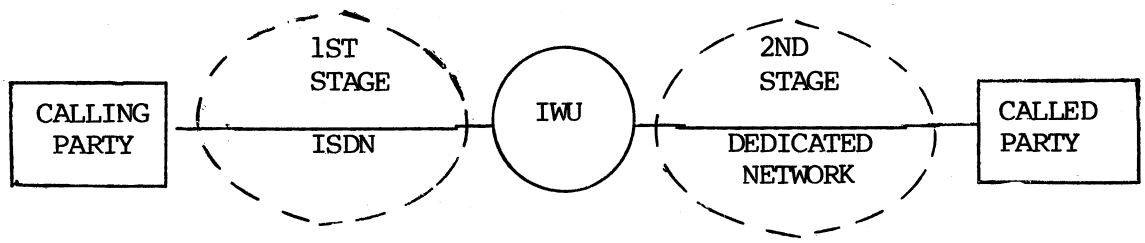
Interworking by single-stage selection may be accomplished in two ways- through a special prefix method or a national destination code (NDC) method. In the first method, interworking is achieved by an arrangement

where the calling party accesses a network by dialing a special prefix followed by the necessary identification required for that particular network. The special prefix may be one or more digits or a nonnumerical address qualifier. An example of this method (See CCITT Rec. X.121) is shown below where a data terminal on a public data network can access a terminator or public telephone network by using a special prefix "9" after the international prefix and before the Telephone Country Code.



Single-stage selection using the NDC method can be accomplished by using several NDC's assigned to each network. The total number of digits cannot exceed the maximum number of digits permitted in the numbering plan.

Two-stage internetworking is achieved by an arrangement wherein the first stage of selection provides the calling party access via the ISDN to an "Internetworking Unit" (IWU) associated with a point of termination of the required dedicated network. This is done by using an assigned local, national, or international number. When a connection is established, the IWU responds. The necessary address information for that particular dedicated network is then forwarded, as a second stage of selection, through the ISDN and IWU to complete the call into the dedicated network. A graphic illustration of the two-stage method is depicted below.



The CCITT recognizes (E.164) that some countries may not be able to offer an interworking capability; therefore, interworking is permitted either in the country of origin or the destination country. The choice is made by bilateral agreement. If interworking happens in the country of origin, both methods of single-stage selection and two-stage selection are allowed. In the destination country, only the NDC method or two-stage selection can be used.

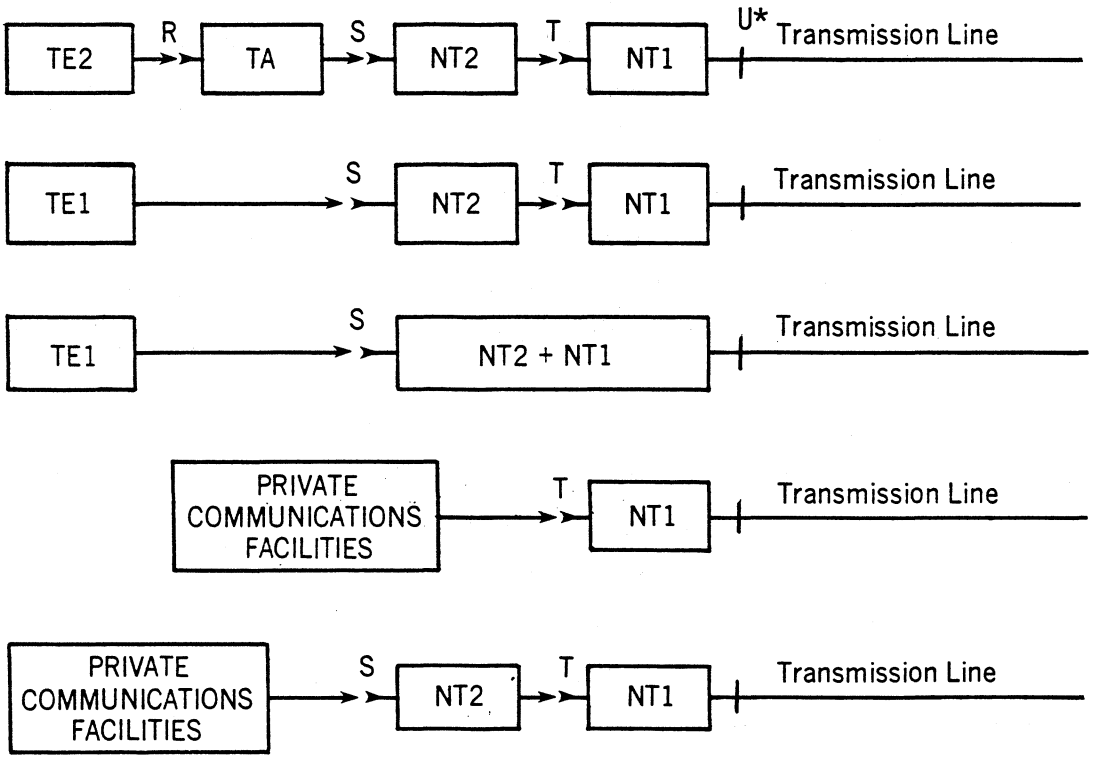
Looking back at the first basic principle of interworking [i.e., that a subscriber (terminal) should be able to interface with a subscriber (terminal) in a different network] in light of the interworking methods described immediately above, will allow a more specific discussion of that principle.

Figure 11 shows ISDN reference configurations for user/network interfaces. From a user's perspective, an ISDN is completely described by the attributes that can be observed at an ISDN usernetwork interface (i.e. physical, protocol, operational characteristics, etc.) Reference points and functional groupings are shown in the figure. Reference points are simply the conceptual points dividing the functional groupings. A reference point may correspond to a physical interface between pieces of equipment. However, two or more functional groupings may be embodied in a single physical equipment and a specific reference point may in fact not exist or be accessible. Functional groupings are sets of functions that may be needed in user access arrangements. (See Table 3 for more detailed definitions of the various reference point and functional groupings.) All ISDN's shall be able to assign an ISDN number to an interface at reference points "T" or "S" (I.330). That is, an ISDN number should be able to identify a particular:

- physical, virtual, or multiple interface at reference point "T", or
- physical, virtual, or multiple interface for point-to-point configurations at reference point "S".

The CCITT objective has been that single stage interworking be used wherever possible. More specific CCITT guidance regarding various interconnections is summarized here: (CCITT Recommendation I.330)

1. A particular interface, or multiple of interfaces, may be assigned more than one ISDN number. This interface, for example, may be to private communication facilities (LAN's, PABX's, etc.) at an "S" or "T" reference point.



*This interface was formerly designated as the "U" interface. See the U.S. network termination equipment (NT1) viewed as customer premise equipment. This implies that the "U" interface is the connection between customer premises and the network.

Figure 11. ISDN reference configurations for user/network interfaces (from CCITT I.411 and I.330).

Table 3. Definitions of ISDN Reference Points and Functional Groupings

Reference Point "R"	This is the reference point corresponding to existing standard interfaces that are expected to work with the ISDN. Physical interfaces not included in CCITT Recommendations may appear here. Today's analog telephone has an R interface that carries analog voice plus signaling information [pulses or dual-tone multifrequency (DTMF) signaling]. An X.25 host has an R interface that operates using X.25 protocols at one of the transmission speeds specified in CCITT Recommendation X.1. Other R interface examples for data include CCITT X.21 for circuit switching and RS-232-C for asynchronous terminals. The R interfaces for facsimile are those defined for Group I, II, and III Facsimile equipment.
Reference Point "S"	This is the reference point corresponding to the all-digital interface for TE1. The S interface will be available in a configuration that permits subsets. Basic ISDN access is through an S interface containing one or more transparent user channels and a separate signaling channel. The S interface may have four wires for data transfer and an additional two or four wires for power transfer. The S interface is considered to represent the smallest individually addressable unit within the ISDN.
Reference Point "T"	This is the interface between NT1 and NT2. In some other countries, T will not exist; a PTT may choose to provide both NT1 and NT2 functions in a single box with no visible T interface. In the United States NT-1 is considered customer premises equipment and so another interface is defined. This is sometimes denoted the "U" interface.
Terminal Equipment, TE	This includes functions broadly belonging to layer 1 and higher layers of the X.200 (OSI) Reference Model. Digital telephone, data terminal equipment, and integrated work stations are examples of equipment or combinations of equipment that provide the functions. The TE functions are: - protocol handling - maintenance functions - interface functions - connection functions to other equipments.
Terminal Equipment Type 1, TE1	This includes functions belonging to the functional TE, with an interface that complies with the ISDN user-network interface Recommendations.

Table 3 (cont'd)

Terminal Equipment Type 2, TE2	This includes functions belonging to the functional group TE, but with an interface that complies with interface Recommendations other than the ISDN interface Recommendation (e.g., the X-series interface Recommendations) or interface not included in CCITT Recommendations (e.g., pre-ISDN era).
Terminal Adapter, TA	Includes functions broadly belonging to layer 1 and higher layers of the X.200 (OSI) Reference Model that allow a TE2 terminal to be serviced by an ISDN usernetwork interface. Adaptors between physical interfaces at reference points R and S or R and T are examples of equipment or combinations of equipment that provide TA functions.
Network Termination 1, NT1	This includes functions broadly equivalent to Layer 1 (Physical of the OSI Reference Mode). These functions are associated with the proper physical and electromagnetic termination of the network. NT1 functions are: - line transmission termination - layer 1 line maintenance functions and performance monitoring - timing - power transfer - layer 1 multiplexing - interface termination, including multidrop termination employing layer 1 contention resolution.
Network Termination 2, NT2	This includes functions broadly equivalent to layer 1 and higher layers of the X.200 (OSI) Reference Model. PABXs, local area networks, and terminal controllers are examples of equipment or combinations of equipment that provide NT2 functions. NT2 functions include: - layers 2 and 3 protocol handling - layers 2 and 3 multiplexing - switching - concentration - maintenance functions - interface termination and other layer 1 functions.

Note: TE, NT1, and NT2 definitions are from Draft Recommendation I.411

2. For mobile services, the ISDN number identifies an interface in the mobile subsciber's premises (at an "S" reference point).

3. In the case where an ISDN number identifies a mobile TE, or a TE served by several interfaces or networks, an ISDN may need to map from the ISDN number on to a specific interface designation.

4. The ISDN number is not required to identify a connection (or channel) directly where, on an interface, more than one connection (or channel) may be present at a given instant. An indirect identification of channels may occur (e.g., the ISDN number identifies an interface and there is only one channel).

5. As stated above, where a number of public or private ISDN's exist in a country, it is not mandatory to integrate their numbering plans. It is a CCITT objective however, that connections between the TE's on the various networks can be completed using only the ISDN address.

6. For a private network that spans more than one country, the International ISDN Number will cause the delivery of a call to the particular private networks in the country specified by the CC.

7. TE1's are always allowed to use ISDN numbers when originating a connection. Some ISDN's may also permit other numbers to be used, conveyed with an identification of the relevant numbering plan.

8. At an interface between an ISDN and a dedicated bearer service public network, an interworking unit (see Figure 11) shall convert between ISDN addresses and Dedicated Bearer Service Network (DBSN) numbers when required.

9. When a TE2 calls a user of a ISDN, the TE2 may use the dedicated bearer service access number. In the case of a TE2 placing an outgoing call via an ISDN that uses only the ISDN numbering plan, the dedicated service number will be converted into an ISDN number. Numbering conversion should (preferably) be performed at the point of interworking between the ISDN and dedicated network. Some networks may also provide numbering conversion as an inherent function.

10. At the person-machine interface, a method of distinguishing between abbreviated and complete representations of an ISDN Number is required. This method demands further study by the CCITT. The method of distinguishing between an ISDN Number and a number from another numbering plan shall be by separate identification of the applicable numbering plan. CCITT procedures are not yet established for this method.

Nonzoned Services

Some of the networks with which the PSTN's have had to interwork are the so-called "Nonzoned" services. The term "nonzoned" refers to such non-fixed networks as the VHF/UHF and Maritime Mobile-Satellite Services and the Public Land Mobile Networks (PLMN). The interworking between the PSTN, whose numbering plan functions in accordance with E.163, and the Maritime Mobile Services (VHF/UHF and Satellite), also bound to the 12-digit numbering plan, has been addressed by Recommendations E.210 and E.211. These Recommendations set up the numbering system whereby PSTN subscribers can call ship stations in the Maritime Mobile Services and vice versa.

Draft Recommendations E.212 and E.213 provide guidance relative to numbering for the Public Land Mobile Networks. E.212 proposes an identification plan for land mobile stations, while E.213 specifies a telephone numbering plan for land mobile stations in a PLMN.

A. Maritime Mobile Service

Recommendation E.211 standardized the numbering and dialing procedures for subscribers in the public switched telephone network calling ship stations in the VHF/UHF and Maritime Mobile-Satellite Telephone Services and the procedures for calling a subscriber, or an operator, in the PSTN from ship stations. The routing and numbering techniques adopted were designed to require as little change as possible to national and international PSTNs.

Each ship is allocated a unique 9-digit station identity in accordance with E.210. The initial three digits define the nationality of the ship. The first digit of these Maritime Identification Digits (MID) identifies the geographical region to which the nationality (registry) of the ship relates. For example, "2" signifies Europe; "3" is North America. (Only the digits 2 through 7 are used.) The second digit of the MID may be 1 through 9, and the third digit may be 0 through 9. A minimum number of digits is used for ship station numbers to permit maximum automation. (Some countries find it practical to only use six-digit ship station numbering.) Trailing zeros are added to ship station numbers (received from an automatic PSTN network) to form nine-digit ship station identities.

Dialing procedures for various origin-termination combinations present in the Maritime Mobile Service are shown below. Generally, these plans contain a prefix, country code, and station (subscriber) number as defined in E.211.

Use-Pair Combination (Origin-Termination)	Numbering Structure
Shore-to-Ship	P + 87 + S + MIDXXXXXX
Ship-to-Shore	00 + CC + N(S)N
Ship-to-Ship	00 + 87 + S + MIDXXXXXX

Notes: P = international prefix
S = ocean area and satellite system designator
MID = maritime identification digits
CC = 1, 2, or 3-digit country code

For automatic shore-originated calls, international dialing procedures include the use of an international prefix, and "87" country code [also called a Maritime International Code (MIC)] with accompanying digit to indicate applicable ocean area or satellite system, and a ship station number. For automatic ship-originated calls to terrestrial subscribers, the international dialing procedure will include a standardized prefix, 00, i.e., all ships in all ocean areas will use the same prefix to identify an automatic international call.

Prefixes are also used to identify other functions for the satellite system. See Table 4 for a list of prefix allocations.

The type of interworking illustrated immediately above is considered single stage selection. A modification to E.211 (Annex 2) has been proposed by CCITT Study Group II, whereby the shore-to-ship dialing procedure would include a service termination designation as follows:

P	International Prefix
87	MIC
S	Ocean area and satellite system
8Y	Service Termination
NIDXXXXXX	Ship station number

Table 4. Allocation of Telephone Prefixes and Telex Access Codes for the Maritime Mobile Service (E.211)

Category	Prefix or access code		Applications (Notes 2 and 3)	Telephone	Telex	Data
	Digit 1	Digit 2				
Operator	1	0	Spare	–	–	–
	1	1	International outgoing operator	A	A	NA
	1	2	International information service	A	A	FS
	1	3	National operator	A	A	NA
	1	4	National information service	A	A	FS
	1	5	Radiotelegram service	FS	A	NA
	1	6	Spare	–	–	–
	1	7	Booking of telephone calls (Note 4)	A	A	NA
	1	8	Spare	–	–	–
	1	9	Spare	–	–	–
Automatic facilities	2	0	Access to maritime PAD (Note 5)	A	NA	NA
	2	1	Store-and-forward (international)	NA	A	NA
	2	2	Store-and-forward (national)	NA	A	NA
	2	3	Abbreviated dialling (short code selection)	A	A	NA
	2	4	Telex letter service	NA	A	NA
	2	5	Spare	–	–	–
	2	6		–	–	–
	2	7		–	–	–
	2	8		–	–	–
	2	9		–	–	–
Specialized assistance (Notes 6 and 7)	3	0	Spare	–	–	–
	3	1	Maritime enquiries	A	A	A
	3	2	Medical advice	A	A	A
	3	3	Technical assistance	A	A	A
	3	4	Person-to-person call	A	NA	NA
	3	5	Collect calls	A	NA	NA
	3	6	Credit card calls	A	A	NA
	3	7	Time and charges requested at end of call	A	A	NA
	3	8	Medical assistance	A	A	A
	3	9	Maritime assistance	A	A	A
Ship reporting (Note 6)	4	0	Spare	–	–	–
	4	1	Meteorological reports	A	A	A
	4	2	Navigational hazards and warnings	A	A	A
	4	3	Ship position reports	A	A	A
	4	4	Spare	–	–	–
	4	5		–	–	–
	4	6		–	–	–
	4	7		–	–	–
	4	8		–	–	–
	4	9		–	–	–

Table 4. (Cont'd)

Category	Prefix or access code		Applications (Notes 2 and 3)	Telephone	Telex	Data
	Digit 1	Digit 2				
Information retrieval	5	0	Spare	–	–	–
	5	1	Meteorological forecasts	FS	FS	FS
	5	2	Navigational warnings	FS	FS	FS
	5	3	Videotex (international)	FS	NA	FS
	5	4	Videotex (national)	FS	NA	FS
	5	5	News (international)	FS	FS	FS
	5	6	News (national)	FS	FS	FS
	5	7	Spare	–	–	–
	5	8		–	–	–
	5	9		–	–	–
Specialized use (Note 8)	6		Administration specialized use, e.g. leased lines	A	A	FS
	7		Spare	–	–	–
	8		Spare	–	–	–
Test (Note 6)	9	0	Spare	–	–	–
	9	1	Automatic test line	A	A	FS
	9	2	Commissioning tests	A	A	A
	9	3	Spare	–	–	–
	9	4	Spare	–	–	–
	9	5	Operational coordination	A	A	A
	9	6	Spare	–	–	–
	9	7		–	–	–
	9	8		–	–	–
	9	9		–	–	–

Note 1 – The same table is contained in Recommendations E.211, F.121 and X.350.

Note 2 – The entries in the columns under Telephone, Telex and Data have the following meanings:

A = Applicable for access by this service
NA = Not applicable for access by this service
FS = For further study.

Note 3 – The prefix or access code may be followed by an optional telephone country code, data country code (or data network identification code) or telex destination code, or other optional digits.

Note 4 – Via some coast earth stations it would be possible to book telephone calls using the telex service.

Note 5 – PAD = Packet Assembly/Disassembly facility. The prefix 20 should be followed by two digits indicating the required data rate (see Recommendation X.351).

Note 6 – Some of the facilities under this category are defined in Annex B.

Note 7 – The prefixes 34, 35, 36 and 37 may be followed by the international number of the called subscriber.

Note 8 – Digits following digit 6 will be allocated on a national basis.

The value of digit "Y" would be different for each service termination. Several things should be noted about this dialing procedure:

- The digits 8Y cannot be used for in-dialing for discrimination between several terminals of the same kind.
- The digits 8Y should not be dialed for ordinary telephone calls.
- The first digit of the MID cannot take the value "8" for ships participating in the maritime satellite service as long as the digits 8Y are used for the above-defined purpose.

B. Public Land Mobile Networks

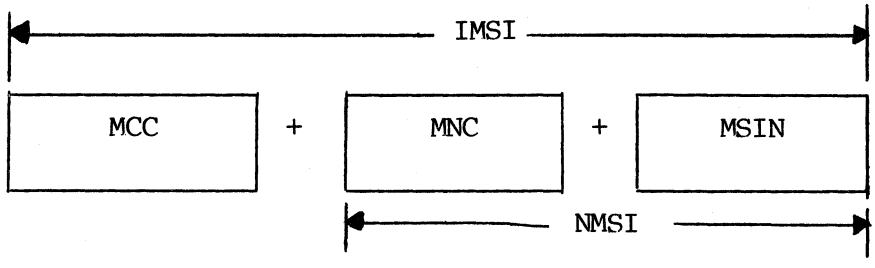
The design considerations for the identification plan for land mobile stations, proposed in new draft Recommendation E.212, are listed below:

1. There could be a number of public land mobile networks (PLMN's) in a country. (Country in this Recommendation is also used to mean geographical area.)
2. When a number of PLMN's exist in one country, it should not be mandatory to integrate the identification plans for the various networks.
3. The identification plan should permit the identification of the country as well as the PLMN in which the mobile station is registered.
4. The number of digits comprising the code used to identify the country and a specific PLMN should be the same in all countries.
5. The number of digits used to identify a specific mobile station should be a national matter.
6. The identification plan should provide for substantial spare capacity to accommodate future requirements.
7. It should be possible to assign different international numbers to a mobile station for different service and network interconnection (e.g. PSTN's, ISDN's, PDN's) and still relate them to the same unique international identity.

It can be seen that there is a correlation between the above design considerations and those listed for Recommendations X.121 (PDN) and I.330 (ISDN Numbering and Addressing Principles). There is also a numbering structure proposed for the PLMN similar to that recommended for ISDN. At this time, however, the ISDN-NP and the data numbering plan for land mobile

stations (i.e., the integration thereof) are for further CCITT study. One of the unique problems facing the PLMN is that it is desired to have the mobile station number remain the same regardless of mobile station location. Also, the following is stated in E.212: "Since the International Mobile Station Identity is not used for dialing and routing purposes through the PSTN, PDN's, ISDN, etc., its length would not be influenced by any numbering constraints to these networks." In other words, even if the ISDN-NP allows up to 15 digits, the PLMN-NP may require even more and may not be directly compatible. This type of situation would almost certainly require either a one or two-stage method for network interworking. The PLMN structure is as follows:

MCC = Mobile Country Code (3 digits, 2-7)
MNC = Mobile Network Code ($\leq$6 digits)
MSIN = Mobile Station Identification Number
NMSI = National Mobile Station Identity (assigned by administration)
IMSI = International Mobile Station Identity ($\leq$ 15 digits)



Monitoring and Numbering Analysis

In order to perform network management functions (routing, billing, etc), calls (messages) are monitored and analyzed by the originating country, the transit country or counties, and the destination country. The numerical analysis requires certain configurations of digits to appear within the ISDN, telephone, or data number. The requirements below for international ISDN, international telephone, and international data numbers were defined from Recommendations E.164, E.163, and X.121:

A. The Originating Country needs to determine the country of destination, the most appropriate network routing, and proper charging. This is accomplished by looking at a combination of country code and network identification information. Depending on the length (number of digits) of the country code, the number of network identification digits need only be the lengths shown below.

For ISDN Networks

Country Code digits	N(S)N digits
3	3
2	4
1	5

For Telephone Networks

TCC digits	N(S)N digits
2 or 3	2
1	3

For Data Networks

DCC digits	Network digit
3	1

B. Transit Countries require complete international numbers to process and monitor traffic.

C. The destination country should receive complete international numbers. (For International Data Numbers, however, arrangements should be made to suppress DCC's if the country does not want to receive them.)

If more than 10 Public Data Networks exist in a country, the DCC identifies the group of networks within which the called network is included and verifies that the call reached the correct country. If less than 10 PDN's exist, the DCC verifies that the correct country has been reached, but the Network Digit identifies the network.

3.3.4 Open Systems Interconnection

In the Recommendation X.200 Open Systems Interconnection (OSI) Reference Model, addresses identify "service access points" at each layer. As the essential purpose of the OSI Network Layer is to achieve routing of information within the OSI environment, the ISDN number has an important relationship to the X.200 Network Layer Service Access Point (NSAP).

The ISDN Address may serve to help to identify OSI Network Layer Service Access Points and to route to it.

When needed, the ISDN Number is related to the OSI Network Layer Address according to the following methods:

- For some OSI Network Layer Addresses, the OSI Network Layer Address is based on the ISDN number with no additional subaddress information necessary to identify the associated NSAP
- For other OSI Network Layer Addresses, the OSI Network Layer Address is based on the ISDN number and users information in the ISDN subaddress to further identify the associated NSAP

- For the remaining OSI Network Layer Addresses, the OSI Network Layer Address is not based on the ISDN number. The entire OSI Network Layer Address must be conveyed in the ISDN subaddress and the corresponding ISDN number must be derived from the OSI Network Layer Address.

The ISDN address is not directly related to a physical, data link, transport, session, presentation or application layer entity, or service access point. Indirect relationships may occur as one or some of these entities or service access points may be in correspondence with network layer service access points.

3.4 CCITT Study Objectives 1985-1988

The VIIIth CCITT Plenary Assembly charged Study Group II with studies on Question 17/II entitled "Development of the World Numbering Plan for Telephone and ISDN Application. (see Appendix A). Objectives identified for study during the 1985-1988 study period included the following.

- methods for selection of the required service(s), and of access to other dedicated networks, considering the information needed for:
  - a destination address used in a ISDN
  - a bearer service between ISDN interfaces
  - teleservices, for terminal-to-terminal communications
  - terminal selection in a point-to-multipoint configuration
- sub-addressing and shared address space techniques;

  interworking between an ISDN and dedicated networks providing services such as packet and circuit switched data; telex, mobile, and satellite facilities and services; and broadband services
- human factors issues relating to the need for information to assist users of ISDN services, and for universal information and emergency services
- the requirements for digit or number analysis of address information received by exchanges
- provision of guidelines that will assist the evolution of the World Numbering Plan from Recommendation E.163 to E.164.

The first three are considered major study items.

3.5 Numbering Plan Comparisons

Tables 5 and 6 can be used to compare numbering plans from standards given in Section 3 and as currently implemented as described in Appendix B. These comparison tables include the plan name, the pertinent standard nomenclature, prefixes used, the national significant number, and pertinent remarks and references relating to the plan. Explanatory notes concerning both tables are given in Table 7.

4. AREAS FOR FURTHER ATTENTION

In the previous sections we have attempted to acquaint the reader with the ISDN philosophy and the complexities involved in establishing a numbering/addressing/connection plan to bring the philosophy to operational life. Desirable numbering plan attributes were offered early in the report, and were acknowledged frequently later as CCITT Recommendations and Questions applicable to ISDN numbering were cited. The standards documents themselves provide many desired plan characteristics through their specifications.

There are still several technical areas remaining where concerted efforts are necessary to standardize numbering, addressing, or connection-related approaches particularly in interworking situations. An examination of actual numbering plans (Appendix B), and the ISDN service-concepts show areas that have not been addressed. These areas are outlined below.

4.1 Transition from PSTN to ISDN

The ISDN-NP (Rec. E.164 or I.331) specifies 15 digits to be used for the ISDN number. This creates one of several transition problems that will have to be studied and resolved as ISDN's begin to take shape. Since switches with 15 digit register capacity will be introduced only gradually, some questions requiring consideration are:

- Will the use of 15-digit numbers eventually effect a change in the composition of the N(S)N?
- With area codes presently at a premium, will new schemes have to be developed to extend the capability of this three-digit code, such as:

Table 5. CCITT Recommended Numbering Plans

CCITT Rec. No.	Numbering Plan (NP)	Structure(s)	Remarks
X.121	International NP for PDN's To DTE's on PDN's	P^2 + [International Data Number: DNIC[1] (ZXXX) | (NTN) Network Terminal Number (XXXXXXXXXX)]	To DTE not part of national integrated numbering scheme
		P^2 + [International Data Number: DCC[3] (ZXX) | (NN) National Number (XXXXXXXXXX)]	To DTE that is part of national integrated numbering scheme
		Special Prefix P^2 + 9 + [International Telephone Number: TCC[4] | National (Significant) Number: Trunk/Area Code | CO Code | Subscriber/Directory No.]	ID of DTE on a PSTN, accessed to or from a PDN
		Special Prefix P^2 + 8 + [International Telex Number: TDC[5] | National Telex Number] Per F.69	ID of DTE on a Public Telex Network, accessed to or from a PDN
E.163	Numbering Plan for the International Telephone Service	P^2 + [International Telephone Number: TCC[4] (Per E.163) | (NSN) National (Significant) Telephone Number: Trunk/Area Code | CO code | Subscriber/Directory No.]	
E.210/ E.211	Ship Station Identification for VHF/UHF and Maritime Mobile-Satellite Services/ Numbering and Dialing Procedures for VHF/UHF and Maritime Mobile-Satellite Telephone Services	P_1 + [Maritime Country Code: Maritime International Code (87) | Ocean Area and Satellite System (S) | Ship Station Number: (MID = Maritime Identification Digits) MID$^X_4 \ldots ^X_n$] P_1 = Prefix or access number assigned by E.211	only one example shown, per E.211, showing Shore-to-Ship call. See E.211 Appendix this report) for all situations.
E.164	Numbering Plan for the ISDN Era	P^2 + [International ISDN Number: (E.163) TCC | National (Significant) Number: (NDC) National Destination Code[6] | (SN) Subscriber Number] + [Sub-Address]	Sub-address not part of ISDN Number; part of ISDN Address only.

Table 6. Actual and Proposed Numbering Plans

<table>
<tr><th>Country or Agency NP</th><th>CCITT Rec. Followed</th><th>Structure(s)</th><th>Remarks</th></tr>
<tr><td>France (New NP)</td><td>E.163</td><td>
Intermediate Phase (1985):
<table>
<tr><th>Prefix</th><th>Trunk Code</th><th>Subscriber/Directory Number</th></tr>
<tr><td>16</td><td>1</td><td>NXXX XXXX</td></tr>
<tr><td>16</td><td>---</td><td>NXXX XXXX</td></tr>
<tr><td>----</td><td>---</td><td>NXXX XXXX</td></tr>
<tr><td>----</td><td>---</td><td>NXXX XXXX</td></tr>
</table>
Final Phase (1989):
(W = 2-5)
<table>
<tr><th>Trunk Code</th><th>Subscriber/Directory Number</th></tr>
<tr><td>01</td><td>NXXX XXXX</td></tr>
<tr><td>0W</td><td>NXXX XXXX</td></tr>
<tr><td>----</td><td>NXXX XXXX</td></tr>
<tr><td>----</td><td>NXXX XXXX</td></tr>
</table>
</td><td>(After Collett, et al, 1981)

Provinces to Paris Region
Paris Region to Provinces
Province to Province
Intra-Paris Region

Inter-Zone to Paris Region
Inter-Zone (other than to Paris)
Intra-Zone
Intra-Paris Zone</td></tr>
<tr><td>Dutch Datanet</td><td>X.121</td><td>
P^2 +
<table>
<tr><td>Data Country Code</td><td colspan="4">National Number (NN)</td></tr>
<tr><td>DCC</td><td>A^7</td><td>Geog. Zone</td><td>Serial No. within Geog. Zone</td><td>Future Sub-Numbering</td></tr>
<tr><td>Per X.121</td><td></td><td>XXX</td><td>YYY</td><td>(4 Digits)</td></tr>
</table>
</td><td>(van der Graaf, 1982)</td></tr>
<tr><td>Denmark</td><td>E.163 and CEPT</td><td>
P^2 +
<table>
<tr><td></td><td colspan="2">National (Significant) Number</td></tr>
<tr><td>Trunk Prefix</td><td>Trunk Code</td><td>Subscriber Number</td></tr>
<tr><td>None Req'd</td><td>XY</td><td>b c d e f g</td></tr>
</table>
P = 009 outgoing; 45 incoming (TCC)
No Trunk Prefix required; whole country becomes one numbering area
</td><td>(Nielsen, 1980)

X = 0-9
Y = 0-9
b = 2-9
all others = 0-9</td></tr>
<tr><td>North American</td><td>E.163</td><td>
P^2 +
<table>
<tr><td></td><td colspan="3">National (Significant) Number</td></tr>
<tr><td>Trunk Prefix</td><td>Trunk/Area Code</td><td>CO Code</td><td>Subscr./Direc. No.</td></tr>
<tr><td>0/1</td><td>N 0/1 X</td><td>NNX</td><td>XXXX</td></tr>
<tr><td>0/1</td><td>----</td><td>NNX</td><td>XXXX</td></tr>
<tr><td>---</td><td>----</td><td>NNX</td><td>XXXX</td></tr>
<tr><td>0/1</td><td>N 0/1 X</td><td>NXX</td><td>XXXX</td></tr>
<tr><td>0/1</td><td>----</td><td>NXX</td><td>XXXX</td></tr>
<tr><td>---</td><td>----</td><td>NXX</td><td>XXXX</td></tr>
</table>
P = 011 outgoing; 1 incoming (TCC for integrated numbering area)
</td><td>Toll to FNPA
Toll to HNPA
Local

No Inter-changeable CO code

Toll to FNPA
Toll to HNPA
Local

with inter-changeable CO code</td></tr>
</table>

Table 7 Notes for Table 5 and 6

Integer value ranges: N = 2 through 9
X = 0 through 9
Z = 2 through 7 (or, see Note 1)

1. DNIC = Data Network Identification Code First digit, Z, values:
   0-
   1- Reserved
   2 -7- For DNIC's
   8- For interworking with telex networks
   9- For interworking with telephone networks

2. P = International Prefix: For outgoing calls, a national matter.
3. DCC = Data Country Code assigned by X.121
4. TCC = Telephone Country Code assigned by E.163
5. TDC = Telex Destination Code assigned by F.69
6. National Destination Code (NDC) provides for a Trunk Code (TC) and/or a network identification function (E.164)
7. A = 1 for dedicated X.25 connections. Other numbers reserved for future use.

a. Extending the allowable middle-digit values beyond the present 0 or 1; or,

b. Expand area codes to 4 digits?

- Should central office codes be expanded?
- Should subscriber numbers be expanded?

A very fundamental problem is how a subscriber connected to an "old" exchange can call a subscriber connected to a "new" exchange, as his exchange cannot handle a 15 digit address (or corresponding longer national number, as compared to the present number length). One way to resolve this problem is to delay introduction of 15 digit numbers until essentially all exchanges have been replaced or modified. At present, no clear cut solution to this problem is available.

These are but a few of the issues, among many, that are all part of the fundamental issue of how the transition from PSTN to ISDN should be handled.

4.2 Interconnection of Private Networks to Public Networks and ISDNs

Private voice networks [such as the Automatic Voice Network, AUTOVON, the Federal Telecommunication Service (FTS), and the Defense Switched Network (DSN) may operate completely independent of all other public voice networks, or they may be embedded within them. It is not yet clear, how private networks operating within an ISDN or PSTN can address and interconnect with another private or public network operated by a different administration. Various documents have suggested that prefixing, sub-addressing, or signaling techniques may be appropriate to provide a connection mechanism. This is precisely the problem which the OSI NSAP addressing scheme is designed to solve.

Further study appears to be required relative to this question.

4.3 Special ISDN Features

One of the most impressive characteristics of the Integrated Services Digital Network (or set of ISDN's) is the ability to incorporate special service features on a broad scale. This characteristic has two aspects. First, many different features can be introduced into the network(s). And second, a tremendous number of ISDN subscribers could have access to a

variety of features provided for example, by the many separate networks. Special features provided by value-added networks might include such capabilities as:

- priority/precedence: the ability to assign certain services or users the capability of accessing and maintaining a network connection at better than a random probability

- security/privacy: the ability to protect (from eavesdropping or tampering) selected communications from end-to-end (including voice, data, facsimile, video, etc.)

- special access codes: the ability to use short codes (e.g., three digits) to invoke special network services (e.g., directory information, emergency human services) not only within a subscriber's network, but into other networks as well

- multiaddressing: the ability on a contract basis to communicate to more than one subscriber simultaneously without having to "dial" each subscriber separately (e.g., for data transmissions)

- user transmission media selection: the ability of a user to select a particular transmission path for a certain communication action (e.g., choosing a terrestrial path instead of satellite path for a data message)

- user quality of service (QOS) selection: the ability to select from various levels of network quality for a particular communication action (e.g., choosing extremely-low, bit-error-rate performance for a critical data message)

- delayed transmission for economy-voice storage, etc.

CCITT documentation has indicated that "service identifiers" describing the requirements of the calling terminal will be in the signaling information and will not be reflected in a formal international number, (e.g., an ISDN number). International and national trunk prefixes are used to access large, automatic switching equipment, and subaddressing suffixes are used to reach subscriber terminals within private communication facilities through local switches (e.g., PABX's). These and other intelligent-switch processing, related specifically to ISDN types of functions must still be considered.

4.4 Gateway Traffic Analysis

With a global integrated services network concept comes the requirement to provide "gateways" (i.e., interface and protocol conversion nodes) between private networks, public networks, ISDN's operating with other ISDN's within a country, and ISDN's that are the sole networks for their respective countries. The design of gateway capacity is dependent upon the projection of traffic type and volume for the networks connected by gateways. The United States and other countries, therefore, need to know present and anticipated traffic flow statistics.

4.5 Integration of Numbering Plans for PLMN and ISDN

CCITT Recommendations E.212 and E.213 for the Public Land Mobile Networks may not provide adequate standardization to accommodate ISDN (E.164) numbering plan restrictions. That is, there is no apparent PLMN requirement to limit land mobile numbers to the 15-digit ISDN limit. Present numbering arrangements in E.212 and E.213 require escape codes or two-stage interworking procedures to be used to interface with ISDN subscribers.

Integration of PLMN and ISDN numbering plans is required.

4.6 Subaddressing Procedures

Although broad guidelines are offered for direct dialing-in and subaddress techniques for reaching inside a subscriber's premises, more definitive specifications appear to be in order, particularly in light of local area network (LAN) popularity and the use of these networks in an OSI environment.

Addressing schemes are currently being examined by the OSI Network Services Access Point to determine applications where organizations use optional bypass networks to skirt around the conventional transmission paths; i.e., public switches are avoided in favor of private dedicated paths (or systems).

4.7 Recent Actions by T1D1

These and other issues are continually being addressed by U.S. standards organizations who make contributions to the CCITT via the USCCITT Committee on ISDN. One such organization is the T1D1 subcommittee formed under the auspices of the Exchange Carriers Standards Association. Because this group is constantly engaged in various standards activities that continually change or are completed it is impossible to keep current with their results. The interested reader is referred to the T1D1 working documents.

5. REFERENCES

CCITT (1985) Red Book, Vol II, Fascicle II.2, Numbering plan for the international telephone service, Recommendation E.163 (Appendix C).

CCITT (1985) Red Book, Vol II, Fascicle II.2, Numbering plan for the ISDN era, Recommendation E.164 (Appendix D).

CCITT (1985) Red Book, Vol II, Fascicle II.4, Plan for telex destination codes, Recommendation F.69 (Appendix E).

CCITT (1985) Red Book, Vol VIII, Fascicle VIII.3, International numbering plan for public data networks, Recommendation X.121 (Appendix F).

CCITT (1985) Red Book, Vol VIII, Fascicle VIII.5, Reference model of Open Systems Interconnection for CCITT applications, Recommendation X.200

CEPT (1982), Report on Integrated Services Digital Network Studies (ISDN IN EUROPE), Doc. T/CCH(82)30; Doc. T/GSI(82)71, Stockholm, November.

Collett, P; D. Fraysse and E. Paul (1981), Le nouveau plan de numérotage (The New Numbering Plan), Echo. Rech. (French), No. 105, July.

Dorros, I. (1983), Telephone nets go digital, IEEE Spectrum 20, No. 4, April

Mulhausen, C. W., Stewart, W. V. , and Everhart, J. R. (1983), Numbering Plans for Military and Commerical Networks, 1983 IEEE Military Communications Conference (MILCOM '83), Washington, D.C. Oct. 31 - Nov. 2.

Nielsen, J. A. (1980), The New Danish Numbering Plan Teleteknik (English Ed.) (Denmark) 24, No. 1, pp. 1-8.

van der Graaf, B. V. (1982), Technical Aspects of the Dutch Data Network and its Operation, Het PTT-Bedrijf (Netherlands) XXIIL, No. 3, February.

APPENDIX A

Question 17/II: - Development of the World Numbering Plan for Telephone and ISDN Application

Considering

- that the ISDN numbering plan in accordance with Recommendation E.164 is based on and shall evolve from the World Numbering Plan for Telephony;

- that the ISDN numbering plan envisages a maximum number length of 15 digits;

- that ISDN customer access arrangements have been specified by CCITT and may be offered to users in the near future;

- that number allocation for ISDN customers is likely to be more complex than current practice in telephony;

- that the development of the ISDN numbering plan may have an impact on existing numbering plans;

- that public networks such as public data networks have been specified by the CCITT;

- that many of these public networks are already established in some administrations and in other Administrations such networks are in an advanced state of planning or implementation;

- that there is a need for these networks to provide international service;

- that the capability of accessing these public networks from the public telephone network is being implemented and shall be required from the future ISDN.

What rules could facilitate ISDN number allocation and what are the implications on numbering, selection and access procedures and routing of interworking between public telephone networks and other public networks (including ISDN)?

What new Recommendations or modifications to existing Recommendations would be required?

Note 1 - The interconnected networks will carry voice and nonvoice services. Close cooperation with Study Groups I, III, VII, XI, and XVIII is required and an account will need to be taken of human factors studies

Note 2 - In conjunction with the development of the World Numbering Plan, the following aspects require further study:

- Instructions to subscribers on selection procedures, including methods of indicating service and RPOA/network selection in the ISDN era. In addition further study is required on subaddressing and shared address space addressing techniques.

- The necessary steps and the methods to be applied for the numbering plan evolution from Recommendation E.163 to E.164 needs careful consideration. Such guidance would be of assistance to ensure a worldwide uniform approach and to recommend dates of implementation.

APPENDIX B

EXISTING AND PROPOSED NUMBERING PLANS

B.1 Introduction

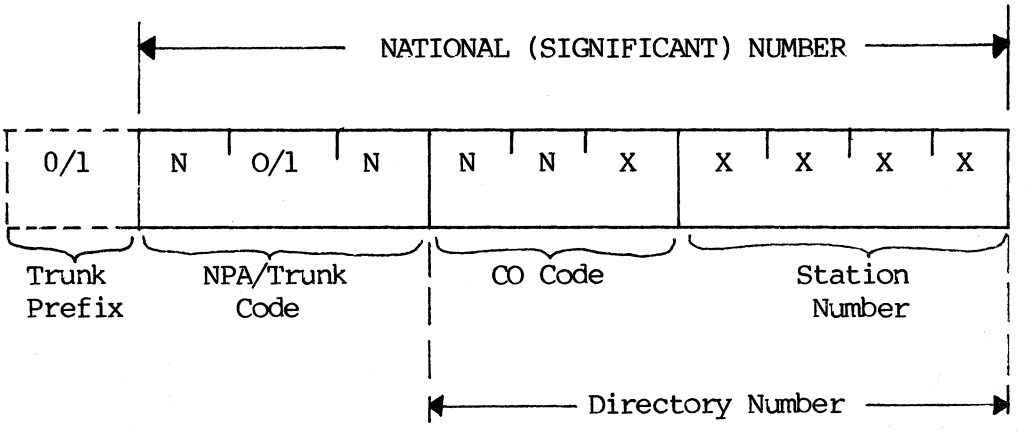
Just as a telecommunication system should be designed to meet the requirements of its users, so should the numbering plan, used to implement that system, meet those same needs. The numbering plans resulting from different CCITT Recommendations, are each used for a specific type of network and have been designed generally to embrace the philosophy of that network. Existing and proposed numbering plans of various networks throughout the world need to be designed for the most understandable and expedient employment by the network users. In this appendix several plans are reviewed. They can be compared against the type of network used, the CCITT Recommendation generally followed, the method used for interworking with other networks, and any other features of particular interest. The summary comparison chart for the network described here is given in Table 1 of Section 3.5.

B.2 North American Numbering Plan

The North American Numbering Plan Area (NPA) includes the entire United States and Canada, parts of Mexico, and the Caribbean Islands excepting Cuba. The systems that service this integrated numbering area include the American Telephone and Telegraph Company (AT&T), the Bell Operating Companies (BOC), and over 1500 Independent Telephone Companies and Other Common Carriers (OCC). In addition, literally thousands of private branch exchanges (PBX) and local area networks (LAN) within organizations and institutions, common control switching arrangements (CCSA) such as the Federal Telecommunications System (FTS), value-added networks (VAN) such as TELENET and TYMNET, and many other dedicated networks must all interwork with and have access to the North American Public Switched Telephone Network (PSTN).

The numbering plan uses a unique 10-digit address that conforms to CCITT Recommendation E.163. The present numbering plan format has grown and changed from necessity, much as the ISDN Numbering Plan is expected to evolve. All Number Calling (ANC), which is the destination code routiing system used, employs a three-digit Numbering Plan Area (NPA) Code and a

seven-digit telephone, or directory, number. These unique 10 digits make up the National (Significant) Number (NSN). The seven-digit subscriber or "directory", number consists of a three-digit Central Office (CO) code plus a four-digit station number. The structure of the (national) network address, or "destination code," is shown below.



N = 2-9
0/1 = digit zero or one
X = 0-9

The NPA code, also called the trunk code (E.160) determines the general (geographical) location of the directory number called. In addition to the N(S)N, a caller must use a trunk prefix (E.160) if calling a number within the same country or integrated numbering area but outside of the caller's Home Numbering Plan Area (HNPA). The called area in that case is referred to as a "Foreign" NPA (FNPA) and may be directly dialed using a "1" trunk prefix. By using a "0", operator assistance may be requested. A call amde to a station within an HNPA does not require the HNPA code but, depending upon the location of the called station, may need the trunk prefix "1" or "0". The "0" or "1" used as the second NPA code digit, and the digits 2 through 9 used in the second CO code position, solve the problem of distinguishing between the two adjacent codes in a common control system.

Because of increased applications, the structure shown above is evolving such that the CO code has, in some limited areas, presently taken the form NXX. Ultimately, both the NPA and CO codes will have this form. The less restrictive NXX format embodies the concept of interchangeable codes, wherein end office (i.e., CO) codes and NPA codes will no longer be characterized by mutually exclusive formats. Some special area codes (SAC) have been designed and reserved for such use as Wide Area Telephone Service (WATS) 800, DIAL-IT services (900), TWX, services, etc.

While the ISDN is still only conceptual in nature, the many OCC's and their networks that operate in the North American NPA, as well as AT&T Communications (formerly AT&T Long Lines), offer some or all of the integrated services that are envisioned. It is recognized that existing networks are predominantly analog. There are other capabilities such as the Local Area Data Transport Capability (LADT) and the Data Bridging Capability that support an eventual ISDN.

The evolving Local Area Data Transport (LADT) capability is intended for two types of users; the occasional user who is satisfied with not having voice communications while accessing a data base and the user who requires more continuous voice communications while accessing a data base (see Figure B-1).

The upper half of the figure shows alternate analog or low-speed data through the interface to an analog switch. This user can seize a port on a statistical multiplexer at a central office by pushbutton telephone and then send 1200 b/s data through a modem from the terminal. The user terminal will need X.25 support, based on the International Organization for Standardization (ISO) Open Systems Interconnection (OSI) reference model, Level 2, Link Layer. Packetized data will then be sent between the user and the data base through a packet switch. The multiplexer will concentrate incoming data from multiple users so that data is sent at 56 kb/s to the packet switching facility.

The second component of the LADT capability permits simultaneous analog voice and digital data. A user who requires more continuous voice service along with data transmission can reach the statistical multiplexer through a dedicated line by using the data over voice (DOV) concept. Through appropriate equipment at both ends, digital data up to 8 kb/s can be sent while analog voice conversations are routed to the analog switch.

The data bridging capability provides a service where there is a need to transmit digital data, such as graphics or teleconferencing, from one user location to several. A data bridge can be added to a No. 4 ESS switch that would route data from a single input to multiple receiving sites. The input data could come over a standard analog loop at 4.8 kb/s, or at 56 kb/s, through the public switched digital or LADT capabilities.

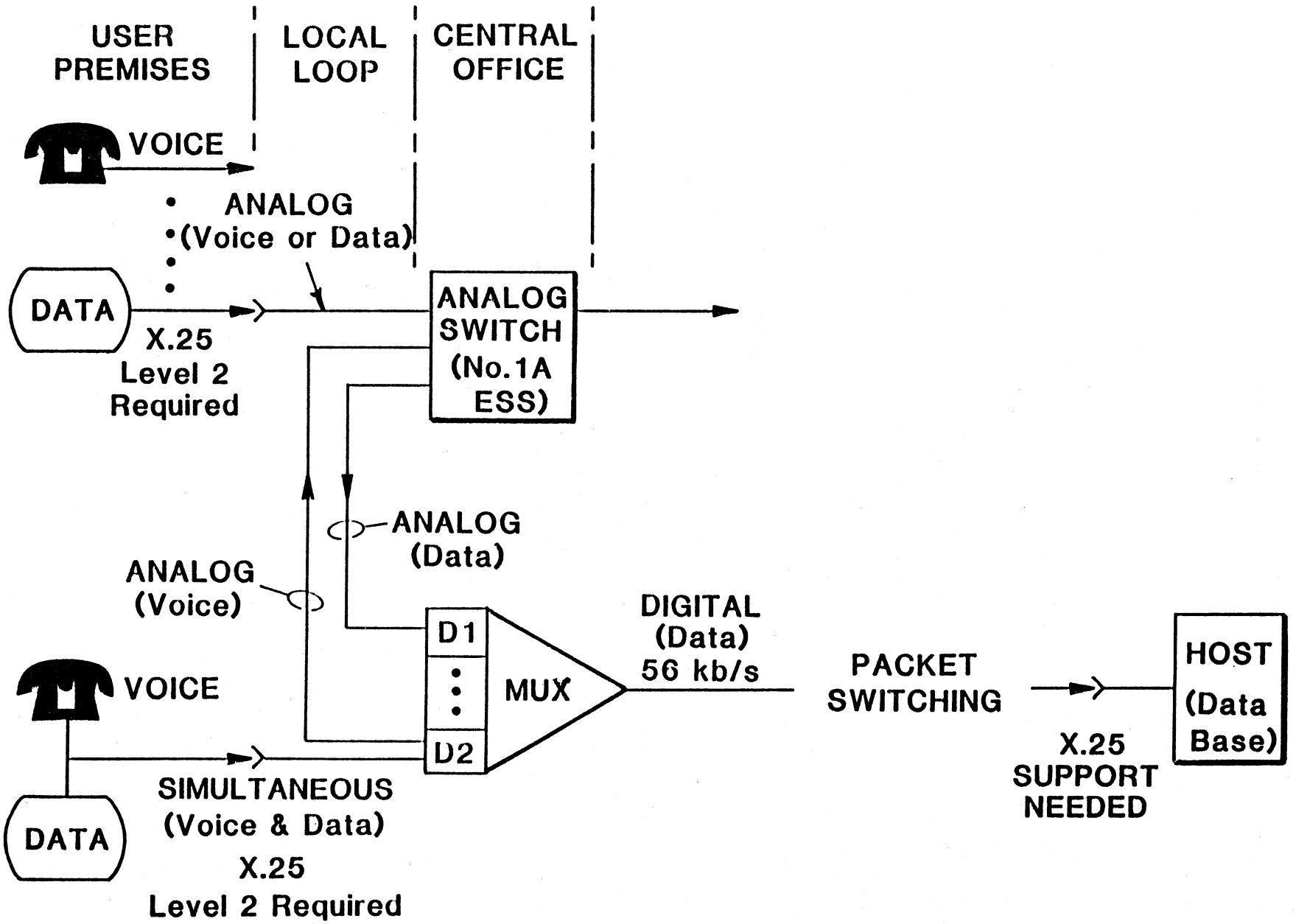


Figure B-1. Local area data transport capability (after Handler, 1981).

The physical configuration of a North American NPA ISDN is not the subject of this report. The technical details, as well as those dealing with policy issues are covered in other reports and documentation, some of which are in the references, others in the bibliography. The main intent of this report is to discuss the various aspects of numbering schemes as well as how they may be used to provide network interworking. Regardless of the technical characteristics (i.e., analog or digital) of a network or its size, for it to fulfill its primary purpose of acting as a telecommunication link for information of any type (e.g., voice, data, facsimile, video, electronic mail, telemetry, etc.), it must interwork with other networks. To accomplish this end, the individual numbering plans used may be as varied as the networks themselves.

The FTS, which is the largest private network in the North American NPA, uses an escape code method of interworking, as does the Department of Defense Automatic Voice Network, AUTOVON. Using this method, the caller dials one access digit in the same way as is done to go from PBX (or PABX) to a PSTN. With FTS however, the access level code 8 is generally routed over leased trunk lines without switching in the PSTN ((private communication) Hull et al, 1984). Once access is gained to the FTS network, the numbering plan used requires the first three digits of the called FTS intraexchange switch instead of the commercial end office CO code; the station number remains the same.

Until recently a subscriber *accessed a Specialized Common Carrier (SCC) network such as General Telephone Electronics (GTE) SPRINT, Microwave Communications Incorporated (MCI), or Southern Pacific Communications Corporation (SPCC) using a two-stage escape code. One example of the method used (for SPRINT) required the subscriber first to access the SCC office by dialing that seven-digit directory number. (Under existing agreements and tariffs, only the dual-tone multifrequency (DTNF) signaling could be used for SCC access.) After reaching the SCC office, a special dial tone was presented and the subscriber then dialed a unique 6-digit identification code plus the 10-digit N(S)N (NPA code plus directory number) of the called station. The SCC then routed the call either by PSTN or a bypass (e.g., satellite). Exchange Network Facilities for Interstate Access (ENFIA)

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*An "equal access" arrangement 61 will change the scenarios. See Section 2.4 for details.

tariffs provided the mechanism for the SCC's to interconnect their toll traffic to local exchange areas for local call origination and completion

A third method of network interworking can be illustrated by the way the value-added networks (VAN's) access the PSTN. Such networks lease trunk facilities for long-haul operations (e.g., AT&T DDS). The access method employed by these networks is known generally as the port method. Because of varying procedures and protocols, cross-network (i.e., VAN-to-VAN) operations are not encouraged. Within one VAN, however, the DTE/DCE-to-host interface is made by access address, via local public telephone lines and switches, to a network central office. A called DTE port is "seized" by the caller using the accepted address which may include, typically, the caller's name, an access identification code, and the called address. In VAN's using packets, the packet formats conform to CCITT X.25 while the access address format conforms to CCITT X.121. The access address comprises a 4-digit node number, which is actually a Data Network Identification Code (DNIC) and a 10-digit Network Terminal Number (NTN). A partial listing of access codes for a VAN (TYMNET) is shown in Table B-1.

In addition to the networks and services already mentioned, it should be remembered that the maritime radio service must be considered when discussing ISDN and ISDN Numbering Plans. Presently, this network conforms generally to CCITT E.210 and E.211. If an ISDN numbering plan for the North American NPA is to be conceived, the maritime community must, necessarily, be a part of that conception, as should the Public Land Mobile Network (PLMN). The public switched telephone service and the maritime communication service in the United States have distinct characteristics that differ from many other countries (Linfield and de Haas, 1978).

B.3 Numbering Plan for Dutch Data Network -DATANET 1

The Dutch data network is a public (packet) switched data network (PSDN) that operates in accordance with CCITT X.25 and uses a numbering scheme conforming to CCITT X.121. This network has its own switching resources (described briefly below) and modems that connect it to line circuits in the existing cable and/or radio relay routes of the telephone transmission network. The topology of the Dutch PSDN is straightforward (Figures B-2 thru B-4). One network operation and management center (NOMC) is lined to

Table B-1. Sample Listing of Value-Added-Network Access Codes

[TYMNET]

TYMNET ACCESS SORTED BY STATE 4/12/1983 PAGE 2

NODE	CITY	STATE	DEN	ACCESS #	MODEM
2247	HOUSTON	TEXAS	HIGH	713/977-4080	
2245	HOUSTON	TEXAS	HIGH	713/977-7671	(212A)
2434 +	HOUSTON	TEXAS	LOW	713/556-6700	(VADIC 3476)
2245	HOUSTON	TEXAS	HIGH	713/975-0500	(VADIC 3467)
2177	LONGVIEW	TEXAS	LOW	214/758-1756	(VADIC 3467)
2706	LUBBOCK	TEXAS	LOW	806/762-0136	(VADIC 3467)
3127 +	MCALLEN	TEXAS	LOW	512/631-0020	(VADIC 3467)
2706	MIDLAND	TEXAS	MED	915/683-5645	(VADIC 3467)
2434 +	NEDERLAND	TEXAS	LOW	713/724-0726	(VADIC 3467)
2706	ODESSA	TEXAS	LOW	915/563-3745	(VADIC 3467)
2753	SAN ANTONIO	TEXAS	HIGH	512/225-8002	(VADIC 3467)
2177 +	TYLER	TEXAS	LOW	214/592-1372	(VADIC 3467)
2177 +	WACO	TEXAS	LOW	817/752-1642	(VADIC 3467)
2177 +	WICHITA FALLS	TEXAS	LOW	817/761-1315	(VADIC 3467)
2737 +	OGDEN	UTAH	LOW	801/627-2022	(VADIC 3467)
2737 +	PROVO	UTAH	LOW	801/375-0645	(VADIC 3467)
2737	SALT LAKE CITY	UTAH	HIGH	801/364-0780	(VADIC 3467)
2554	BURLINGTON	VERMONT	LOW	802/658-2123	(VADIC 3467)
2616 +	CHARLOTTESVILLE	VIRGINIA	LOW	804/971-1001	(VADIC 3467)
2544	FAIRFAX	VIRGINIA	HIGH	703/691-8200	(VADIC 3467)
2613	LYNCHBURG	VIRGINIA	LOW	804/528-1903	(VADIC 3467)
2616	MIDLOTHIAN	VIRGINIA	HIGH	804/744-4860	(VADIC 3467)
1563	NEWPORT NEWS	VIRGINIA	MED	804/596-7609	(VADIC 3467)
2251	NORFOLK	VIRGINIA	MED	804/625-8301	(212A)
2616 +	PETERSBURG	VIRGINIA	LOW	804/862-4700	(VADIC 3467)
2616	RICHMOND	VIRGINIA	HIGH	804/744-4860	(VADIC 3467)
2705	ROANOKE	VIRGINIA	LOW	703/345-4730	(VADIC 3467)
1563	WILLIAMSBURG	VIRGINIA	MED	804/872-9592	(VADIC 3467)
2503	ENUMCLAW	WASHINGTON	LOW	206/825-6576	(VADIC 3467)
2503	OLYMPIA	WASHINGTON	LOW	206/754-3900	(VADIC 3467)
2564	RICHLAND	WASHINGTON	MED	509/375-3367	(VADIC 3467)
2503	SEATTLE	WASHINGTON	HIGH	206/285-0109	(VADIC 3467)
2776	SPOKANE	WASHINGTON	MED	509/747-4105	(VADIC 3467)
2503	TACOMA	WASHINGTON	LOW	206/473-7810	(VADIC 3467)
2540 +	VANCOUVER	WASHINGTON	LOW	206/693-0371	(VADIC 3467)
2503 +	YAKIMA	WASHINGTON	LOW	509/453-1591	(VADIC 3467)

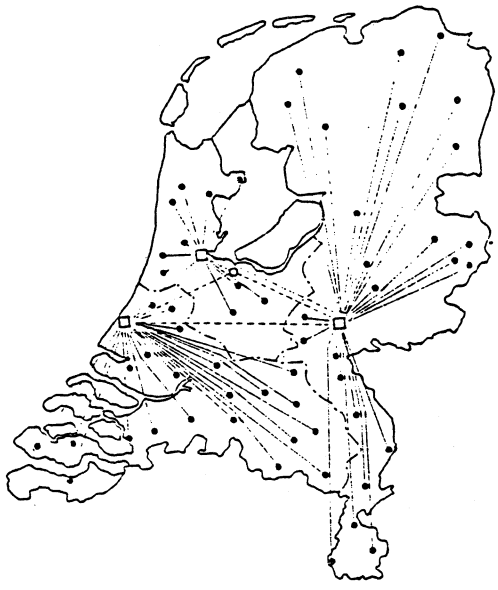


Figure B-2. The Dutch data network

- o = *NOMC*
- □ = *PSE*
- • = *PDS*
- ---·--- = *boundary of a PSE area*
- ------ = *trunk between PSEs or between the NOMC and a PSE*
- ——— = *trunk between a PDS and a PSE*

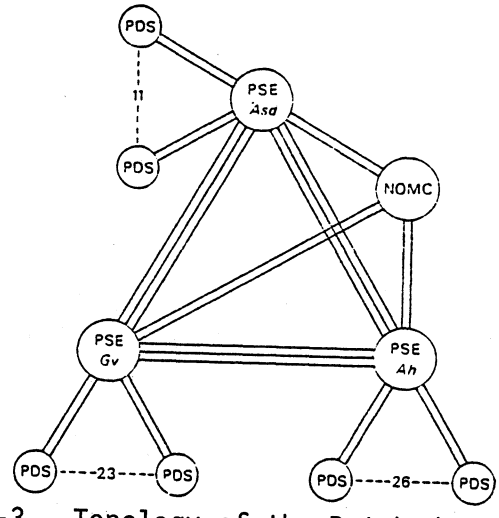


Figure B-3. Topology of the Dutch data network

Asd = *Amsterdam* *Gv* = *The Hague*
Ah = *Arnhem* —— = *trunk*

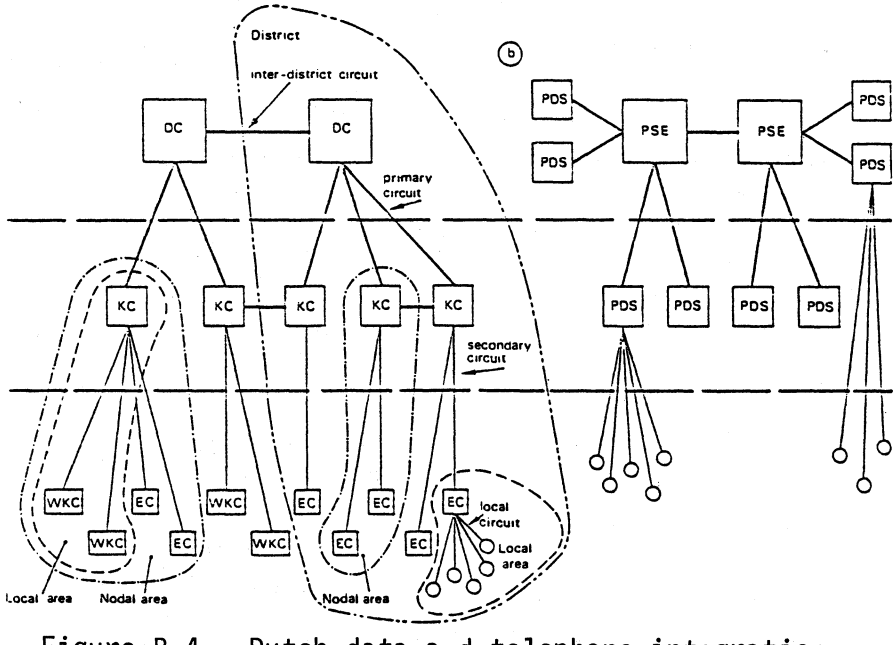


Figure B-4. Dutch data and telephone integration

a. Structure of the Dutch telephone and the type of transmission links employed; b. Integration of the data network into the existing telephone network structure. The switching facilities (PSE, PDS) are separate but the same transmission resources are used for both data and telephone connections.

- ○ = *subscriber*
- —— = *circuit with FDM carrier systems*
- —— = *circuit without FDM carrier systems*
- *DC* = *district exchange*
- *KC* = *nodal exchange*
- *EC* = *terminal exchange*
- *WKC* = *local exchange*
- *PSE* = *packet switching exchange*
- *PDS* = *packet data satellite*

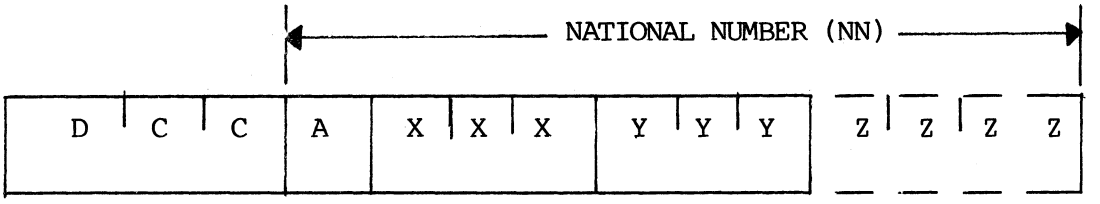
three packet switching exchanges (PSE's) which, in a mesh-type configuraton, are linked to 60 packet data satellites (PDS's) throughout the country (van der Graaf, 1982). Message routing is accomplished by a zone number in the netgram header which is compared with routing tables stored in node data bases (NDB's) with each PSE. This method of directory and routing storage lends permanency to the numbering plan since subscriber numbering need not be changed with changes in network topology.

Netgram protocol follows the X.25 datagram principle with the added capability for reassembling the packets into correct order at the destination end. Netgram protocol may be placed at level 3 (network) in the OSI model and level 3 (packet) of the X.25 DTE/DCE interface. More about this principle and its associated philosophy may be found in the literature in general and in the references in particular.

Non-X.25 terminals have access to, and are able to interwork with the PSDN by means of packet assemblers and disassemblers (PAD's). This means that during the early years of the network, a large group of small and medium-size companies that do not have the resources needed to acquire their own X.25 adaption provisions, will have access to the network (Drukarch and van den Burg, 1980).

The X.121 numbering format used in the Dutch PSDN is shown in Figure B-5. Since the Netherlands, like most European countries, will in the long term have only one PSDN, a network identification code (NIC) was considered unnecessary and the three-digit data country code (DCC) operation was chosen. This left 11 digits for the national number (NN) (van der Graaf, 1982).

The last four digits, ZZZZ in Figure B-5, may be used at some future time to identify specific terminals or programs within the structure of the total network. This affords both expandibility and adaptibility to the numbering plan. Further adaptibility is provided in the plan by making special network services available to subscribers through the use of the digit 9 as the first geographical zone digit. The longevity of this numbering plan has been virtually assured by the intitially large numbering potential, 9×10^5 plus special numbering, compared to projected needs. Flexibility was also built into the plan by the number of zones that can be covered by each PDS (a geographical zone corresponds to the area served by a telephone nodal exchange). The allowable number of seven-digit terminal connections in each PDS is 1000; a second zone number can be assigned if more connections are needed.



Where: A = first digit of NN determining the category of terminal connection. Dedicated X.25 connections to the network identified by A = 1, other values of A to be assigned in future
XXX = geographical zone
YYY = serial number within geographical zone
ZZZZ = for possible future subscriber use of subnumbering

Figure B-5. Dutch PSDN numbering format (after van der Graaf, 1982)

The Dutch data network may be considered to be a dedicated PSDN that makes common use of the existing telephone and radio relay network. It is not very difficult to envision, therefore, that at some future date, this network could become the packet switched part of an ISDN. For the introduction stage of ISDN evolution, it is foreseen that use will be made of specialized nodes at the trunk network level. Such nodes may be the exchanges (e.g., PSE's) of the current dedicated networks (CEPT 1982).

B.4 Proposed Danish Numbering Plan

The Technical Committee of the Danish Public Telephone Services Supervisory Commission has taken steps to accommodate a large increase in subscribers in the next few decades. The number of subscribers in 1980 was about 2 million and the existing numbering plan contains 8.1 million subscriber numbers. This is expected to be insufficient in several areas of the country in less than 10 years (Nielsen, 1980). In 1978, a working group was formed to study the problem and propose one, or several, new numbering plan(s) for consideration. (The existing numbering plan shown in Table B-2 conforms with CCITT Recommendation E.163.) It is interesting to study the terms of reference used by the working group and shown in Table B-3, and to see how closely they parallel many of the design considerations and criteria for both the X.121 (data) and ISDN numbering plans.

Table B-2. Existing Danish Numbering Plan (Nielsen, 1980)

Trunk prefix:	0a-bcdefg	
Trunk code:	0a-bcdefg	a = 1-9
The Faroe Islands:	042-cdefg	
Greenland (future):	041-cdefg	
Automatic mobile telephone (future):	049-cdefg	
Subscriber number:	0a-bcdefg	b = 1-9
In the Faroe Islands:	042-cdefg	c = 1-9
In Greenland:	041-cdefg	c = 1-9
Automatic mobile telephone (future):	049-cdefg	c = 1-9
National (significant) number (NSN):	0a-bcdefg	
International prefix:	009 outgoing	
(TCC):	45 incoming	
Special service codes and emergency calls:	00de and 000	

Table B-3 Terms of Reference for Danish Technical Committe Working Group (Nielsen, 1980).

1. Simple and uniform dialing procedure.
2. Easily comprehensible and uniform presentation of numbers in telephone directories.
3. Long lifetime (30-50 years), but a low number of digits for calling.
4. Conformity with CEPT and CCITT recommendations.
5. Short and uniform emergency and special service codes.
6. Possibility for direct PBX in-dialing, for the same subscriber number to various branches of the same institution or company, for "called subscriber pays", and for numbering in connection with other telecommunication services, e.g. text communication, data communication, etc.
7. Simple change to the new plan for the subscribers, avoiding confusion with numbers in the old plan.
8. Technical, practical and administrative practicability.

The working group settled on six evaluation models after going through an analysis of how many digits to use, the values of those digits, and the structure of the total number, all as functions of the terms of reference. By conforming to those terms, an eight-digit National (significant) Number (NSN) was selected, with a six-digit subscriber number as shown below.

xy - b c d e f g

where x = 0 - 9
y = 0 - 9
b = 2 - 9
all others = 0 - 9.

By making the whole country one numbering area in the new numbering plan (Bornholm, the Faroe Islands, and Greenland are expected to have their own international country code), the need for a trunk prefix was eliminated and use was made of the first two digits as a trunk code. (Remember, the North

American NPA code is a trunk code.) The subscriber number, bcdefg, was left intact. To agree with CEPT recommendations, the first dialed digit, "b", of the subscriber number should be neither a "0" nor a "1". With only those restrictions (i.e., b = 2-9), the new numbering scheme could then accomodate up to 80 million numbers for telephone and other telecommunication services.

The model selected and recommended for use replaces the trunk prefix and trunk code allowing for a rough and fine placement in the national numbering plan. The model was approved in November 1979 for future use and work has since been concentrating on the technical, practical, and economic aspects of introducing such a plan.

B.5 The New French Numbering Plan

When the existing numbering plan was established in 1955 (See Figure B-6), France had less than 2 million telephone subscribers. In 1983 there were over 20 million and the figure is expected to rise to 30 million by the end of the 1980's. In view of this sharp increase, the numbering plan is reaching a saturation point. It has a maximum capacity of just under 30 million numbers. The study of a new plan was launched in 1972. Taking into account the technical requirements (preparation of the modifications to be made to the exchanges involved and on-site work to carry out the necessary adjustments), this plan will come into force in 1985 (Telecommunications, 1984). The new plan is based on one central criterion: the assignment to each subscriber of a definitive eight-digit number. This number is obtained by incorporating the current two- or one-digit area code in the current six (provinces) or seven-(Ile-de-France, Lyon, etc.) digit number. (Compare Figure B-6 with the new number structure shown in Figure B-7). It will thus simply be a matter of deleting the brackets, thereby meeting one of the public's (and ISDN's) main requirements, namely that the subscriber numbers be altered as little as possible. For example, (70) 294799 will become 70294799 and (7)893 50 50 will become 7893 50 50.

There will, however, be one exception for Paris and the suburbs where "4" will replace "1" at the beginning of the current 7-digit number. For example, (1) 538 32 32 will become 4 538 32 32.

France will be divided into two areas (instead of the current 64), with the provinces constituting a single 8-digit zone and the Paris Region the second 8-digit zone, identified by the area code "1". The "16" will then be used for traffic transfer between these two areas.

National Number

	National Indicator (Trunk Area Code)	Regional (Local) Number	
		Switch Serial Number (Central Office)	Switch Position (Subscriber Number)
Province	NX	XX	XXXX
Paris Region	N	XXX	XXXX

Figure B-6. Original (1955) French numbering scheme (after Collet et al., 1981)

FROM / TO	Paris Region	Province
Province	16 + 1 + XXXX XXXX (11 digits)	NXXX XXXX (8 digits)
Paris Region	XXXX XXXX (8 digits)	16 + NXXX XXXXX (10 digits)

Figure B-7. French numbering plan change: intermediate phase structure

After the "16" is dialed, a second dial tone is presented. At that time, the eight digits of the local subscriber number may be dialed if leaving the Paris Region and, if calling from the Provinces to the Paris Region, a "1" plus the local subscriber number (nine digits) may be dialed. It can be seen that the available number of subscribers has been expanded with the introduction of prefix cueing (i.e., access code), but not at the expense of losing the original local number. In the initial phase of the changeover (1985), the plan is till Province-oriented as shown in Figure B-8.

The final phase configuration, which is expected to be completed in 1989, is shown in Figure B-9. The plan now becomes zone-oriented and more streamlined by the use of automatic switching throughout. The country is divided into five zones instead of just inter- or intra-zone with the Paris Region being one of the zones. Calls from one zone to another will be made by selecting "0" followed by the zone (area) code and an eight-digit number. The final phase numbering structure is depicted as follows.

Intra-Zone Call:	NXXX XXXX	(8 digits)
Intra-Zone (in Paris Region):	XXXX XXXX	(8 digits)
Intra-Zone Call:	OZ NXXX XXXX	(10 digits)
Intra-Zone (to Paris Region):	01 XXXX XXXX	(10 digits)

Note: Z = 1-5 (For the Paris Zone, Z=1)

The plan will therefore be simple, durable, insofar as it will increase capacity four-fold in relation to 1985 while imposing the fewest possible changes on users, and will offer an acceptable level of technical performance while at the same time meeting international requirements.

B.6 Numbering Plan for the Automatic Voice Network (AUTOVON)

The AUTOVON is the principal long-haul, nonsecure voice communications network in the U.S. Defense Communications System (DCS), and has over 500,000 users connected by 15,000 access lines. It handles approximately 750,000 originating calls a day. Approximately 60 automatic switches located in the United States and Canada are connected in a polygrid scheme and are leased from independent and Bell Operating telephone companies. In addition, there are 16 AUTOVON switches located overseas.

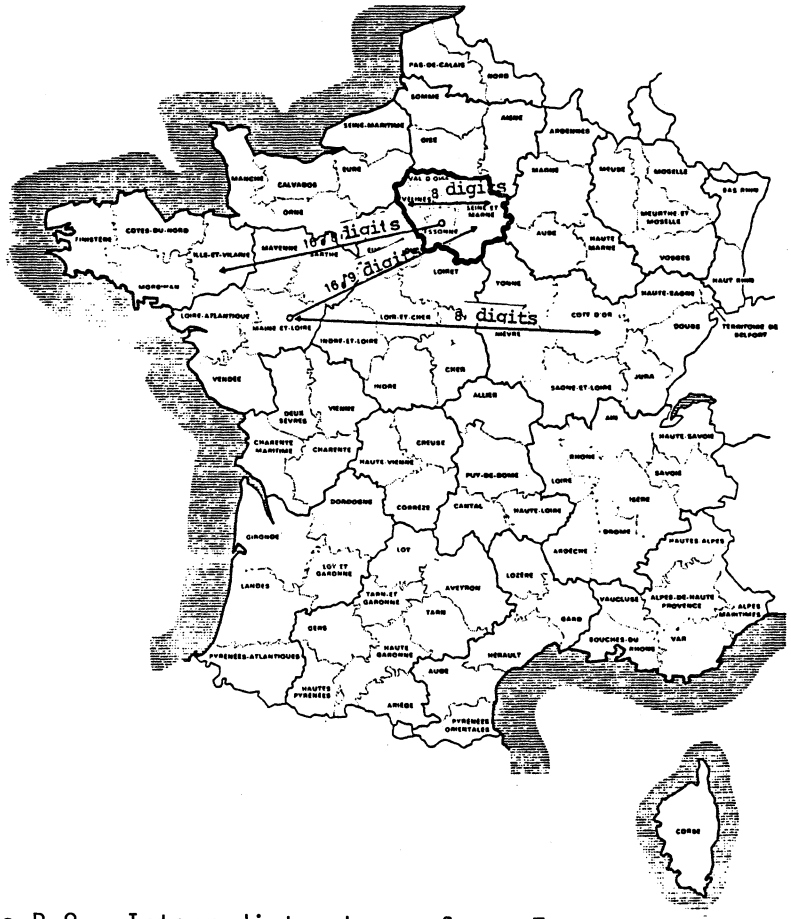


Figure B-8. Intermediate phase of new French numbering plan (after Collett et al., 1981)

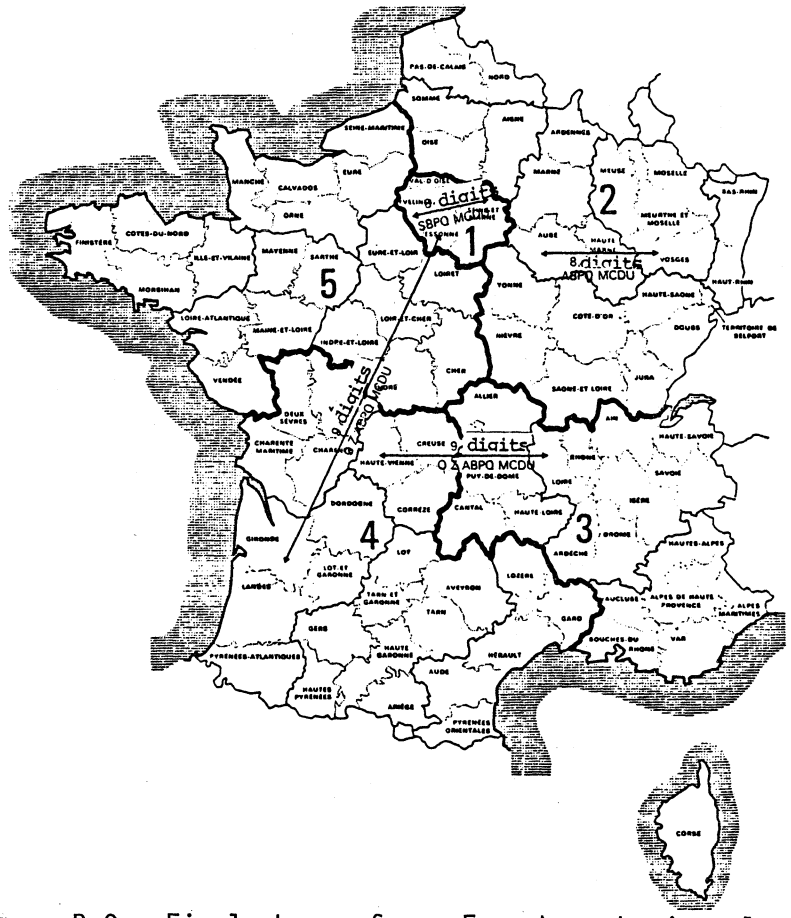


Figure B-9. Final phase of new French numbering plan (after Collet et al., 1981).

The numbering format for the DCS, as prescribed in MIL-STD-187-310, is comprised of the following parts, which will appear in the order indicated:

P F E A

where P is the precedence code, F is the special features code, E is the escape code, and A is the address information.

The precedence code is the first element dialed by the subscriber, if that option is exercised. The subscriber may assign to any call any precedence up to and including the highest level he is authorized by using only one digit. The levels in order of decreasing precedence are:

FO - Flash Override
F - Flash
I - Immediate
P - Priority

The Routine (R) precedence is indicated (activated) by the absence of any other precedence indicator at the start of the dialing sequence.

The special feature code is optional and its absence causes the call to be treated as an ordinary voice call, contingent on the subscriber's classmarks*. The various special features available are as follows:

conferencing (progressive or preprogrammed)
call transfer
data service
compressed dialing (two-digit code to remote-switch subscriber)
attendant access
call forwarding
abbreviated dialing (three to five digit code to local-switch subscriber)
trunk access
Digital Access Exchange (DAX) Tieline access

A two-digit feature code is presently being used to invoke a certain feature. A three-digit prefix is planned for future use as the number of features increases.

Escape codes, as defined in MIL-STD-187-310, are one-digit prefixes used before abbreviated dialing, and therefore are not implemented in all cases. These escape codes should not be confused with what is normally regarded as an escape code, i.e., a prefix digit(s) used to make a transition from one numbering plan to another. In this numbering plan, the digits used for that function are called access digits.

*Classmarks are designators used to describe the service privileges and restrictions for lines accessing a switch, e.g., precedence level, conference privilege, security level, zone restriction.

The address digits conform to the same basic 10-digit format (E.163) as the North American Numbering Plan, and that is:

Area Code	Switch Code	Line or Station Number
NYX	NNX	XXXX

where N = 2-9

X = 0-9

Y = 0 or 1

An example of an AUTOVON calling number using precedence and special features is shown below. Illustrated is a data call at flash priority to a subscriber using a distant switch. The local (caller's) switch has an abbreviated dialing capacity.

P	F	E	Address Digits
F	3C	9	NNXXXXX

B.7 Defense Switched Network Worldwide Numbering Plan

The Defense Switched Network (DSN) numbering plan must be compatible and interoperable with the AUTOVON and the European Telephone System (ETS) both of which are, in turn, compatible and interoperable with the North American Numbering Plan. This means that all four systems conform to Recommendation E.163. The Worldwide DSN Numbering Plan (DSN-NP) as proposed by the Defense Communications Engineering Center (Private Communication from Defense Communications Engineering Center [DCA/DCEC], DCEC 1983 informal report) of the Defense Communications Agency (DCA), will accommodate at least the following:

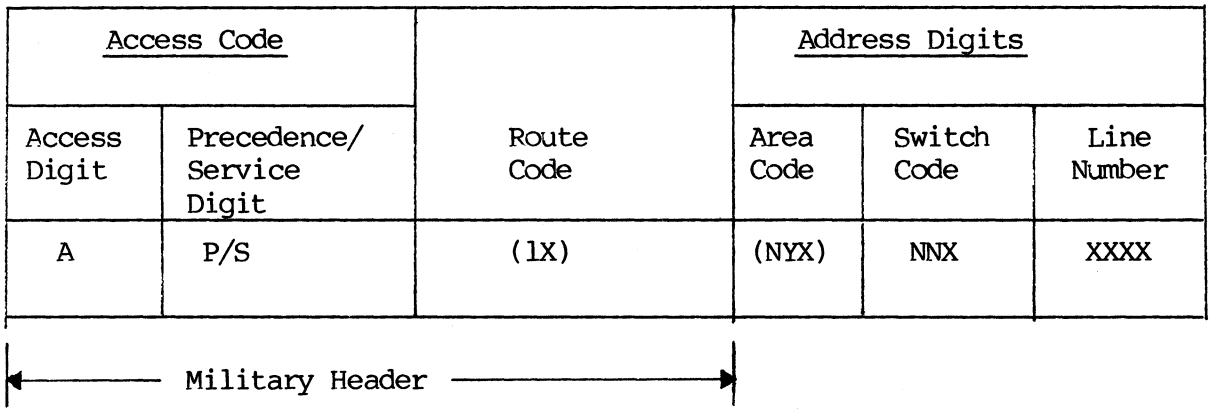
- Uniform DSN Dialing Worldwide
- DSN/AUTOVON and Administrative Dialing from a Single Telephone
- Open Numbering Structure
- ISDN and Worldwide Digital Systems Architecture (WWDSA) Features and Functions
- Use of Authorization Codes
- Most Economical Routing (MER)
- Modern Telephone Switch Features
- Abbreviated Local Service and Emergency Codes
- Seven Digit Local Dialing (four or five Digit Optional)

- Precedence Service for Rotary Dial and 10, 12, 15, or 16 Button Keysets
- Direct Dial Access to and From NATO and Tactical Systems
- Satellite Link Control
- Local and Remote DSN Assistance Operator Service
- Direct Dial Access to Local and Long Distance Public System:
  (1) Public systems and services for local, national and international calls
  (2) The private line and software defined portions of DSN for local, national, and international voice or data calls.
- Present AUTOVON Numbering
- Direct Dial Access to and from Other Government and Commerical Networks, and special common carrier services.

The structure of the DSN number is shown in Figure B-10. An explanation of the components comprising the DSN number format follows, and the assignments of digits are listed in Tables B-4 through B-6.

The "Access Code" consists of the access digit, A, and a DSN precedence or service digit, P or S. The access digit allows a properly classmarked subscriber to dial a DSN precedence from a rotary dial or a push button telephone, or to choose other government or commercial networks where available. Until a Most Economical Routing (MER) feature is incorporated, the subscriber will have the choice of networks. While DSN ROUTINE calls may be dialed without an access code, time-outs are required to resolve number ambiguities. Table B-4 lists the DSN precedence digits. Table B-5 lists the service digits. The access digit for Government (e.g. military) networks is "8". The access digit for commercial networks is "9".

The "Route Code" is a special purpose DSN code used to progressively inform switches in the call setup of special routing or termination requirements. Present usage of the route code is limited in the DSN (including AUTOVON), to determining whether a call will use data or voice grade trunking, or to indicating that the number dialed is either in the FTS or commercial network. In the future, the route code may be used to disable echo suppressors or override satellite link control when that feature is incorporated. For voice calls with no required special features, no route code is necessary. The first digit of the route code (See Table B-6) informs the switch that the next digit dialed will be a route digit.



A = 8 (Government Access) or 9 (Commercial Access)

P/S = 0-9 or DTMF tone associated with FO, F, I, or P Keys on a 15 or 16 button keyset.

N = 2-9

Y = 0 or 1

X = 0-9

Note: Digits shown in parentheses ( ) not subscriber dialed on all calls

Figure B-10. Dialing format for DSN numbering plan

Table B-4. DSN Precedence Digits

Precedence Digit (Rotary Dial)	Function	15/16 Button Keysets Only
0	DSN - FLASH OVERRIDE	FO
1	DSN - FLASH	F
2	DSN - IMMEDIATE	I
3	DSN - PRIORITY	P
4	DSN - ROUTINE	---
5	FTS ---	
6	Reserved	---
7	Spare	---
8	Spare	---
9	Spare	---

Table B-5. DSN Service

Service Digit	Function
0	Commerical Operator
1	Spare
2	Spare
3	Spare
4	Spare
5	Spare
6	Reserved (Other Commercial Carriers)
7	Reserved (Other Commercial Carriers)
8	Reserved (Other Commercial Carriers)
9	Public Telephone Network

Table B-6. DSN Route Code Assignments

Route Code	Function
10	Voice or data grade trunking may be used
11	Data grade trunking required
12	Unassigned
13	Unassigned
14	Unassigned
15	Unassigned
16	Unassigned
17	FTS Numbering Plan (Not required at switches using commercial access codes)
18	Unassigned
19	Commerical Number Plan (Not required at switches using commercial access codes)

The "Address Digits" comprise the final three sections of the call destination routing. The three parts are then Area Code, the Switch Code, and the Line Number. The Area Code has the same NO/1X format, (N = 2-9, X = 0-9), and is used in the same way as the North American Plan Area Code. There are 160 area codes available for use worldwide; 50 area codes have been assigned to tactical networks.

The Switch Code indicates the location of a switching center within a numbering plan area and is used in the same way as the commercial Central Office. There are 640 switch codes available in each numbering plan area. The three-digit switch code usually is of the form NNX (N = 2-9, X = 0-9). At selected locations, however, the switch code will be a four-digit code of the form NNX-N.

The Line Number is the unique subscriber identification and is usually of the form XXXX (X = 0-9). At those locations where the switch code uses the 4-digit code, the line number will use the form XXX. The line number, while unique within a switch location, can be reused from switch to switch; as many as 9,999 subscriber numbers per switch can be identified. (All zero digits are not customarily used.)

The proposed DSN will also provide many types of special features and services at each of the switches and, although a universal numbering scheme is proposed for the use of those features and services, they are not part of the DSN-NP and should not be used as a basis of comparison. The DSN-NP as proposed (Figure B-10), indicates that the Address Digits portion of the numbering structure is the same as the North American Plan. The military header portion of the address, which consists of the route code and access code, allows additional flexibility. Recommendation F.164 states that the international prefix and trunk prefix are not part of the international ISDN number. In the DSN-NP the access digit is equivalent to a trunk prefix.

Following the trend toward an ISDN concept, the DCEC has proposed a future DSN-NP for the 1995 timeframe. The proposed numbering format is shown in Figure B-11.

Access Digit	Precedence/ Service Digit	Route Code	Country Code	Trunk Code Network Identification	Subscriber Number	Sub-Address
A	P/S	(1X)	(X)(X)(X)	(NYX)	NNX-XXXX	(X.....)

Military Header → ← Network Number

STATION DIALING

Precedence/ Service Digit	Route Digit	Country Code	Trunk Network Identification	Subscriber Number	Sub-Address
P/S	X	(X)(X)(X)	(NYX)	NNX-XXXX	(X.....)

Military Header (Fixed) → ← Network Number (Variable)

MACHINE OUTPULSING

Figure B-11. Far-term DSN numbering structure (DCEC, 1983)

The objectives of the future DSN-NP are as follows:

- Direct dialing of either DNS, or commercial local, long distance or international numbers
- Addresses based on physical locations
- Utilization of North American ISDN numbering formats in the DSN
- Use of an open numbering plan
- Numbering compatibility with the commercial world
- Dialing of network features using commercial procedures and codes
- Easy addition of new government or commercially available features
- Use of commerically available equipment with little modification
- Use of commercial numbers for administrative calling in North American portion of DSN
- DSN-unique numbers for overseas and selected military locations in the continental United States

The military header portion of the address will be identical in format to the earlier version DSN-NP and will provide a means for the subscriber to indicate to which numbering plan the call is being placed, the DSN precedence of the call, and the route treatment desired. The network number will include the called subscriber's address and, by use of a sub-address, the network features desired. The DCEC plan proposes the subaddress as dialable, whereas draft Recommendation I.311 calls for the ISDN subaddress information to be transmitted transparently through the underlying network architecture. The structure and general use of the ISDN subaddress is an important point upon which the CCITT must still agree and make recommendations.

B.8 References

Collet, P; D. Fraysse, and E. Paul, (1981), Lenouveau plan de numberotage (The New Numbering Plan), Echo Rech. (French), No. 105, July.

Nielsen, J.A. (1980), The New Danish Numbering Plan, Teleteknik (English Ed.) (Denmark) 24, No. 1, pp. 1-8.

van der Graaf, B.V. (1982), Technical Aspects of the Dutch Data Network and its Operation, Het PTT-Bedrijf (Netherlands) XXII, No.3, February.

Handler, G.J. (1981), Planning switched data transport capabilities in the Bell System, IEEE National Telecommunications Conference, New Orleans, Louisiana, Vol. 1 of 4, pp. B2.3.1 to B2.3.4.

Linfield, R.F., and de Haas, T. (1978), Interfacing the automated maritime mobile telephone system with the U.S. public switched telephone network, NTIA Report 78-7.

Drukarch, C.Z., and Van Den Burg, J.M. (1980), The Dutch datanet, general aspects and typical network structure, Data Network: Development and Uses; Proveedings of Networks 80, pp. 233-49, June.

CEPT(1982), Report on Integrated Services Digital Network Studies (ISDN IN EUROPE) Doc. T/CCH(82)30; Doc. T/GSI(82)71, Stockholm, November.

CCITT(1983), Red Book, Vol II, Fascicle II.2, Definitions relating to national and international numbering plans, Rec. E.160.

CCITT(1985), Red Book, Vol II, Fascicle II.3, Numbering plan for the international telephone service, Rec. E.163.

APPENDIX C

Recommendation E.163 [1]

NUMBERING PLAN FOR THE INTERNATIONAL TELEPHONE SERVICE

Introduction

This Recommendation describes the numbering plan for the International Telephone Service. Recommendation E.164 describes the numbering plan for the ISDN era. It is for each Administration to choose the method of application from the two Recommendations which would provide the optimum approach to meeting their future national numbering plan needs. Evolution between the plans is for further study. However, for new equipment, it is recommended that E.164 be adopted.

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[1] This Recommendation is also included in the Series Q Recommendations under the number Q.11 *bis*.

1 National numbering plan

1.1 Each telephone Administration should give the most careful consideration to the preparation of a *national numbering plan*[2] its own network. This plan should be designed so that a subscriber is always called by the same number in the trunk service. It should be applicable to all incoming international calls.

1.2 *Number analysis*

1.2.1 The national numbering plan of a country should be such that an analysis of a minimum number of digits of the national (significant) number (see definitions in Recommendation E.160):

a) gives the most economical routing of incoming international traffic from various other countries;

b) indicates the charging area in those countries where there are several.

1.2.2 In the case of a country with a two- or three-digit country code, not more than two digits of the national (significant) number should be analyzed for these purposes.

In the case of a country with a one-digit country code, not more than the three digits of the national (significant) number should be analyzed for these purposes.

1.2.3 In the case where an integrated numbering plan covers a group of countries, the digit analysis specified in § 1.2.2 should also determine the country of destination.

1.2.4 For the requirements relating to frontier traffic, see Recommendation D.390 R [2].

2 Limitation of the number of digits to be dialled by subscribers

2.1 *International number*

The CCITT recommended in 1964 that the number of digits to be dialled by subscribers in the automatic international service should not be more than 12 (excluding the international prefix). It is emphasized that this is the maximum number of digits and Administrations are invited to do their utmost to limit the digits to be dialled to the smallest possible number.

2.2 *National (significant) number*

Noting that:

a) the international number (excluding the international prefix) consists of the country code followed by the national (significant) number;

b) the smallest possible number of digits to be dialled in the automatic international service is achieved by limiting the number of digits of the country code and/or of the national (significant) number;

c) in some countries where telephony is already developed to an advanced stage, the national numbering plans in force enable the number of digits of the international number to be limited to less than 12;

d) some other countries which drew up their national numbering plans some time before 1964 have taken steps to ensure that the number of digits of the international number will not exceed 12 and may even be less;

the CCITT recommends that the number of digits of the national (significant) number should be equal to a maximum of $12 - n$, where n is the number of digits of the country code.

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[2] See the CCITT manual cited in [1] for a comprehensive study of for national numbering plans from the national point of view.

3 Digit capacity of international registers

The CCITT considers it advisable to recommend that the digit capacity of registers dealing with international traffic should allow for future conditions that may arise, but not possible to specify at the present time. In this regard, registers dealing with international traffic should have a digit capacity, or a capacity that can be expanded, to cater for more than the maximum 12-digit international number envisaged at present. The increase in the number of digits above 12 is left as a matter of decision to be taken by individual Administrations. However, for new applications a minimum digit capacity of 15 digits is recommended (see Recommendation E.164). Administrations are recommended, when making such a decision, to take account of the new applications likely to be introduced in the international service, and which are now being studied by the CCITT.

4 Prefixes and codes

4.1 *International prefix* [3]

It is recommended by the CCITT that the Administrations of countries that have not yet introduced automatic international operation, or Administrations that are, for various reasons, revising their numbering plans should adopt an international prefix (a code for access to the international automatic network) composed of the two digits 00.

The reasons for this recommendation are:

- to provide a maximum degree of standardization such that dialling is made as easy as possible for a person travelling in different countries (many countries already use the code 00),
- to minimize the number of digits to be dialled in automatic international operation,
- to simplify, for a future time when the use of the international prefix might have become a universal international standard, the format for writing an international telephone number.

4.2 *Country code* [3], [4]

4.2.1 Country codes will be used:

- in semiautomatic operation, to route calls to the required country when the calls are transit calls or when, on the outgoing positions, there is common dialling access to all the outgoing routes;
- in automatic operation.

4.2.2 A list of country codes was prepared by the CCITT within the framework of a worldwide automatic telephone numbering plan.

This list was set up according to the following principles:

a) The number of digits of the country code is one, two or three according to the foreseeable telephonic and demographic development of the country concerned.

b) The nine digits from 1 to 9 have been allocated as the country code or as the first digit of the country code. These digits define *world numbering zones.*

c) In the case of Europe, owing to the large number of countries requiring two-digit codes, the two digits 3 and 4 have been allocated as the first digit of the country codes.

4.2.3 The list of country codes already assigned is given in Annex A.

4.3 *Assignment of country codes*

4.3.1 The existing world numbering plan should be maintained and codes presently assigned should not be changed, unless consolidation of an existing numbered area yields an advantage in terms of code usage.

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[3] See definitions in Recommendation E.160.

[4] A "country code" may be assigned either to an individual country or to a geographical area.

4.3.2 All spare country codes will be assigned on a 3-digit basis, as detailed in Annex B. The list of spare country codes for the international semiautomatic and automatic service is given in Annex C.

4.3.3 In the case where all the country codes in a world numbering zone have been assigned and an additional code is required in that zone, a spare country code from another world numbering zone can be used in accordance with the following rules:

4.3.3.1 Preference should be given to the assignment of a spare country code from an adjacent world numbering zone.

4.3.3.2 If spare codes are not available from an adjacent world numbering zone, assignments will be made from the zones with the most spare codes.

4.4 *Codes for new international services*

The introduction of some international services requires the allocation of a country code. In such cases, the assignment of a country code will be determined by the rules detailed in Annex B.

4.5 *Trunk prefix*[5)]

4.5.1 The *national (significant) number* (see definition 6 of Recommendation E.160) does not include the trunk prefix. Accordingly, in the international service, the trunk prefix of the country of destination must not be dialled.

It should be noted that, in some countries, it is customary to consider *for national purposes* that the trunk prefix is included in the national number [which is then not the national (significant) number]. A careful distinction must therefore be made between such national definition or practice and the CCITT definition, which is internationally valid. In order to avoid misunderstanding, the CCITT definition includes the word "significant" between brackets, reading as follows: "national (significant) number".

4.5.2 It is recommended by the CCITT that the Administrations of countries that have not yet adopted a trunk prefix for access to their national automatic trunk network should adopt a prefix composed of a single digit, preferably 0. Irrespective of what digit is adopted as a trunk prefix, this digit should be precluded from being used also as a first digit of the trunk codes.

The reasons for this recommendation are:

- to provide the maximum degree of standardization of the trunk prefixes used in different countries, so that dialling is made as easy as possible for a person travelling from one country to another,
- to minimize the number of digits to be dialled in the automatic national service,
- to reduce user problems which arise because of the requirement, in automatic international operation, that the trunk prefix of the country of destination must not be dialled.

4.5.3 In the automatic international service, following the international prefix and country code of the called country, the caller should dial the national (significant) number of the called subscriber (i.e. without dialling the trunk prefix).

4.5.4 The use and printing of symbols and separators in national and international telephone numbers is detailed in Recommendation E.123.

5) See definitions in Recommendation E.160.

ANNEX A

(to Recommendation E.163)

List of country codes incorporating amendments proposed by the World Plan Committee, 1984

World numbering ZONE 1

Canada	1 [a]	Bermuda	1 [a]
United States of America, including Puerto Rico and the Virgin Islands	1 [a]	Bahamas (Commonwealth of the)	1 [a]
Jamaica	1 [a]	Dominican Republic	1 [a]
Barbados	1 [a]	Grenada	1 [a]
Antigua and Barbuda	1 [a]	Montserrat	1 [a]
Cayman Islands	1 [a]	St. Kitts	1 [a]
British Virgin Islands	1 [a]	St. Lucia	1 [a]
		Saint Vincent and the Grenadines	1 [a]

[a] Integrated numbering area.

World numbering ZONE 2

Egypt (Arab Republic of)	20	Zaire (Republic of)	243
Morocco (Kingdom of)	21 [a]	Angola (People's Republic of)	244
Algeria (People's Democratic Republic of)	21 [a]	Guinea-Bissau (Republic of)	245
Tunisia	21 [a]	Diego Garcia	246
Libya (Socialist People's Libyan Arab Jamahiriya)	21 [a]	Seychelles (Republic of)	248
Gambia (Republic of the)	220	Sudan (Democratic Republic of the)	249
Senegal (Republic of)	221	Rwandese Republic	250
Mauritania (Islamic Republic of)	222	Ethiopia	251
Mali (Republic of)	223	Somali Democratic Republic	252
Guinea (Republic of)	224	Djibouti (Republic of)	253
Ivory Coast (Republic of the)	225	Kenya (Republic of)	254
Upper Volta (Republic of the)	226	Tanzania (United Republic of)	255
Niger (Republic of the)	227	Uganda (Republic of)	256
Togolese Republic	228	Burundi (Republic of)	257
Benin (People's Republic of)	229	Mozambique (People's Republic of)	258
Mauritius	230	Zanzibar (Tanzania)	259
Liberia (Republic of)	231	Zambia (Republic of)	260
Sierra Leone	232	Madagascar (Democratic Republic of)	261
Ghana	233	Reunion (French Department of)	262
Nigeria (Federal Republic of)	234	Zimbabwe (Republic of)	263
Chad (Republic of)	235	Namibia	264
Central African Republic	236	Malawi	265
Cameroon (Republic of)	237	Lesotho (Kingdom of)	266
Cape Verde (Republic of)	238	Botswana (Republic of)	267
Sao Tome and Principe Democratic Republic of)	239	Swaziland (Kingdom of)	268
Equatorial Guinea (Republic of)	240	Comoros (Islamic Federal Republic of the)	269
Gabonese Republic	241	South Africa (Republic of)	27
Congo (People's Republic of the)	242	Faroe Islands (Denmark)	298
		Greenland (Denmark)	299

Spare codes 247
280, 281, 282, 283, 284, 285, 286, 287, 288, 289
290, 291, 292, 293, 294, 295, 296, 297,

[a] *Integrated numbering area with subdivisions:*
- Morocco: 210, 211, 212 (212 in service);
- Algeria: 213, 214, 215;
- Tunisia: 216, 217;
- Libya: 218, 219.

World numbering ZONES 3 and 4

Greece	30	Denmark	45
Netherlands (Kingdom of the)	31	Sweden	46
Belgium	32	Norway	47
France	33 [a)]	Poland (People's Republic of)	48
Monaco	33 [a)]	Germany (Federal Republic of)	49
Spain	34	Gibraltar	350
Hungarian People's Republic	36	Portugal	351
German Democratic Republic	37	Luxembourg	352
Yugoslavia (Socialist Federal Republic of)	38	Ireland	353
Italy	39	Iceland	354
Romania (Socialist Republic of)	40	Albania (Socialist People's Republic of)	355
Switzerland (Confederation of)	41 [a)]	Malta (Republic of)	356
Liechtenstein (Principality of)	41 [a)]	Cyprus (Republic of)	357
Czechoslovak Socialist Republic	42	Finland	358
Austria	43	Bulgaria (People's Republic of)	359
United Kingdom of Great Britain and Northern Ireland	44		

[a)] Integrated numbering plan.

World numbering ZONE 5

Falkland Islands (Malvinas)	500	Brazil (Federative Republic of)	55
Belize	501	Chile	56
Guatemala (Republic of)	502	Colombia (Republic of)	57
El Salvador (Republic of)	503	Venezuela (Republic of)	58
Honduras (Republic of)	504	Guadeloupe (French Department of)	590
Nicaragua	505	Bolivia (Republic of)	591
Costa Rica	506	Guyana	592
Panama (Republic of)	507	Ecuador	593
St. Pierre and Miquelon (French Department of)	508	Guiana (French Department of)	594
Haiti (Republic of)	509	Paraguay (Republic of)	595
Peru	51	Martinique (French Department of)	596
Mexico	52	Suriname (Republic of)	597
Cuba	53	Uruguay (Eastern Republic of)	598
Argentine Republic	54	Netherlands Antilles	599

World numbering ZONE 6

Malaysia	60	Vanuatu	678
Australia	61	Fiji	679
Indonesia (Republic of)	62	Palau	680
Philippines (Republic of the)	63	Wallis and Futuna	681
New Zealand	64	Cook Islands	682
Singapore (Republic of)	65	Niue Island	683
Thailand	66	American Samoa	684
Mariana Islands	670	Western Samoa	685
Guam	671	Kiribati Republic	686
Australian External Territories	672	New Caledonia and Dependencies	687
Brunei	673	Tuvalu	688
Nauru (Republic of)	674	French Polynesia	689
Papua New Guinea	675	Tokelan	690
Tonga (Kingdom of)	676	F.S. of Micronesia	691
Solomon Islands	677	Marshall Islands	692

Spare codes 693, 694, 695, 696, 697, 698, 699

World numbering ZONE 7

Union of Soviet Socialist Republics 7

World numbering ZONE 8

Japan	81
Korea (Republic of)	82
Viet Nam (Socialist Republic of)	84
Democratic People's Republic of Korea	850
Hong-Kong	852
Macao	853
Democratic Kampuchea	855
Lao People's Democratic Republic	856
China (People's Republic of)	86
Maritime Mobile Service	87 [a]
Bangladesh (People's Republic of)	880 [b]

Spare codes 800, 801, 802, 803, 804, 805, 806, 807, 808, 809
830, 831, 832, 833, 834, 835, 836, 837, 838, 839
851, 854, 857, 858, 859
890, 891, 892, 893, 894, 895, 896, 897, 898, 899

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[a] The country code 87 is reserved for the Maritime Mobile Service. The following three digit country codes are assigned: 871 INMARSAT (Atlantic), 872 INMARSAT (Pacific), 873 INMARSAT (Indian Ocean).

[b] The remaining combinations in series 88 will not be allocated until the stock of spare 3-digit codes for the region is exhausted.

World numbering ZONE 9

Turkey	90
India (Republic of)	91
Pakistan (Islamic Republic of)	92
Afghanistan (Democratic Republic of)	93
Sri Lanka (Democratic Socialist Republic of)	94
Burma (Socialist Republic of the Union of)	95
Maldives (Republic of)	960
Lebanon	961
Jordan (Hashemite Kingdom of)	962
Syrian Arab Republic	963
Iraq (Republic of)	964
Kuwait (State of)	965
Saudi Arabia (Kingdom of)	966
Yemen Arab Republic	967
Oman (Sultanate of)	968
Yemen (People's Democratic Republic of)	969
United Arab Emirates [a]	971
Israel (State of)	972
Bahrain (State of)	973
Qatar (State of)	974
Mongolian People's Republic	976
Nepal	977
Iran	98

Spare codes 970, 975, 978, 979
990, 991, 992, 993, 994, 995, 996, 997, 998, 999

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[a] E.A.U: Abu Dhabi, Ajman, Dubai, Fujeirah, Ras Al Khaimah, Sharjah, Umm Al Qiwain.

ANNEX B

(to Recommendation E.163)

Rules for the assignment of spare country codes

The rules listed in this annex are provided as a basis for the most effective utilization of the spare country codes.

B.1 Single isolated 3-digit codes should be assigned prior to the assignment of any 3-digit code which is part of a series of more than two consecutive 3-digit codes.

B.2 The assignment of spare codes of a zone, both within that zone and also to another zone, will take place as follows:

a) When assigning a code to a country in the same zone:

start with the lowest numbered 3-digit codes in ascending order, e.g. 670, 680 ...

b) When assigning a code to a country in another zone:

start with the highest numbered 3-digit codes in descending order, e.g. 688, 685 ...

c) Within code 87 reserved for the Maritime Mobile Service a third digit will be assigned to codes used for maritime satellite ocean area systems, with the restriction that codes 878 and 879 may not be touched because they are reserved for national purposes.

B.3 Country codes for new international services or for the automation of some existing services should be taken from the world numbering zone with the most spare codes.

ANNEX C

(to Recommendation E.163)

List of spare country codes for the international semiautomatic and automatic service

Spare codes 247
280, 281, 282, 283, 284, 285, 286, 287, 288, 289
290, 291, 292, 293, 294, 295, 296, 297,
693, 694, 695, 696, 697, 698, 699
800, 801, 802, 803, 804, 805, 806, 807, 808, 809
830, 831, 832, 833, 834, 835, 836, 837, 838, 839
851, 854, 857, 858, 859
890, 891, 892, 893, 894, 895, 896, 897, 898, 899
970, 975, 978, 979
990, 991, 992, 993, 994, 995, 996, 997, 998, 999

References

[1] CCITT manual *National telephone networks for the automatic service*, ITU, Geneva, 1964, 1968, 1978.

[2] CCITT Recommendation *Accounting system in the international automatic telephone service*, Rec. D.390 R.

APPENDIX D

Recommendation E.164 [1)]

NUMBERING PLAN FOR THE ISDN ERA

1 Introduction

The rapid advances in telecommunications technology coupled with increased diversification of customer demands served by a number of different types of dedicated public switched networks (telephone, telex, data, etc.) have created a need to provide a uniform customer access and network structure. Such a structure is called the Integrated Services Digital Network (ISDN). Implementation of ISDNs have begun in a number of countries and eventually these will carry all existing and new services.

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1) This Recommendation appears in the Series I Recommendations as Recommendation I.331 (Fascicle III.5).

To facilitate ISDN evolution internationally and recognising that during the transition period there will be a need for access between the ISDNs and other dedicated public switched networks, this Recommendation defines the numbering arrangements for an ISDN and considers various methods of interworking.

2 Definitions

Within the integrated service environment, the terms used for all networks and services must be compatible and consistent. A provisional list of terms and their definitions that relate to this Recommendation are given in Annex A.

3 ISDN Numbering plan principles

3.1 *General*

The ISDN numbering and addressing principles are described in Recommendation I.330. The ISDN numbering plan will be based on and evolve from the existing numbering plans applicable to national and international public telephone networks.

In view of the evolutionary nature of ISDN, the international numbering plan should provide for substantial capacity to accommodate future network requirements.

Where multiple destination, i.e. RPOAs/networks, serve the called party's geographic area the national ISDN numbering arrangement in the country [2] of destination shall provide for discrimination between these RPOAs/networks. The procedure for discrimination between multiple transit-RPOAs/networks is not considered to be a destination address requirement and shall therefore be excluded from the ISDN numbering arrangements.

Before the ISDN numbering arrangement attains global penetration, it must allow for network interworking between the ISDN and other public networks. Interworking with private networks shall be taken into account. The definition of private networks and the methods of interworking are for further study and will be covered in Series E Recommendations. However, the broad interworking principles are contained in § 10 below.

The 10 digit decimal character set 0-9 is used throughout the ISDN numbering plan format including subscriber number, national (significant) number and the country code.

Prefixes and other information concerned with identifying selection procedures or network service parameters (such as quality of service or transit delay) do not form part of the ISDN number.

The ISDN numbering plan shall include an unambiguous identification of a particular country [2]. In addition, the ISDN number will identify networks and/or ISDNs within these countries [2], if required. In doing so, it shall retain the integrity of the telephone country code as defined in Recommendation E.160 and E.163.

3.2 *Structure of the international ISDN number*

The international ISDN number is composed of a variable length of decimal digits arranged in specific code fields. The international ISDN number code fields are the country code (CC) and the national (significant) number.

The country code (CC) is used to select the destination country [2] and varies in length as outlined in Recommendation E.163.

The national (significant) number N(S)N is used to select the destination subscriber. In selecting the destination subscriber, however, it may be necessary to select a destination network. To accomplish this selection, the national (significant) number N(S)N code field comprises a national destination code (NDC) followed by the subscribers number (SN).

The NDC code field will be variable in length depending on the requirements of the destination country [2]. It can be used to select a destination network serving the destination subscriber. It can also be used in a trunk code (TC) format as defined in Recommendation E.160, to route the call over the destination network in the called country [2]. The NDC code field can, where required, provide a combination of both the above functions.

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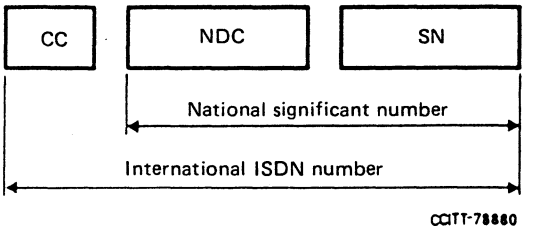
[2] Country or geographical area.

The subscribers number (SN) varies in length depending on the requirements of the destination country [2] and is in accordance with Recommendation E.160.

Figure 1/E.164 shows the number structure.

Where appropriate, identification of an ISDN within the destination country [2] shall be through the use of a national destination code (NDC) incoporated in the ISDN number.



CC Country code as defined by Recommendation E.163
NDC National destination code
SN Subscriber number

Note – National and international prefixes are excluded as they are not considered to be part of the international ISDN number.

FIGURE 1/E.164

Number structure

3.3 *Number length*

The international number may be of variable length. The maximum number length shall be 15 digits. However, some Administrations may wish to increase their register capacity to 16 or 17 digits. The decision on register capacity is left as a matter to be taken by individual Administrations.

The length does not include prefixes, language digit, address delimiters (e.g. end of pulsing signals, etc.) since these items are not considered as part of the international ISDN number.

3.4 *Number analysis*

In order to determine:

- the country [2] of destination,
- the most appropriate network routing,
- the proper charging,

the originating country [2] must analyse a number of digits of the international number. The national destination code (NDC) increases the potential requirement for number analysis because it provides for a combination of either a trunk code (TC) and/or a network identification function. Careful consideration should be given to the preparation of the national destination code (NDC) assignments.

On international calls the number analysis performed at the originating country [2] need not be more than the country code and:

- three digits of the NSN in the case of a country with a three digit country code,
- four digits of the NSN in the case of a country with a two digit country code,
- five digits of the NSN in the case of a country with a one digit country code.

(Translation beyond this requirement could be arranged by bilateral agreement if required.)

[2] Country or geographical area.

4 Number allocation principles

The assignment of country codes are administered by the CCITT, while NSN (NDC plus SN) code assignments are a national responsibility.

ISDN subscriber numbers may be allocated from the range of subscriber numbers available in the local ISDN exchange. These will be assigned to customers who subscribe only to the telephone service, customers with one or more data services and customers with a mixture of telephony and data services.

Subscribers equipped with basic access (the definition of ISDN basic access is given in the Series I Recommendations) should normally be allocated one unique number.

5 Network identification

In countries[2)] served by more than one ISDN and/or Public Switched Telephone Network (PSTN) the network identification of each is a national matter.

Network identification within the national (significant) number shall be such that:

- in a country[2)] all destination ISDN and PSTN networks shall operate under a single Recommendation E.163 country code,
- the international number maximum length of 15 digits shall not be exceeded, nor shall it be necessary for the number of digits for number analysis to exceed that specified in § 3.4,
- provision of network identification is not mandatory for countries using a single integrated numbering plan arrangement for their ISDNs and PSTNs.

6 Service identification

The ISDN number by itself will not identify the particular nature of the service, type of connection or quality of service required. An indication of parameters describing the service required by the calling terminal will be included in a service identifier in the signalling information. This service identifier is not considered to be part of the numbering plan.

7 Dialling procedures

The subscriber dialling procedures for local, national and international calls shall be in accordance with Recommendation E.163. However, subscriber's control procedures for supplementary services will be as defined in Recommendation E.131 or in separate Recommendations for each service.

ISDN subscribers will always be called by the same subscriber number irrespective of where in the network the call originates. For calls in the same numbering area or local network the subscriber number alone is dialled. For national calls between numbering areas or local networks the subscriber number may be preceded by the national prefix and the national destination code.

The addressing procedures for calls using sub-addressing and for interworking with dedicated networks are described in §§ 9 and 10 respectively.

8 Prefixes

The use of prefixes shall be in accordance with Recommendations E.160 and E.163. Where necessary prefixes can also be used for network and service selection.

9 Address information

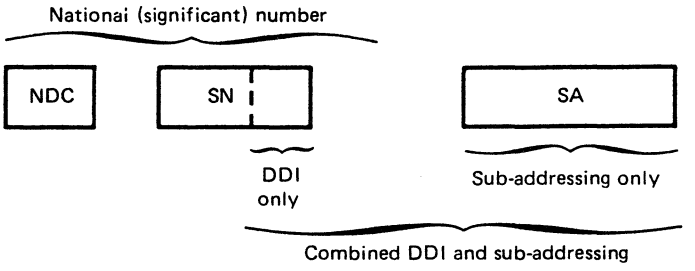
Identification within a subscriber's installation of a point beyond that defined by the ISDN number requires the transfer of address information from the public network to the subscriber's equipment. The following methods apply:

[2)] Country or geographical area.

9.1 *Direct dialling-in*

With direct-dialling-in (DDI) the last few digits forming the end of the ISDN subscriber number are transferred to the called subscriber's installation (see Figure 2/E.164). The number of digits used varies and depends upon the requirements of the called subscriber's equipment and the capacity of the numbering plan used.

ISDN subscriber numbers used for DDI may be those published in the public directory.



NDC National destination code
SN Subscriber number
SA Sub-address

FIGURE 2/E.164

9.2 *Sub-addressing (network address extension)*

Sub-addressing provides a separate additional addressing capacity outside the ISDN numbering plan but constitutes an intrinsic part of the ISDN addressing capabilities. As shown in Figure 2/E.164, one or more decimal digits up to a maximum of 32 (provisionally), may follow the ISDN number and form the ISDN sub-address, which is transferred to the equipment at the subscriber's premises.

When required, the sub-address is sent by the calling party within the call set-up procedure and is passed transparently through the network as a separate entity from both the ISDN number and user-to-user information. Sub-address information is not processed within the public network.

Sub-addressing procedures are the subject of a separate Recommendation.

9.3 *Combination of sub-addressing and direct dialling-in*

Sub-addressing may be used separately or in combination with DDI (see Figure 2/E.164).

9.4 *Address delimiters*

DDI address information may contain an "end of address" (e.g. ST) delimiter. In the case of sub-addressing an "end of subscriber number/beginning of sub-address" delimiter and the "end of address" delimiter are required.

(The use of an address delimiter at the end of an ISDN address is for further study.)

10 Interworking with dedicated networks, nationally and internationally

Interworking is for further study and will be contained in a Series E Recommendation on interworking. However, the broad principles for interworking are contained below.

The following interworking arrangements can be used to allow an ISDN subscriber to set up calls to subscribers or services terminated on other public dedicated networks. Single stage selection procedures should be employed wherever possible, however, two-stage selection can also be employed where necessary.

10.1 *Interworking by single-stage selection*

10.1.1 *Special prefix method*

Interworking by single-stage selection is achieved by an arrangement where the calling party accesses a network by dialling a special prefix followed by the necessary identification required for that particular network.

The special prefix may be:

a) one or more digits

b) a non-numerical address qualifier

10.1.2 *National destination code method*

Interworking with another network can be accomplished by utilizing NDCs specially assigned for interworking purposes. The number of digits of these interworking NDCs must be kept small in order not to exceed the maximum number of digits to be dialled in a single-stage selection procedure.

10.2 *Interworking by two-stage selection*

Two-stage interworking is achieved by an arrangement wherein the first stage of selection provides the calling party access via the ISDN to an interworking unit (IWU) associated with a point of presence of the required dedicated network. The calling party, to gain access to the desired IWU, uses a dialling procedure consisting of an assigned local, national or international number.

When a connection is established the IWU responds. The necessary address information for that particular public dedicated network is then forwarded, as a second stage of selection, through the ISDN and the IWU to complete the call in the dedicated network (see Figure 3/E.164).

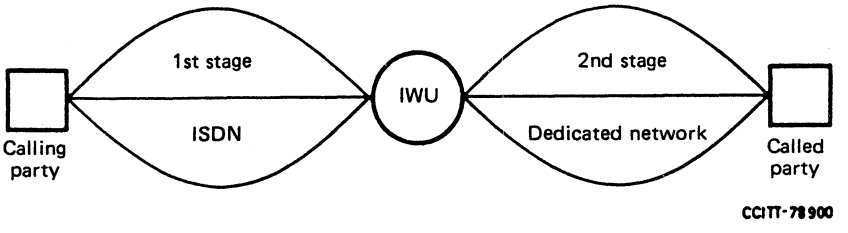


FIGURE 3/E.164

Two-stage selection method

10.3 *International interworking*

It is recognised that some countires[2)] may not be able to offer an interworking capability, therefore interworking will be permitted either in the country[2)] of origin or the country[2)] of destination. The choice will be by bilateral agreement. Because of administrative difficulties, interworking should *not* be performed across the international boundary, unless no other interworking possibility exists.

Both single-stage and two-stage selection procedures can be implemented to meet an Administration's requirements, however, preference should be given to single-stage selection. Interworking can therefore be performed as follows:

a) interworking in the country of origin:
   i) single-stage selection (both the NDC, and the special prefix method are applicable)
   ii) two-stage selection

b) interworking in the country of destination:
   i) single-stage selection (only the NDC method is applicable)
   ii) two-stage selection.

2) Country or geographical area.

ANNEX A

(to Recommendation E.164)

ISDN Numbering terms and definitions

General

The definitions set out in CCITT Recommendation E.160 for international prefix, country[2)] code, trunk prefix, trunk code, subscriber number, national (significant) number and international number apply. The following definitions are provisional and require further study:

A.1 **address (in network addressing)**

The information which is necessary to identify a point in the subscriber's installation (group of terminals, terminal or specific function of terminal equipment). The point unambiguously defines:

- a port where the information flow of the connection concerned passes in outgoing or incoming direction, or
- the point of origin or destination for that information flow, e.g. (N)-Service-Access-Point (Recommendation X.200)

A.2 **sub-address (network address extension)**

Part of an address, for example which identifies to the subscriber's terminal equipment a point in the subscriber's installation (group of terminals, terminal or specific function of terminal equipment). The sub-address is agreed by the calling and called party and transferred by the network. However, sub-address information is not processed by the public network.

A.3 **address delimiter**

A coded character which indicates different parts in an address, e.g. beginning of address, end of address, etc.

A.4 **addressing (network addressing)**

The provision of the address by allocation or indication of a number and possibly one or more non-numeric characters.

A.5 **two-stage selection**

An interworking method whereby an address in the originating ISDN network is used to access an Interworking Unit (IWU) which is a point of an exit (outlet) or an entry (inlet) to another network. A second stage of selection is then used to indicate the address in the destination network.

A.6 **single-stage selection (special prefix, or national destination code method)**

An interworking method where the information provided includes a code indicating that conventions for the codes it precedes are other than those defined for the ISDN numbering scheme.

A.7 **national destination code (NDC)**

A code field, which combined with the subscribers' number (SN), will constitute the national (significant) number of the international ISDN number. The NDC will have a network and/or trunk code selection function.

The NDC can be a decimal digit or a combination of decimal digits (not including any prefix) characterising a numbering area within a country (or group of countries included in one integrated numbering plan).

The NDC has to be inserted before the called subscriber's number when the calling and called parties are located in different number areas.

NDC assignments are a national responsibility and therefore the NDC structure varies from one country[2)] to another. It may take a trunk code format in accordance with Recommendation E.160, or serve for selection of a destination network.

The NDC can in some instances, provide a combination of both the above functions.

[2)] Country or geographical area.

APPENDIX E

Recommendation F.69

PLAN FOR TELEX DESTINATION CODES

The CCITT,

considering

(a) that for controlling the selection of international transit circuits, a group of digits, called a *telex destination code*, should be used to identify each country (or network) in a uniform manner;

(b) that the CCITT therefore has to set up a worldwide list of telex destination codes; for this purpose it has been necessary to decide whether such codes should always comprise three digits or whether they should be made up of one, two or three digits;

(c) that the advantages of uniform three-digit codes are:

i) by allocating the same size code to all countries difficulties would not arise as to the relative importance of the various countries with regard to the telex service;

ii) uniform codes afford some simplification of the design of registers – particularly transit registers;

iii) for the European system a uniform three-digit system could be readily compiled by adding a uniform digit to the range of two-digit codes already in use by a number of European Administrations;

(d) that the advantages of a mixed one, two or three-digit arrangement are:

i) the use of shorter length codes reduces the risk of errors by calling subscribers;

ii) the storage capacity of registers can be kept to a minimum by allocating shorter codes to systems having long subscribers' numbers;

iii) the holding time of circuits could be kept to a minimum;

iv) the maximum number of digits to be examined for routing and other purposes could be kept to a minimum by allocating shorter codes to systems in which the first two digits of a subscriber's number have to be examined in accordance with Recommendation U.7. Similarly, where a country has more than one international exchange the allocation of a shorter code would enable the routing of traffic to be controlled by the examination of a minimum number of digits;

(e) that mixed two-digit and three-digit destination codes have most advantages.

unanimously declares

(1) that telex destination codes shall comprise two or three digits.

Note – In examining the North American position, it was not possible to allocate a single-digit code that would have satisfied access to both the telex (RCA, ACR, WUI and WU domestic) networks and the TWX network in the United States. Therefore it was decided to allocate the first digits 2 and 3 to a series of two-digit and three-digit codes serving the whole of the American area;

(2) With regard to the allocation of the first digit:

0 – not to be used as first digit

1 – see §§ (9) and (10) below

2 – North America and adjacent areas

3 – South America and adjacent areas

4 – Europe and adjacent areas

5 – Europe and adjacent areas and maritime mobile-satellite services

6 USSR and adjacent areas

7 – Pacific and adjacent areas

8 – Middle East, Far East and adjacent areas

9 – Africa, Near East and adjacent areas.

Note 1 – The geographical boundaries of the continents have not been rigidly followed to permit maximum flexibility within the code system.

Note 2 – In relations using Type C signalling (Recommendation U.11) code 000 may be used for retest signalling purposes.

Note 3 – In case of the assignment of codes to a maritime mobile-satellite system, a 3 digit code should exceptionally be assigned to each ocean area of the satellite system.

(3) the number of two-digit codes available is rather restricted. It is undesirable to allocate these to serve individual networks in countries where several networks exist but do not have a coordinated internal numbering scheme;

(4) it is not advisable to allocate all possible two-digit codes, so as to maintain some flexibility to allow future development in world telex traffic to be taken into account;

(5) the list of telex destination codes, as established by the World Plan Committee (Paris, 1980) is given in Annex A. Annex A also shows the corresponding telex network identification codes, which are allocated in accordance with Recommendation F.68 (§ 2.2);

(6) the Member countries of the Union not mentioned in this list that wish to take part in the international automatic telex service should ask the Director of the CCITT for the assignment of an *available* three-digit destination code. In their request they may indicate the available three-digit code preferred. Where the numbering scheme for the appropriate region is exhausted, a code from another region may be allocated;

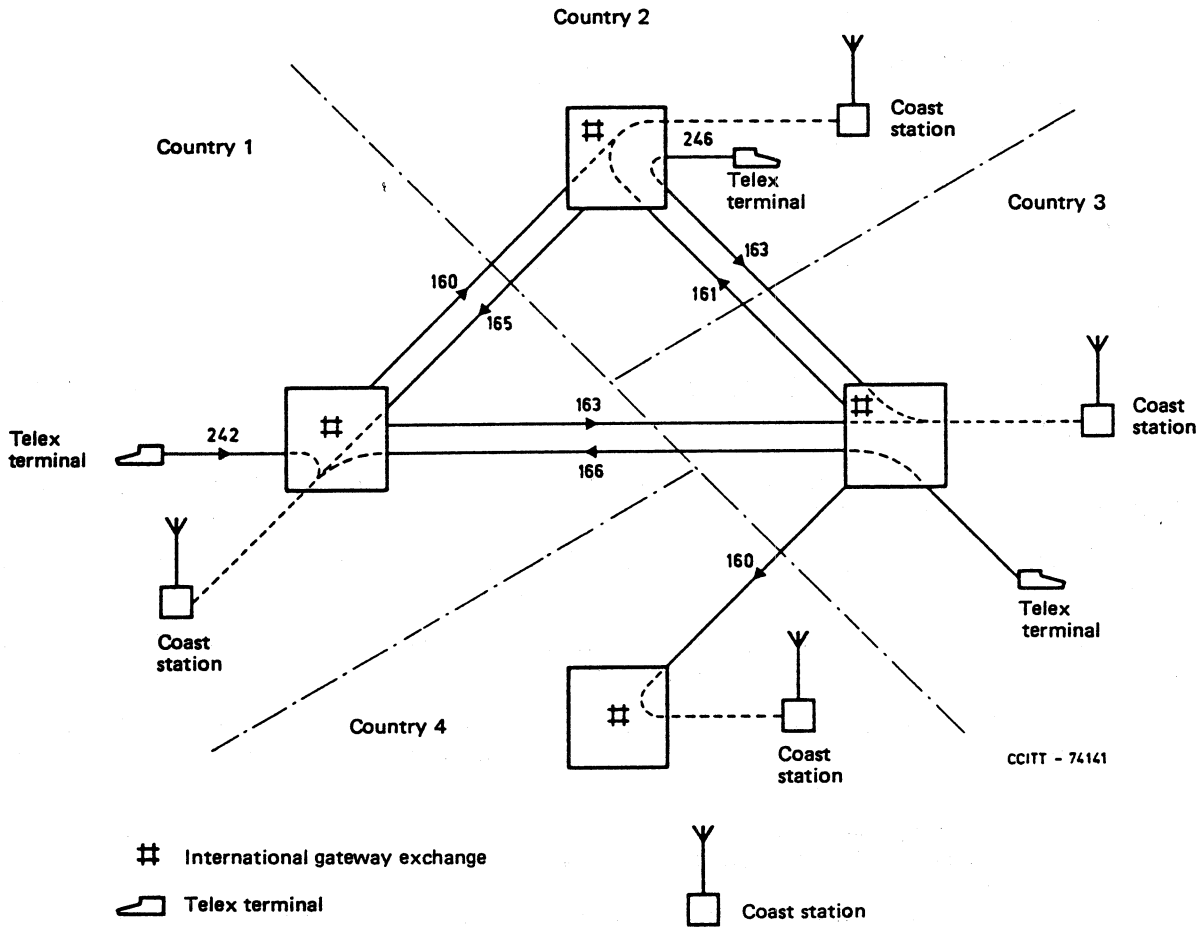
(7) if the requests submitted by Member countries of the Union involve a change in the telex destination codes already assigned to them, or if the Director of the CCITT finds difficulty in satisfying a request submitted in accordance with § (6), these requests will be referred to Study Group I for guidance on technical issues, any allocation of a specific code number being decided by the World Plan Committee;

(8) additions and changes that are accepted will be published in the ITU *Operational Bulletin.* They will become effective on the first day of the third month following publication;

(9) the first digit 1 was initially reserved for special services, which led to its uncoordinated use for a variety of national and international applications in different networks. In all future networks and as soon as practicable in existing networks, it should be possible to allocate the 1 series for destination codes for international purposes.

(10) a block of ten destination codes (160-169) has been set aside to cover the particular needs for access to maritime mobile HF and MF radiotelex services. The choice of code or codes for these applications is left to individual Administrations for use by their own subscribers and/or (after suitable bilateral arrangements have been reached) by subscribers of other Administrations for transit calls [e.g. via the former Administration's coast station(s)]. (See also the explanatory figure, Figure 1/F.69.)

Note – It is recognized that some Administrations use various codes in the 160-169 series at present for national and international applications.



Note 1 – Country 1 does not use F.69 codes in the 16x range to access its own coast station.

Note 2 – Country 1 uses F.69 codes 160 and 163 to access coast stations in countries 2 and 3 respectively (as agreed bilaterally).

Note 3 – Country 2 has agreed bilaterally to use F.69 codes 165 and 163 to access coast stations in countries 1 and 3 respectively.

Note 4 – Country 2 uses F.69 code 163 internally for test purposes and therefore subscribers select a code 246 and this is translated as the international link to 163.

Note 5 – Country 3 has agreed bilaterally to use F.69 codes 166 and 161 to access coast stations in countries 1 and 2 respectively.

Note 6 – Country 3 does not have code 166 available for subscriber use as this is used as a special operator code. However, code 160 is available and this is used by subscribers and is translated to 166 at the international exchange.

Note 7 – Country 3 has agreed bilaterally with Country 4 to use F.69 code 165 to access the coast station in Country 4. This is possible event though Countries 1 and 2 use the same code.

Note 8 – Subscribers in Country 4 do not access coast stations in other countries.

FIGURE 1/F.69

Example of use of F.69 codes in the 16x range (see § 10)

ANNEX A

(to Recommendation F.69)

List of telex destination codes and telex network identification codes

Note 1 – Codes with no entry have not yet been allocated.

Note 2 – (xx): This TNIC is not yet listed in the official TNIC List.

100-149		Temporarily reserved for special
151-159		administrative services
160		
161		
162		
163		
164	X	Maritime Mobile HF and MF Radiotelex
165		
166		
167		
168		
169		
170-179		Temporarily reserved for special administrative services
200	UA	Alaska (United States of America) (RCA)
201	DR	Dominican Republic (RCA)
202	DI	Dominican Republic (AACR)
203	HI	Haiti (Republic of)
204	QN	S. Pierre and Miquelon (French Department of)
205	PT	Puerto Rico (RCAC)
206	PD	Puerto Rico (AACR)
207	(PP)	Puerto Rico (WUI CARIB)
208	VN	United States Virgin Islands and S. Croix
209		Puerto Rico (PRCA)
21	CA	Canada (except TWX)
22	ME	Mexico
23		United States of America [b] (except TWX)
240	(PB)	Puerto Rico (TRT)
241		
242		
243		
244		
245		
246		
247		
248		
249		
25	UQ	United States of America (TWX)
26		Canada (TWX)
270		
271		
272		
273		
274		
275		
276		
277		
278		
279		
28	CU	Cuba
290	BA	Bermuda
291	JA	Jamaica
292	VB	British Virgin Islands
293	CP	Cayman Islands
294	WG	Trinidad and Tobago
295	GY	Guyana
296	TQ	Turks and Caicos Islands
297	BS	Bahamas (Commonwealth of the)
298	MR	Martinique (French Department of)
299	GL	Guadeloupe (French Department of)
300	FG	French Guiana (French Department of)
301		
302		
303		
304	SN	Suriname (Republic of)
305	PY	Paraguay (Republic of)
306	FK	Falkland Islands (Malvinas)
307 [1]		
308	ED	Ecuador
309	BV	Bolivia (Republic of) (ENTEL)
31	VC	Venezuela (Republic of)
32	UY	Uruguay (Eastern Republic of)
33	AR	Argentine Republic
34		Chile [a]
35	CO	Colombia (Republic of)
36	PE	Peru
37		Central America (integrated code):
371	BZ	Belize
372	GU	Guatemala (Republic of)
373	SR	El Salvador (Republic of)
374	HO	Honduras (Republic of)
375	NU	Nicaragua
376	CR	Costa Rica
377	PA	Panama (Republic of) (TRT)
378 [2]		
379	PG	Panama (Republic of) (INTEL)
38	BR	Brazil (Federative Republic of)
390	NA	Netherlands Antilles
391	LA	Anguilla
392	WB	Barbados
393	AK	Antigua and Barbuda
394	DO	Dominica (Commonwealth of)
395	GA	Grenada
396	MK	Montserrat
397	KC	Saint Christopher and Nevis
398	LC	Saint Lucia
399	VQ	Saint Vincent and the Grenadines
400		
401		
402	LU	Luxembourg
403	MT	Malta (Republic of) (GTC)
404	P	Portugal
405	GK	Gibraltar
406	MW	Malta (Republic of) (TELEMALTA)
407	M	Morocco (Kingdom of)

[1] Previously allocated to the Republic of Bolivia.

[2] Previously allocated to the Republic of Panama.

408	DZ	Algeria (People's Democratic Republic of)
409	TN	Tunisia
41	D	Germany (Federal Republic of)
42	F	France [c]
42	MC	Monaco [c]
43	I	Italy
44	NL	Netherlands (Kingdom of the)
45	CH	Switzerland (Confederation of) [c]
45	FL	Liechtenstein (Principality of) [c]
46	B	Belgium
47	A	Austria
480		
481		
482		
483		
484		
485		
486		
487		
488		
489		
490	BN	Bahrain (State of)
491	IK	Iraq (Republic of)
492	SY	Syrian Arab Republic
493	JO	Jordan (Hashemite Kingdom of)
494	LE	Lebanon
495	SJ	Saudi Arabia (Kingdom of)
496	KT	Kuwait (State of)
497	DH	Qatar (State of)
498	ON	Oman (Sultanate of)
499		
500	EI	Ireland
501	IS	Iceland
502	FA	Faroe Islands (Denmark)
503	GD	Greenland (Denmark)
504	VA	Vatican City State
505	SO	San Marino (Republic of)
506		
507		
508		
509		
51	G	United Kingdom of Great Britain and Northern Ireland
52	E	Spain
530		
531		
532		
533		
534		
535		
536		
537		
538		
539		
54	S	Sweden
55	DK	Denmark
56	N	Norway
57	SF	Finland
580	X	Maritime Mobile-Satellite Service (available)
581	X	INMARSAT Atlantic
582	X	INMARSAT Pacific
583	X	INMARSAT Indian Ocean
584		
585		
586	X	Maritime Mobile-Satellite Service (available)
587		
588		
589		
590		
591		
592		
593		
594		
595		
596		
597		
598		
599		
600		
601	GR	Greece
602		
603		
604	AB	Albania (Socialist People's Republic of)
605	CY	Cyprus (Republic of)
606	IL	Israel (State of)
607	TR	Turkey
608		
609		
61	H	Hungarian People's Republic
62	YU	Yugoslavia (Socialist Federal Republic of)
63	PL	Poland (People's Republic of)
64	SU	Union of Soviet Socialist Republics
65	R	Romania (Socialist Republic of)
66	C	Czechoslovak Socialist Republic
67	BG	Bulgaria (People's Republic of)
680		
681		
682		
683		
684		
685		
686		
687		
688		
689		
69	DD	German Democratic Republic
700	GM	Guam (United States of America) (RCA)
701	FJ	Fiji
702	FP	French Polynesia
703	NE	Papua New Guinea
704	HR	Hawaii (United States of America) (RCA)
705	HM	Hawaii (United States of America) (AACR)
706	NM	New Caledonia and Dependencies
707	WF	Wallis and Futuna Islands
708	HW	Hawaii (United States of America) (WUI)
709		Hawaii (United States of America) (WUH)
71	AA	Australia
72	J	Japan
73	IA	Indonesia (Republic of)
74	NZ	New Zealand
75		Philippines (Republic of the) [d]
760	MN	Mariana Islands
761	KI	Kiribati (Republic of)
762	(TL)	Tokelau Islands
763		Palau
764		F.S. of Micronesia
765	MS	Marshall Islands
766		Australian External Territories [g]
767		
768		
769		
770	SB	American Samoa
771	NH	Vanuatu (Republic of)
772	RG	Cook Islands
773		Hawaii (United States of America) (DATATEL)
774	TV	Tuvalu
775	ZV	Nauru (Republic of)
776	NF	Niue Island
777	TS	Tonga (Kingdom of)
778	HQ	Solomon Islands

779	SX	Western Samoa (Independent State of)
780	BJ	Bangladesh (People's Republic of) [e]
781		
782		
783		
784		
785		
786		
787		
788		
789		
79	AF	Afghanistan (Democratic Republic of)
800	MH	Mongolian People's Republic
801	K	Korea (Republic of)
802	HX	Hongkong
803	CE	Sri Lanka (Democratic Socialist Republic of)
804	LS	Lao People's Democratic Republic
805	VT	Viet Nam (Socialist Republic of)
806	AD	Yemen (People's Democratic Republic of)
807	KA	Democratic Kampuchea
808	OM	Macao
809	BU	Brunei Darussalam
81	IN	India (Republic of)
82	PK	Pakistan (Islamic Republic of)
83	BM	Burma (Socialist Republic of the Union of)
84	MA	Malaysia
85	CN	China (People's Republic of) [f]
86	TH	Thailand
87	RS	Singapore (Republic of)
88	IR	Iran (Islamic Republic of)
890		
891	NP	Nepal
892		
893	EM	United Arab Emirates (EMIRTEL)
894		
895	YE	Yemen Arab Republic
896	MF	Maldives (Republic of)
897		
898		
899	KP	Democratic People's Republic of Korea
900	SM	Somali Democratic Republic
901	LY	Libya (Socialist People's Libyan Arab Jamahiriya)
902	ZA	Zambia (Republic of)
903	UU	Burundi (Republic of)
904	MI	Malawi
905	NG	Nigeria (Federal Republic of)
906	SG	Senegal (Republic of)
907	ZW	Zimbabwe (Republic of)
908	WK	Namibia
909	RW	Rwandese Republic
91	UN	Egypt (Arab Republic of)
920		
921		
922		
923		
924		
925		
926		
927		
928		
929		
930		
931		
932		
933		
934		
935		
936		
937		
938	DG	Diego Garcia Island
939	AV	Ascension
94	GH	Ghana
95	SA	South Africa (Republic of) [k]
960	HL	Saint Helena
961	RE	Reunion (French Department of)
962	BD	Botswana (Republic of)
963	LO	Lesotho (Kingdom of)
964	WD	Swaziland (Kingdom of)
965	SZ	Seychelles (Republic of)
966	IW	Mauritius
967	ST	Sao Tome and Principe (Democratic Republic of)
968		
969	BI	Guinea Bissau (Republic of)
970	KN	Cameroon (Republic of)
971	RC	Central African Republic
972	BC	Benin (People's Republic of)
973	GO	Gabonese Republic
974	MQ	Mauritania (Islamic Republic of)
975	NI	Niger (Republic of the)
976	KD	Chad (Republic of)
977	TO	Togolese Republic
978	UV	Burkina Faso
979	DJ	Djibouti (Republic of)
980	ET	Ethiopia
981	KG	Congo (People's Republic of the)
982	ZR	Zaire (Republic of)
983	CI	Ivory Coast (Republic of the)
984	SD	Sudan (Democratic Republic of the)
985	MJ	Mali (Republic of)
986	MG	Madagascar (Democratic Republic of)
987	KE	Kenya (Republic of)
988	UG	Uganda (Republic of)
989	TA	Tanzania (United Republic of) (mainland)
990	TA	Zanzibar (Tanzania)
991	AN	Angola (People's Republic of)
992	MO	Mozambique (People's Republic of)
993	CV	Cape Verde (Republic of)
994	KO	Comoros (Islamic Federal Republic of the)
995	GE	Guinea (Republic of)
996	GV	Gambia (Republic of the)
997	LI	Liberia (Republic of)
998	SE	Sierra Leone
999	EG	Equatorial Guinea (Republic of)

[a] Within this national code and following a decision by the Chilean Telecommunication Administration, the following codes have been allocated to identify the different telex networks in Chile:

Télex Chile (Comunicaciones Telegráficas S.A.)	342	CL
TC (Transradio Chilena)	343	CK
ITTCHL (ITT Comunicaciones Mundiales S.A. Chile)	344	CZ
ENTEL (Empresa Nacional de Telecomunicaciones S.A.)	345	CB
TEXCOM (Telecomunicaciones Internacionales)	346	CT

b) Within this national code and following a decision by the Administration of the United States of America, the following codes have been allocated to identify the different carriers of the United States:

230	UD	Western Union Telegraph Company
231	UT	TRT Telecommunications Corporation
232	UR	RCA Global Communications
233	UB	Graphnet Corporation
234	UI	ITT World Communications
235		ITT World Communications (DTS)
236	UW	Western Union International
237		Consortium Communications International, Inc.
238	(UF)	FTCC Telecommunications
239		Not assigned

c) Integrated numbering plan.

d) Within this national code and following a decision by the Philippines Board of Communications, the following codes have been allocated to identify the different telex networks in the Philippines:

Capitol Wireless, Inc. (CAPWIRE)	751	PS
Philippine Global Communications, Inc. (PHILCOM)	752	PH
Globe-Mackay Cable and Radio Corp. (ITT)	754	PM
Eastern Telecommunications Philippines, Inc. (ETPI)	756	PN
Philippine Telegraph and Telephone Corp. (PTT)	758	PU

The following codes are not allocated: 753, 755, 757 and 759

e) The remaining combinations in the series 78 will not be allocated until the stock of spare 3-digit codes for the region is exhausted.

f) Within this national code, the Telecommunications Administration of the People's Republic of China has notified that the code 855 has been allocated to the province of Taiwan.
(Reference: Notification No. 1157 of 10 December 1980.)

g) The Australian Administration has also informed that as part of code 766 the telex code for Norfolk Island is 766 3. (NV)

h) As requested by South Africa, the telex network identification codes (TNIC) have been allocated to the following geographical areas:

BP Bophuthatswana CX Ciskei TT Transkei VM Venda.

Abbreviations

AACR	All America Cables and Radio, Inc.
EMIRTEL	The Emirates Telecommunication Corporation Ltd.
ENTEL	Empresa Nacional de Telecomunicaciones
GTC	Government Telecommunications Centre (Malta)
INTEL	Instituto Nacional de Telecomunicaciones
RCA	RCA Global Communications, Inc.
RCAC	Radio Corporation of America Communications, Inc.
TELEMALTA	Telemalta Corporation
TRT	TRT Telecommunications Corporation
TWX	TWX Network
WCA	West Coast of America Telegraph Co. Ltd.
WUH	Western Union of Hawaii, Inc.
WUI	Western Union International, Inc.
WUI CARIB	Western Union International Caribbean, Inc.
WUI	Western Union International, Inc.

APPENDIX F

Recommendation X.121

INTERNATIONAL NUMBERING PLAN FOR PUBLIC DATA NETWORKS

(provisional, Geneva, 1978; amended, Geneva, 1980; Malaga-Torremolinos, 1984)

The CCITT,

considering

(a) that the purpose of an International Numbering Plan for Public Data Networks is to facilitate the introduction of public data networks and provide for their inter-working on a worldwide basis;

(b) that there could be a number of public data networks in a country 1);

(c) that the International Numbering Plan should permit the identification of a country 1) as well as a specific public data network in that country 1);

(d) that the International Numbering Plan should provide for substantial spare capacity to accommodate future requirements,

unanimously declares the view

the International Numbering Plan for Public Data Networks should be as defined in this Recommendation.

1 Design considerations

The design considerations that form the basis of this Plan are as follows:

1.1 The international data number is to determine only the specific DTE/DCE interface and, in particular, to identify a country 1), and a network, if several data networks exist in the same country 1).

1.2 Where a number of public data networks are to be established in a country 1), it should not be mandatory to integrate the numbering plans of the various networks.

1.3 The number of digits comprising the code used to identify a country 1) and a specific public data network in that country 1) should be the same for all countries 1).

1.4 A national data number assigned to a DTE/DCE interface should be unique within a particular national network. This national data number should form part of the international data number which should also be unique on a worldwide basis.

---

1) Country or geographical area.

1.5 The number of digits to be used in an international data number should be governed by national and international requirements but a reasonable limit on the overall number of digits should be imposed.

1.6 The Numbering Plan should make provision for the interworking of data terminals on public data networks with data terminals on public telephone and telex networks.

Note - The term "telex" employed in this Recommendation, includes TWX networks.

1.7 The Numbering Plan should not preclude the possibility of a single national network providing an integrated telecommunications system for services of all kinds.

1.8 Where multiple RPOA facilities exist providing service to or within the same country [1], provision for the selection of a specific RPOA facility should be allowed for in the facility request part of the selection signals.

Note - The term RPOA in this Recommendation refers to Recognized Private Operating Agency.

2 Characteristics and application of the Numbering Plan

2.1 Number system

2.1.1 The 10-digit numeric character set 0-9 should be used for numbers (or addresses) assigned to DTE/DCE interfaces on public data networks. This principle should apply to both national and international data numbers.

2.1.2 Use of the above number system will make it possible for data terminals on public data networks to interwork with data terminals on public telephone and telex networks.

2.2 Data network identification codes

2.2.1 A Data Network Identification Code (DNIC) could be assigned as follows:

2.2.1.2 To non-zoned service, such as the Maritime Mobile Service (see § 2.2.10);

2.2.1.3 To a Public Switched Telephone Network (PSTN) for the purpose of making calls from DTEs connected to a PDN to DTEs connected to that PSTN;

2.2.1.4 To a group of PDNs within a country, when permitted by national regulations;

(3576)

2.2.1.5 To a group of private data networks connected to PDNs within a country, where permitted by national regulations.

Note - For administrative purposes, including charging, a group of networks which have been assigned a single DNIC, will, in the international context, be considered as a single entity.

2.2.2 In the system of data network identification codes, the first digit of such codes should be in accordance with Table 1/X.121.

TABLE 1/X.121

First digit of data network identification code

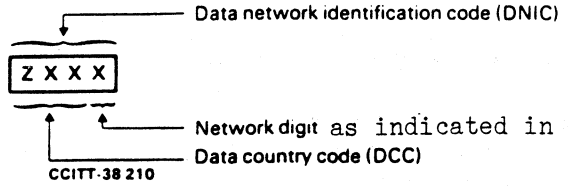
0	Reserved
1	Reserved (see also paragraph 2.2.10)
2	For data network identification codes (DNIC)
3	
4	
5	
6	
7	
8	May be used for interworking with telex networks
9	May be used for interworking with telephone networks

Note 1 - The allocation of codes for non-zoned services, other than the marine satellite services, is for further study.

Note 2 - The allocation of the two-digit codes 18 and 19 for OSI use is for further study in collaboration with ISO.

2.2.3 All data network identification codes (DNIC) should consist of four digits. The first three digits should always identify a country 1) and could be regarded as a Data Country 1) Code (DCC). The fourth, or network digit, should identify a specific data network in the country 1).

2.2.4 Each country 1) should be assigned at least one 3-digit data country 1) code (DCC). The data country 1) code (DCC) in conjunction with the fourth digit can identify up to 10 public data networks. The format for data network identification codes (DNIC) should be as indicated in Figure 1/X.121.



X denotes any digit from 0 through 9

Z denotes any digit from 2 through 7 as indicated in § 2.2.2

FIGURE 1/X.121

Format for data network identification codes (DNIC)

2.2.5 The system of data network identification codes (DNIC) indicated in §§ 2.2.2 and 2.2.4 above will provide for 600 data country 1) codes (DCC) and a theoretical maximum of 6000 DNIC.

2.2.6 Should a country 1) have more than 10 public data networks, an additional data country 1) codes(s) (DCC) would be assigned to it.

2.2.7 A list of data country 1) codes (DCC) to be used in the development of data network identification codes (DNIC) is given in Annex D to this Recommendation. This list was prepared in accordance with the requirement that the first digit of a DNIC, which is also the first digit of the embedded data country 1) code (DCC), should be restricted to the digits 2-7 inclusive (see § 2.2.2 above). As first digits of data country 1) codes (DCC), the digits 2-7 are arranged to represent world zones.

2.2.8 The assignment of data country 1) codes (DCC) is to be administered by the CCITT. The assignment of network digits will be made nationally and the CCITT Secretariat notified.

The Member countries of the International Telecommunication Union not mentioned in this list who wish to take part in the international data service or those Members who require an additional data country 1) code(s) (DCC) should ask the Director of the CCITT for the assignment of an available 3-digit data country 1) code(s) (DCC). In their request, they may indicate the available 3-digit code(s) preferred.

Assignments by the Director of the CCITT of data country 1) codes (DCC) as well as assignments by countries 1) of the network digits will be published in the Operational Bulletin of the International Telecommunication Union.

2.2.9 Examples indicating how data network identification codes (DNIC) could be developed, are given in Annex A to this Recommendation.

2.2.10 International data number for stations in the maritime mobile service

The DNIC allocated to the maritime mobile service is 111S where the digit S indicates ocean area and/or maritime system. The digit S has the values as shown in Annex C.

The ship station is identified by a unique 9-digit ship station identity common for telephony, telex, data transmission and other services as defined in Recommendation E.210/F.120.

The complete international data number for ships is composed as follows:

111S + ship station identity (Recommendation E.210/F.120) + X, where X is an optional digit which, if present, designates a particular DTE on board the ship.

Note 1 - A subscriber directly connected to a PDN should always use the complete ship station identity. In Recommendation E.210/F.120 it is recognized that a ship station number, shorter than the ship station identity, may at present have to be used to convey the address information through some networks other than PDNs (e.g. telephone and telex networks), due to equipment constraints. When concatenation of such networks and PDN(s) occurs, the question of where translation of ship station number to ship station identity, or vice versa, must be done is for further study.

Note 2 - In the maritime mobile satellite service, the use of the S digit for indicating the ocean area in which the ship station is located at the time of the call is considered a temporary arrangement. It is recognized that such an arrangement should be avoided in the future if possible since it requires the calling user to know the exact ocean area of a destination ship station at the time of the call, and since such an area may change from time to time for that ship station.

2.3 International data number

2.3.1 A data terminal on a public data network when called from another country 1) should be addressed by the international data number assigned to its DTE/DCE interface. The international data number should consist of the data network identification code (DNIC) of the called public data network, followed by the network terminal number (NTN) of the called DTE/DCE interface, or, for example, where an integrated numbering scheme exists within a country 1), the data country 1) code (DCC) followed by the National Number (NN) of the called DTE/DCE interface, i.e.:

International data number = DNIC + NTN, or, DCC + NN

2.3.2 The Network Terminal Number (NTN) should consist of the full address that is used when calling the data terminal from within its serving public data network. The national number (NN) should consist of the full address used when calling the data terminal from another terminal within the national integrated numbering scheme. These numbers should consist of all the digits necessary to uniquely identify the corresponding DTE/DCE interface within the serving network and should not include any prefix (or access code) that might be employed for such calling.

Note 1 - Network Terminal Numbers (NTN) or National Numbers (NN) may be assigned by a PDN to DTEs connected to other public networks, when interworking capabilities are provided with that PDN.

Note 2 - An example of the development of NTNs where a DNIC is assigned to a group of public or private data networks connected to PDNs within a country, is shown in Annex B.

2.4 Number of digits

2.4.1 International data numbers could be of different lengths but should consist of at least 5 digits but not more than 14 digits.

With the data network identification code (DNIC) fixed at 4 digits and the data country 1) code (DCC) fixed at 3 digits, it would, therefore, be possible to have a network terminal number (NTN) of 10 digits maximum, or, a national number (NN) of 11 digits maximum.

Note - The limit of 14 digits specified above applies exclusively to the international data number information. Adequate register capacity should be made available at data switching exchanges to accommodate the above digits as well as any additional digits that might be introduced for signalling, or other purposes.

2.5 International prefix

2.5.1 To distinguish between different address formats within a public data network (e.g. national data number and international data number formats), a prefix would generally be required. Any such prefix does not form a part of the data number. Pending further study, the use and composition of such a prefix is a national matter. However, the possible need to accommodate such a prefix with regard to digit register capacity should be noted.

Note - In the case of Recommendation X.25 access, the prefix can only be one digit.

2.6 Number analysis - international calls between public data networks

2.6.1 In the case of international calls between public data networks, provision should be made in originating countries 1) to interpret the first three digits of the international data number. These digits constitute the data country 1) code (DCC) component of the data network identification code (DNIC) and identify the terminal country 1). This information is required in the originating country 1) for routing purposes.

2.6.2 In originating countries 1), it might also be necessary to interpret the fourth, or network, digit of a DNIC. Such interpretation would provide the identity of a specific network in a country 1) where several public data networks are in service. This information might be required for billing purposes or for the selection of specific routes to called networks.

Note - With regard to RPOA selection, see § 1.8 above.

2.6.3 Countries [1] receiving international calls for public data networks should receive the complete international data number. However, where a country [1] of destination indicates that it does not wish to receive the data country [1] code (DCC) component of the DNIC, arrangements should be made to suppress the DCC.

2.6.4 For destination countries [1] with more than ten public data networks, interpretation of the first three digits of the DNIC [i.e., the data country [1] code (DCC)] would identify the group of networks within which the called network is included. Interpretation of the fourth, or network, digit of the DNIC would identify the called network in that group. Interpretation of the first three digits would also make it possible to verify that an incoming call has in fact reached the correct country [1].

2.6.5 In the case of destination countries [1] where there are fewer than ten public data networks, the first three digits of the DNIC could provide the verification indicated in § 2.6.4 above. Interpretation of the fourth, or network, digit of the DNIC would identify the specific network being called.

2.6.6 In transit countries [1] the complete international data number must be received. Interpretation of the first three digits would identify the called country [1]. Interpretation of the fourth or network digit would identify a specific data network in the called country [1]. Interpretation of the fourth digit might be required for billing purposes or for route selection beyond the transit country [1].

2.6.7 Where a data call is to be routed beyond a transit country [1] through a second transit country [1], the complete international data number should always be sent to the second transit country [1]. Where the data call is to be routed by a transit country [1] to the country [1] of destination, the arrangements indicated in § 2.6.3 above should apply.

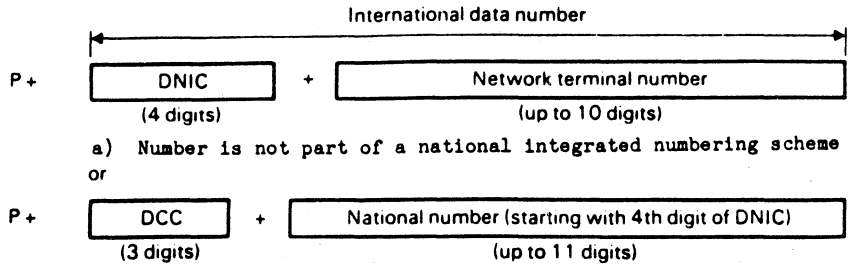
2.7 Directories and letterheads

2.7.1 Directories for public data networks should include information on the procedures to be followed for making international data calls. A diagram, such as that of Figure 2/X.121, could assist the customer in these procedures.

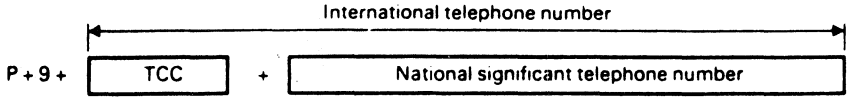
2.7.2 With regard to the prefix (or access code) shown in Figure 2/X.121, it should be noted that the same prefix (designated P) could be used for all three types of calls. The choice of prefix is, however, a national matter.

2.7.3 With regard to RPOA selection (see § 1.8 above), it should be noted that an RPOA facility request designator would be used either in international data calls or within certain countries. Provision of this facility as well as the designation of the RPOA facility selection designator is a national matter in the originating country [1].

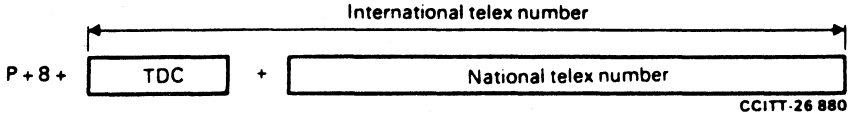
2.7.4 With regard to the publication of international data numbers on letterheads or other written material, it is recommended that the network terminal number (NTN) or national number (NN) should be easily distinguished within the international number, i.e. that there be a space between the 4-digit DNIC and the network terminal number (NTN) or, between the 3-digit data country [1] code (DCC) and the national number (NN), where the fourth digit of the DNIC is included in the national number (NN).



A. International identification of DTE/DCE interface on public data networks



B. An example of the international identification of a DTE/DCE interface on the public telephone network when accessed to or from a public data network (see Note)



C. An example of the international identification of a DTE/DCE interface on the public telex network when accessed to or from a public data network (see Note)

P international prefix
DNIC data network identification code
DCC data country code
TCC telephone country code
TDC telex destination code

Note – This illustrates the case where the data terminal on the public telephone or telex network is identified by the telephone or telex number. Other cases are possible. The various interworking scenarios will be described in a separate Recommendation.

FIGURE 2/X.121

International format

(3576)

ANNEX A

(to Recommendation X.121)

Development of Data Network Identification Codes (DNIC)

Example 1

In this example, it is assumed for illustrative purposes only, that the Netherlands has established its first public data network. To develop the data network identification code (DNIC) for this network, it would be necessary for the Netherlands to assign to it a network digit to follow the listed data country 1) code (DCC) 204 (see Annex D). Assuming that the Netherlands selected the digit 0 as the network digit, the data network identification code (DNIC) for this initial network would be 2040.

Example 2

In this example, it is assumed for illustrative purposes only, that five public data networks have been established in Canada. To develop the data network identification codes for these networks, it would be necessary for Canada to assign to each of these networks a network digit to follow the listed data country 1) code (DCC) 302 (See Annex D). Assuming that Canada assigned the network digits 0-4 to the five networks, the resulting data network identification codes (DNIC) would be 3020, 3021, 3022, 3023 and 3024.

Example 3

In this example, it is assumed for illustrative purposes only, that eight public data networks have been established in the United States of America. It is also assumed that network digits 0-7 would be assigned by the United States of America to follow the listed data country 1) code (DCC) 310 (see Annex D). The data network identification codes (DNIC) thus formed for these eight networks would be 3100, 3101, 3102, 3103, 3104, 3105, 3106 and 3107.

If, some time later, four additional public data networks were to be introduced in the United States of America, two of the four new networks could be assigned network digits 8 and 9 in association with data country 1) code (DCC) 310, to produce the data network identification codes (DNIC) 3108 and 3109.

For the remaining two public data networks, the United States of America would have to ask the CCITT for an additional data country 1) code (DCC). A request for a code next in sequence, i.e. 311, could be made if this code appeared to be spare. If code 311 could be made available it would be assigned to the United States of America. If it was not available, a spare code in the "300" series of data country 1) codes (DCC) would be assigned. Assuming data country 1) code (DCC) 311 was available and issued to the United States of America, the two remaining public data networks could be assigned network digits 0 and 1 in association with data country 1) code (DCC) 311, to produce the data network identification codes (DNIC) 3110 and 3111.

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1) Country or geographical area.

The data network identification codes (DNIC) for the 12 public data networks would then be 3100, 3101, 3102, 3103, 3104, 3105, 3106, 3107, 3108, 3109, 3110 and 3111.

Example 4

In this example, it is assumed for illustrative purposes only, that a public data network is to be established in each of two Caribbean islands that are part of the group of islands known as the French Antilles. The islands concerned are Guadeloupe and Martinique.

To develop the data network identification codes (DNIC) for these public data networks, it is assumed that the French Administration would assign network digit 0 to the network in Guadeloupe and network digit 1 to the network in Martinique and associate these network digits with the listed data country 1) code (DCC) 340 for the French Antilles (see Annex D). The data network identification codes (DNIC) thus formed would be 3400 for Guadeloupe and 3401 for Martinique.

This example indicates that the system of data network identification codes (DNIC) is appropriate for application to groups of islands or regions of a country 1) since one data country 1) code (DCC) could provide for up to ten public data networks dispersed over several islands or regions. At the same time such island or regional networks would be distinguishable from each other.

ANNEX B

(to Recommendation X.121)

Development of NTNs where a DNIC is assigned to a group of public data networks or to a group of private data networks connected to public data networks within a country

The following is an example, for illustrative purposes only, of a suggested technique for allocating within a country data numbers for DTE/DCE interfaces on private data networks which are in turn connected to public data networks where permitted by national regulations.

Note - In the context of this Annex, a PNIC may also be used to identify a specific public data network in a group of public data networks that share a common DNIC.

B.1 A private data network identification code (PNIC) is assigned to each private data network contained within a group of private data networks identified by a specific DNIC. The private data network identification code (PNIC)-digits are the first digits of the NTN.

B.2 All private data network identification codes (PNIC) consist of six digits. The format for the private data network identification codes (PNIC) is as follows:

ZXXXXX Private data network identification code (PNIC).

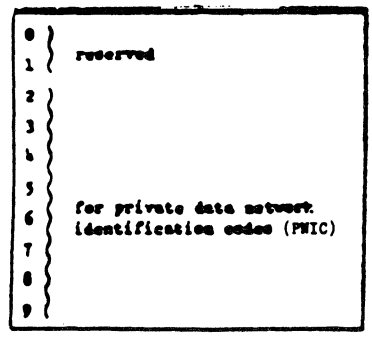
Z denotes any digit from 2 through 9 as indicated in § B.3.

X denotes any digit 0 through 9.

B.3 In the system of private data network identification codes (PNIC), the first digit of such codes is in accordance with the following table:

TABLE B-1/X.121

First digit of private data network identification code



(3576)

B.4 If a country has more private data networks than can be grouped under one DNIC or, if the public data networks within a country are not all interconnected, another DNIC may be allocated for each new group of private data networks.

B.5 If a private data network requires more numbers for DTE/DCE interfaces than can be grouped under one PNIC, multiple PNICs may be allocated to a single private data network.

B.6 The assignment of private data network identification codes (PNIC) is administered nationally.

ANNEX C

(to Recommendation X.121)

List of DNICs for non-zoned systems

Maritime mobile services

Code	Area	System
1110	Spare	
1111	Atlantic Ocean	Maritime satellite packet switched data transmission system
1112	Pacific Ocean	Maritime satellite packet switched data transmission system
1113	Indian Ocean	Maritime satellite packet switched data transmission system
1114	Spare	
1115	Spare	
1116	Spare	
1117	Spare	
1118	Spare	
1119	Spare	

ANNEX D

(to Recommendation X.121)

List of data country or geographical area codes

Note - The countries or geographical areas shown in this Annex include those that already have code assignments in the case of other public telecommunication networks.

Zone 2

Code	Country or Geographical Area
202	Greece
204	Netherlands (Kingdom of the)
206	Belgium
208	France
212	Monaco
214	Spain
216	Hungarian People's Republic
218	German Democratic Republic
220	Yugoslavia (Socialist Federal Republic of)
222	Italy
226	Romania (Socialist Republic of)
228	Switzerland (Confederation of)
230	Czechoslovak Socialist Republic
232	Austria
234	United Kingdom of Great Britain and Northern Ireland
238	Denmark
240	Sweden
242	Norway
244	Finland
250	Union of Soviet Socialist Republics
260	Poland (People's Republic of)
262	Germany (Federal Republic of)
266	Gibraltar
268	Portugal
270	Luxembourg
272	Ireland
274	Iceland
276	Albania (Socialist People's Republic of)
278	Malta (Republic of)
280	Cyprus (Republic of)
284	Bulgaria (People's Republic of)
286	Turkey

Zone 2, Spare Codes: 68

Zone 3

Code	Country or Geographical Area
302	Canada
308	St. Pierre and Miquelon
310	United States of America
311	United States of America
312	United States of America
313	United States of America
314	United States of America
315	United States of America
316	United States of America
330	Puerto Rico
332	Virgin Islands (USA)
334	Mexico
338	Jamaica
340	French Antilles
342	Barbados
344	Antigua
346	Cayman Islands
348	British Virgin Islands
350	Bermuda
352	Grenada
354	Montserrat
356	St. Kitts
358	St. Lucia
360	St. Vincent
362	Netherlands Antilles
364	Bahamas (Commonwealth of the)
366	Dominica
368	Cuba
370	Dominican Republic
372	Haiti (Republic of)
374	Trinidad and Tobago
376	Turks and Calcos Islands

Zone 3, Spare Codes: 68

Zone 4

Code	Country or Geographical Area
404	India (Republic of)
410	Pakistan (Islamic Republic of)
412	Afghanistan (Democratic Republic of)
413	Sri Lanka (Democratic Socialist Republic of)
414	Burma (Socialist Republic of the Union of)
415	Lebanon
416	Jordan (Hashemite Kingdom of)
417	Syrian Arab Republic

Zone 4 (cont'd)

Code	Country or Geographical Area
418	Iraq (Republic of)
419	Kuwait (State of)
420	Saudi Arabia (Kingdom of)
421	Yemen (Arab Republic)
422	Oman (Sultanate of)
423	Yemen (People's Democratic Republic of)
424	United Arab Emirates
425	Israel (State of)
426	Bahrain (State of)
427	Qatar (State of)
428	Mongolian People's Republic
429	Nepal
430	United Arab Emirates (Abu Dhabi)
431	United Arab Emirates (Dubai)
432	Iran (Islamic Republic of)
440	Japan
450	Korea (Republic of)
452	Viet Nam (Socialist Republic of)
454	Hong Kong
455	Macao
456	Democratic Kampuchea
457	Lao People's Democratic Republic
460	China (People's Republic of)
470	Bangladesh (People's Republic of)
472	Maldives (Republic of)

Zone 4, Spare Codes: 67

Zone 5

Code	Country or Geographical Area
502	Malaysia
505	Australia
510	Indonesia (Republic of)
515	Philippines (Republic of)
520	Thailand
525	Singapore (Republic of)
528	Brunei
530	New Zealand
535	Guam
536	Nauru (Republic of)
537	Papua New Guinea
539	Tonga (Kingdom of)
540	Solomon Islands
541	New Hebrides
542	Fiji
543	Wallis and Futuna Islands
544	American Samoa

Zone 5 (cont'd)

Code	Country or Geographical Area
545	Gilbert & Ellice Islands
546	New Caledonia and Dependencies
547	French Polynesia
548	Cook Islands
549	Western Samoa

Zone 5, Spare Codes: 78

Zone 6

Code	Country or Geographical Area
602	Egypt (Arab Republic of)
603	Algeria (Algerian Democratic and Popular Republic)
604	Morocco (Kingdom of)
605	Tunisia
606	Libya (Socialist People's Libyan Arab Jamahiriya)
607	Gambia (Republic of the)
608	Senegal (Republic of the)
609	Mauritania (Islamic Republic of)
610	Mali (Republic of)
611	Guinea (Revolutionary People's Republic of)
612	Ivory Coast (Republic of the)
613	Upper Volta (Republic of)
614	Niger (Republic of the)
615	Togolese Republic
616	Benin (People's Republic of)
617	Mauritius
618	Liberia (Republic of)
619	Sierra Leone
620	Ghana
621	Nigeria (Federal Republic of)
622	Chad (Republic of the)
623	Central African Republic
624	Cameroon (United Republic of)
625	Cape Verde (Republic of)
626	Sao Tome and Principe (Democratic Republic of)
627	Equatorial Guinea (Republic of)
628	Gabon Republic
629	Congo (People's Republic of the)
630	Zaire (Republic of)
631	Angola (People's Republic of)
632	Guinea-Bissau (Republic of)
633	Seychelles
634	Sudan (Democratic Republic of the)
635	Rwanda (Republic of)
636	Ethiopia
637	Somali Democratic Republic

Zone 6 (cont'd)

Code	Country or Geographical Area
638	Republic of Djibouti
639	Kenya (Republic of)
640	Tanzania (United Republic of)
641	Uganda (Republic of)
642	Burundi (Republic of)
643	Mozambique (People's Republic of)
645	Zambia (Republic of)
646	Madagascar (Democratic Republic of)
647	Reunion (French Department of)
648	Zimbabwe
649	Namibia
650	Malawi
651	Lesotho (Kingdom of)
652	Botswana (Republic of)
653	Swaziland (Kingdom of)
654	Comoros (Federal and Islamic Republic of the)
655	South Africa (Republic of)

Zone 6, Spare Codes: 47

Zone 7

Code	Country or Geographical Area
702	Belize
704	Guatemala (Republic of)
706	El Salvador (Republic of)
708	Honduras (Republic of)
710	Nicaragua
712	Costa Rica
714	Panama (Republic of)
716	Peru
722	Argentine Republic
724	Brazil (Federative Republic of)
730	Chile
732	Colombia (Republic of)
734	Venezuela (Republic of)
736	Bolivia (Republic of)
738	Guyana
740	Ecuador
742	Guiana (French Department of)
744	Paraguay (Republic of)
746	Suriname (Republic of)
748	Uruguay (Oriental Republic of)

Zone 7, Spare Codes: 80

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15. ABSTRACT *(A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)*

The factors that affect the design of a numbering plan for the Integrated Services Digital Network (ISDN) involved a complex interplay between existing plans, national priorities and technical system limitations. These factors are the subject of this report. Desirable attributes of any numbering plan are explained, existing standards covering various plans are discussed and some actual plans currently in use are examined. The development of the Numbering plan for ISDN by the Consultative Committee for International Telegraph and Telephone is essentially complete. However there is still a need to understand and make sense of the relationship of all of the standardized plans and the implications on interworking as public networks evolve toward the ISDN concept and technology.

16. Key Words *(Alphabetical order, separated by semicolons)*

addressing; interworking; ISDN; numbering plans; telephony

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