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PART I

Recommendations E.401 to E.428

INTERNATIONAL TELEPHONE NETWORK MANAGEMENT

AND CHECKING OF SERVICE QUALITY

MONTAGE: PAGE 2 = PAGE BLANCHE

SECTION 1

INTERNATIONAL SERVICE STATISTICS

Recommendation E.401

STATISTICS FOR THE INTERNATIONAL TELEPHONE SERVICE

(NUMBER OF CIRCUITS IN OPERATION AND VOLUME OF TRAFFIC)

(Statistics exchanged by Administrations)

Administrations exchange each year, *in February* , statistics showing the number of circuits used and the volume of traffic monitored in the preceding year, as well as estimates of the number of circuits which will be required three years and five years later. These statistics shall be drawn up in the form indicated below.

A copy of the statistics shall be sent to the CCITT Secretariat for information.

ANNEX A

(to Recommendation E.401)

How to fill in the table on international telephone traffic statistics

Column 1 Designation of the connection by giving the name of the outgoing exchange first and then the name of the incoming exchange. Two-way connections will be shown in alphabetical order.

Columns 2 and 3 Number of circuits in operation as on *31 December*
| f the year of the statistics.

The number will be shown in column 2 when it refers to outgoing circuits and in column 3 when it refers to both-way circuits.

Columns 4 and 5 Number of circuits which would have been required during the year of the statistics.

Column 6 Method of operation.

The following abbreviations will be used:

A for automatic,

SA for semiautomatic,

M for manual,

A + SA for automatic and semiautomatic.

Column 7 Destination of traffic.

Each relation will be shown in this column on a separate line.

In the example given, the traffic routed over the Zürich-København circuits is destined for Denmark (terminal), Sweden, Norway and Finland (transit). In this case, the data for each destination will be shown in columns, 8, 9, 10 and 11. The total traffic figure, however, should not be omitted. These data will be bracketed together. If the connection handles traffic only to the country in which the incoming exchange is situated, only the word ‘‘terminal’’ will appear in column 7.

Columns 8 and 9 Busy-hour traffic, expressed in *erlangs* . (See Recommendation E.600.)

The traffic measured during the busiest month of the year of the statistics is given in column 9. For two-way circuit groups the total amount of incoming and outgoing traffic should be given. In column 8 the month of the year during which the traffic was measured should be indicated in roman numerals.

Column 10 Busy hour (UTC).

This refers to the busy hour as defined in Recommendation E.600.

Column 11 Annual increase, in %. Each Administration should insert in this column the annual traffic increase rate with respect to the previous year.

Columns 12 and 13 Columns 12 and 13 should show the estimated number of circuits required to route traffic in three and five years' time, respectively. For example, if the statistics relating to 1982 are drawn up in February 1983, column 12 will give the estimated number of circuits required in 1986 and column 13 those required in 1988.

TABLEAU, p. 366 (R´ecup.) T1.401

SECTION 2

INTERNATIONAL NETWORK MANAGEMENT

Recommendation E.410

INTERNATIONAL NETWORK MANAGEMENT — GENERAL INFORMATION

1 Introduction

The demand for international telephone service continues to increase substantially. This increasing demand has been met by advances in both technology and operational techniques. The growth of traffic has also required the development of larger transmission systems and exchanges to provide the capacity to meet the required grade of service. With the continued growth of the international automatic service, direct supervision and control over traffic has decreased since operators are no longer involved in establishing most calls.

In addition to the above, the introduction of larger digital transmission and switching systems, along with common channel signalling, has resulted in an international telephone network which is highly interconnected and interactive, and which has become increasingly vulnerable to overload and congestion. This overload and congestion can occur with little or no advance warning.

A number of events may arise which can have a serious effect on the international telephone service. Among these events are:

— failures of international or national transmission systems;

— failures of international or national exchanges;

— planned outages of transmission systems and exchanges;

— abnormal increases in traffic demand. The events which give rise to such traffic demand may be foreseen (e.g., national or religious holidays, international sporting events) or unforeseen (e.g., natural disasters, political crises);

— focussed overloads, and in particular, mass-calling;

— difficulties in meeting the requirements of international traffic resulting (for example) from delays in the provision of additional circuits or equipment;

— congestion in connected networks.

These events can lead to congestion which, if uncontrolled, may spread and thus seriously degrade the service in other parts of the international network. Considerable benefits can be derived for the international network as a whole if prompt action is taken to control the effect on service of such events.

In addition, as the telephone network migrates toward ISDN, interworking with other networks will develop. With interworking, failure or congestion in one network, or in the interface between networks, can have an adverse impact on the performance of the connected network(s).

The above considerations have led to the development of ‘‘international network management’’, which encompasses all the activities necessary to reduce the effect on service of any situation affecting unfavourably the international telephone network, and in the future, the ISDN.

Note — Much of the guidance on international network management may be applicable in national networks.

2 Definition of international network management

international network management is the function of supervising the international network and taking action when necessary to control the flow of traffic.

Network management requires real-time monitoring and measurement of current network status and performance, and the ability to take prompt action to control the flow of traffic.

3 Objective of network management

The objective of network management is to enable as many calls as possible to be successfully completed. This objective is met by maximizing the use of all available equipment and facilities in any situation through the application of the principles given below.

4 Principles of international network management

4.1 *Utilize all available circuits*

There are periods when, due to changing traffic patterns, the demand for service cannot be met by the available circuits in the normal

routing. At the same time, many circuits to other locations may be idle due to differences in calling patterns caused by time zones, local calling habits, or busy season variations. After negotiation and agreement amongst the Administrations affected, some or all of the unusually heavy traffic can be redirected to this idle capacity for completion.

4.2 *Keep all available circuits filled with traffic which has a high probability of resulting in effective calls*

The telephone network is generally circuit-limited; therefore the number of simultaneous effective calls is strongly influenced by the number of available circuits. However, ineffective calls can occupy circuit capacity which would otherwise be available for effective calls. Therefore identifying those call attempts which are likely to be ineffective because of a situation in the network (e.g., a failure), and reducing them as close to their source as possible, will allow circuit capacity to be available for call attempts which have a higher probability of being effective.

4.3 *When all available circuits are in use, give priority to calls requiring a minimum number of circuits to form a connection*

When telephone networks are designed using automatic alternate routing of calls, efficient operation occurs when traffic loads are at or below engineered values. However, as traffic loads increase above the engineered value, the ability of the network to carry effective calls decreases since an increased number of calls require two or more circuits to form a connection. Such calls increase the possibility of one multi-link call blocking several potential calls.

Thus automatic alternate routing should be restricted to give preference to direct routed traffic during periods of abnormally high demand.

4.4 *Inhibit switching congestion and prevent its spread*

A large increase in switching attempts can result in switching congestion when the switching capacity of an exchange is exceeded. If the switching congestion is left uncontrolled, it can spread to connected exchanges or networks and cause a further degradation of network performance. Controls should be applied which inhibit switching congestion by removing attempts from the congested exchange which have a low chance of resulting in a succesful call.

Note — Network management assumes that the network is adequately engineered to meet the normal levels of traffic, the requirement for which is described in Recommendations E.171, E.510, E.520, E.522, E.540 and E.541.

5 Benefits derived from international network management

Among the benefits to be derived from international network management are:

5.1 Increased revenue which is derived from an increase in successful calls.

5.2 Improved service to the customer. This can lead, in turn, to:

- improved customer relations;
- stimulation of customer calling rate;
- increased customer acceptance of new services.

5.3 More efficient use of the network. This can result in:

- an increased return on the capital invested in the network;
- an improvement in the ratio of effective to ineffective calls.

5.4 Greater awareness of the actual status and performance of the network. Such awareness can lead to:

- a basis by which network management and maintenance priorities can be established;
- improved network planning information;
- improved information on which future capital investment in the network can be decided;
- improved public relations.

5.5 Protection of revenue and important services, particularly during severe network situations.

6 Network management functions

Network management encompasses all of the activities necessary to identify conditions which may adversely affect network performance and service to the customer, and the application of network controls to minimize their impact. This includes the following functions:

a) monitoring the status and performance of the network on a real-time basis, which includes collecting and analyzing relevant data;

b) detecting abnormal network conditions;

c) investigating and identifying the reasons for abnormal network conditions;

d) initiating corrective action and/or control;

e) cooperating and coordinating actions with other network management centres, both domestic and international, on matters concerned with international network management and service restoration;

f) cooperating and coordinating with other work areas (e.g., maintenance, operator services or planning) on matters which affect service;

g) issuing reports of abnormal network situations, actions taken and results obtained to higher authority and other involved departments and Administrations, as required;

h) providing advance planning for known or predictable network situations.

7 Cooperation and coordination

Effective network management depends on the prompt availability of information indicating when and where a problem is occurring, and a trained group working in cooperation with all parts of the telecommunications organization. Just as there is a need for coordination in planning and building the network, there also is a need for coordination in managing it. The network is such that equipment malfunctions or overloads frequently produce unacceptable performance at a distance from the physical location of the problem. Therefore, those who monitor and manage the network, both nationally and internationally, must cooperate to ensure satisfactory service.

Network management is highly technical in nature, and depends on the skill and creativity of those who share an understanding of network management philosophy, objectives, terminology, tools and techniques. These items are specified in Recommendations E.410 through E.414, and provide a basis for the cooperation and coordination which are a vital part of network management.

8 Further Recommendations on network management

8.1 Recommendation E.411 provides operational guidance for network management including:

- status and performance parameters;
- expansive and protective traffic controls;
- criteria for application of controls.

8.2 Recommendation E.412 provides information on network management controls:

- traffic to be controlled;
- exchange controls;
- automatic controls;
- status of controls;
- operator controls.

8.3 Recommendation E.413 provides guidance on planning for events such as:

- peak calling days;
- failures of transmission systems;
- failures of exchanges;
- failures of common channel signalling systems;
- mass-calling situations;
- disasters;
- introduction of new services.

8.4 Recommendation E.414 provides guidance on the functional elements of a network management organization which need to be identified internationally as contact points. These comprise:

- planning and liaison;
- implementation and control;
- development.

8.5 It is emphasized that it is not necessary to meet the full scope of these Recommendations to achieve some benefit from the application of network management, particularly when getting started. However, the Recommendations do provide detailed information over a wide range of techniques, some of which can be implemented readily, whilst others may require considerable planning and design effort. Additional information may also be found in the handbook on Quality of service, network management and maintenance [1].

Reference

[1] CCITT Manual *Quality of service, network management and maintenance* , ITU, Geneva, 1984.

Recommendation E.411

INTERNATIONAL NETWORK MANAGEMENT — OPERATIONAL GUIDANCE

1 Introduction

Network management requires real-time monitoring of current network status and performance and the ability to take prompt action to control the flow of traffic when necessary (see Recommendation E.410). Operational guidance to meet these requirements, including a description of status and performance parameters, traffic controls and the criteria for their application are included in this Recommendation. It should be noted that the complete range of parameters and traffic controls are not necessary for the introduction of a limited network management capability, however a comprehensive selection will bring substantial benefit (see Recommendation E.410, § 5). In addition, some guidance on beginning network management is provided, along with information on developing a network management centre and the use of common channel signalling for network management purposes.

2 Information requirements

2.1 Network management requires information of where and why difficulties are occurring or are likely to occur in the network. This information is essential to identify the source and effect of a difficulty at the earliest possible time, and will form the basis for any network management action which is taken.

2.2 The information relating to current difficulties can be obtained from:

a) real-time surveillance of the status and performance of the network;

b) information from telephone operators as to where they are experiencing difficulties; or where they are receiving customer complaints of difficulties;

c) transmission system failure and planned outage reports (these reports need not relate only to the network local to one Administration, but should reflect the whole international network);

d) international or national exchange failures and planned outage reports;

e) news media reports detailing unforeseen events which stimulate traffic (for example, natural disasters).

2.3 The information relating to difficulties which are likely to occur in the future will be obtained from:

a) reports of future planned outages of transmission systems;

b) reports of future planned outages of international or national exchanges;

c) knowledge of special events (for example, international sporting events, political elections);

d) knowledge of national holidays and festivals (e.g., Christmas Day, New Year’s Day);

e) an analysis of past network performance.

2.4 The system availability information point, defined in Recommendation M.721, will provide a ready source for much of the information indicated above.

3 Network status and performance data

3.1 In order to identify where and when difficulties are occurring in the network, or are likely to occur, data will be required which will indicate the status and measure the performance of the network. Such data will require real-time collection and processing, and may require the use of thresholds (see § 5.1).

3.2 Data may be collected in various ways which include counters in electromechanical exchanges which can be read manually when required (e.g., during periods of heavy traffic or special events), data output reports from SPC exchanges, or computerized network management operations systems which can collect and process data from a large number of exchanges.

3.3 Network status information includes information on the status of exchanges, circuit groups and common channel signalling systems. This status information can be provided by one or more types of displays. These may include printers, video displays, and/or indicators on a display board or network management console. To be useful, network status indicators should be available as rapidly as possible.

3.3.1 Exchange status information includes the following:

Load measurements — These are provided by attempt counts, usage or occupancy data, data on the percent of real-time capacity available (or in use), blocking rates, percentage of equipment in use, counts of second trials, etc.

Congestion measurements — These are provided by measurements of the delay in serving incoming calls, holding times of equipment, average call processing and set-up time, queue lengths for common control equipment (or software queues), and counts of equipment time-outs, etc.

Service availability of exchange equipment — This information will show when major items of equipment are made busy to traffic. This could highlight a cause of difficulty or give advance warning that difficulties could arise if demand increases.

Congestion indicators — In addition to the above, indicators can be provided by SPC exchanges which show the degree of congestion. These indicators can show:

— moderate congestion Level 1;

— serious congestion Level 2;

— unable to process calls Level 3.

Note — While this is desirable, SPC exchanges may not be able to provide a level 3 indicator during catastrophic failures.

The availability of specific exchange status information will depend on the switching technology employed by each Administration. Details of exchange measurements are found in Recommendations E.502 and Q.544.

3.3.2 Circuit group status information relates to the following:

— status of all circuit groups available to a destination;

— status of individual circuit sub-groups in a circuit group;

— status of circuits on each circuit group.

Status indicators can be provided to show when the available network is fully utilized by indicating:

— when all circuits in a circuit group are busy;

— when all circuits in a circuit sub-group are busy;

— when all circuit groups available to a destination are busy.

This would indicate that congestion is present or imminent. Status information can be provided to show the availability of the network for service, by reporting the number or percentage of circuits on each circuit group that are made busy or are available for traffic.

This information could identify the cause of difficulty or give advance warning that difficulties may arise as the demand increases.

3.3.3 Common channel signalling system status provides information that will indicate failure or signalling congestion within the system. It includes such items as:

— receipt of a transfer prohibited signal (Signalling Systems Nos. 6 and 7),

— initiation of an emergency restart procedure (Signalling System No. 6),

— presence of a signalling terminal buffer overflow condition (Signalling System No. 6),

— signal link unavailability (Signalling System No. 7),

— signal route unavailability (Signalling System No. 7),

— destination inaccessible (Signalling System No. 7).

This information may identify the cause of difficulty or give advance warning that difficulties may arise as the demand increases.

3.3.3.1 Network management actions may help to reduce congestion in common channel signalling systems by reducing traffic being offered to common channel signalling circuit groups, or by diverting traffic to conventional signalling circuit groups.

3.4 Network performance data should relate to the following:

— traffic performance on each circuit group;

— traffic performance to each destination;

— effectiveness of network management actions.

It may also be desirable to assemble performance data in terms of circuit group and destination combinations and/or traffic class (for example, operator-dialled, subscriber-dialled, transit). (See Recommendation E.412, § 2.1.)

3.5 Data collection should be based on a system of measurement which is either continuous or of a sufficiently rapid sampling rate to give the required information. For example, for common control switching equipment, the sampling rate may need to be as frequent as every second.

Reports on network status and performance should be provided periodically, for example, on a 3 minute, 5 minute, 15 minute, 30 minute or hourly basis, with the more frequent reports usually being more useful. However, the more frequent reports may produce erratic data due to the peakedness of traffic, especially on small circuit groups. Data reports compiled by a network management operations system take on added value in that a more global view of network performance is provided.

3.6 The network performance data is generally expressed in parameters which help to identify difficulties in the network. Among these parameters are:

3.6.1 **percentage overflow (% OFL)**

% OFL indicates the relationship between the total bids offered to a circuit group or destination, in a specified period of time, and the quantity of bids not finding a free circuit. It will, therefore, give an indication of the overflow from one circuit group to another, or the bids which fail because all circuit groups to a destination are busy.

$$\% \text{ OFL} = \frac{verflows\ bids\,(to\ another\ circuit\ group\ or\ circuit\ busy\ signal)}{otal\ bids\ \text{for}\ the\ circuit\ group\,(or\ all\ circuit\ groups\ a\ destination)} \times 100$$

International networks contain one-way and both-way operated circuits, and their traffic flow characteristics are inherently different. This difference needs to be taken into account when calculating BCH and SCH either by:

i) multiplying the number of one-way circuits by 2 to derive an equivalent number of both-way circuits or;

ii) dividing the number of both-way circuits by 2 to derive an equivalent number of one-way circuits.

When analyzing BCH and SCH data, and when BCH and SCH data are exchanged between Administrations, it is essential that the method used is understood so that erroneous conclusions may be avoid ed.

3.6.2 **bids per circuit per hour (BCH)**

BCH is an indication of the average number of bids per circuit, in a specified time interval. It will therefore identify the demand and, when measured at each end of a both-way operated circuit group, will identify the direction of greater demand.

$$\text{BCH} = \frac{ids\ per\ hour}{uantity\ of\ circuits\ available\ \text{for}\ service}$$

It is not necessary to accumulate data for an hour to calculate BCH. However, the calculated BCH must be adjusted when data accumulation is less than hourly. For example, the bids should be doubled if 1/2 hour data is used. The result would be BCH for the data collection period.

3.6.3 **answer seizure ratio (ASR)**

ASR gives the relationship between the number of seizures that result in an answer signal and the total number of seizures. This is a direct measure of the effectiveness of the service being offered onward from the point of measurement and is usually expressed as a percentage as follows:

$$\text{ASR} = \frac{\textit{eizures resulting in answer signal}}{\textit{otal seizures}} \times 100$$

Measurement of ASR may be made on a circuit group or on a destination basis.

3.6.4 **answer bid ratio (ABR)**

ABR gives the relationship between the number of bids that result in an answer signal and the total number of bids. ABR may be made on a circuit group or on a destination basis.

$$\text{ABR} = \frac{\textit{ids resulting in answer signal}}{\textit{otal bids}} \times 100$$

ABR is expressed as a percentage and is a direct measure of the effectiveness of traffic onward from the point of measurement. It is similar to ASR except that it includes bids that do not result in a seizure.

3.6.5 **seizures per circuit per hour (SCH)**

SCH is an indication of the average number of times, in a specified time interval, that each circuit group is seized. When related to the expected values of average call holding times and effective call/seizure rate for the circuit group, it will give an indication of the effectiveness of the service being offered.

$$\text{SCH} = \frac{\textit{eizures per hour}}{\textit{uantity of circuits available } \text{for } \textit{service}}$$

It is not necessary to accumulate data for an hour to compute SCH. (See § 3.6.2 — BCH.)

3.6.6 **occupancy**

Occupancy can be represented in units (for example, erlangs, hundred-call-seconds (CCS) or as a percentage. It can be measured as a total for a destination or for a circuit group and as an average per circuit on a circuit group. Its use for network management purposes is to show usage and to identify unusual traffic levels.

3.6.7 **mean holding time per seizure**

This is the total holding time divided by the total number of seizures and can be calculated on a circuit group basis or for switching equipment.

3.6.8 **busy-flash seizure ratio (BFSR)**

BFSR gives the relationship between the number of seizures that result in a ‘‘busy-flash’’ signal (or its equivalent) and the total number of seizures. Measurement of BFSR is usually made on a circuit group basis.

$$\text{BFSR} = \frac{\textit{eizures resulting in a ``busy-flash''}}{\textit{otal seizures}} \times 100$$

Note — The source of ‘‘busy-flash’’ signals, or their equivalent, will vary with the signalling system used. Therefore, the calculated BFSR on individual circuit groups may naturally be different, and as a result, caution should be used when comparing BFSR among circuit groups.

3.7 The number of parameters possible or necessary for particular Administration purposes will depend upon a variety of factors. These will include:

a) the data available at an exchange;

b) the particular routing arrangements employed (for example, SCH and BCH relate to circuit group performance only; ABR, ASR, and % OFL can relate to circuit group or destination performance);

c) the interrelationships which exist between the parameters (for example, SCH can give similar indications to ASR — see § 3.6.5 above).

4 Interpretation of parameters

The interpretation of parameters on which network management actions are based can most conveniently be made by considering the originating international exchange as the reference point (see Figure 1/E.411).

Figure 1/E.411, p.

From this reference point, the factors which affect call completion can broadly be divided into three main components:

a) switching loss (near-end loss);

b) circuit congestion loss (near-end loss);

c) distant network loss (far-end loss).

4.1 *Switching loss*

Switching loss may be due to:

1) common equipment or switchblock congestion, or queue overflows or processor overloads;

2) failures in incoming signalling;

3) subscriber/operator dependent errors, such as insufficient or invalid digits, premature call abandonment, etc.;

4) routing errors, such as barred transit access;

5) other technical failures.

Guidance to the identification of switching loss can be obtained from § 3.3.

4.2 *Circuit congestion loss*

This loss will depend on:

1) the number of circuits available for a destination, and:

2) the level of demand for that destination,

3) the traffic performance on the circuit groups to that destination.

Indication that circuit congestion loss may occur can be obtained from the status information detailed in § 3.3.2 above.

Circuit congestion loss can be identified by any of the following:

— percentage overflow (see § 3.6.1),

— a difference between the ‘‘bids per circuit per hour’’ and ‘‘seizures per circuit per hour’’ measurements on the final circuit group (see §§ 3.6.2 and 3.6.5),

— a difference between the ‘‘answer bid ratio’’ and the ‘‘answer seizure ratio’’ (see §§ 3.6.3 and 3.6.4).

It should be noted that for both-way operated circuit groups, excessive demand in the incoming direction may also cause circuit congestion loss. This can be identified by comparing incoming and outgoing bids, seizures or occupancy.

4.3 *Distant network loss*

Distant network loss may be divided into:

1) *technical loss* | due to distant exchange and national circuit faults,

2) *subscriber dependent loss* | due to subscriber B busy, no answer, invalid distant number, number unavailable, etc.,

3) *traffic dependent loss* | these losses are due to lack of distant network capacity to meet traffic demand.

Under normal conditions, and for a large sample measured over a long period, distant network loss can be said to have a fixed or ambient overhead loss (this value depends on destination with some hour-by-hour and day-by-day variations).

Under abnormal situations (heavy demand, failures, etc.) distant network losses can be significantly affected. Variations in distant network loss can be identified by any of the following:

— answer seizure ratio (see § 3.6.3) (this is a direct measurement),

— seizures per circuit per hour (see § 3.6.5) (this is an indirect measurement),

— mean holding time per seizure (see § 3.6.7) (this is an indirect measurement),

— busy-flash seizure ratio (see § 3.6.8) (this is a direct measurement).

5 Criteria for action

5.1 The basis for the decision on whether any network management action should be taken will depend upon real-time information on the status and performance of the network. It is advantageous if the output of this information can be initially restricted to that which is required to identify possible difficulties in the network. This can be achieved by setting threshold values for performance parameters, and for the number or the percentage of circuits and common control equipment which are in service, such that when these threshold values are crossed, network management action can be considered. These threshold values will represent some of the criteria by which decisions are reached.

5.2 Indications that a threshold has been crossed and ‘‘all circuits on a circuit group are busy’’ and ‘‘all circuit groups to a destination are busy’’ may be used to direct attention to the particular area of the network for which detailed performance information will then be required.

5.3 The decision on whether or not to take network management action, and what action will be taken, is the responsibility of the network management personnel. In addition to the criteria mentioned above, this decision will be based on a number of factors, which could include:

— a knowledge of the source of the difficulty;

— detailed performance and status information;

— any predetermined plans that exist (see Recommendation E.413);

— experience with and knowledge of the network;

— routing plan employed;

— local traffic patterns;

— ability to control the flow of traffic (see Recommendation E.412).

This personnel is responsible for ensuring that conventional network management controls, once activated, are not left unsupervised.

6 Network management actions

6.1 *General*

Network management actions fall into two broad categories:

a) ‘‘expansive’’ actions, which are designed to make available lightly loaded parts of the network to traffic experiencing congestion;

b) ‘‘protective’’ actions, which are designed to remove traffic from the network during congestion which has a low probability of resulting in successful calls.

Normally, the first choice response to a network problem would be an expansive action. Protective actions would be used if expansive actions were not available or not effective.

Network management actions may be taken:

— according to plans which have been mutually agreed to between Administrations prior to the event (see Recommendation E.413);

— according to ad hoc arrangements agreed to at the time of an event (see Recommendation E.413);

— by an individual Administration wishing to reduce its traffic entering the international network, or to protect its own network.

6.2 *Expansive actions*

Expansive actions involve the rerouting of traffic from circuit groups experiencing congestion to other parts of the network which are lightly loaded with traffic, for example, due to differences in busy hours.

Examples of expansive actions are:

a) establishing temporary alternative routing arrangements in addition to those normally available;

b) in a country where there is more than one international exchange, temporarily reorganizing the distribution of outgoing (or incoming) international traffic;

c) establishing alternative routings into the national network for incoming international traffic;

d) establishing alternative routings to an international exchange in the national network for originating international traffic.

The protective action of inhibiting one direction of operation of both-way circuits [see § 6.3 a)] can have an expansive effect in the other direction of operation.

6.3 *Protective actions*

Protective actions involve removing traffic from the network during congestion which has a low probability of resulting in successful calls. Such traffic should be removed as close as possible to its origin, thus making more of the network available to traffic which has a higher probability of success.

Examples of protective actions are:

a) Temporary removal of circuits from service (circuit busying). This action may be taken when a distant part of the network is experiencing serious congestion.

Note — In the case of both-way circuits, it may only be necessary to inhibit one direction of operation. This is called directionalization

b) Special instructions to operators. For example, such instructions may require that only a limited number of attempts (or none at all) be made to set up a call via a congested circuit group or exchange, or to a particular destination experiencing congestion.

c) Special recorded announcements. Such announcements may be connected at an international or national exchange and, when there is serious congestion within part of the network, would advise customers (and/or operators) to take appropriate action.

d) Inhibiting overflow traffic. This action prevents traffic from overflowing onto circuit groups or into distant exchanges which are already experiencing congestion.

e) Inhibiting direct traffic. This action reduces the traffic accessing a circuit group in order to reduce the loading on the distant network.

f) Inhibiting traffic to a particular destination (code blocking or call gapping). This action may be taken when it is known that a distant part of the network is experiencing congestion.

g) Circuit reservation. This action reserves the last few idle circuits in a circuit group for a particular type of traffic.

6.4 Information on the network management controls (and their method of activation) which can be used for expansive and protective actions is found in Recommendation E.412.

6.5 *Actions during disasters*

6.5.1 Disasters whether man-made or natural can result in damage to the telephone network, they can give rise to heavy calling, or both.

6.5.2 A single point of contact for network-related information should be established to prevent confusion, duplication of effort, and to ensure an orderly process of returning communications to normal. It is recommended that the single point of contact be the network management implementation and control point (see Recommendation E.414, § 4) within the Administration affected by the disaster.

6.5.3 The role of the network management implementation and control point may vary depending on the size or impact of a disaster. However, the following are functions which may be required:

— assess the impact of the disaster on the network (transmission systems, exchanges, circuit groups, destination codes, isolated destinations);

— provide status information, as appropriate, to:

i) operator services

ii) public relations and media

iii) government agencies

iv) other network management implementation and control points;

— develop and implement control strategies (expansive and protective);

— assist in determining the need for, and locating, technical equipment to restore communications.

7 Exchange of information

7.1 Effective network management requires good communications and cooperation between the various network management elements within an Administration and with similar elements in other Administrations (see Recommendation E.414). This includes the exchange of real-time information as to the status and performance of circuit groups, exchanges and traffic flow in distant locations.

7.2 Such information can be exchanged in a variety of ways, depending on the requirements of the Administrations. Voice communications can be established between or among network management centres using dedicated service circuits or the public telephone network. Certain operational signals, such as switching congestion indicators, may be transported directly by the common channel signalling system. (See Recommendation Q.297 for Signalling System No. 6 and Recommendations Q.722, Q.723, Q.724, Q.762, Q.763 and Q.764 for Signalling System No. 7.)

Larger data exchange requirements on a

regular basis may be supported by the Telecommunications Management Network (TMN) (see Recommendation M.30) or by use of a packet switched network capability. The transfer of smaller amounts of data on an infrequent basis may be supported by telex or similar media, or by facsimile.

7.3 *Guidance on the use of common channel signalling for network management*

7.3.1 Common channel signalling systems provide a fast and reliable means of transfering network management operational signals between exchanges. An example is the transfer of exchange congestion status signals for the Automatic Congestion Control (ACC) system (see Recommendation E.412, § 3.1). These signals should be given a high priority in common channel signalling flow control. Specific details on the application of network management operational signals in Signalling System No. 6 are found in Recommendation Q.297. In the case of Signalling System No. 7, the details for the Telephone User Part (TUP) are found in Recommendations Q.722, Q.723 and Q.724, and the ISDN User Part (ISUP) are found in Recommendations Q.762, Q.763 and Q.764.

7.3.2 Signalling System No. 7 may also be used to transfer network management data and status information between an exchange and its network management operations system, and between network management operations systems. It should be noted that in these applications, the volume of data to be transferred can be quite large and its frequency of transmission can be as high as every three minutes. When this data is transferred over signalling links which also handle user signalling traffic, stringent safeguards must be adopted to minimize the risk of signalling system overloads during busy periods when both user signalling traffic and network management data transmissions are at their highest levels. These safeguards include the following:

— limiting the amount of network management information to be transferred on signalling links which also carry user signalling messages;

— using dedicated signalling links for network management purposes;

— using the telecommunications management network (TMN), or the Operations and Maintenance Application Part (OMAP) in Signalling System No. 7 (for further study);

— developing appropriate flow control priorities for network management information (for further study);

— equipping the network management operations system in such a way that it can respond to signalling system flow control messages.

8 Beginning network management

The introduction of network management into an existing network should be viewed as a long-term project. This long period is required:

— to gain knowledge and experience of network management;

— to carry out studies on the requirements of an individual network;

— to write specifications for network management requirements in present and future telephone exchanges and to hold discussions with manufacturers;

— to oversee the introduction of facilities and to organize and train suitable network management staff;

— to introduce limited facilities in existing older technology exchanges.

A rational approach would consist in first using existing limited facilities to manage the network, while at the same time developing full network management facilities with the introduction of modern stored program control (SPC) exchanges.

8.1 *Utilizing existing resources and capabilities*

8.1.1 *Responsibility*

As an important first step, the responsibility for network management should be identified and assigned within an organization. This initial organization can then be expanded, as required, in accordance with Recommendation E.414.

8.1.2 *Telephone operators*

Operators are usually aware of problems as they occur in the network, and this information can reveal the need to control traffic. The operators can then be directed to modify their procedures to reduce repeated attempts, or to use alternative routings to a destination. They can also provide special information and/or instructions to customers and distant operators during unusual situations.

8.1.3 *Exchange capabilities*

Exchanges may have been provided with certain features which can be adapted for network management purposes. Data already available for maintenance or traffic engineering purposes could be used for network management, or could be made available through the addition of an interface unit. In addition, manually operated switches or keys can be provided in electro-mechanical exchanges to block certain destination codes or to change alternate routing. They can be provided separately for each item of common control equipment, thereby allowing flexible control of traffic to a destination.

The scope for network management in a telecommunications network may depend on the technology of the exchanges in that network. However, close examination of the manufacturers' specifications for SPC exchanges may reveal that certain network management functions may be available, for example, via a maintenance terminal.

8.1.4 *Circuits*

Both-way circuits can be made busy to one direction of operation to improve the flow of traffic in the other direction. In addition, both-way and one-way circuits can be removed from service, when necessary. Both of these actions may be taken by verbal direction to the responsible maintenance organization.

8.2 *Improving capabilities*

From the experience gained through the use of these simple tools, more sophisticated network management facilities can be specified. In the interest of cost reduction, these up-graded network management capabilities should be planned for introduction as a part of a planned addition or modification to an exchange, and should be specified as a part of the initial installation of new systems. Before purchasing a new exchange, attention should be paid to the ability of the exchange to provide network management requirements as specified in Recommendations Q.542 and Q.544.

In some cases, certain off-line network management information storing and processing needs may be accommodated by the use of personal computers.

9 Considerations for the development of network management

9.1 Network management can be provided on a distributed basis, where network management functions are provided ''on-site'' at the exchange, or on a centralized basis, where network management functions for a number of exchanges are provided at a single location. Each approach provides certain advantages which should be recognized when deciding which one would be appropriate for an Administration's situation. In general, the decentralized distributed

approach may be more appropriate where activity levels are relatively low. It may also be an appropriate way to get started in network management. The centralized approach may be more appropriate in networks where activity levels are high. In some networks, a combination of these approaches may be most effective.

9.2 *Advantages of the decentralized (distributed) approach*

The decentralized (distributed) approach provides certain advantages, which include the following:

— locally available features and capabilities can be developed and used (see § 8.1.3);

— a more detailed analysis and assessment of localized problems are possible;

— survivability of network management functions is improved, since a problem or outage at one location will not usually result in the loss of all network management capabilities;

— network management functions may be assigned to existing staff, eliminating the need to develop a dedicated, specialized staff;

— it may provide an interim capability while a long-term plan is being developed and deployed.

9.3 *Advantages of the centralized approach*

A centralized network management centre provides a number of operational benefits when compared with a distributed approach, where network management functions are provided ''on-site'' at the exchange. These include:

— more effective network management operations. A centralized approach is inherently more effective in dealing with complex, interrelated network problems in the SPC-common channel signalling environment, and will become more so during the transition to ISDN. In many cases, the most effective response to a problem in the international network might be to take action in the national network, and vice-versa. A centralized approach simplifies the problem of coordination of activities in these cases;

— a more ‘‘global’’ view of network performance. This, in turn, will permit faster and more accurate problem identification, and the development of more effective control strategies which can be implemented with less delay;

— a central point of contact for network management, both internally and with other Administrations (see Recommendation E.414);

— more efficient network management operations. The cost of staffing and training is reduced, and staff expertise is enhanced through specialization.

9.4 *Network management operations systems*

A computer-based network management operations system can provide considerable benefits to a network management centre due to its ability to process large volumes of information and to present that information in a common format. The functions of a network management operations system include the following:

— collecting alarms, status information and network management traffic data from exchanges (see § 3 and Recommendation E.502);

— processing the collected data and calculating network management parameters (see § 3 and Recommendation E.502);

— providing performance reports (see § 9.4.1);

— comparing network management parameters with thresholds to identify unusual conditions;

— applying controls in exchanges based on input commands;

— calculating hard-to-reach status of destinations and providing this information to exchanges;

— interfacing with network management centre visual displays, and work station terminals and printers;

— preparing administrative reports;

— maintaining a database of network statistics and information.

Note — Many of these functions can also be provided to the Network Management Centre by each SPC exchange, however, the provision of these functions in a network management operations system may reduce the requirements placed on the exchanges.

9.4.1 *Performance reports*

Performance reports can be provided in the following ways:

i) *automatic data* — this data is provided automatically as specified in the operations system software, and cannot be readily changed by the network manager;

ii) *scheduled data* — this data is provided according to a schedule established by the network manager;

iii) *demand data* — this data is provided only in response to a specific request by the network manager. In addition to performance data, demand data includes reference data, such as the number of circuits provided or available for service, routing information, assigned threshold values, numbers of installed switching system components, etc.;

iv) *exception data* — this data is provided when a data count or calculation crosses a threshold established by the network manager.

Data reports can be provided on a regular basis, for example, every 3 minutes, 5 minutes, 15 minutes, 30 minutes, or hour. The specific interval for any data report will be determined by the network manager. Historic data relating to at least the previous two or three periods should also be available.

9.4.2 *Other considerations*

It should be noted that shorter collection intervals increase the usefulness of the data to the network manager, but also increase the size and cost of the operations system and may increase the volatility of the data.

It should also be noted that it is important that network management controls should not become completely unavailable due to the failure or malfunction of the network management operations system or of its communications links with exchanges. Therefore, network management operations systems should be planned with a high degree of reliability, survivability and security. This could be achieved through the provision of certain essential capabilities (such as controls and automatic routing protection mechanisms) on-site in the exchange, or by redundancy in computers and data links, or through the provision of alternative stand-by centres.

The failure of a network management operations system should not have an adverse impact on normal traffic flow in the network.

ANNEX A
(to Recommendation E.411)

Terminology for network management

A.1 **circuit**

A circuit connects two exchanges. A national circuit connects two exchanges in the same country. An international circuit connects two international exchanges situated in different countries. (Based on Recommendation D.150 and Recommendation F.68.)

A.2 **circuit group**

The set of all switched circuits which directly interconnect one exchange with another.

A.3 **circuit sub-group**

A set of circuits within a circuit group which are uniquely identifiable for operational or technical reasons. A circuit group may consist of one or more circuit sub-groups.

A.4 **destination**

A country in which the called subscriber is located or an area or other location that may be specified within that country. A destination can be identified by the digits used for routing the call.

A.5 **bid**

An attempt to obtain a circuit in a circuit group or to a destination. A bid may be successful or unsuccessful in seizing a circuit in that circuit group or to that destination.

A.6 **seizure**

A seizure is a bid for a circuit in a circuit group which succeeds in obtaining a circuit in that circuit group.

A.7 **answer signal**

A signal sent in the backward direction indicating that the call is answered. (Based on Recommendation Q.254.)

A.8 **holding time**

The time interval between seizure and release of a circuit or switching equipment.

A.9 **busy-flash signal (sent in the backward direction)**

This signal is sent to the outgoing international exchange to show that either the circuit group, or the called subscriber, is busy (Signalling Systems No. 4 and No. 5, see Recommendations Q.120 and Q.140).

Note — In Signalling Systems No. 6 and No. 7, there is no busy-flash signal. However, the equivalent of busy-flash can be roughly approximated through the aggregation of specific backward failure signals such as circuit group congestion, national network congestion and subscriber busy.

Recommendation E.412

NETWORK MANAGEMENT CONTROLS

1 Introduction

1.1 Network management controls provide the means to alter the flow of traffic in the network in support of the network management objectives given in Recommendation E.410. Most network management controls are taken by or in the exchange (see Recommendation Q.542), but certain actions can be taken external to the exchange. This Recommendation provides specific information on network management controls and gives guidance concerning their application. However, it should be noted that the suggested use for each network management control is given only for the purpose of illustration. Other controls, separately or in combination, may be more appropriate in any given situation.

1.2 The application or removal of network management controls should be based on network performance data which indicates that action is

required in accordance with the network management principles in Recommendation E.410, § 4. Performance data will also measure the effect of any network management control taken, and will indicate when a network management control should be modified or removed (see Recommendations E.411 and E.502).

1.3 Controls can be activated or removed in an exchange by input from a network management operations system or by direct input from a terminal. In some cases, controls can be activated automatically either by external or internal stimulus, or when a parameter threshold has been exceeded. [The automatic congestion control (ACC) system is an example (see § 4.1).] When automatic control operation is provided, means for human override should also be provided.

2 Traffic to be controlled

2.1 *Type of traffic*

Exchanges should be capable of applying a range of network management controls (see Recommendation Q.542). For increased flexibility and precision, there is considerable advantage when the effect of a control can be limited to a particular specified traffic element.

The operating parameters of a control can be defined by a set of traffic attributes. As shown in Figure 1/E.412, these parameters include distinctions based on the origin of the traffic, for example customer-dialled, operator-dialled, transit or other such classification as may be specified by the Administration. These can be further classified by type of service, particularly for ISDN.

Figure 1/E.412, p.

Additional attributes can be specified based on information which may be available in the exchange. For example, incoming/outgoing circuit group class, or hard-to-reach status of destinations (see § 2.2) can be used. Further distinctions can be based on the outgoing traffic type, for example direct routed, alternate routed or transit.

In general, the more attributes that can be specified for a control, the more precise will be its effect.

Note — Precision is of vital importance, particularly in the case of protective controls.

2.2 *Hard-to-reach (HTR) process*

2.2.1 A hard-to-reach process for network management will enable exchanges to automatically make more efficient use of network resources during periods of network congestion by improving the performance of network management controls. This improved performance is derived from the ability to distinguish between destinations that are easy to reach (ETR) and destinations that are hard-to-reach (HTR), (e.g., destinations with a low answer bid ratio) and applying heavier controls to HTR traffic. This distinction can be based on:

i) internal performance measurements within the exchange and/or the network management operations system;

ii) similar information gathered and reported by other exchanges;

iii) historical and current observations of network performance by network managers.

The network manager should have the ability to set the threshold for HTR determination in the exchange or network management operations system, and to assign a destination as HTR regardless of its actual status.

2.2.2 *Controlling traffic based on HTR status*

When a call to a destination that is on the HTR list is being routed and a network management control on HTR traffic is encountered, the call should be controlled according to the relevant parameters. If a destination is considered HTR, it normally should be HTR for all outgoing circuit groups.

Additional details of the hard-to-reach process can be found in Recommendation Q.542.

2.3 *Methods for specifying the amount of traffic to be controlled*

2.3.1 *Call percentage control*

There is considerable advantage when exchange controls can be activated to affect a variable percentage of traffic (for example 10%, 25%, 50%, 75% or 100%).

2.3.2 *Call rate control*

An ability to set an upper limit on the maximum number of calls to be allowed to access the network during a specified period of time is of particular advantage.

3 Exchange controls

Network management controls may be applied in exchanges to control traffic volume or to control the routing of traffic. The resulting effect on traffic of these controls may be expansive or protective, depending on the control used, its point of application and the traffic element selected for control.

3.1 *Traffic volume controls*

Traffic volume controls generally serve to control the volume of traffic offered to a circuit group or destination. These include the following:

3.1.1 *Destination controls*

3.1.1.1 *Code blocking*

This control bars routing for a specific destination on a percentage basis. Code blocking can be done on a country code, an area code,

an exchange identifying code or an individual line number. The last of these is the most selective control available.

Typical application: | Used for immediate control of focussed overloads or mass-calling situations.

3.1.1.2 *Call-gapping*

This control sets an upper limit on the number of call attempts allowed to be routed to the specified destination in a particular period of time (for example, no more than 5 call attempts per minute). Thus, the number of call attempts that are routed can never exceed the specified amount.

Typical application: | Used for the control of focussed overloads, particularly mass-calling to an individual line number. A detailed analysis may be required to determine the proper call-rate parameters.

3.1.2 *Cancellation of direct routing*

This control blocks the amount of direct routed traffic accessing a circuit group.

Typical application: | Used to reduce traffic to congested circuit groups or exchanges where there is no alternate routed traffic.

3.1.3 *Circuit directionalization*

This control changes both-way operated circuits to incoming operated circuits, either on a percentage basis or by a specified number of circuits. At the end of the circuit group for which access is inhibited, this is a protective action, whereas at the other end of the circuit group (where access is still available), it is an expansive action.

Typical application: | To enhance the flow of traffic outward from a disaster area while inhibiting incoming traffic. To have an effect, it is recommended that the minimum amount of directionalization be at least 50%.

3.1.4 *Circuit turndown/busying/blocking*

This control removes one-way and/or both-way operated circuits from service, either on a percentage basis or by a specified number of circuits.

Typical application: | Used to control exchange congestion when no other control action is available.

3.1.5 *Specialized volume controls*

Both the automatic congestion control (ACC) system and the selective circuit reservation control (SCR) are volume controls, but due to their specialized nature, they are described separately in § 4.1 and § 4.2.

3.2 *Routing control*

Routing controls are used to control the routing of traffic to a destination, or to or from a circuit group. However, it should be noted that in some cases a routing control may also affect the volume of traffic. Controls which are applied to circuit groups may also be applied to circuit sub-groups, when appropriate.

3.2.1 *Cancellation of alternative routing*

Two versions of this control are possible. One version prevents traffic from overflowing *FROM* | the controlled circuit group: alternative routing from (ARF). The other version prevents overflow traffic from all sources from having access *TO* the controlled circuit group: alternative routing to (ART). See Figure 2/E.412.

Typical application: | There are many uses for this control. These include controlling alternative routing in a congested network to limit multi-link connections, or to reduce alternative routed attempts on a congested exchange.

Figure 2/E.412, p.

3.2.2 *Skip*

This control allows traffic to bypass a specified circuit group and advance instead to the next circuit group in its normal routing pattern.

Typical application: | Used to bypass a congested circuit group or distant exchange when the next circuit group can deliver the call attempts to the destination without involving the congested circuit group or exchange. Application is usually limited to networks with extensive alternative routing. When used on both-way circuit groups it has an expansive effect on traffic flow in the opposite direction.

3.2.3 *Temporary alternative routing*

This control redirects traffic from congested circuit groups to other circuit groups not normally available which have idle capacity at the time.

Typical application: | To increase the number of successful calls during periods of circuit group congestion and to improve the grade of service to subscribers.

3.2.4 *Special recorded announcements*

These are recorded announcements which give special information to operators and/or subscribers, such as to defer their call to a later time.

Typical application: | Used to notify customers of unusual network conditions, and to modify the calling behavior of customers and operators when unusual network conditions are present. Calls that are blocked by other network management controls can also be routed to a recorded announcement.

Figure 3/E.412, p.

4 Automatic exchange controls

Automatic dynamic network management controls represent a significant improvement over conventional controls. These controls, which are preassigned, can quickly respond to conditions internally detected by the exchange, or to status signals from other exchanges, and are promptly removed when no longer required. Automatic control applications should be planned, taking into account the internal overload control strategy provided in the exchange software.

4.1 *Automatic congestion control system*

4.1.1 *Exchange congestion*

When a digital international/transit exchange carries traffic above the engineered level, it can experience an overload that diminishes its total call processing capability. Because of the speed of the onset of such congestion and the critical nature of the condition, it is appropriate that control be automatic. The automatic congestion control (ACC) system consists in the congested exchange sending a congestion indicator to the connected exchange(s) using common channel signalling. The exchange(s) receiving the congestion indication can respond

by reducing a certain percentage of the traffic offered to the congested exchange, based on the response action selected for each application.

4.1.2 *Detection and transmission of congestion status*

An exchange should establish a critical operating system benchmark, and when continued levels of nominal performance are not achieved (e.g. due to excessive traffic), a state of congestion is declared. Thresholds should be established so that the two levels of congestion can be identified, with congestion level 2 (CL2) indicating a more severe performance degradation than congestion level 1 (CL1). When either level of congestion occurs, the exchange should have the capability to:

1) code an ACC indication in the appropriate common channel signalling messages, and

2) notify its network management centre and support system of a change in its current congestion status.

4.1.3 *Reception and control*

When an exchange receives a signal that indicates a congestion problem at a connected exchange, the receiving exchange should have the capability to reduce the number of seizures sent to the congested exchange.

An exchange should have the capability of:

1) assigning an ACC response action on an individual circuit group basis, as specified by the network manager, and

2) notifying its network management centre and support system of a change in congestion status received from a distant exchange.

There should be several control categories available in the exchange. Each category would specify the type and amount of traffic to be controlled in response to each of the received ACC indicators. The categories could be structured so as to present a wide range of response options.

For a specific ACC response category, if the received ACC indicator is set to a CL1 condition then the receiving exchange could, for example, control a percentage of the Alternate Routed To (ART) traffic to the affected exchange. The action taken by the control would be to either SKIP or CANCEL the controlled calls, depending on the ACC response action that was assigned to that circuit group. In a similar manner, if a CL2 condition is indicated, then the receiving exchange could control all ART traffic and some percentage of Direct Routed (DR) traffic. Other options could include the ability to control hard-to-reach traffic, or transit traffic. In the future, control categories

could be expanded to include service-specific controls. This would be particularly useful in the transition to ISDN.

Note — ACC response categories can be set locally in the exchange or by input from a network management centre, or operations system.

Table 1/E.412 is an example of the flexibility that could be achieved in response to a signal from an exchange that is experiencing congestion. In this example, different control actions would be taken based upon the distinction between ART and DR traffic types. These actions could represent the initial capabilities available with the ACC control. Other alternatives in the future could include the ability to control hard-to-reach traffic (see § 2.2), or transit traffic or to provide other controls such as call-gapping. Additional response categories could also be added to Table 1/E.412 to give greater flexibility and more response options to the ACC control. It could also be possible to exclude priority calls from ACC control.

H.T. [T1.412]

TABLE 1/E.412

ACC control response

Congestion level	Traffic type	Response category A	Response category B	Response category C
CL1	ART DR	0 0	0 0	100 0
CL2	ART DR	100 0	100 75	100 75

Table 1/E.412 [T1.412], p.

In this context, the

term ‘‘circuit group’’ refers to all of the outgoing and both-way circuit sub-groups which may directly connect the congested exchange and the responding exchange.

4.1.4 Any international application of ACC should be based on negotiation and bilateral agreement among the affected Administrations. This includes an agreement as to whether the controlled calls should be skipped or cancelled. Application within a national network would be a national matter. An exchange that is capable of ‘‘ACC receive and control’’ should not indiscriminately assign ACC to all routes since a distant exchange may be equipped for common channel signalling, but may not yet have an ACC transmit capability. This could result in invalid information in the ACC fields in the signalling messages and the inappropriate application of ACC controls at the receiving exchange. Additional details on the ACC system are in Recommendation Q.542.

4.2 *Selective circuit reservation control*

4.2.1 The selective circuit reservation control enables an exchange to automatically give preference to a specific type (or types) of traffic over others (e.g., direct routed calls over alternate routed calls) at the moment when circuit congestion is present or imminent. The selective circuit reservation control can be provided with one or two thresholds, with the

latter being preferred due to its greater selectivity. Specific details on the selective circuit reservation control may be found in Recommendation Q.542.

4.2.2 *General characteristics*

The selective circuit reservation control has the following operating parameters:

— a reservation threshold(s),

— a control response,

— a control action option.

The reservation threshold defines how many circuits or how much circuit capacity should be reserved for those traffic types to be given preferred access to the circuit group. The control response defines which traffic types should be given a lesser preference in accessing the circuit group, and the quantity of each type of traffic to control. The control action option defines how those calls denied access to the circuit group should be handled. The control action options for processing of calls denied access to the circuit group may be SKIP or CANCEL.

When the number of idle circuits or the idle capacity in the given circuit group is less than or equal to the reservation threshold, the exchange would check the specified control response to determine if calls should be controlled. The SKIP response allows a call to alternate-route to the next circuit group in the routing pattern (if any) while the CANCEL response blocks the call.

These parameters should be able to be set locally in the exchange for each selected circuit group or by input from a network management operations system. In addition, the network manager should have the capability to enable and disable the control, and to enable the control but place it in a state where the control does not activate (e.g., by setting the reservation threshold to zero). Further, the network manager should have the ability to set the values for the response categories.

4.2.3 *Single threshold selective circuit reservation control*

In this version of the control, only a single reservation threshold would be available for the specified circuit group.

Table 2/E.412 is an example of the flexibility that could be achieved in the control’s response to circuit group congestion. In the future, other

distinctions between traffic could be identified that would expand the number of traffic types in Table 2/E.412. An example would be to control hard-to-reach traffic as indicated in § 2.2, or to give preference to priority calls.

4.2.4 *Multi-threshold selective circuit reservation control*

The multi-threshold control provides two reservation thresholds for the specified circuit group. The purpose of multiple reservation thresholds is to allow a gradual increase in the severity of the control response as the number of idle circuits in the circuit group decreases. The only restriction on the assignment of reservation thresholds would be that a reservation threshold associated with a more stringent control must always be less than or equal to the reservation threshold of any less stringent control, in terms of the number of reserved circuits, or circuit capacity.

H.T. [T2.412]

TABLE 2/E.412

An example of a single threshold selective circuit reservation
Percentage control response table

{		{		
		A	B	C
RT1	ART DR	25 0	50 0	100 25

Table 2/E.412 [T2.412], p.

Table 3/E.412 is an example of the flexibility that could be achieved in the control's response to circuit group congestion with a two-reservation threshold control. In the future, other distinctions between traffic could be identified that would expand the number of traffic types in Table 3/E.412. An example would be to control hard-to-reach traffic as indicated in § 2.2.

H.T. [T3.412]

TABLE 3/E.412

An example of a two-threshold selective circuit reservation
Percentage control response table

{		{				
		A	B	C	D	E
RT1	ART DR	25 0	50 0	75 0	100 0	100 0
RT2	ART DR	50 0	75 0	75 25	100 50	100 100

Table 3/E.412 [T3.412], p.

5 Status and availability of network management controls

5.1 The exchange and/or network management operations systems should provide information to the network management centre and/or the exchange staff as to what controls are currently active and whether the controls were activated automatically or by human intervenion. Measurements of calls affected by each control should also be available (see Recommendation E.502).

5.2 To help insure the viability of network management functions during periods of exchange congestion, network management terminals

(or exchange interfaces with network management operations systems), and functions such as controls, should be afforded a high priority in the exchange operating software.

6 Operator controls

Traffic operators are usually aware of problems as they occur in the network, and this information can reveal the need to control traffic. The operators can then be directed to modify their normal procedures to reduce repeated attempts (in general, or only to specified destinations), or to use alternative routings to a destination. They can also provide information to customers and distant operators during unusual situations, and can be provided with special call handling procedures for emergency calls.

Recommendation E.413

INTERNATIONAL NETWORK MANAGEMENT — PLANNING

1 Introduction

1.1 Many situations arise which may result in abnormally high or unusually distributed traffic levels in the international network, or loss of network capacity, or both. These situations include the following:

- peak calling days,
- failure of transmission systems (including planned outages),
- failure of exchanges,
- failure of common channel signalling systems,
- mass-calling situations,
- disasters,
- introduction of new services.

Experience has shown that advanced planning for these situations has a beneficial effect on overall network management efficiency and effectiveness. The timely application of planned control strategies can be instrumental in improving network performance.

1.2 For known or predictable events, predetermined network management plans should be developed and agreed between Administrations, bearing in mind the costs involved. The degree of detail of any plan will depend on the type of situation to be covered. For example, a recurring event such as Christmas or New Year's Day may be planned in great detail. The lack of real-time network management facilities in an Administration should not preclude planning activities.

1.3 When unforeseen situations arise for which predetermined plans do not exist, ad hoc arrangements will need to be agreed at the time. Whether network management actions result from a negotiated plan, or an ad hoc arrangement, it is essential that agreement be reached between Administrations concerned before such actions are actually implemented.

1.4 Network management planning is normally performed by the ‘‘network management planning and liaison’’ point (see Recommendation E.414).

1.5 Another aspect of network management planning is long-range planning for the development and introduction of new network management techniques and capabilities for surveillance and control. This includes the development of new or improved controls which may be necessary due to the introduction of new services or the transition to ISDN. These functions are normally performed by the ‘‘network management development’’ point (see Recommendation E.414).

2 Development of plans

2.1 A comprehensive network management plan would include some or all of the following, as appropriate:

— Key indicators or criteria which should be used to decide when a plan should be implemented.

— The identification of destinations or points likely to be affected, along with an assessment as to the likely impact on originating and/or terminating traffic.

— Control actions which may be required or that should be considered locally and in distant locations. This includes the identification of temporary alternative routings which may be available for use, and the modifications to automatic controls which may be necessary.

— Special call handling procedures to be used by operators, and notification requirements.

— Communication requirements. This includes identification of the necessary information flows between the network management centre and other organizations which may be involved or may have information concerning the problem (such as maintenance and operator centres).

— Data requirements. This includes determining what information may be relevant and where it is available.

— Key events or milestones. These are critical elements which can measure the success or progress of a plan, and indicate when certain actions should begin or end.

2.2 Regardless of the format or detail in a plan, it will not be fully effective unless it is readily available and understood by all who may be involved including other Administrations. This requires that network management plans be reviewed on a regular basis. Plans should be reviewed to ensure that they reflect changes or additions that may have taken place in the network since the plan was prepared. This is particularly important for plans which are used

infrequently. Attention should be directed to changes in routing, the introduction of new circuit groups, new exchanges or common channel signalling, or the addition of new network management capabilities since the plan was first developed.

2.3 When developing network management plans, it is important that they be flexible and, if possible, contain a number of alternatives. This is necessary because a planned action may not be viable or available at a given time, for example:

— it may be under consideration for the same or another problem,

— it may already be in use for some other purpose,

— a planned transit point may not be available due to congestion or a lack of spare capacity to or from the transit point at the time.

3 Peak day planning

3.1 There are a number of days which give rise to heavy calling in the international network. These usually correspond to certain religious or national holidays. Plans should be developed for those holidays which have resulted, or are expected to result, in unusually heavy traffic.

Peak-day calling can result in significant and sustained blockages in the network. This can be caused by two factors:

— the average length of conversation on a peak day in many cases can be significantly longer than on a normal business day;

— the calling pattern (which is usually residential in nature) may be different than the normal pattern (which is usually business-oriented).

A combination of these factors can result in a network that is highly congested and which requires careful planning and extensive network management controls to optimize service and revenues.

It should be noted that many peak calling days may also be public holidays. As a result, staffing in telephone exchanges and administrative offices may be minimal and some traffic data and service measurements may not be readily available. These factors should also be considered in peak-day planning.

3.2 Peak-day plans may include information on the following, as appropriate:

— Network management staffing requirements and expected hours of operations, and the exchange of such information with other network management centres.

— Provision of temporary additional circuits.

— Directionalization of both-way circuits where appropriate.

— Temporary alternative routings to take advantage of anticipated idle capacity.

— Controls to inhibit alternate routing via transit points that are expected to be congested.

— Identification of anticipated hard-to-reach points and planned controls to reduce attempts to hard-to-reach points.

— Special calling procedures for operators, including the exchange of network status information with operator centres.

— Advance testing of new controls, or those infrequently used (including the testing of the rerouting to ensure proper operation and the ability to complete to a terminating number via the transit point).

— Consideration of limiting installation and maintenance activity just prior to the peak day to only essential work in order to insure that all available circuits and switching equipment are in service.

— Procedures to take into account special situations, such as inter-ISC circuit groups, circuit multiplication systems, etc.

4 Transmission system failure planning

4.1 The impact on service of the failure of an international transmission system will depend on a number of variables:

— the size of the failed transmission system and its relationship to the total network capacity;

— its loading (the number of channels that are assigned for use) (this may change frequently);

— the destinations and/or services assigned to the transmission system and their relationship to their respective totals (this may change frequently);

— the traffic intensity during the period from the onset of a failure until restoration or repair (this can vary significantly);

— the duration of the failure (this is usually unpredictable);

— the availability of restoration capacity (this can vary).

Thus, it can be seen that it is difficult, if not impossible, to predict the precise impact on service of a failure at a given point in time. However, recognizing the increasing size and loading of modern transmission systems, the impact of a failure on service can often be severe, and as a result, significant effort has been expended by Administrations to develop and refine transmission system failure restoration plans.

Experience has shown that network management actions can also play a significant role in minimizing the adverse impact of failures on service. However, it should be noted that these network management actions will usually complement or enhance a transmission failure restoration plan and do not necessarily supplant the need for such plans. For short duration failures, e.g., solar interference on satellites, network management plans may be the only viable solution.

4.2 When an international transmission system fails, network management and transmission restoration activities should proceed in parallel on a coordinated basis.

— The network management centre will become aware of the impact of a failure on service via its network surveillance capacity; in some cases, this will occur before the specific details of the failure are known. The network management centre can identify the affected routes, destinations and/or services. This information will guide the application of network management controls and may also be useful to the restoration control point (Recommendation M.725) in setting priorities for restoration.

— The first response of the network management centre should be to consider the use of temporary alternative routings in order to complete traffic which is being blocked by the failure. In many cases, these actions can begin immediately, before the decision is made to activate a transmission restoration plan.

— If significant congestion continues despite the expansive controls, protective controls should be considered. Emphasis should be placed on the identification of destinations that are hard-to-reach and the selective reduction of traffic to these points so that the remaining network can be used by traffic with a higher probability of success.

4.3 It is recommended that a network management plan for the failure of a major international transmission system should include the following, as appropriate:

— identification of destinations or points affected for originating and terminating traffic,

— temporary alternative routings which may be utilized to bypass the failure, and hours of availability,

— notification lists,

— special call handling procedures for operators,

— controls which may be required in connected networks,

— controls to be requested of distant network management centres,

— actions to be taken after fault correction to restore the network to its normal configuration,

— special recorded announcements to customers, when necessary.

5 International exchange failure planning

5.1 The impact on service of the failure of an international exchange will depend on a number of variables, which include:

— whether there is a single or multiple international exchange(s),

— the routing plan and the distribution of circuit groups among the international exchanges,

— the traffic intensity during the failure,

— the duration of the failure,

— the size (capacity) and the current loading of the failed exchange, and its relationship to the total international switching capacity.

In any case, the failure of an international exchange usually will have a severe impact on service. Network management exchange failure plans can provide considerable benefits during the failure by limiting the spread of congestion to connected exchanges and providing alternative ways of routing traffic to bypass the failed exchange.

5.2 It is recommended that a network management exchange failure plan should include the following information, as appropriate:

— general information about the exchange and its function in the network, including diagrams of the normal network configuration and the reconfigured network during a failure,

— actions to be taken to verify a total failure of an exchange to differentiate it from certain fault recovery actions in SPC exchanges which may, at first, appear similar,

— notification lists,

— initial control actions to be taken upon verification of exchange failure,

— additional control actions to be taken based on the prognosis of the failure,

— controls to be applied within the national network,

— controls to be requested of distant network management centres,

— modifications which may be required to automatic controls,

— sequence of control removal when the exchange is restored to normal operation.

5.3 It is recommended that network management exchange failure plans be reviewed and up-dated whenever a significant change in network configuration occurs, or at least annually. A network management exchange failure plan should be prepared for a new international exchange before it is introduced into the network.

6 Common channel signalling (CCS) failure planning

6.1 When a failure in the common channel signalling system interrupts the flow of traffic, the affected traffic may be diverted by network management controls to other unaffected circuits groups. It is preferable that these actions be planned in advance. These plans should identify the modifications to the automatic CCS flow control responses which may be required in the exchanges to permit the planned actions to be taken [for example, to change the normal programmed response to the receipt of a transfer prohibited signal (TFP)].

6.2 It should be noted that, as more of the international network converts to common channel signalling, the availability of potential alternative routings may become limited, which will increase the need for careful planning.

7 Mass-calling planning

7.1 Uncontrolled mass-calling has the potential to seriously disrupt calling in the network. However, with proper planning, the adverse effects of many mass-calling situations may be minimized. The key to success is advance warning and interdepartmental cooperation and planning.

This requires that the Administration be alert to potential mass-calling situations so that the proposed use of the network can be evaluated in advance to determine the potential for congestion. When congestion appears likely, alternative serving arrangements may be proposed, which may include the use of network management controls.

7.2 With widespread availability of call-gapping controls (see Recommendation E.412), certain mass-calling applications may be provided without harm to the network. The call-gap controls can be set at each exchange to limit outgoing calls to only the amount necessary to keep the called lines filled. It must be noted, however, that no mass-calling control strategy can

prevent originating congestion and dial tone delays in local exchanges if a large number of customers simultaneously attempt to dial a service or specific number.

8 Disasters

Disasters can be natural (for example, a typhoon, an earthquake) or man-made (an airplane or railroad accident). These events can result in either damage to network facilities or in an extraordinary number of calls, or both. While it is difficult to predict such a disaster, the effects of a disaster on the telephone network can be predicted with some degree of accuracy and plans developed accordingly. These plans should include:

— contact and notification lists,

— control actions required locally and/or in other Administrations,

— arrangements for additional staffing and extended hours of operation.

(See Recommendation E.411, § 6.5.)

9 Planning for the introduction of new services

The introduction of new services in the network may result in new or unusual traffic flow characteristics, and/or unusual traffic demand, particularly when there is strong initial interest in the new service. Therefore, the potential impact on the network of a new service should be evaluated to identify where congestion or deteriorated service might occur, and to identify what special network management surveillance and control capabilities may be required. It is important that this analysis take place well in advance of the planned service availability date, so that the necessary modifications to the exchange and/or network management operations system software can be completed in a timely manner. This will help to insure that the necessary surveillance and control capabilities will be available when the new service is introduced.

10 Negotiation and coordination

10.1 Administrations should exchange information concerning their network management capabilities as part of the network management planning process. Specific plans should be negotiated in advance on a bilateral or multilateral basis, as appropriate. Negotiation in advance will allow time to fully consider all aspects of a proposed plan and to resolve areas of concern, and will permit prompt activation when needed.

10.2 The use of any network management plan must be coordinated with the involved Administrations at the time of implementation. This will include (as appropriate):

— determining that planned transit exchange(s) have switching capacity to handle the additional traffic,

— determining that there is capacity in the circuit group(s) between the planned transit point and the destination,

— advising the transit Administration(s) that transit traffic will be present in its circuit groups and exchanges,

— arranging for the activation of controls at distant locations,

— arranging for surveillance of the plan while in effect to determine the need to modify the plan.

When the use of a plan is no longer required, all involved Administrations should be notified of its discontinuance, so that the network can be restored to its normal configuration.

Recommendation E.414

INTERNATIONAL NETWORK MANAGEMENT — ORGANIZATION

1 Introduction

The required high degree of cooperation and coordination in international network management can best be achieved by efficient and effective interworking between international network management organizations in the various countries. This Recommendation specifies the organizational elements necessary for this purpose, and outlines the functions and responsibilities of each element.

Only those organizational elements vital to the network management development, planning, implementation and control of the international network are dealt with in the Recommendation. It is recognized that other functions must necessarily be carried out within the network management organization, either in support of the functions specified below or in connection with the management of the national network.

It is also recognized that Administrations may not wish to assign each element to a separate staff or create a separate organization. Administrations are, therefore, afforded the freedom to organize such functions in a manner which best suits their own situation and the level of development of network management.

2 International network management — organization

2.1 As far as international cooperation and coordination are concerned, network management should be based on an organization comprising the following elements, all of which should exist in each country practicing international network management:

a) network management planning and liaison;

b) network management implementation and control;

c) network management development.

Each element represents a set of functions and reponsibilities, and are further defined in §§ 3 to 5.

2.2 At the discretion of the Administration concerned, the elements defined in §§ 3 to 5 below can be grouped together in a single organizational entity, for example, an International Network Management Centre This is likely to be the most convenient and efficient approach where the level of development and degree of practice of network management is high. Where such an approach is not possible, or is impractical, international network management functions could be carried out at locations where related activities are performed. § 6 offers specific guidance on the relationship between network management and network maintenance, and includes consideration for the possible combining of organizational elements involved in the two fields of activity.

2.3 Irrespective of which arrangement an Administration decides for its international network management organization, it must ensure that the functions and responsibilities of a particular organizational element are not divided between two separate locations. Administrations can then issue a list of contact point information (see § 7 for guidance) which will give telephone, telex numbers, service hours etc. for each element.

3 Network management planning and liaison

3.1 Network management planning and liaison is an element within the international network management organization. It is concerned with liaising with other Administrations to develop plans to cater for unforeseen high traffic levels and any other situation likely to adversely affect the completion of international calls.

3.2 Network management planning and liaison is responsible for the following set of functions:

a) liaising with similar points in other Administrations to determine the actions necessary to overcome unforeseen high traffic levels and other situations adversely affecting the completion of international calls;

b) producing plans to cater for the abnormal traffic levels produced by foreseen national and international events;

c) liaising with the restoration liaison officer (RLO) within the Administration concerning network management plans for failures and planned outages;

d) liaising with similar points in other Administrations to establish the required actions when plans to overcome abnormal situations cannot be implemented;

e) ensuring that the facilities and network management controls required for the rapid implementation of agreed plans are available and ready for use when required.

4 Network management implementation and control

4.1 Network management implementation and control is an element within the international network management organization. It is concerned with monitoring the performance and status of the network in real time, determining the need for network management action, and, when necessary, implementing and controlling such action.

4.2 Network management implementation and control is responsible for the following set of functions:

a) monitoring the status and performance of the network;

b) collecting and analysing network status and performance data;

c) determining the need for the control of traffic as indicated by one or more of the following conditions:

— the failure or planned outage of an international or national transmission system,

— the failure or planned outage of an international or national exchange,

— congestion in an international exchange,

— congestion in a distant network,

— congestion to an international destination,

— heavy traffic caused by an unusual situation;

d) applying or arranging for network management control action, as described in Recommendation E.411, and Recommendation E.412;

e) liaising and cooperating with similar points in other Administrations in the application of network management controls;

f) liaising with the fault report point (network) within the Administration concerning the exchange of information available at either point;

g) liaising with the restoration control point within the Administration concerning failures and planned outages;

h) disseminating information as appropriate within its own Administration concerning network management actions which have been taken.

5 Network management development

5.1 Network management development is an element within the international network management organization. It is concerned with the development and introduction of techniques and facilities for the purpose of network management surveillance and control at the international level, although it may also have similar responsibilities for the national network.

The fault report point (network) is a functional element in the general maintenance organization (see Recommendation M.716).

The restoration control point is a functional element in the general maintenance organization (see Recommendation M.725).

5.2 Network management development is responsible for the following set of functions:

a) developing facilities to enable the application of current network management techniques;

b) long range planning for the coordinated introduction of new network management techniques and improved network surveillance and controls;

c) evaluating the effectiveness of current plans, controls and strategies with a view to identifying the need for improved controls, control strategies and support systems, particularly those which may be required for new services and the ISDN.

6 Cooperation and coordination between network management and network maintenance organizations

Considerable benefit may be obtained by close cooperation and coordination between the network management organization identified in this Recommendation and the network maintenance organization identified in the M.700 series of Recommendations. For example, reports of network difficulties received by the fault report point (network) in the maintenance organization may assist the network management implementation and control point in refining its control action. Similarly, difficulties reported to the fault report point (network) may be explained by information already available to the network management implementation and control point. For this reason, and to take into account the particular operating situation and stage of development of network management within an Administration, some of the functional elements identified in this Recommendation may be located with one of the groupings of functional elements of the network maintenance organization as outlined in Recommendation M.710.

Where it is advantageous to create a separate international management centre containing the elements defined above, care should be taken to ensure that suitable liaison and information flows occur between such a centre and the network maintenance organization.

7 Exchange of contact point information

For each of the three organizational elements in §§ 3 to 5 above, Administrations should exchange contact point information. Network management contact points should be exchanged as part of the general exchange of contact point information as specified in Recommendation M.93.

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