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SERIES Q: SWITCHING AND SIGNALLING

International automatic and semi-automatic working –
Signalling for circuit multiplication equipment

Signalling between signal processing network equipments (SPNE) and international switching centres (ISC)

ITU-T Recommendation Q.55

ITU-T Q-SERIES RECOMMENDATIONS
SWITCHING AND SIGNALLING

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ITU-T Recommendation Q.55

**Signalling between signal processing network equipments (SPNE)
and international switching centres (ISC)**

Summary

This ITU-T Recommendation describes a signalling interface, procedures, and protocol required between an International Switching Centre (ISC) and Signal Processing Network Equipment (SPNE). This signalling interface provides for the call by call control of an SPNE in real time to ensure an appropriate signal enhancement capability such as echo control. The framework of this signalling interface allows for growth for the control of potential further SPNE types.

FOREWORD

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NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

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CONTENTS

Introduction

There is a need in networks for signal processing equipment, including echo cancellers, automatic level controllers, frequency equalizers, noise reducers, A-Law to μ-Law converters, etc. This equipment needs to be controlled on a call by call basis, to ensure the highest possible transmission quality.

This ITU-T Recommendation describes signalling interface procedures and protocols required between an International Switching Centre (ISC) and Signal Processing Network Equipment (SPNE). This signalling interface enables an SPNE to be controlled in real time, on a call by call basis, to ensure that the appropriate signal enhancement capability and parameters are provided for the call. This is referred to as Per-Call-Control (PCC). The framework of this signalling interface allows for growth for the control of potential further SPNE types. This signalling interface can be used to facilitate the efficient support of existing and further signal processing equipment at the international interface, such as echo cancellation, automatic level control, noise reduction, frequency equalization, A-Law to μ-Law converters and other capabilities. It can be used to ensure that the appropriate capabilities are enabled or disabled on a call by call basis.

The method by which a switch determines whether a Signal Processing Function (SPF) should be enabled or disabled is not covered by this ITU-T Recommendation.

This ITU-T Recommendation includes both the upper layer protocol and references to lower layers of the signalling interface. Lower layers include Data Link for 1544 kbit/s facilities, timeslot 0 or 1 – "n" for 2048 kbit/s facilities, a local area network interface, and a Signalling System No. 7 interface with simplified MTP.

ITU-T Recommendation Q.55

**Signalling between signal processing network equipments (SPNE)
and international switching centres (ISC)**

(Geneva, 1999)

1 Scope

This ITU-T Recommendation describes a signalling interface between an International Switching Centre (ISC) and Signal Processing Network Equipment, referred to as an SPNE. This ITU-T Recommendation covers the following SPFs: echo control devices, noise reduction devices, automatic level control devices, A-law/µ-law converters and frequency equalization devices. Left for further study are additional SPF types, such as PCM offset converters, etc. This interface can be supported in a facility-related manner using the Data Link (DL) of 1544 kbit/s facilities or any timeslot including timeslot 0 of 2048 kbit/s facilities. The interface can also be supported using a Local Area Network (LAN) or Signalling System No. 7 (SS7). This ITU-T Recommendation is specifically concerned with the transfer of signalling information on a per-call-control basis between the ISC and the SPNE, and for controlling various functions contained in the SPNE.

This ITU-T Recommendation defines several signalling protocol architectures; however, it is not necessary that an ISC or SPNE support all of them.

The signalling interface defined in this ITU-T Recommendation assumes a fixed relationship between the circuits of the ISC and the SPNE.

While this ITU-T Recommendation is intended for use on international networks, the information defined here may be used within national networks.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision: all users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published.

- ITU-T Recommendation G.165 (1993), *Echo cancellers*.

- ITU-T Recommendation G.168 (1997), *Digital network echo cancellers*.

- ITU-T Recommendation G.169 (1999), *Automatic level control devices*.

- CCITT Recommendation G.703 (1991), *Physical/electrical characteristics of hierarchical digital interfaces*.

- ITU-T Recommendation G.704 (1998), *Synchronous frame structures used at 1544, 6312, 2048, 8448 and 44 736 kbit/s hierarchical levels*.

- CCITT Recommendation G.711 (1988), *Pulse code modulation (PCM) of voice frequencies*.

- ITU-T Recommendation Q.50 (1993), *Signalling between circuit multiplication equipments (CME) and international switching centres*.

- ITU-T Recommendation Q.115 (1997), *Logic for the control of echo control devices*.

–　　　CCITT Recommendation Q.422 (1988), *Clauses for exchange line signalling equipment*.

–　　　ITU-T Recommendation Q.701 (1993), *Functional description of the message transfer part (MTP) of Signalling System No. 7*.

–　　　ITU-T Recommendation Q.704 (1993), *Signalling System No. 7 – Signalling network functions and messages*.

–　　　CCITT Recommendation Q.710 (1988), *Simplified MTP version for small systems*.

–　　　ITU-T Recommendation Q.921 (1997), *ISDN user-network interface – Data link layer specification*.

–　　　CCITT Recommendation Q.940 (1988), *ISDN user-network interface protocol for management – General aspects*.

–　　　IEEE Std 802 (1990), *Local and Metropolitan Area Networks: IEEE Standards: Overview and Architecture*.

3　　　Definitions

This ITU-T Recommendation defines the following terms:

3.1　　　A-law – μ-law converter (AMC): An A-Law – μ-Law converter is a device that converts a received PCM signal sample from A-Law to μ-Law in one direction, and μ-Law to A-Law in the other.

3.2　　　automatic level controller (ALC): An automatic level controller is defined as an SPF located in the digital transmission path that automatically adjusts the level of a signal towards a predetermined value. Devices that modify the frequency response or spectral content of the signal are also covered by this definition. The telecommunications carrier and the ALC manufacturer will typically agree upon features to be included. See ITU-T Recommendation G.169.

3.3　　　channel: Used herein to refer to a 64 kbit/s digital circuit occupying a specific position in a frame.

3.4　　　channel associated signalling (CAS): CAS refers to the channel associated signalling referred to in G.704.

3.5　　　data link (DL): A 4 kbit/s channel derived from the multi-frame alignment signal in the 1544 kbit/s multiplexed digital signal defined in ITU-T Recommendation G.704.

3.6　　　E1 facility: A transmission link operating at 2048 kbit/s, supporting 30 or 31 64 kbit/s channels.

3.7　　　echo canceller device (ECD): An echo canceller device is an SPF that is able to remove some or all of the returned echo signal from a voice circuit. It operates by monitoring the speech signal sent to a voice circuit, and by comparing this signal with the signal received from the circuit, is able to determine what components of the returned signal are caused by an echo path in the circuit. It then is able to remove some or all of the returned echo, providing a voice circuit that is free or nearly free from the echo signal. ITU-T Recommendations G.165 and G.168 describe echo canceller performance.

3.8　　　facility related (FR): A signalling channel carried within the bit stream of a 1544 kbit/s or 2048 kbit/s facility, carrying information related to the speech channels integral to this facility.

3.9　　　frequency equalizer (FE): A frequency equalizer is a device capable of amplifying or attenuating certain frequencies of a speech channel. It is a subset of an automatic level controller (see above).

3.10   functional entity (In telecommunications service provision applications): A grouping of service providing functions in a single location and a subset of the total set of functions required to provide the service. An entity that comprises a specific set of functions at a given location. (From Q.1290.)

3.11   group: An assembly, by digital multiplexing, of digital signals occupying a specified number of timeslots to form a composite signal having a bit rate of 2048 kbit/s or 1544 kbit/s.

3.12   incoming echo control device (IECD): An incoming echo control device cancels the echo returned from the destination network with reference to the direction in which the call is set up. An IECD is normally located at the destination end of the call. However, it may be located at or near the origination end of the network if its echo processing capability is sufficient to handle the round trip delay from origination end to the destination end and back.

3.13   local area network (LAN): A shared, 10 or 100 Mbit/s signalling interface with a transport defined by IEEE and an application component defined in this ITU-T Recommendation.

3.14   message associated signalling (MAS): MAS refers to the message oriented signalling using LAPD as referred to in G.704.

3.15   noise reduction device (NRD): A noise reduction device is an SPF that is able to remove some or all of the unwanted noise component from a voice signal. It operates by monitoring the noise and speech signal received from or sent to a voice circuit, and by using a noise reduction algorithm that distinguishes unwanted noise from real speech, is able to remove some or all of the noise signal, providing a voice circuit which is free or nearly free from the noise signal. There is as yet no ITU-T Recommendation that specifies the performance of a noise reduction device. The telecommunications carrier and the NRD manufacturer will typically agree upon noise reduction features to be included.

3.16   non-facility related: A signalling channel not carried within the bit stream of a 1544 kbit/s or 2048 kbit/s facility, carrying information related to the channels integral to this facility.

3.17   outgoing echo control device (OECD): An outgoing echo control device cancels the echo returned from the origination network with reference to the direction in which the call is set up. An OECD is normally located at the origination end of the call. However, it may be located at the destination end of the network if its echo processing capability is sufficient to handle the round trip delay from destination end to the origination end and back.

3.18   PCM offset controller (for further study): A PCM offset controller is an SPF capable of removing PCM offset from a received A-Law or μ-Law voice signal. PCM offset is a constant positive or negative bias contained in the PCM voice signal, such that a zero analogue input voltage results in a constant, non-zero PCM digital output.

3.19   protocol entity (PE): The PE is that part of a layer entity which is dedicated to peer-to-peer communications. A layer PE provides services to the next upper layer and uses services of the next lower layer (refer to Q.940).

3.20   physical entity: A physical entity contains one or more functional entities.

3.21   signal processing function (SPF): A function such as echo cancellation or automatic noise reduction that is contained within an SPNE. An SPNE contains one or more SPFs.

3.22   signal processing network equipment (SPNE): Type of equipment which contains one or more signal enhancement functions on speech channels passing through it. Examples include echo cancellers, noise cancellers, automatic level controllers, frequency equalizers, A-law to μ-law converters and PCM offset controllers. An SPNE as referred to in this ITU-T Recommendation is external to an ISC.

3.23   T1 facility: A transmission link operating at 1544 kbit/s supporting 24 speech channels.

4 Abbreviations

This ITU-T Recommendation uses the following abbreviations:

ALC   Automatic Level Controller

AMC   A-Law – μ-Law Converter

CAS   Channel Associated Signalling

DL   Data Link

ECD   Echo Control Device

FE   Frequency Equalizer

FR   Facility Related

IECD   Incoming Echo Control Device

ISC   International Switching Centre

LAN   Local Area Network

MAS   Message Associated Signalling

MTP   Message Transfer Part

NLP   Non-Linear Processor, a component of an echo canceller

NRD   Noise Reduction Device

OECD   Outgoing Echo Control Device

PCC   Per-Call-Control

PDU   Protocol Data Unit

PE   Protocol Entity

SPF   Signal Processing Function

SPNE   Signal Processing Network Equipment

SPNEUP   Signal Processing Network Equipment User Part

SS7   Signalling System No. 7

5 Architecture

Q.55 includes both a network-oriented architecture and a protocol-oriented architecture.

5.1 Network oriented architecture

The network architecture deals with where SPNE equipment is located in the network.
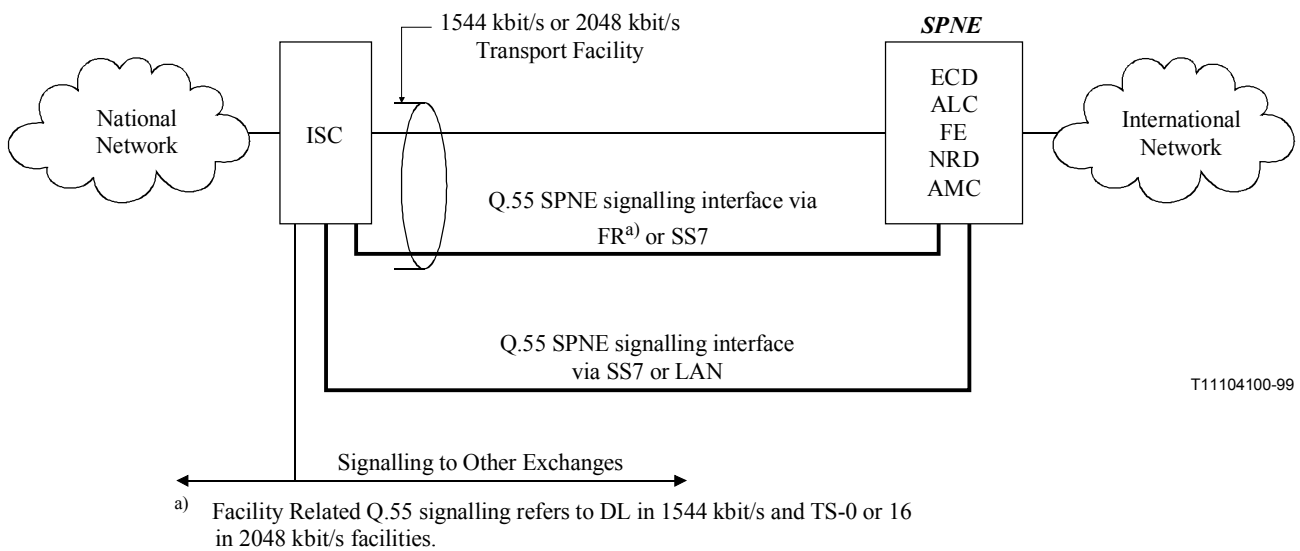
Figure 5-1a/Q.55 – Network Architecture

An SPNE can contain one or more of the Signal Processing Functions as illustrated in Figure 5-1a. Figure 5-1b shows a CAS arrangement, Figure 5-1c shows a control architecture where different SPFs within the same SPNE associated with 1544 kbit/s or 2048 kbit/s facilities are controlled with PCC signalling using LAN or SS7. Figure 5-1d is similar but with PCC signalling using Facility Related control signalling in 1544 kbit/s and 2048 kbit/s facilities. Figure 5-1e illustrates more than one SPNE on a single facility that can be controlled by any of the control methods in this Recommendation with the exception of CAS.

Definitions of each of these devices can be found in clause 3. Note that not all of these devices are yet covered by ITU-T Recommendations on equipment or performance.

SPF Signal Processing Function
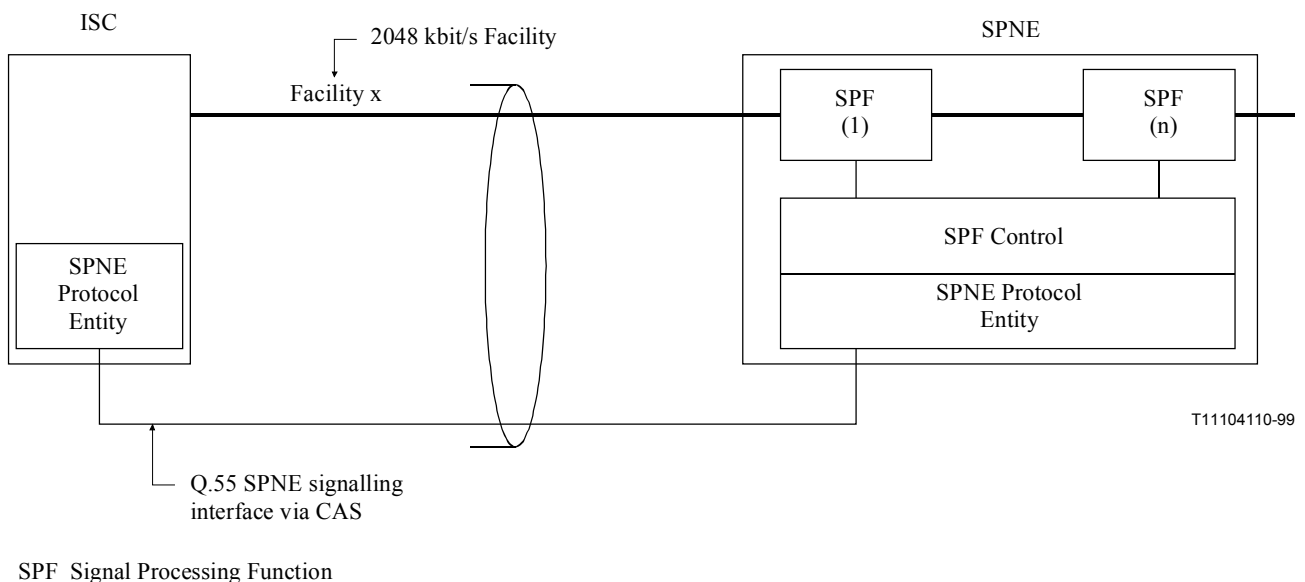
Figure 5-1b/Q.55 – CAS based interface

Figure 5-1c/Q.55 – LAN or SS7 based interface

Figure 5-1d/Q.55 – Facility related signalling to multiple SPNEs

NOTE – An SPNE physical entity may contain multiple SPNE functional entities.
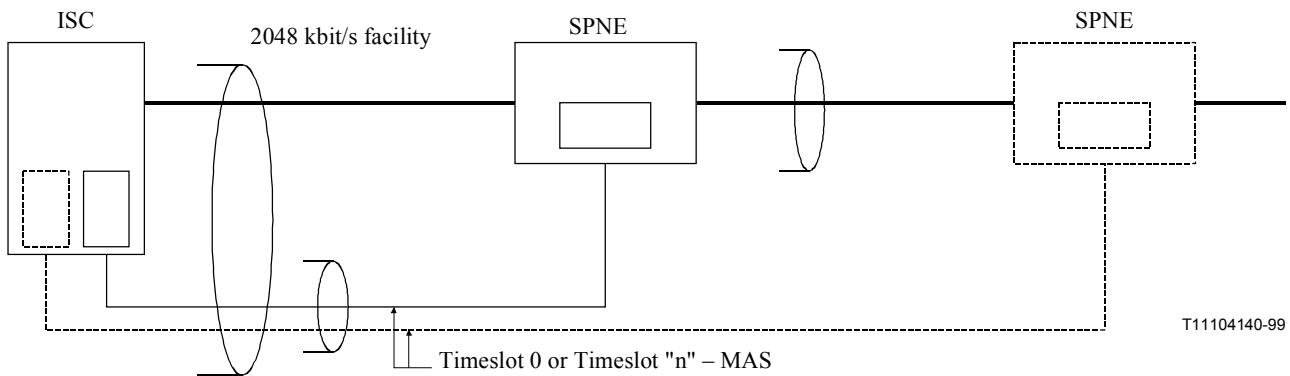
Figure 5-1e/Q.55 – Multiple SPNEs on a single transport facility

Figure 5-2 below illustrates the various locations in which SPNEs can be located within a network. Figure 5-2a is the traditional arrangement, Figure 5-2b positions combined associated SPNEs on the national network side of the ISC, and Figure 5-2c positions combined associated SPNEs on the international network side of the ISC.
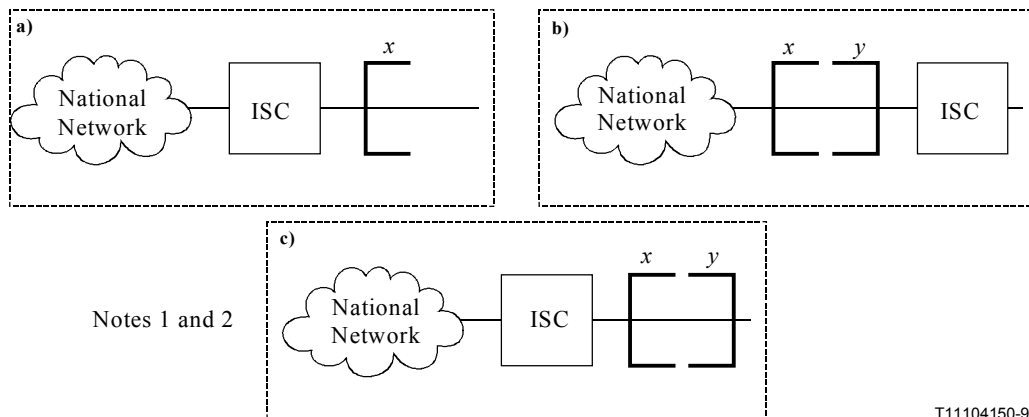
NOTE 1 – *x*: This direction treats speech arriving from the national network side. For an international incoming call, it is an incoming SPF (IECD in case of an ECD). For an outgoing call, it is an outgoing SPF (OECD in the case of an ECD). *y*: This direction treats speech arriving from the international network side. For an international incoming call, it is an outgoing SPF (OECD in the case of an ECD). For an outgoing call, it is an incoming SPF (IECD in the case of an ECD).
NOTE 2 – SPNEs *x* and *y* may be separate devices or they may be combined into a single device. In the case where they are echo cancellers, this configuration is referred to as a "combined associated echo canceller".

Figure 5-2/Q.55 – Location of SPFs within a Network

Figure 5-3 below illustrates the relationship between the Q.55 PCC signalling interface at the ISC and other relevant signalling protocols. These other signalling protocols include signalling to other exchanges for call and connection control. If a DCME is in the connection there may be a PCC interface to it using Q.50. Services requiring transmission enhancements performed by the SPNE may need to be indicated in ISDN-UP.

A DCME may be considered a special type of SPNE. Control of a DCME via the SPNE interface is for further study.
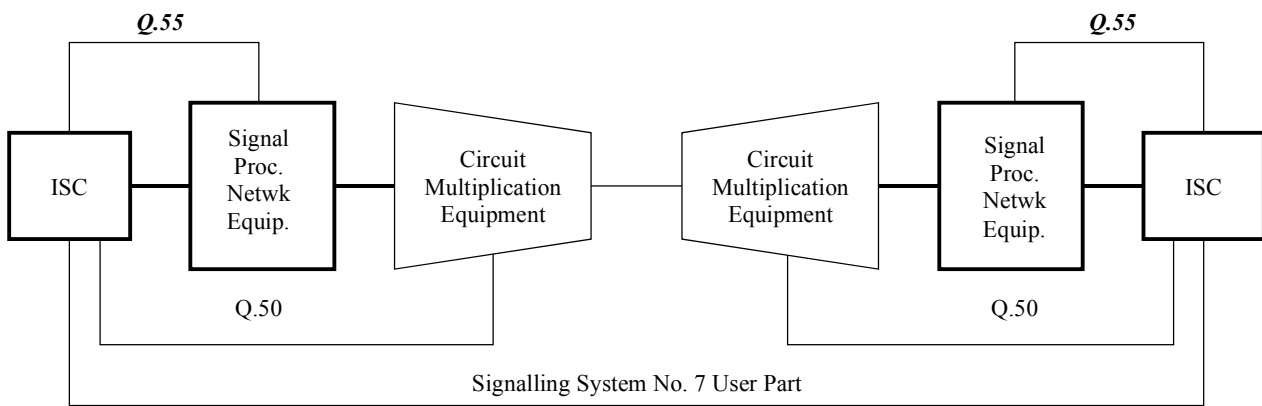
NOTE 1 – Circuit Multiplication Devices may or may not be included.
NOTE 2 – R2 or C5 Signalling may also be supported between ISCs.

Figure 5-3/Q.55 – Relationship of Q.55 to other signalling protocols

Figure 5-4 below illustrates the distribution of functional entities within call control signalling systems. Block A represents the SPNE on the Incoming side of the ISC. Block E represents the SPNE on the Outgoing side of the ISC. Blocks B and D represent the Incoming and Outgoing signalling system protocols, respectively, and Block C represents Call Control for echo control logic and the logic for enhanced services.

Signalling for enhanced services
e.g. Noise reduction, PCM Offset Control (FFS), etc.
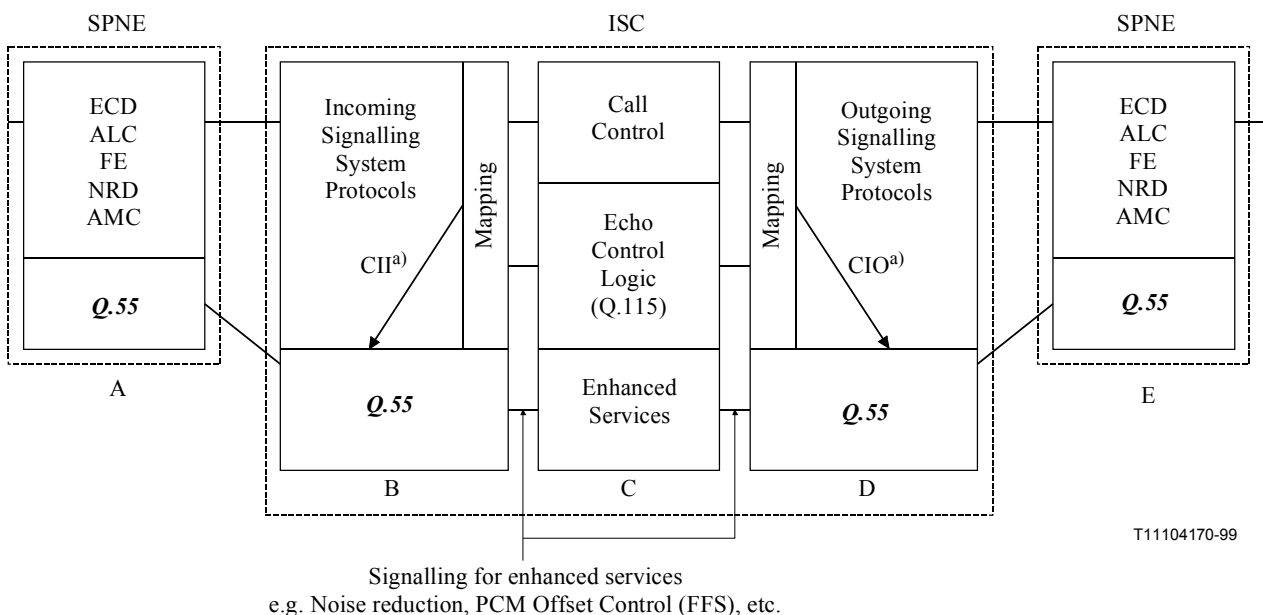
a) CII and CIO are defined in Recommendation Q.115

NOTE 1 – It is outside the scope of this ITU-T Recommendation to define how call control determines the requirements for SPNE functions. Q.115 should be used for echo control devices.
NOTE 2 – The functional entity associated with incoming and outgoing signalling systems protocols may be located in the same physical entity.

Figure 5-4/Q.55 – Distribution of functional entities

5.2 Protocol oriented architecture

The Q.55 protocol architecture consists of an upper layer protocol supported by a set of lower layer protocols, as illustrated in Figure 5-5a.
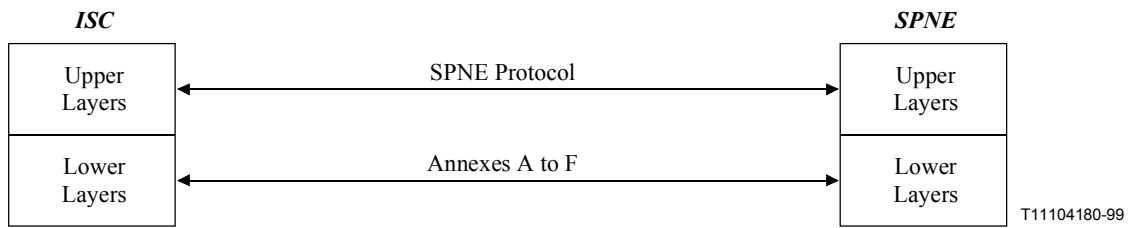
Figure 5-5a/Q.55 – Protocol architecture

An illustration of the protocol layers used when Q.55 is carried over CAS in 2048 kbit/s networks is shown in Figure 5-5b.
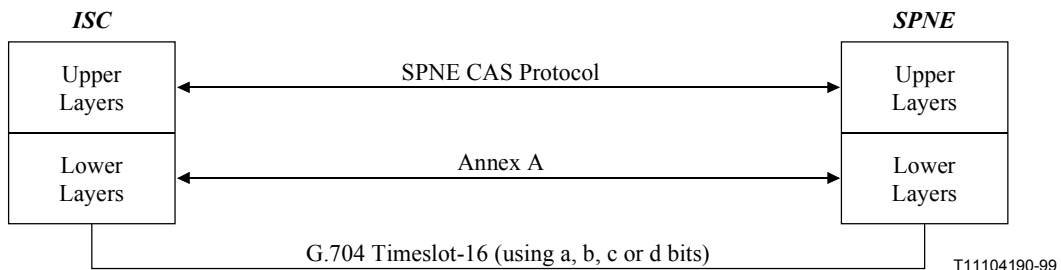
Figure 5-5b/Q.55 – CAS protocol architecture

An illustration of protocol layers that are used when Q.55 is carried over a facility-related MAS interface is illustrated in Figure 5-5c.
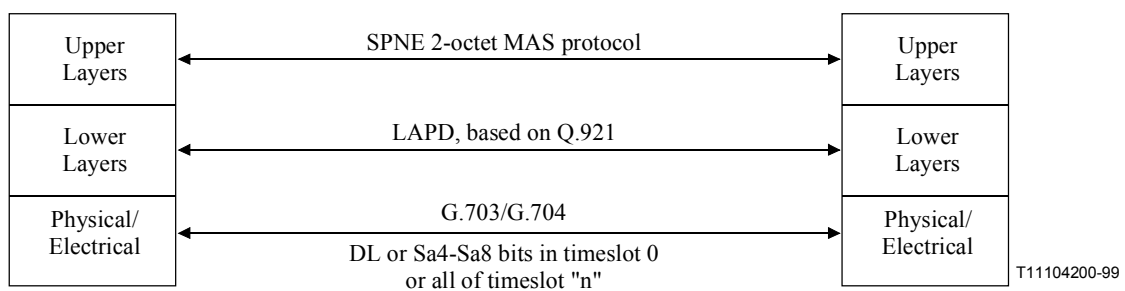
Figure 5-5c/Q.55 – Example of Q.55 Layers used for facility-related MAS

Figure 5-5d illustrates a PCC SPNE signalling protocol over a Local Area Network (LAN). In this arrangement, the PCC SPNE signalling is used as an application of the typical TCP/IP lower layers of an operating system of a LAN.
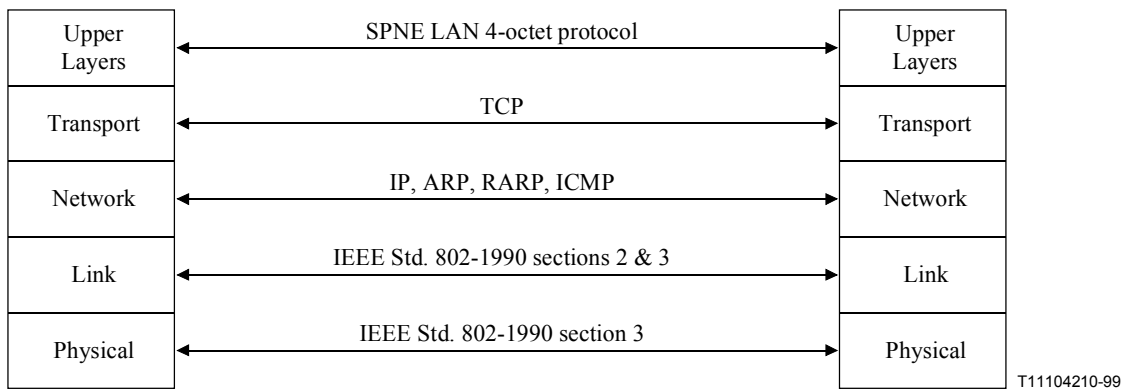
Figure 5-5d/Q.55 – Example of Q.55 interface via LAN

The protocol stack that is used when Q.55 is carried over an SS7 interface is illustrated in Figure 5-5e. In this case, the upper layer protocol is referred to as a Signal Processing Network Equipment User Part (SPNEUP).

Figure 5-5e illustrates a PCC SPNE signalling protocol over Signalling System No. 7 (SS7). In this arrangement, the PCC SPNE signalling is a user part of the Simplified Message Transfer Part (MTP).
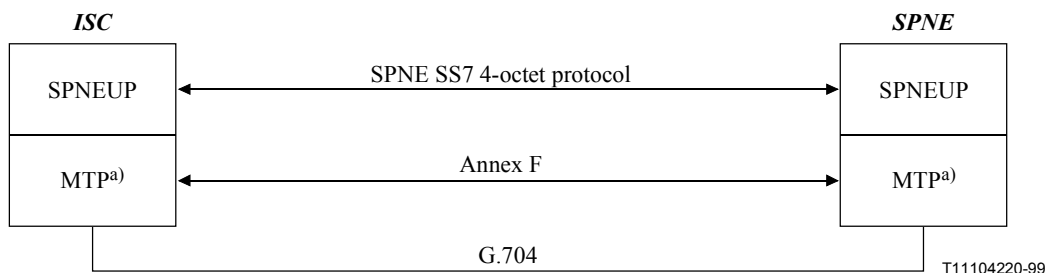
a)   Simplified MTP (Q.710)

Figure 5-5e/Q.55 – SS7 protocol architecture

5.2.1   Upper layer protocol architecture

The upper layer protocol receives control information from call control and the signalling system and transfers it to a peer protocol entity in Signal Processing Network Equipment.

It is beyond the scope of this ITU-T Recommendation how ISC call control determines the requirements for SPNE functions. This assumes that other ITU-T Recommendations are defining the call control logic to determine requirements for SPNE functions. ITU-T Recommendation Q.115 is such a document for echo control.

Figure 5-6 describes a family concept for the interface between an ISC and an SPNE.

Using facility related, message associated signalling in either 1544 kbit/s or 2048 kbit/s networks, a two-octet protocol is used. The DL channel is used in 1544 kbit/s networks, and either timeslot 0 or timeslot "n" can be used, where "n" = 1-31 in 2048 kbit/s networks

A channel associated signalling protocol using timeslot 16 in a 2048 kbit/s facility is also described.

Using non-facility related signalling such as LAN or SS7, a four-octet protocol is used. Procedures and protocols for both formats are described later in this ITU-T Recommendation.
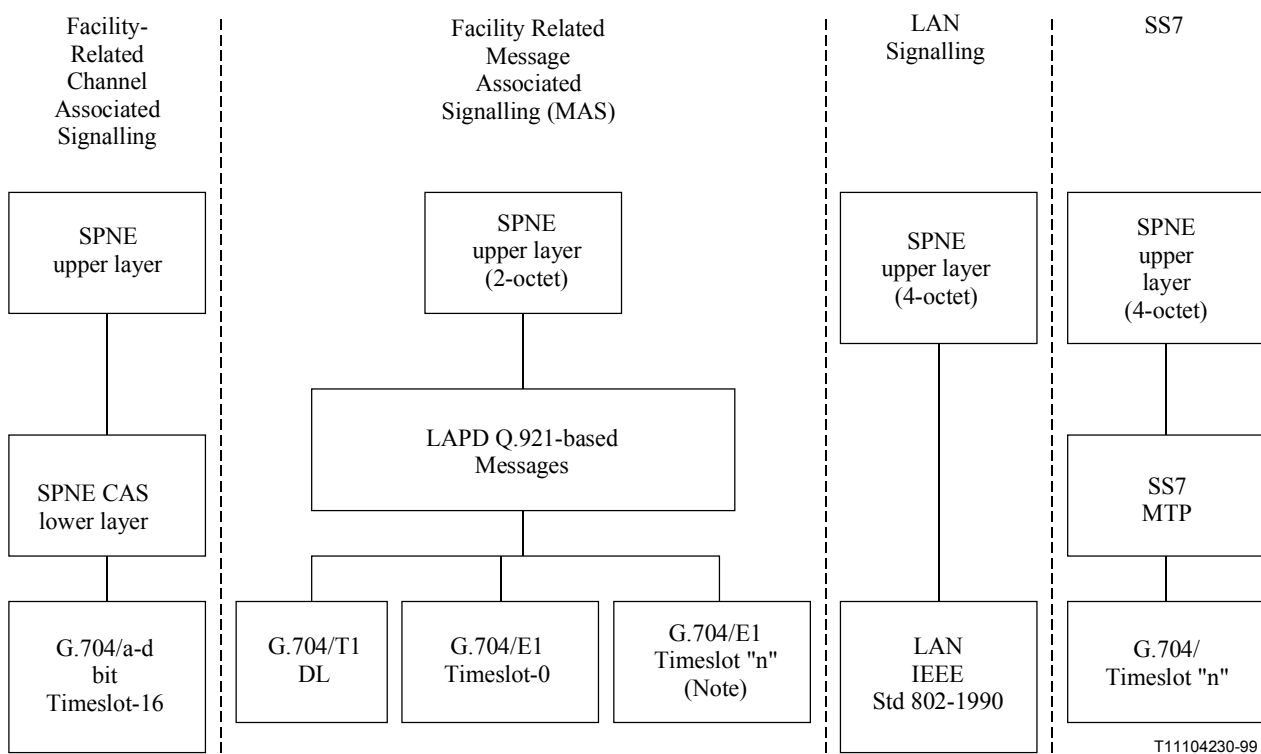
NOTE – Only 4 kbit/s of bandwidth are required for up to a 3-octet MAS message but a 64 kbit/s channel must be allocated. Combined CAS and MAS is not allowed.

Figure 5-6/Q.55 – Protocol architecture overview

5.2.2   Lower layer protocol architecture

Protocols that are used in this ITU-T Recommendation include:

- a CAS-based protocol using the a, b, c or d bits of timeslot 16 in 2048 kbit/s facilities;
- a MAS-based data link (DL) protocol in 1544 kbit/s facilities;
- a MAS-based protocol used in timeslot 0 of 2048 kbit/s facilities;
- a MAS-based, time-slot "n" protocol in 2048 kbit/s (E1) facilities;
- a Local Area Network (LAN) based protocol;
- a Signalling System No. 7 based protocol.

The CAS protocol is point-to-point, and can support only a single SPNE on an E1 facility.

The MAS protocol used for timeslot "n" can support from one to eight SPNEs on a single 2048 kbit/s facility.

In 2048 kbit/s CAS based networks, one or more of the a, b, c, d signalling channels in timeslot 16, described in 2.3.2/G.704 are used. Annex A describes the lower layer of this signalling method.

The SPNE signalling interface via 1544 kbit/s facilities uses the "m" bits, known as the DL. Since this m bit is also used for alarms, the capacity available for transporting the Q.55 protocol is approximately 4 kbit/s. A detailed description of the DL signalling channel can be found in 2.1.3 and 2.2.3.3 of ITU-T Recommendation G.704. Annex B describes the lower layer of this signalling method.

Annex C describes the Message Associated Signalling (MAS) protocol used in timeslot 0 of 2048 kbit/s networks.

Annex D describes the Message Associated Signalling (MAS) protocol used in timeslot "n" of 2048 kbit/s networks.

Annex E describes the Message Associated Signalling (MAS) protocol used on Local Area Networks (LAN).

Annex F describes the Message Associated Signalling (MAS) protocol used for SS7.

6 Signalling procedures

This clause describes the procedures at the ISC-SPNE interface, including the control elements incorporated into them for various types of signal processing functions.

The signalling interface defined in this ITU-T Recommendation comprises the ISC and the SPNE. The basic signalling function is to support the real time control of the SPFs contained in an SPNE to ensure that the appropriate signal enhancement function for a given speech channel is correctly configured and enabled, depending on the call type for that channel.

Signal processing functions that are controlled using the protocols described in this ITU-T Recommendation are described below. (Control of additional SPNE types is for further study.)

6.1 Normal procedures

6.1.1 ISC procedures

When an ISC determines that a signal processing function (SPF) needs to be enabled or disabled on a particular channel, it will create a message called a PCC Request Message to be transmitted to the SPNE. The PCC Request Message will contain the location and channel of the SPF (e.g. ECD, ALC, FE, NRD, AMC), and whether it is an incoming, outgoing, or combined associated SPNE (see 5.1 for a description of incoming and outgoing devices). In addition, it will include control elements for the various functions within the SPF, such as echo cancellation, non-linear processor, or comfort noise generator.

If more than one SPF requires control in an SPNE, the ISC sets the extension bit and appends additional control elements to the message.

For a LAN or SS7 configuration the manner in which the ISC determines the specific SPNE to be controlled is implementation dependent. In a CAS configuration this information is not required as there is only one SPNE that may be addressed. The procedure for determining which SPNE is to be controlled and its address is implementation dependent and outside the scope of this ITU-T Recommendation. In the case of LAN or SS7 signalling, additional addressing required to communicate with a specific SPNE can be found in the protocol section of this ITU-T Recommendation.

The SPNE may be configured to leave signal processing elements enabled or disabled as a default state. The specific default state used in the SPNE will determine the use and sequence of PCC Request Messages required for data and voice calls. The ISC must consider the default method being used. Voice connections refer to voice and voiceband data. Data connections refer to digital data.

Data connections

Where a data connection is being established and the SPNE is configured to leave any SPFs enabled as a default condition, then a PCC Request Message is sent to disable these SPFs for the channel selected. At the end of a data call, a PCC Request message is sent to enable these SPFs.

Where an SPF default is set to a disabled state, then no PCC Request Messages are necessary.

Voice connections

Where a voice connection is being established that requires use of a specific SPF and the SPNE is configured to leave this SPF disabled as a default state, then a PCC Request Message is sent to enable this SPF for the channel selected.

At the end of the voice call, a PCC Request Message is sent to disable the SPF.

Where the SPF default is set to the enabled state, then no PCC Request Messages are necessary.

Where a voice connection is being established that does not require the use of a specific SPF and the SPNE is configured to leave this SPF enabled as a default state, then a PCC Request Message is sent to disable this SPF for the channel selected. At the end of the voice call, a PCC Request Message is sent to enable this SPF.

Where the SPF default is set to disabled state, then no PCC Request Messages are required.

6.1.1.1   Acknowledgment

Acknowledgment messages are optional and for further study.

Where acknowledgment messages are used, the following procedures apply:

The ISC sends a Request message to order the execution of function(s) on an SPNE and starts a timer T. When the SPNE receives a Request message and can execute all of the functions ordered by it, the SPNE returns an Acknowledgment message that is the same as the Request message sent to the SPNE. The ISC then stops timer T.

If timer T expires, indicating that an Acknowledgment message has not been received, the switch recognizes that the ordered function(s) cannot be executed. Reference may be made to ITU-T Recommendation Q.115 for available ECD procedures in this case. Procedures for additional SPFs are for further study. The value of timer T is for further study.

6.1.2   SPNE procedures

When an SPNE receives a Request Message, it determines whether the SPF type matches its own.

If the message is the correct type, the SPNE analyses the message. It reads the incoming SPNE/outgoing SPNE bit, the channel number and the SPNE function or functions, and sends the appropriate commands to its signal processing functions.

The SPNE may be configured to leave SPFs enabled or disabled as a default state. The specific default state used in the SPNE will determine the use and sequence of Request Messages required for data and voice calls. Voice connections refer to voice and voiceband data. Data connections refer to digital data.

6.1.2.1   SPNE Acknowledgment

Acknowledgment messages are optional and for further study.

Where acknowledgment messages are used, the following procedures apply:

When the SPNE receives a Request message and can execute all of the functions ordered by it, the SPNE then returns the same message to the ISC.

6.2 Abnormal procedures

6.2.1 Abnormal ISC procedures (for further study)

6.2.1.1 Receipt of unreasonable signalling information messages by the ISC

An unreasonable message contains information not recognized by the ISC.

Unreasonable signalling information may be received at an ISC.

The following are considered unreasonable messages:

a)   The message length is less than or more than the number of octets required.

b)   An acknowledgment message is received that is different from the transmitted request message.

When an unreasonable message is detected, the message is ignored and flagged for maintenance purposes.

An unreasonable message can only be detected when the message is recognized.

6.2.1.2 Handling of unexpected messages by the ISC

An unexpected message is one which contains a message type that is within the set supported at this ISC, but is not expected to be received in the current signalling state.

An example of this would be an acknowledgment message received from an SPNE that is received when none is expected.

Unexpected messages are ignored and flagged for possible maintenance purposes. Additional procedures are for further study.

6.2.2 Abnormal SPNE procedures

6.2.2.1 Receipt of unreasonable signalling information messages at the SPNE

An unreasonable message contains information not recognized by the SPNE.

The following are considered unreasonable messages:

a)   The message length is less than or more than the number of octets required.

b)   The message coding does not match an acceptable code.

When an unreasonable message is detected, the message is ignored.

An unreasonable message can only be detected when the message is recognized.

6.2.2.2 Handling of unexpected messages at the SPNE

There are no unexpected messages at the SPNE.

6.3 Maintenance procedures

6.3.1 Connectivity test (optional)

The connectivity test, used only for LAN implementations, is a means for an ISC to verify correct addressing to control a specific SPNE using the facility tables in the switch. The initiation of the connectivity test may be preset or on demand, under control of the ISC. When a test is requested, the SPNE will respond with an 8-bit test pattern.

The ISC can request a connectivity test on a channel in order to verify routing and addressing to an SPNE derived from facility tables. The Request message selects the specific T1 or E1 facility and channel to be tested.

The ISC can request the timing interval for the response signal pattern from the SPNE in the PCC Request Message. The interval has 8 settings for a range of 1-8 seconds.

The connectivity test is not mandatory as part of the setup or tear-down PCC procedures.

6.3.1.1 ISC connectivity test procedures

When an ISC determines that an SPNE needs to be tested with the connectivity test, a test indicator is set in the PCC request message.

The ISC then waits a period of time T, and reads the appropriate incoming speech channel. It reads the bit pattern on this channel, and determines whether it matches the required test pattern.

If the pattern matches what is expected, the call proceeds. If the pattern does not match, the ISC selects another trunk circuit. If this trunk also fails, then the ISC releases the call.

6.3.1.2 SPNE connectivity test procedures

When an SPNE receives a connectivity test message via the LAN interface, it transmits within the 8-bits of the timeslot in the direction towards the ISC, an alternating "1/0" pattern, starting with the most significant bit on the designated channel for the designated timing interval.

At the time of the publication of this ITU-T Recommendation, no ITU-T SPNE equipment Recommendation yet exists that describes this test.

7 Detailed protocol description

7.1 Lower layer protocol description

Lower layer considerations used to support the SPNE protocols in this ITU-T Recommendation include:

- available bandwidth;
- switch access to channel;
- latency;
- bit error rate;
- transport protocol.

Details of the lower layer protocols are included in Annexes A to F.

Annex A describes the Channel Associated Signalling (CAS) protocol used in timeslot 16 of 2048 kbit/s networks.

Annex B describes the Message Associated Signalling (MAS) protocol used in the Data Link of 1544 kbit/s networks.

Annex C describes the Message Associated Signalling (MAS) protocol used in timeslot 0 of 2048 kbit/s networks.

Annex D describes the Message Associated Signalling (MAS) protocol used in timeslot "n" of 2048 kbit/s networks.

Annex E describes the Message Associated Signalling (MAS) protocol used on Local Area Networks (LAN).

Annex F describes the Message Associated Signalling (MAS) protocol used for SS7.

7.2 Upper layer protocol description

There are six upper layer protocols used in this ITU-T Recommendation:

1) CAS based for timeslot 16 of 2048 kbit/s networks.

2) MAS-based for 1544 kbit/s networks, using 2-octet messages.

3) MAS-based for timeslot 0 of 2048 kbit/s networks, using 2-octet messages.

4) MAS-based for timeslot "n" of 2048 kbit/s networks, using 2-octet messages.

5) LAN-based protocol, using 4-octet messages.

6) SS7-based protocol, using 4-octet messages.

A list of Protocol Data Units (PDUs) used for these protocols can be found in Annex H.

7.2.1 Channel associated signalling for 2048 kbit/s networks

CAS for 2048 kbit/s networks makes use of the a-d bits of timeslot 16 as defined in ITU-T Recommendation G.704.

A description of the lower layer protocol may be found in Annex A. Note that CAS signalling supports only a subset of the complete signalling messages described in this ITU-T Recommendation.

Message format

Any combination of one or more of the a-d bits.

Bits			
a	**b**	**c**	**d**
x	x	x	x

Coding

The value of the selected a-d bit is as follows:

SPF with single bit control (e.g. ECD, NRD, ALC, FE, AMC):

Mode 1

Bit a, b, c or d, as available and agreed upon between ISC and SPNE.

Bit a, b, c or d	Function
0	Enable SPF
1	Disable SPF

Mode 2

Bit a, b, c or d, as available and agreed upon between ISC and SPNE.

Bit a, b, c or d	Function
0	Disable SPF
1	Enable SPF

NOTE 1 – Either mode 1 or mode 2 may be used, provided that both the ISC and SPNE use the same mode.

NOTE 2 – Implementations using bits a-d of timeslot 16 prior to the existence of this ITU-T Recommendation are deemed to be compliant with this ITU-T Recommendation.

NOTE 3 – A combination of up to 3 of the possible four bits may be used for this signalling interface (see G.704, Note 3, Table 14).

Where SPF includes any of: ECD, NRD, FE, AMC, etc.

SPF with multiple bit control is for further study.

7.2.2   Message associated signalling in 1544 kbit/s networks

In 1544 kbit/s networks, the Data Link (DL) as defined in ITU-T Recommendation G.704 is used.

Annex B describes the lower layer protocol used for MAS in 1544 kbit/s networks.

Within this DL, LAPD protocol is used, based upon that defined in ITU-T Recommendation Q.921.

Message Format

Bits								Octet
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**	
Message type	Direction		Channel					1
Extension Bit	SPF type		SPF function					2
								3-n: repeat of octet type 2, if present

The upper layer MAS signalling contains two octets as follows:

Octet 1

Bit 7	Bits 6 5	Bits 4 3 2 1 0
Message type 0 PCC messages 1 Reserved for future use	Direction 0 0 Not used 0 1 Outgoing SPF 1 0 Incoming SPF 1 1 Both incoming and outgoing SPF	Channel 0 0 0 0 0 Not used 0 0 0 0 1 Timeslot 1 0 0 0 1 0 Timeslot 2 0 0 0 1 1 Timeslot 3 …. 1 0 0 0 0 Timeslot 16 (Note 1) …. 1 1 0 0 0 Timeslot 24 1 1 0 0 1 Timeslot 25 (Note 2) …. 1 1 1 1 0 Timeslot 30 1 1 1 1 1 Timeslot 31
NOTE 1 – Timeslot 16 not available when this is used for 2048 kbit/s networks using CAS.		
NOTE 2 – For 1544 kbit/s networks, timeslots 25 and higher are not available.		

Octet 2-n (depending on whether extension bit is set)

Bit 7	Bits 6 5 4	Bits 3 2 1 0
Extension Bit 0 Last octet 1 Another octet of this type follows	SPF type 0 0 0 ECD 0 0 1 ALC 0 1 0 FE 0 1 1 NRD 1 0 0 AMC All other values reserved for future use.	SPF Function

Where SPF Function is as follows:

SPF type = ECD
Bit 0   0 = disable echo cancellation
          1 = enable echo cancellation
 	
Bit 1   0 = disable non-linear processor
          1 = enable non-linear processor
 	
Bit 2   0 = disable comfort noise injection
          1 = enable comfort noise injection
 	
Bit 3   Reserved for future use

SPF type = ALC Bit 0   0 = disable ALC   1 = enable ALC Bits 3 2 1 0 0 0   ALC type 0 0 0 1   ALC type 1 0 1 0   ALC type 2 0 1 1   ALC type 3 All other values reserved for future use. NOTE – ALC type is determined and configured by manufacturer and/or carrier and is outside the scope of this ITU-T Recommendation.

```
SPF type = NRD
Bit 0      0 = disable
           1 = enable

Bits
3 2 1
0 0 0      NRD type 0
0 0 1      NRD type 1
0 1 0      NRD type 2
0 1 1      NRD type 3
All other values reserved for future use.

NOTE – NRD type is determined and configured by manufacturer and/or carrier and is outside the scope
of this ITU-T Recommendation.
```

```
SPF type = FE
Bit 0      0 = disable
           1 = enable

Bits
3 2 1
0 0 0      FE type 0
0 0 1      FE type 1
0 1 0      FE type 2
0 1 1      FE type 3
All other values reserved for future use.

NOTE – FE type is determined and configured by manufacturer and/or carrier and is outside the scope of
this ITU-T Recommendation.
```

```
SPF type = AMC
Bit 0      0 = disable conversion
           1 = enable conversion
Bit 1      0 = enable conversion from μ-Law
                to A-Law
           1 = enable conversion from A-Law
                to μ-Law
For this SPF type the direction bit in octet 1 is not relevant. The point of reference for the conversion is
assumed to be the ISC. For example, enabling conversion from μ-Law to A-Law converts speech coming
from the ISC from μ-Law to A-Law.

Bits
3 2
x x        Values reserved for future use
```

7.2.3 Message associated signalling in timeslot 0 of 2048 kbit/s networks

MAS in timeslot 0 makes use of one of the Sa4-Sa8 bits, as defined in G.704. See Annex C for a
description of the lower layer protocols for this signalling method.

Within the signalling channel derived from the selected bit, a LAPD protocol is used, based upon
that defined in ITU-T Recommendation Q.921.

The upper layer MAS signalling contains two octets as described in 7.2.2.

7.2.4 Message associated signalling in timeslot "n" of 2048 kbit/s networks

MAS in timeslot "n" makes use of all bits in this timeslot, as defined in G.704. See Annex D for a
description of the lower layer protocol for this signalling method.

Within the signalling channel derived from the selected timeslot, a LAPD protocol is used, based upon that defined in ITU-T Recommendation Q.921.

The upper layer MAS signalling contains two octets as described in 7.2.2.

7.2.5   Local Area Network (LAN)

The Request messages are sent over a 10-Base T LAN for PCC interface to control multiple signal processing functions in an SPNE. The ISC generates these messages as appropriate during the setup and tear-down phase of a connection. Routing of the Request messages to a specific SPNE will be performed by the ISC using facility tables. The Request messages are also used to request connectivity tests on a channel.

The upper layer LAN signalling contains four octets as follows:

Message Format

Bits								Octet
7	6	5	4	3	2	1	0	
Reserved				SPF Type				1
Address								2
Extension	Direction		Channel					3
Connectivity test time			Connectivity	SPF function				4
								5-8 etc., same as octets 1-4, if present

An extension mechanism (octet 3, bit 7) allows for the simultaneous control of more than one SPF.

Coding

Octet 1

Bits 7 6 5 4 3	Bits 2 1 0
0 0 0 0 0 All other values reserved.	SPF type 0 0 0 ECD 0 0 1 ALC 0 1 0 FE 0 1 1 NRD 1 0 0 AMC All other values reserved for future use.

Octet 2

Bits 7 6 5 4 3 2 1 0	Facility Number (Note)
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 1 0 -- 1 1 1 1 1 1 1 1	Not used 1 2 --- 255 NOTE – This indicator specifies a particular 1.544 Mbit/s (T1) or 2.048 Mbit/s (E1) facility where the signal processing is being requested. An ISC will determine this indicator.

Octet 3

Bit 7	Bits 6 5	Bits 4 3 2 1 0

Extension Bit
0 Last octet
1 Another
   4-octet
   message
   follows
   octet 4
	Direction
	0 0 Not used
	0 1 Outgoing SPF
	1 0 Incoming SPF
	1 1 Both incoming and outgoing SPF
		Channel number
		0 0 0 0 0 Not used
		0 0 0 0 1 Timeslot 1
		0 0 0 1 0 Timeslot 2
		0 0 0 1 1 Timeslot 2
		….
		1 0 0 0 0 Timeslot 16
		….
		1 1 0 0 0 Timeslot 24
		1 1 0 0 1 Timeslot 25 (Note)
		….
		1 1 1 1 0 Timeslot 30
		1 1 1 1 1 Timeslot 31

NOTE – For 1544 kbit/s networks, timeslots 25 and higher are not available.		

Octet 4

Bits 7 6 5	Bit 4	Bits 3 2 1 0
0 0 0 1 s 0 0 1 2 s 0 1 0 3 s 0 1 1 4 s 1 0 0 5 s 1 0 1 6 s 1 1 0 7 s 1 1 1 8 s NOTE – This field is only active when bit 4 = 1, indicating connectivity testing is requested.	0 No connectivity test 1 Connectivity test	SPF Function

Where SPF Function is the same as that defined in SPF function of octet 2 of the 2-octet format described in 7.2.2.

7.2.6 SS7 based protocol

The PCC Request Messages are sent over SS7 links to convey control information to multiple signal processing functions in an SPNE. The ISC generates this message as appropriate during the set-up and tear-down phase of a connection. How the signalling point code of the specific SPNE is derived is implementation dependent.

Message Format

See 7.2.5. The information field referring to the connectivity test is not used in the SS7 based protocol.

Coding

See 7.2.5.

The SPNE User Part (SPNEUP) has to support the abstract upper MTP (L3) boundary in order to use the MTP services. The services as described in ITU-T Recommendation Q.710 are required.

The SPNEUP contains the SPNE application protocol. The SPNEUP supports the full PDU (4-octet) message repertoire.

ANNEX A

SPNE over TS16 (CAS): Lower layer protocol

Use of timeslot 16 in 2048 kbit/s networks for channel associated signalling is defined in Recommendation G.704. When set for Channel Associated Signalling, timeslot 16 provides 4 signalling bits (a-d) for each of the 30 channels in the 2048 kbit/s facility. Arranged in this manner, there are four 500 bit/s PCC signalling links for each of the 30 channels. Combination of these bits into a single signalling channel is for further study.

Using one of these four channel associated signalling bits, the ISC sets the pre-selected bit to control an SPF for a specific channel in the 2048 kbit/s facility. This is done during the setup and tear-down phases of the call. The ISC and the SPNE need agreement on which bit is used for which SPF.

The recognition time for a transition from 0 to 1 or vice versa on any of the bits a-d is 20 ms ± 10 ms.

This recognition time is defined as the duration of the signals representing 0 or 1 in order to be recognized by the SPNE. These conditions are the same as those defined in ITU-T Recommendation Q.422.

Where timeslot 16 is also arranged for PCC of Digital Circuit Multiplication Equipment (DCME) according to ITU-T Recommendation Q.50, only bits c and d remain available for PCC of other SPFs.

The upper layer protocol for CAS in timeslot 16 is described in 7.2.1.

State transition diagram

The state transition diagram as seen by the SPNE (TS16/CAS) is shown below (see Figure A.1 and Table A.1):
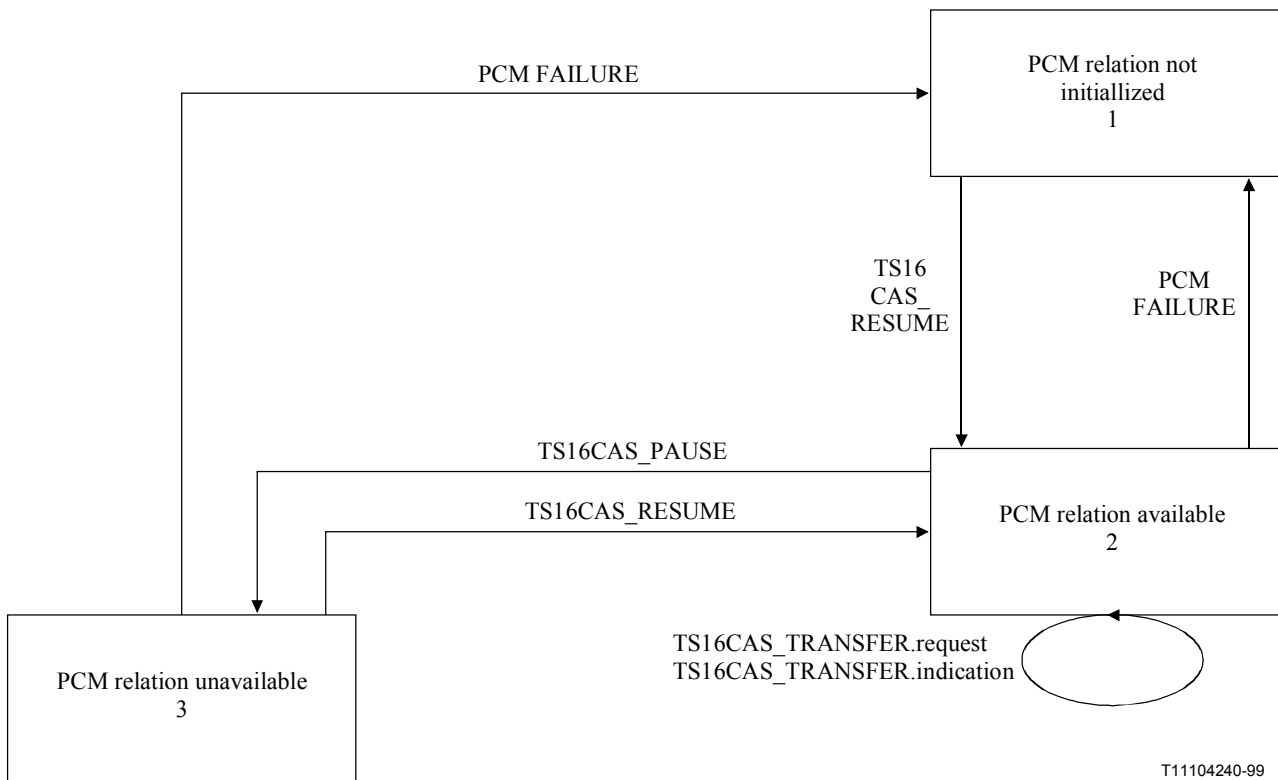
TS16 CAS primitives:
– TS16CAS_TRANSFER; type: request, indication
– TS16CAS_PAUSE; type: indication
– TS16CAS_RESUME; type: indication

Figure A.1/Q.55 – State transition diagram as seen by the SPNE (TS16/CAS)

Table A.1/Q.55 – Table of primitives for SPNE (TS16/CAS)

Primitive name	Type	Contents of primitive
TS16CAS_TRANSFER	request; indication	Channel number, user data
TS16CAS_PAUSE	indication	
TS16CAS_RESUME	indication	

ANNEX B

Protocol for MAS in the DL channel in 1544 kbit/s networks

For 1544 kbit/s facilities, the Data Link (DL) is defined in G.704 where two applications for it are described. G.704 specifies that DS-1 source and sink terminals can use the DL to send facility status information such as LOF, AIS and LOS. These messages are sent using predefined keywords and have the highest priority on the DL. These messages are sent continuously if one of these conditions occurs. Secondly, a Performance Report Message (PRM) is defined. The PRM is intended to convey facility performance statistics between two terminals. The SPNE message structure is based on the LAPD structure used for the PRM.

The DL is described in ITU-T Recommendation G.704. It uses a LAPD structure based on the unnumbered, unacknowledged frame operation of Q.921/LAPD for the message link format. The DL is formed using the first bit of every other frame (e.g. m-bits), starting with frame 1 (e.g. 1, 3, 5 … 23) of the 24-frame multiframe, and provides a 4 kbit/s channel. The LAPD frame is transmitted starting with the right-most bit (except for FCS) of the first byte which is inserted into the DL.

The 1544 kbit/s Data Link (DL) provides a communications path to convey the two-octet message structure described in 7.2.2 and is used to control the SPF functions of the SPNE associated with the ISC.
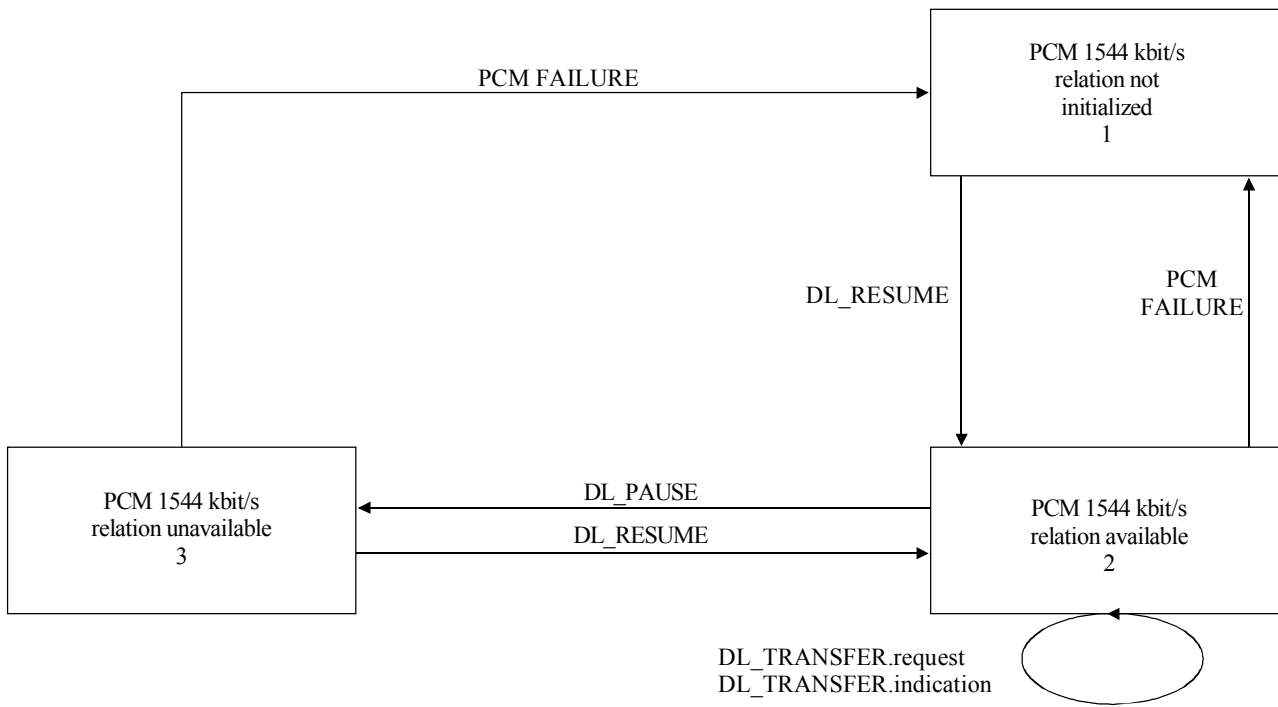
See Appendix III for further information.

The following DL LAPD message structure is used to convey the two-octet PCC message (see Figures B.1, B.2 and Table B.1):

FLAG			
SAPI		C/R	EA
TEI			EA
Octet 1 (Note)			
Octet 2 (Note)			
…Octet n, if extension bit used (Note)			
FCS			
FCS			

Where: SAPI = 0, C/R = 1, EA = 0, TEI = 0.

NOTE – Description of these fields is found in 7.2.2.

Figure B.1/Q.55 – LAPD-based message associated signalling structure

PCM 1544 kbit/s
relation not
initialized
1

PCM 1544 kbit/s
relation unavailable
3

PCM 1544 kbit/s
relation available
2

PCM FAILURE

DL_RESUME

PCM
FAILURE

DL_PAUSE

DL_RESUME

DL_TRANSFER.request
DL_TRANSFER.indication

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DL primitives:
– DL_TRANSFER; type: request, indication
– DL_PAUSE; type: indication
– DL_RESUME; type: indication

Figure B.2/Q.55 – LAPD-based 1544 kbit/s data link state transition diagram

Table B.1/Q.55 – Table of primitives for SPNE (DL/MAS)

Primitive name	Type	Contents of primitive
DL_TRANSFER	request; indication	User data
DL_PAUSE	indication	Channel number range
DL_RESUME	indication	Channel number range

ANNEX C

Lower layer protocol for MAS within timeslot 0 in 2048 kbit/s networks

Message Associated Signalling within timeslot 0 in 2048 kbit/s networks makes use of one of the Sa4-Sa8 bits, as defined in G.704. It applies a LAPD-based message structure to one of these bits based on the unnumbered, unacknowledged frame operation of Q.921/LAPD for the message link format. The LAPD message channel is carried by any one of these bits. The ISC and the SPNE must agree upon which Sa bit is used. The LAPD frame is transmitted starting with the rightmost bit of the first byte, which is inserted into the selected Sa bit.
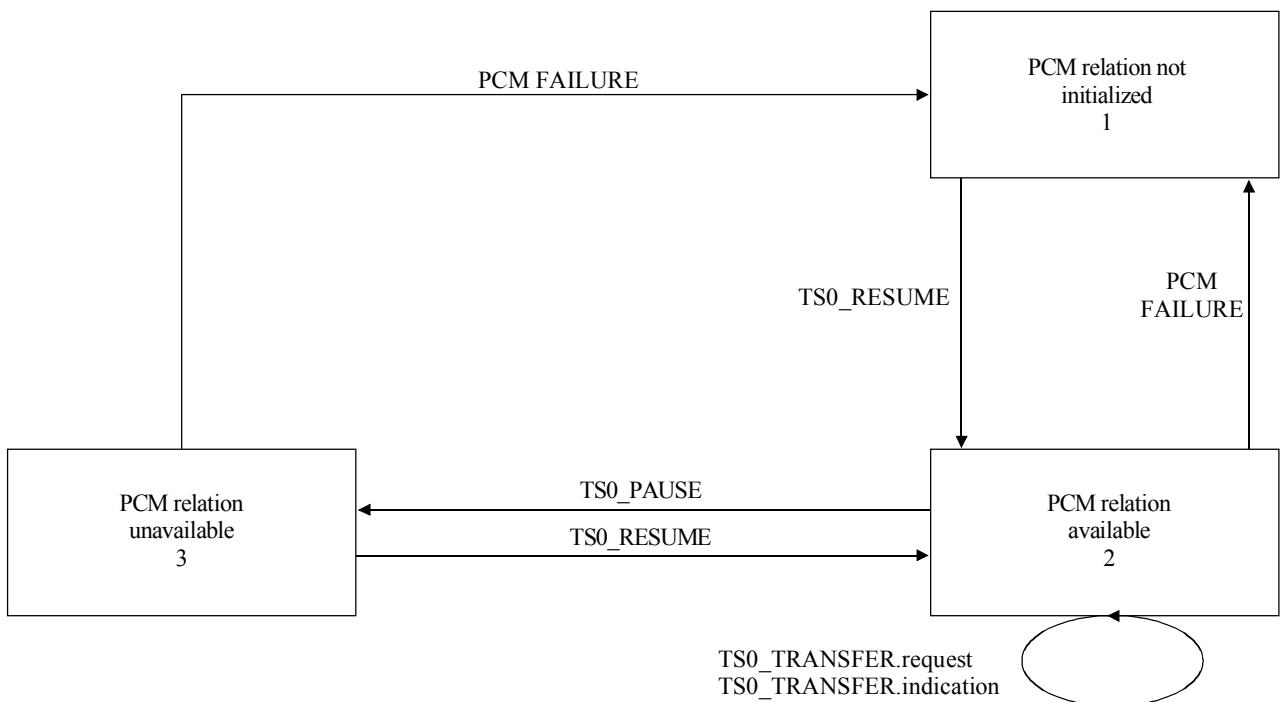
The following LAPD message structure is used to convey the two-octet PCC message (see Figures C.1, C.2 and Table C.1):

FLAG		
SAPI	C/R	EA
TEI		EA
Octet 1 (Note)		
Octet 2 (Note)		
…Octet n, if extension bit used (Note)		
FCS		
FCS		

Where: SAPI = 0, C/R = 1, EA = 0, TEI = 0.

NOTE – Description of these fields is found in 7.2.2.

Figure C.1/Q.55 – LAPD-based message associated signalling structure in timeslot 0

TS0 primitives:
– TS0_TRANSFER;   type: request, indication
– TS0_PAUSE;   type: indication
– TS0_RESUME;   type: indication

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Figure C.2/Q.55 – LAPD-based 2048 kbit/s timeslot-0 state transition diagram

Table C.1/Q.55 – Table of primitives for SPNE (TS-0/MAS)

Primitive name	Type	Contents of primitive
TS0_TRANSFER	request; indication	User data
TS0_PAUSE	indication	Channel number range
TS0_RESUME	indication	Channel number range

ANNEX D

Lower layer protocol for MAS in timeslot "n" with 2048 kbit/s networks

Message Associated Signalling within timeslot "n" in 2048 kbit/s networks makes use of one of the timeslots numbered 1 through 31 as defined in G.704. It applies a LAPD-based message structure to a selected timeslot. Any available timeslot other than 0 may be used to convey MAS messages.

This message is transmitted using unacknowledged frame operation of Q.921/LAPD for the message link format.

When only one SPNE is located on a 2048 kbit/s facility, the LAPD frame is transmitted in every bit of the timeslot starting with the right-most bit of the first byte of the frame. Acknowledgment messages, where used, are sent from the SPNE to the ISC in the same manner.

Where more than one SPNE is located on a 2048 kbit/s link, a point-to-multipoint signalling protocol is used as follows:

Messages from the ISC to the SPNE are addressed to specific SPNEs using the TEI field in the LAPD message. The SPNE number is inserted into the TEI field.

For acknowledgment messages sent from the SPNE to the ISC, the following multipoint-to-point protocol is used:

The SPNE inserts its SPNE number in the TEI field of the message.

For 2 SPNEs: SPNE 1 uses bits 1-4 of each PCM sample and SPNE 2 uses bits 5-8.

For either 3 or 4 SPNEs: SPNE 1 uses bits 1-2, SPNE 2 uses bits 3-4, SPNE 3 uses bits 5-6, and SPNE 4 uses bits 7-8.

For 5 to 8 SPNEs: SPNE 1 uses bit 1, SPNE 2 uses bit 2, SPNE 3 uses bit 3, SPNE 4 uses bit 4, SPNE 5 uses bit 5, SPNE 6 uses bit 6, SPNE 7 uses bit 7, SPNE 8 uses bit 8.

In each case, the SPNE puts the least significant bit of the first byte of the acknowledgment message frame in the lowest numbered bit of the PCM word.

The following LAPD message structure is used to convey the two-octet PCC message (see Figures D.1, D.2 and Table D.1):

FLAG			
SAPI		C/R	EA
TEI			EA
Octet 1 (Note)			
Octet 2 (Note)			
…Octet n, if extension bit used (Note)			
FCS			
FCS			

Where: SAPI = 0, C/R = 1, EA = 0, TEI = 0 for point-to-point operation, SPNE number for multipoint operation.

NOTE – Description of these fields are found in 7.2.2.

Figure D.1/Q.55 – LAPD-based message associated signalling structure in timeslot "n"
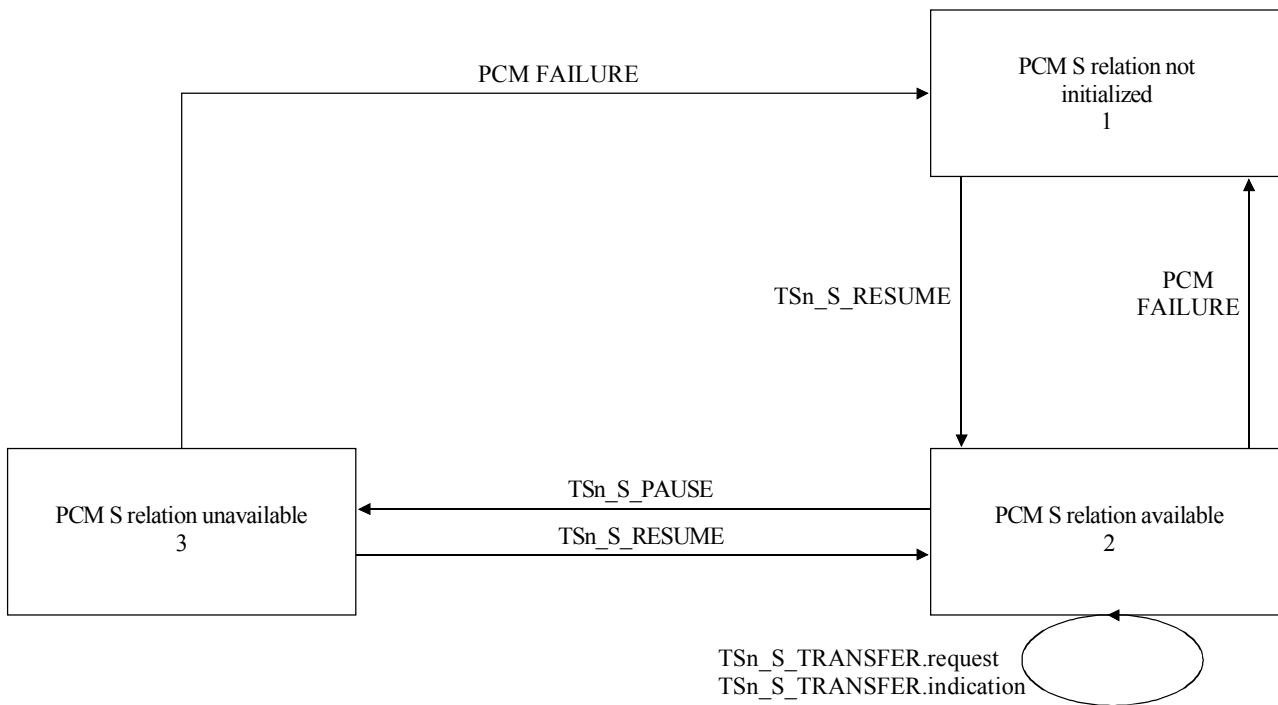
PCM primitives:
– TSn_S_TRANSFER;   type: request, indication
– TSn_S_PAUSE;   type: indication
– TSn_S_RESUME;   type: indication
Where S = SPNE number.

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Figure D.2/Q.55 – LAPD-based 2048 kbit/s timeslot-n state transition diagram

Table D.1/Q.55 – Table of primitives for SPNE (TS-n/MAS)

Primitive name	Type	Contents of primitive
TSn_S_TRANSFER	request; indication	User data
TSn_S_PAUSE	indication	Channel number range
TSn_S_RESUME	indication	Channel number range

ANNEX E

**Lower layer protocol for local area network signalling link**

For a LAN signalling link, the International Switching Center (ISC) and Signal Processing Network Equipment (SPNE) Per-Call-Control messages use the services of a Local Area Network (LAN) as the lower layer transport. In this arrangement, the PCC application interfaces with the Transmission Control Protocol (TCP) layer of the LAN for delivery. The TCP (normally referenced as TCP/IP to denote usage of the Internet Protocol) is part of the typical stack of layers used to transport application information over a LAN.

The term TCP/IP is generally accepted as relevant for the application. It describes the primitives at the boundary between an application and the TCP/IP transport layer.

Procedures and primitives between associated TCP/IP locations and between the TCP/IP and layers below it are beyond the scope of this ITU-T Recommendation. The procedures and protocols are generally the same for any application of TCP/IP to deliver applications. References can be found in clauses 6 and 7.

Request messages are sent from the ISC via TCP/IP to the SPNE application at the SPNE location. A similar procedure is used to send a message from the SPNE to the ISC. Because the ISC controls the SPNE in a master/slave relationship, the ISC establishes and controls the signalling connection through TCP/IP.

The terms used to describe the primitives between a LAN application and the TCP/IP lower layers are terms that have been generally accepted in the industry. While no specific TCP standards exist, the primitive terms and procedures appear in textbooks on TCP/IP and have universal use. Therefore, this ITU-T Recommendation will utilize the terms included. This ITU-T Recommendation describes a PCC application for control of remote located signal processing functions. The TCP delivery mechanism is beyond the scope of this ITU-T Recommendation (see Figure E.1 and Table E.1).
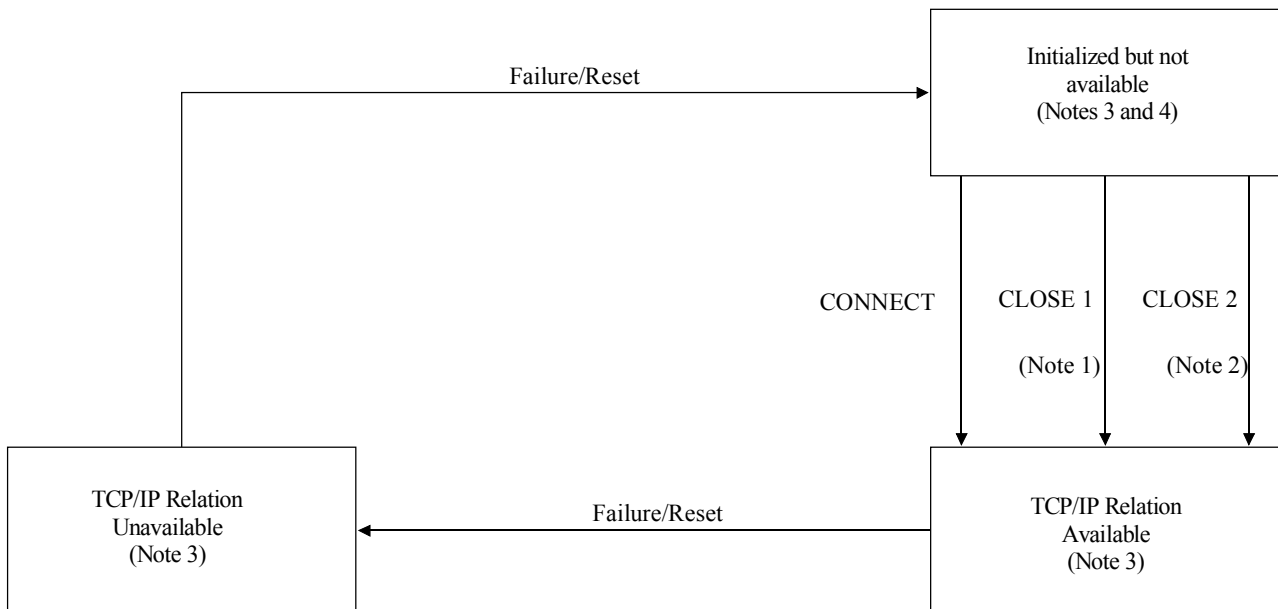
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NOTE 1 – This indication for a Close is a result of a "Heart-Beat" failure. Whether or not the Close is considered Graceful is TCP/IP implementation dependent.

NOTE 2 – This Close indication is used for normal or planned closings of a Connection between an Application and TCP/IP such as planned timed switch over to a Standby link.

NOTE 3 – The primitive relations defined are taken from typical relations between an Application and the TCP/IP layer. The same relations are used to define primitives between Internet applications over TCP/IP. There are additional communications such as OPEN, WRITE, and READ that are considered internal to a typical TCP/IP socket interface used by any application. They are therefore considered beyond the scope of this ITU-T Recommendation

NOTE 4 – The Initialized state in a TCP/IP is achieved through an internal OPEN request from the Application in order to open a socket interface. This step occurs when the equipment is turned on and the state is shown as Initialized in this diagram.
The application then uses a primitive to establish a Connection to the remote TCP/IP which is considered the first step in preparing for two-way delivery of Application information.

TCP/IP LAN:
– TCP/IP_CONNCT;   type: request, indication
– TCP/IP_CLOSE1;   type: request, indication
– TCP/IP_CLOSE2;   type: request, indication
– TCP/IP_FAILURE/RESET;   type: indication
– TCP/IP_RESTART;   type: indication

**Figure E.1/Q.55 – LAN-based message structure**

Table E.1/Q.55 – Table of primitives for SPNE (LAN)

Primitive name	Type	Contents of primitive
TCP/IP_CONNECT	request, indication	
TCP/IP_CLOSE 1	request, indication	
TCP/IP_CLOSE 2	request, indication	
TCP/IP_TRANSFER	request; indication	Channel number, frame number, user data
TCP/IP_PAUSE	indication	Channel number range
TCP/IP_RESUME	indication	Channel number range

ANNEX F

SPNE Over SS7: Lower layer protocol

The state transition diagram as seen by the SPNE User Part is shown in Figure F.1 below.
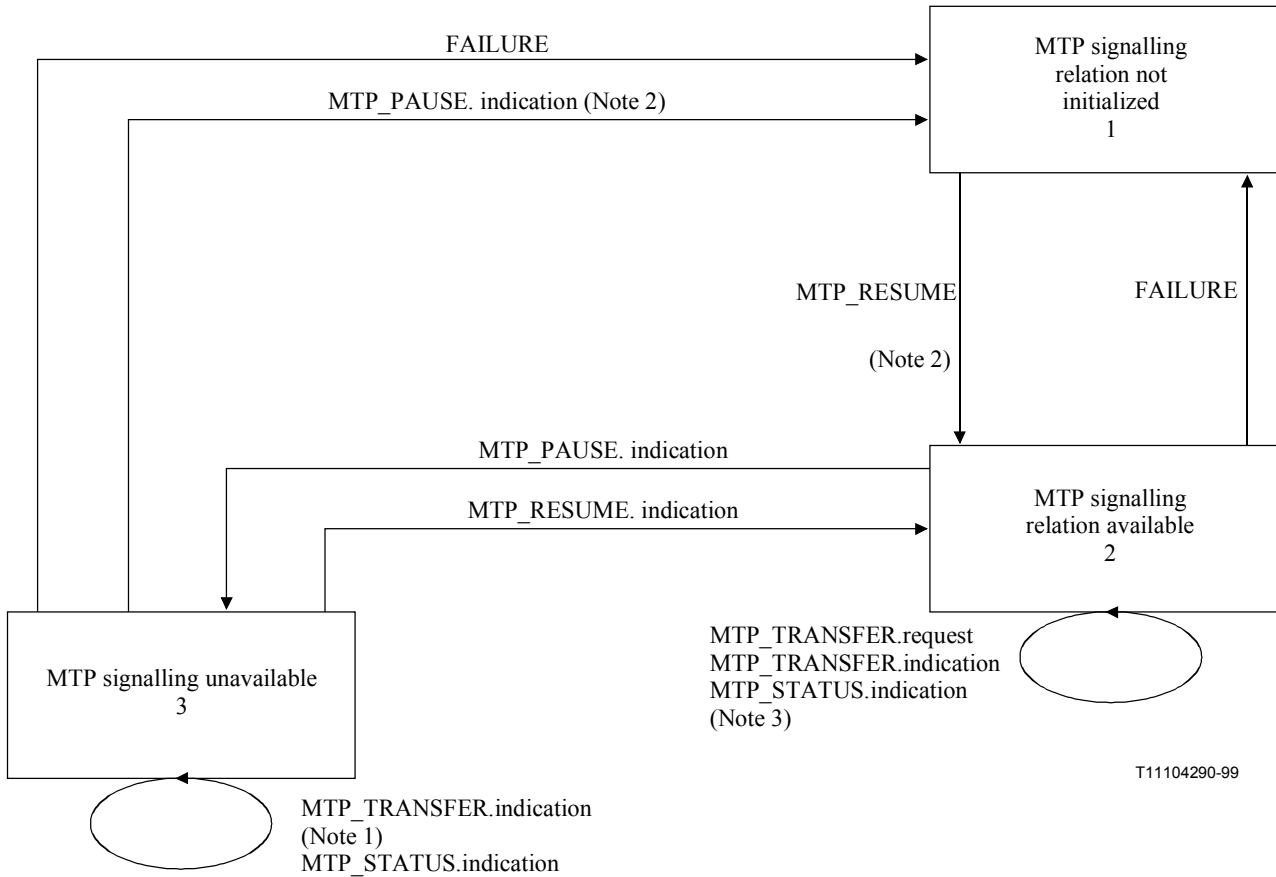
NOTE 1 – MTP_TRANSFER.indication in state 3 is a result of the availability of the signalling relation towards the local MTP, but the unavailability of the signalling relation towards the remote MTP.
NOTE 2 – These transitions are implicitly triggered by the MTP restart procedure.
NOTE 3 – The MTP itself does not keep track of the status of the remote MTP user, so that each user is responsible for detecting the availability of its remote peer.

MTP primitives:
– MTP_TRANSFER;   type: request, indication
– MTP_PAUSE;   type: indication
– MTP_RESUME;   type: indication
– MTP_STATUS;   type: indication
See ITU-T Recommendation Q.701.

Figure F.1/Q.55 – State Transition Diagram as seen by SPNEUP

Message format (conveying peer-to-peer information of the user part)

8	7	6	5	4	3	2	1	Bit/Octet
< MSB	S.S. -	Field	LSB >	<MSB	Serv.	Indic.	MSB >	1/SIO
			DPC				LSB >	2/DPC
	LSB >	< MSB						3/DPC, OPC
			OPC					4/OPC
< MSB	SLS		LSB >	< MSB				5/OPC, SLC
			USER				LSB >	6/DATA1
			"					
< MSB			USER					n/DATAn

Figure F.2/Q.55 – Message signal unit for SPNEUP

Coding for Service Indicator

Bits			
D	C	B	A
1	0	1	1

(SPNEUP)

(See 14.2.1/Q.704.)

Coding for SubService Field

Bits			
D	C	B	A
X	X	0	0

Network Indicator (x = 0, 1)

(See 14.2.2/Q.704.)

Coding for Signalling Link Selection

Bits			
D	C	B	A
0	0	0	0

Signalling Link number

(See 3.4.1/Q.710.)

ANNEX G

Specification and Description Language (SDL) diagrams

G.1 SDLs for Facility Related Channel Associated Signalling (CAS)

See Figures G.1a to G.1d.

*/ This system is the SPNE application in the ISC. Control information received from call control, (more specifically: the signalling system and the logic for enhanced services) is sent to the SPNE device via TS16 in a channel associated mode. Information received from the SPNE device is sent to the signalling system.
Information referring to the signalling network received from the E1 processing is sent to call control (specifically: the signalling system and/or the logic for enhanced services)*/

SIGNAL   SPF_CONTROL, TS16CAS_TRANSFER, TS16CAS_PAUSE, TS16CAS_RESUME, CIRCUIT_OUT_OF_SERVICE, CIRCUIT_BACK_IN_SERVICE
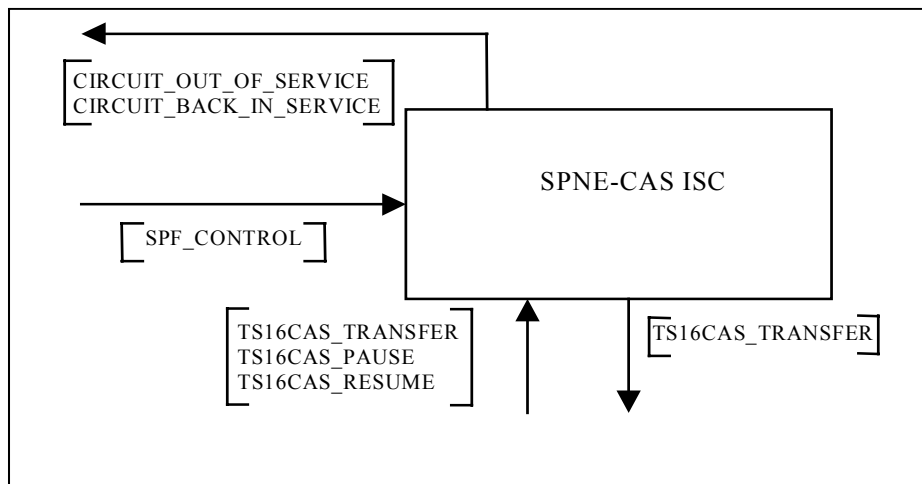

Figure G.1a/Q.55 – Block diagram of SPNE-CAS in the ISC

Figure G.1b/Q.55 – Finite State Machine for SPNE-CAS in ISC

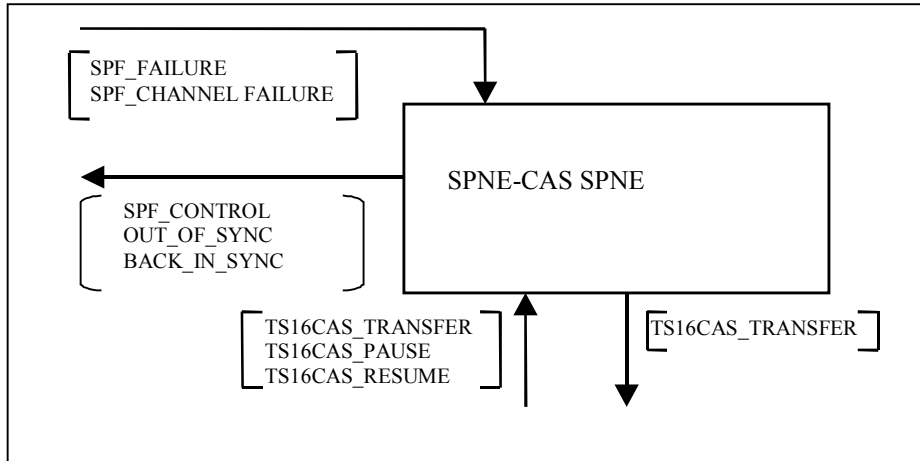**Figure G.1c/Q.55 – Block Diagram of SPNE-CAS in the SPNE**
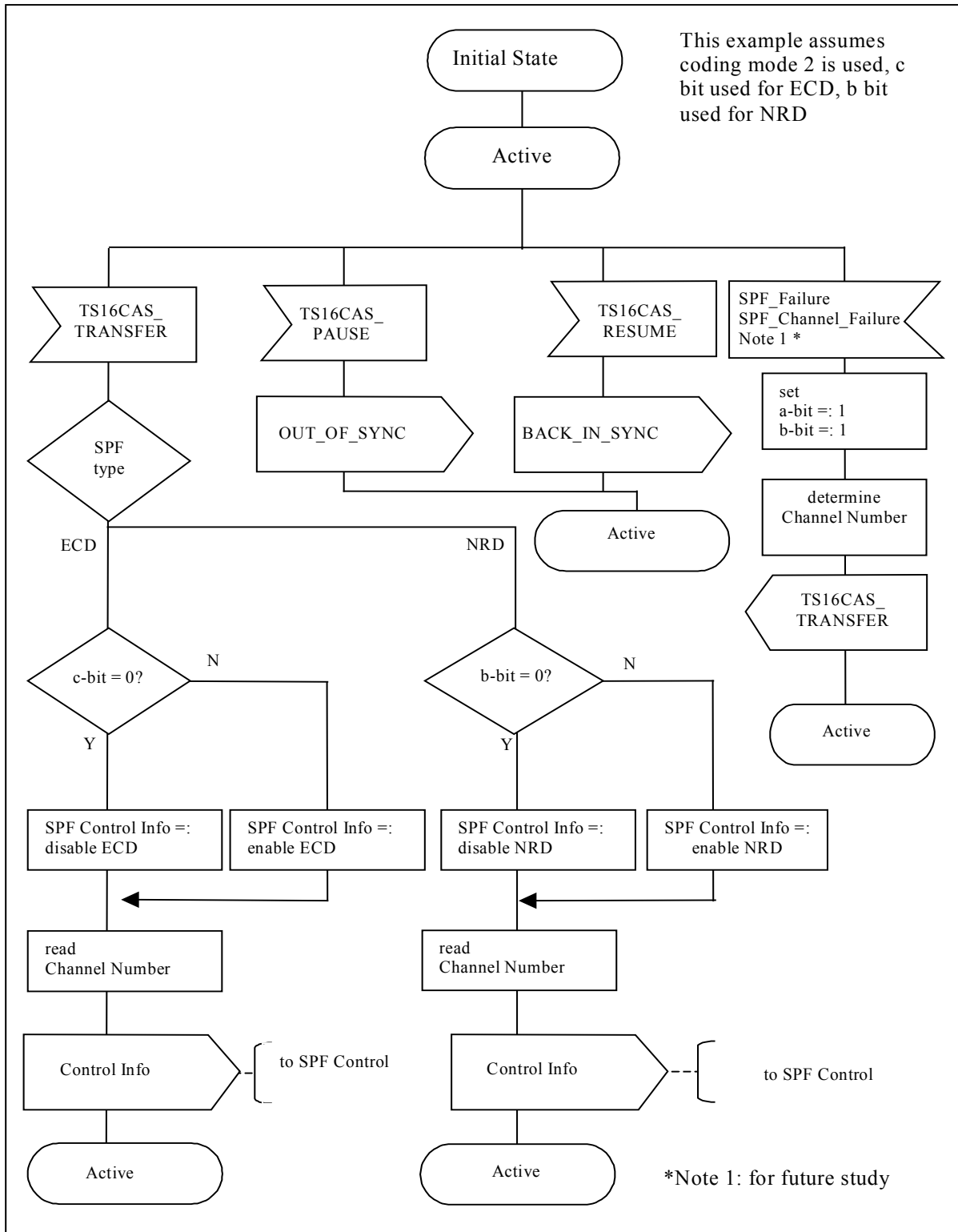
Figure G.1d/Q.55 – Finite State Machine for SPNE-CAS in the SPNE

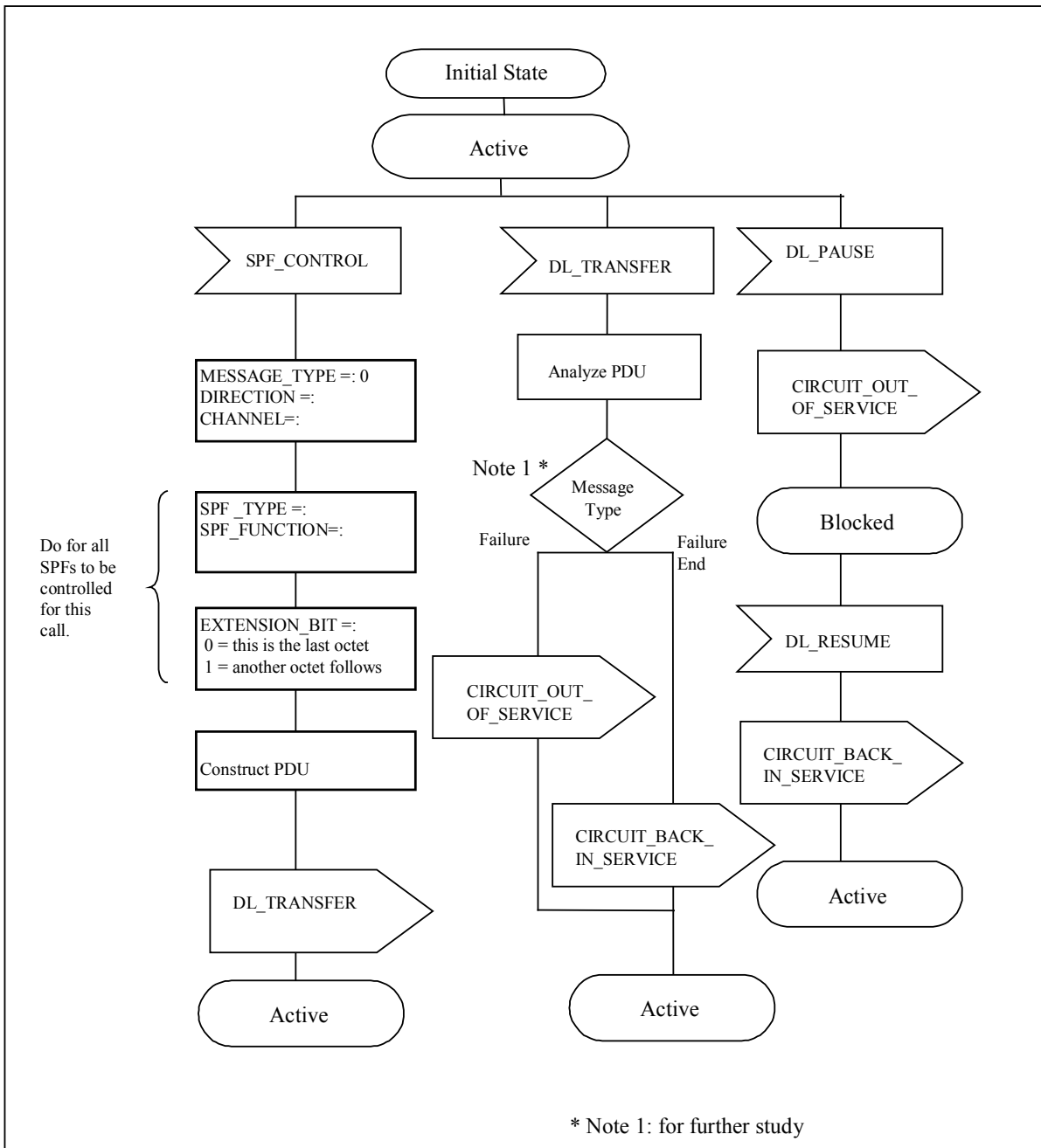## G.2 SDLs for Facility Related Message Associated Signalling (MAS)

See Figures G.2a to G.2m.

Figure G.2a/Q.55 – Block diagram of SPNE-MAS in the ISC for DL signalling

Figure G.2b/Q.55 – Finite State Machine for SPNE-MAS in the ISC for DL signalling

```
* This system is the SPNE application in the SPNE. Control information received from the ISC is sent to
the SPF concerned.*/

SIGNAL          SPF_CONTROL_SIGNAL, DL_TRANSFER, SPF_FAILURE,
                SPF_FAILURE_END
```


Figure G.2c/Q.55 – Block diagram for SPNE-MAS in SPNE for DL signalling
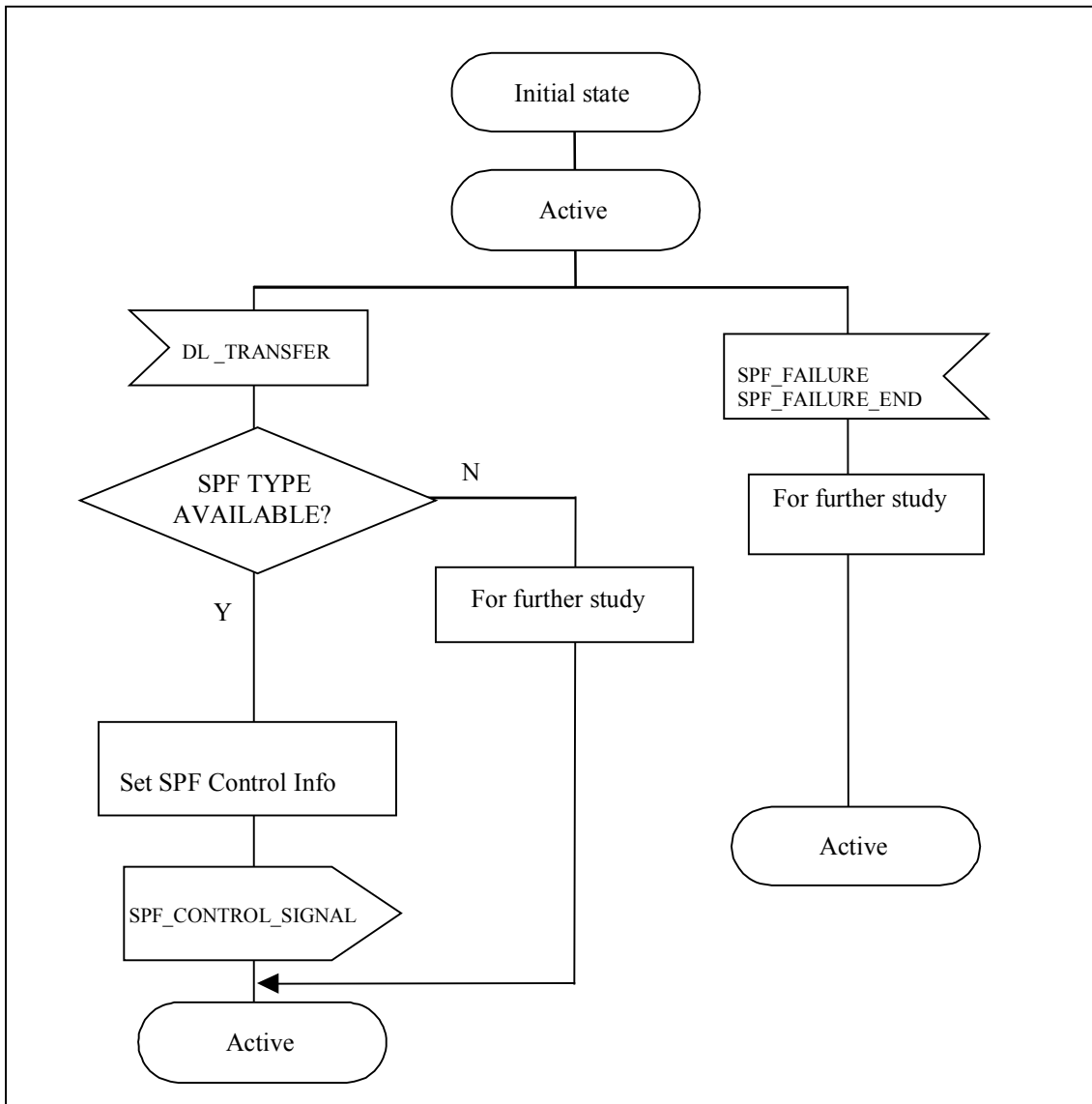
Figure G.2d/Q.55 – Finite State Machine for SPNE- MAS in SPNE for DL signalling

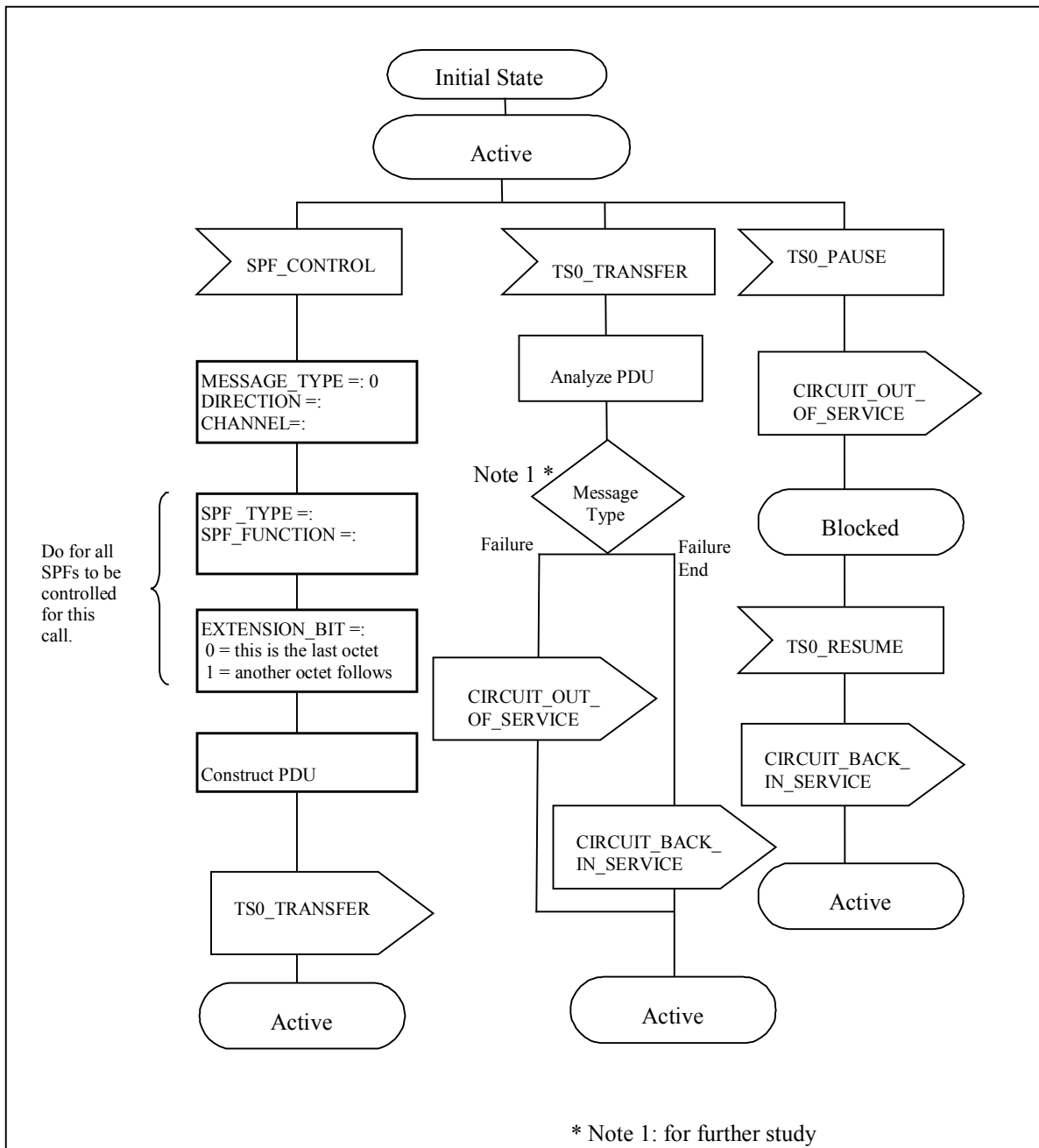* This system is the SPNE application in the ISC. Control information received from call control (more specifically: the signalling system and the logic for enhanced services) is sent to the SPNE device via one of the spare bits in timeslot 0. Information received from the SPNE device is sent to the signalling system. Information referring to the signalling information received from the E1 processing is sent to call control (more specifically: the signalling system, and the logic for enhanced services)*/

SIGNAL   SPF_CONTROL, TS0_TRANSFER, TS0_PAUSE, TS0_RESUME,
                CIRCUIT_ OUT_OF_SERVICE, CIRCUIT_BACK_IN_SERVICE

**Figure G.2e/Q.55 – Block diagram for SPNE-MAS in ISC for Timeslot 0
in 2048 kbit/s networks**

Figure G.2f/Q.55 – Finite State Machine for SPNE-MAS in ISC for Timeslot 0 in 2048 kbit/s networks

```
* This system is the SPNE application in the SPNE. Control information received from the ISC is sent to
the SPF concerned. Information received from an SPF is sent to the ISC. */

SIGNAL          SPF_CONTROL_SIGNAL, TS0_TRANSFER, SPF_FAILURE,
                SPF_FAILURE_END
```
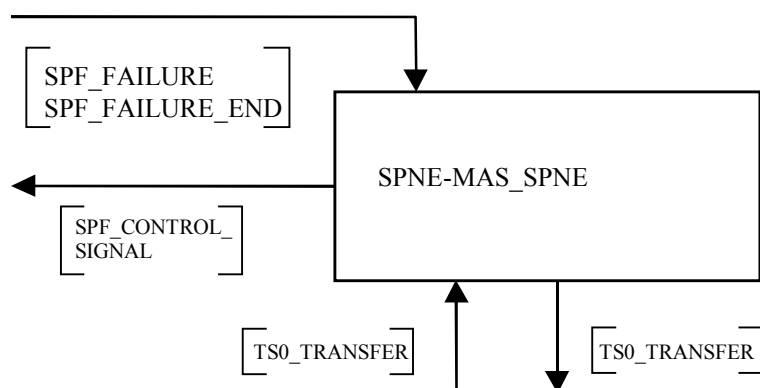

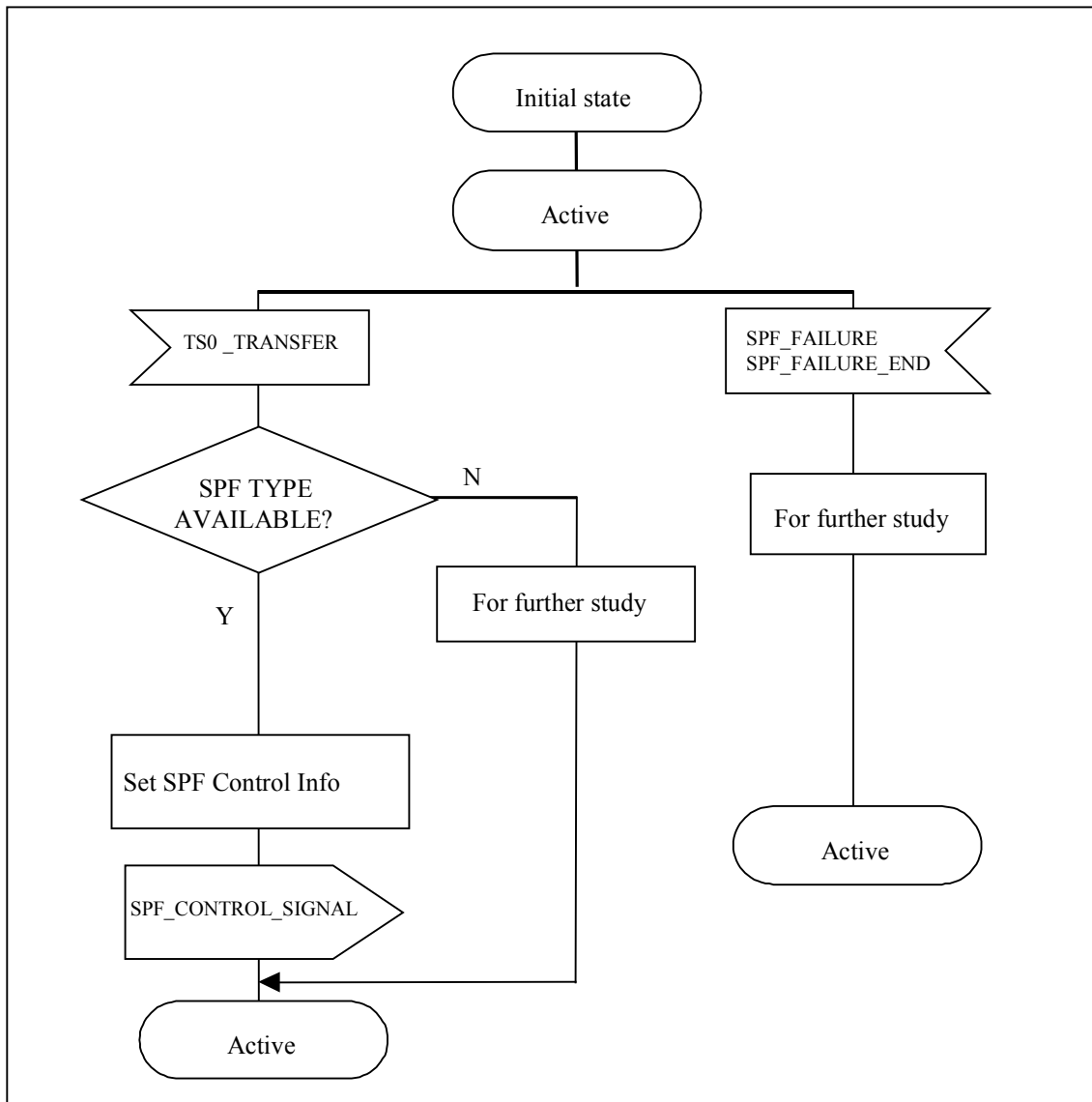**Figure G.2g/Q.55 – Block diagram for SPNE-MAS in SPNE in Timeslot 0
in 2048 kbit/s networks**

Figure G.2h/Q.55 – Finite State Machine for SPNE-MAS in SPNE in Timeslot 0 in 2048 kbit/s networks 2
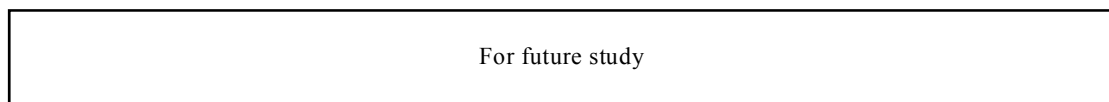
For future study

Figure G.2i/Q.55 – Block diagram for SPNE-MAS in ISC Within Timeslot "n" in 2048 kbit/s networks
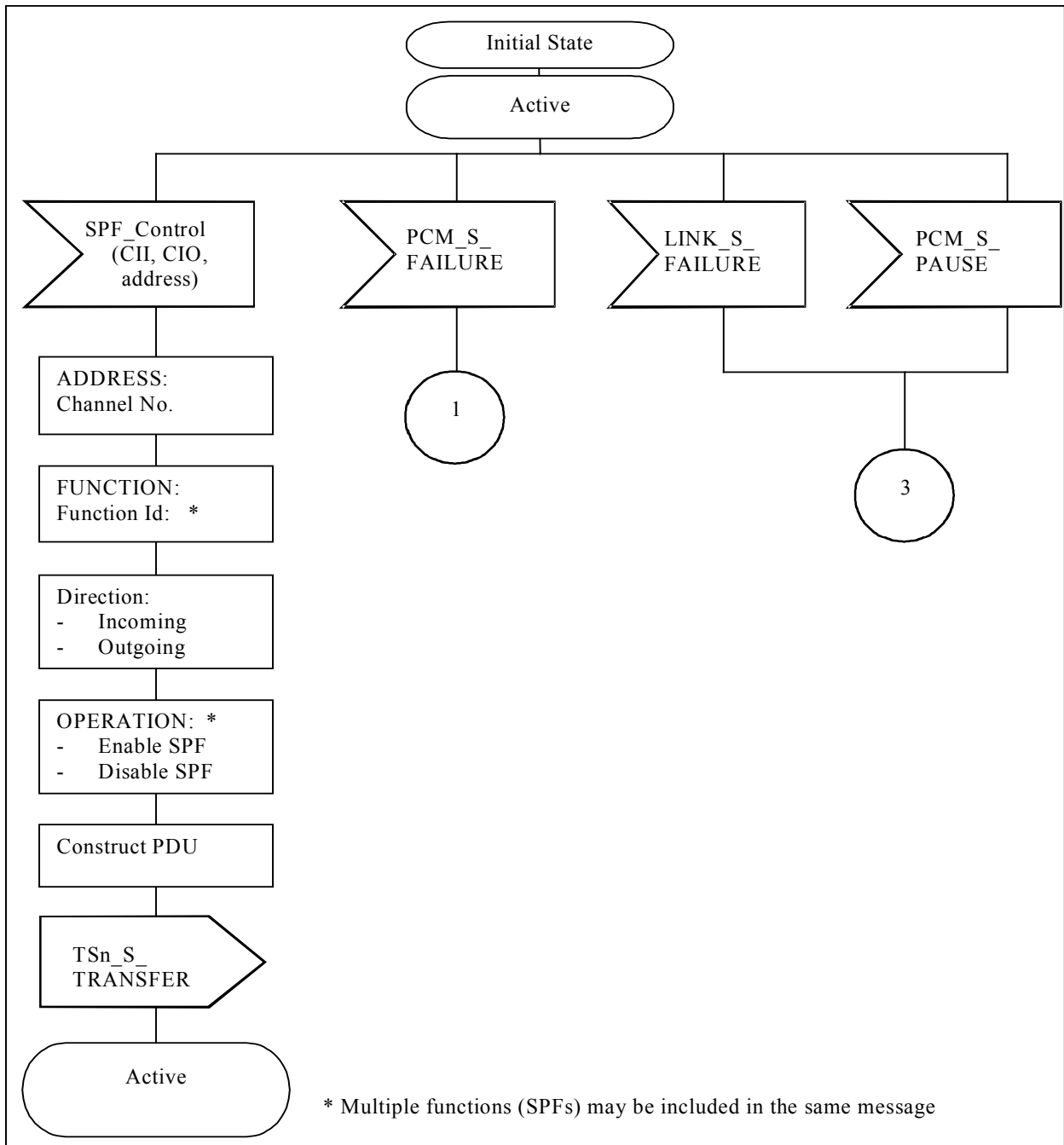
**Figure G.2j/Q.55 – Finite State Machine for SPNE-MAS in ISC in Timeslot "n"
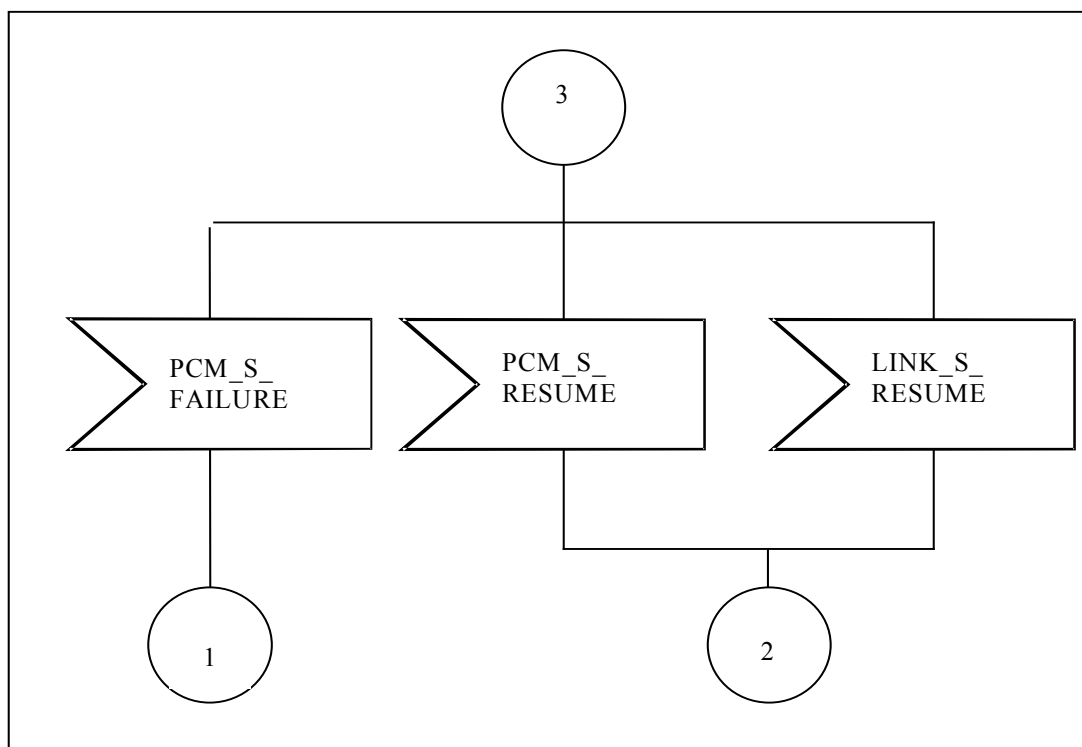with 2048 kbit/s networks** *(sheet 1 of 2)*

**Figure G.2k/Q.55 – Finite State Machine for SPNE-MAS in ISC in Timeslot "n"
with 2048 kbit/s networks** *(sheet 2 of 2)*

For future study

**Figure G.2l/Q.55 – Block diagram for SPNE-MAS in SPNE in Timeslot "n"
in 2048 kbit/s networks**

For future study

**Figure G.2m/Q.55 – Finite State Machine for SPNE-MAS in SPNE in Timeslot "n"
in 2048 kbit/s networks**

G.3   SDLs for LAN signalling

See Figures G.3a to G.3e.

```
*/ This system is the SPNE LAN Application in the ISC. Control information received from
call control (more specifically: the signalling systemand the logic for enhanced services) is
sent to the SPNE device via LAN. Information received from the SPNE device is sent to the
signalling system. Information referring to the signalling network received from the LAN is
sent to call control (more specifically the signalling system and the logic for enhanced
services) */

  SIGNAL          OUT_OF_SERVICE, BACK_IN_SERVICE, TCP/IP_READ,
                  TCP/IP_WRITE, SPF_CONTROL,RESET, SPF_FAILURE*,
                  SPF_CHANNEL_FAILURE*

  * for future study
```
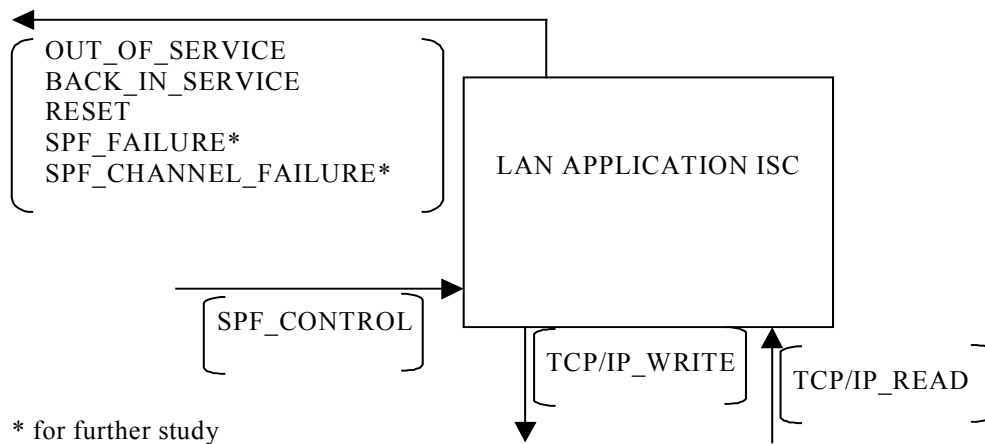

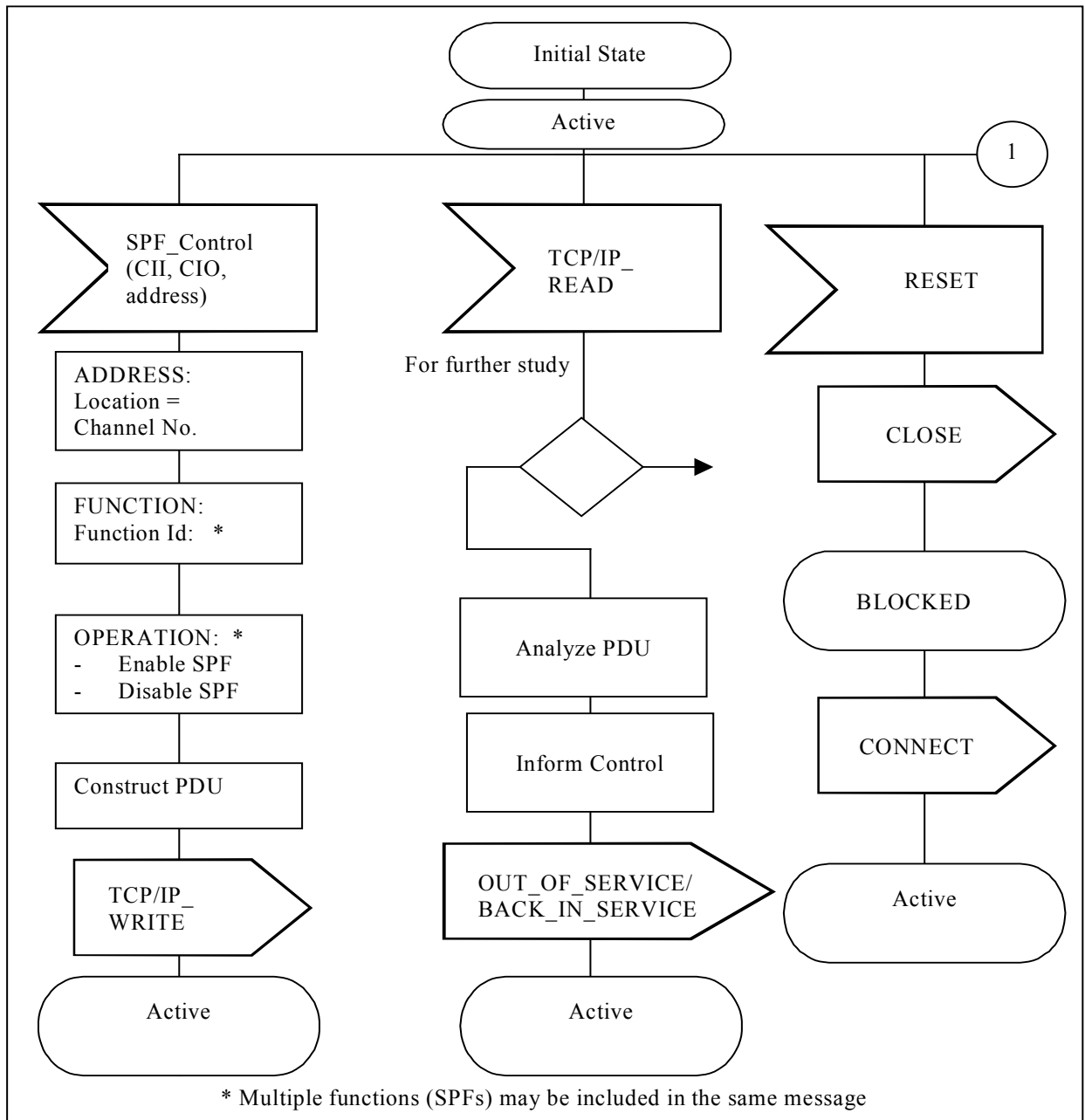**Figure G.3a/Q.55 – Block diagram of SPNE-LAN in ISC**

**Figure G.3b/Q.55 – Finite State Machine for SPNE-LAN in the ISC for
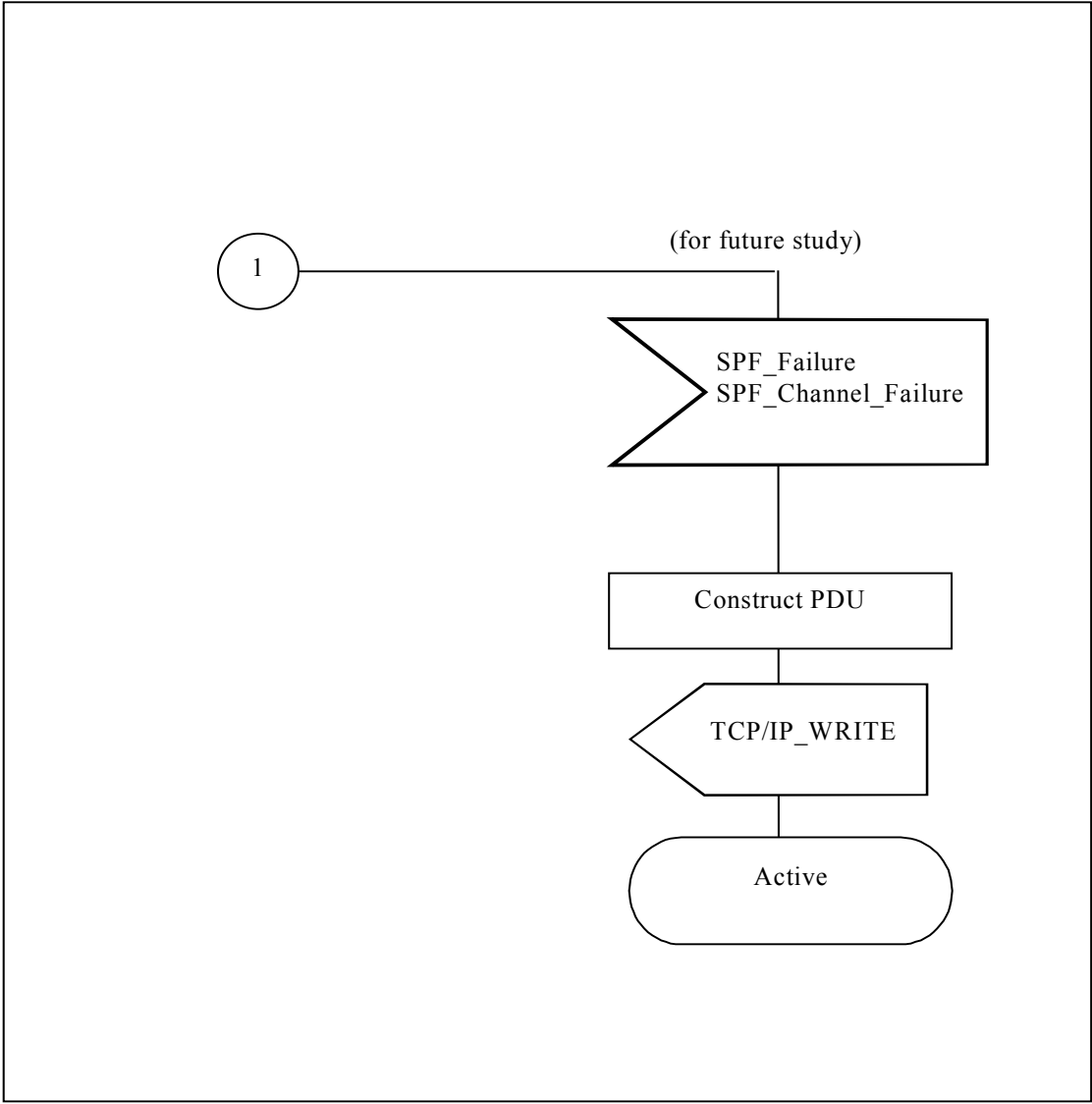LAN signalling** *(sheet 1 of 2)*

**Figure G.3c/Q.55 – Finite State Machine for SPNE-LAN in the ISC for
LAN signalling** *(sheet 2 of 2)*

*/ This system is the SPNE LAN Application in the ISC. Control information received from call control (more specifically: the signalling system, …) is sent to the SPNE device via LAN. Information received from the SPNE device is sent to the signalling system. Information referring to the signalling network received from the LAN is sent to call control (more specifically the signalling system, …) */

SIGNAL   SPF_FAILURE_START, SPF_FAILURE_END, SPF_CONTROL,
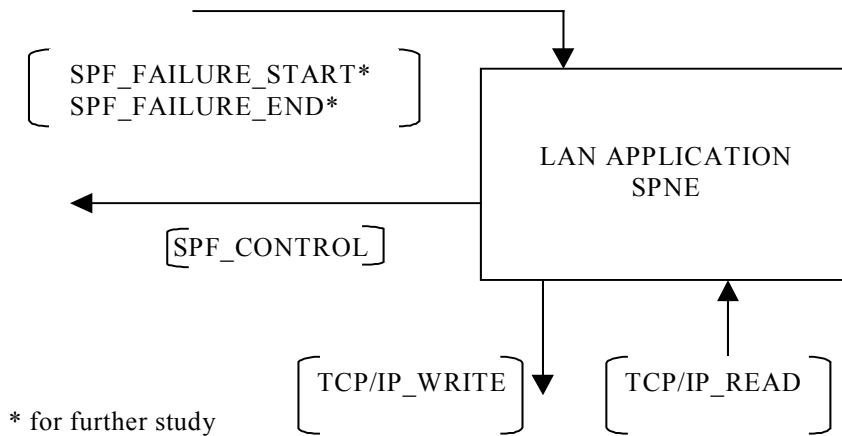   TCP/IP_READ, TCP/IP_WRITE

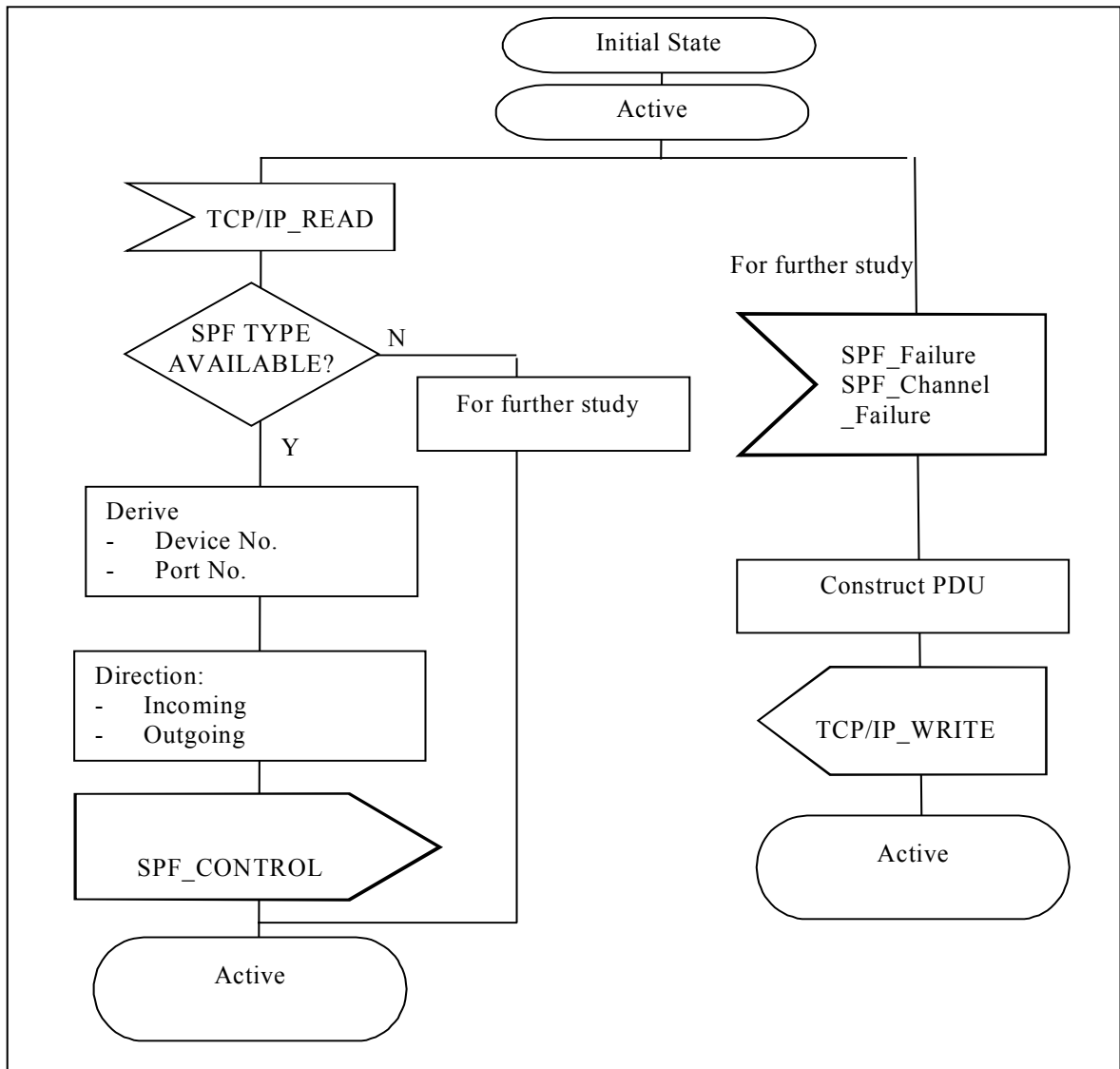**Figure G.3d/Q.55 – Block diagram for SPNE-LAN in SPNE for LAN signalling**

Figure G.3e/Q.55 – Finite State Machine for SPNE-LAN in SPNE for LAN signalling
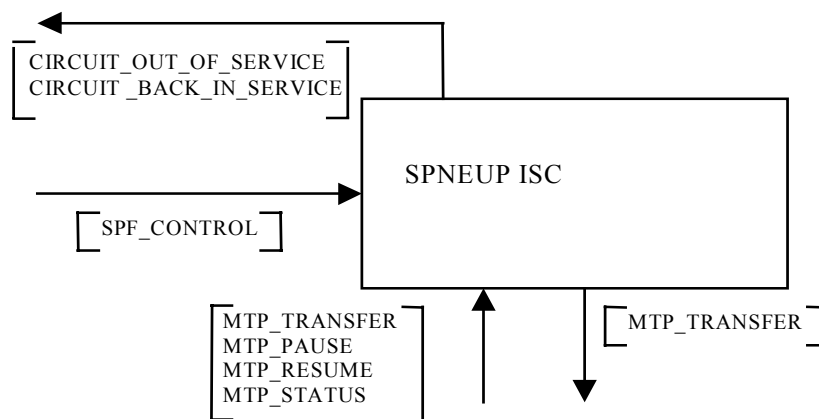
G.4 SDLs for SS7

See Figures G.4a to G.4d.

```
* This system is the SPNE application (user part) – SPNEUP-  in the ISC. Control information
received from call control (more specifically: the signalling system and the logic for enhanced
services) is sent to the SPNE device via MTP (Q.710). Information received from the SPNE device is
sent to the signalling system. Information referring to the signalling network received from the MTP is
sent to call control (more specifically: the signalling system, and the logic for enhanced services)*/

SIGNAL          SPF_CONTROL, MTP_TRANSFER, MTP_PAUSE, MTP_RESUME, CIRCUIT
                OUT_OF_SERVICE, CIRCUIT BACK_IN_SERVICE
```
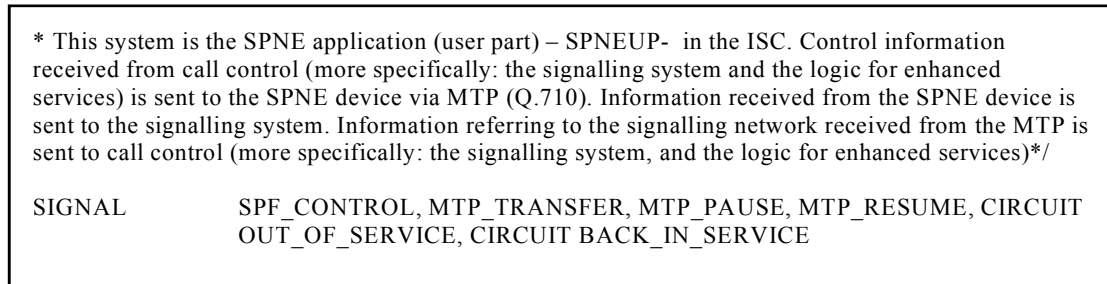

Figure G.4a/Q.55 – Block diagram of SPNE User Part in the ISC
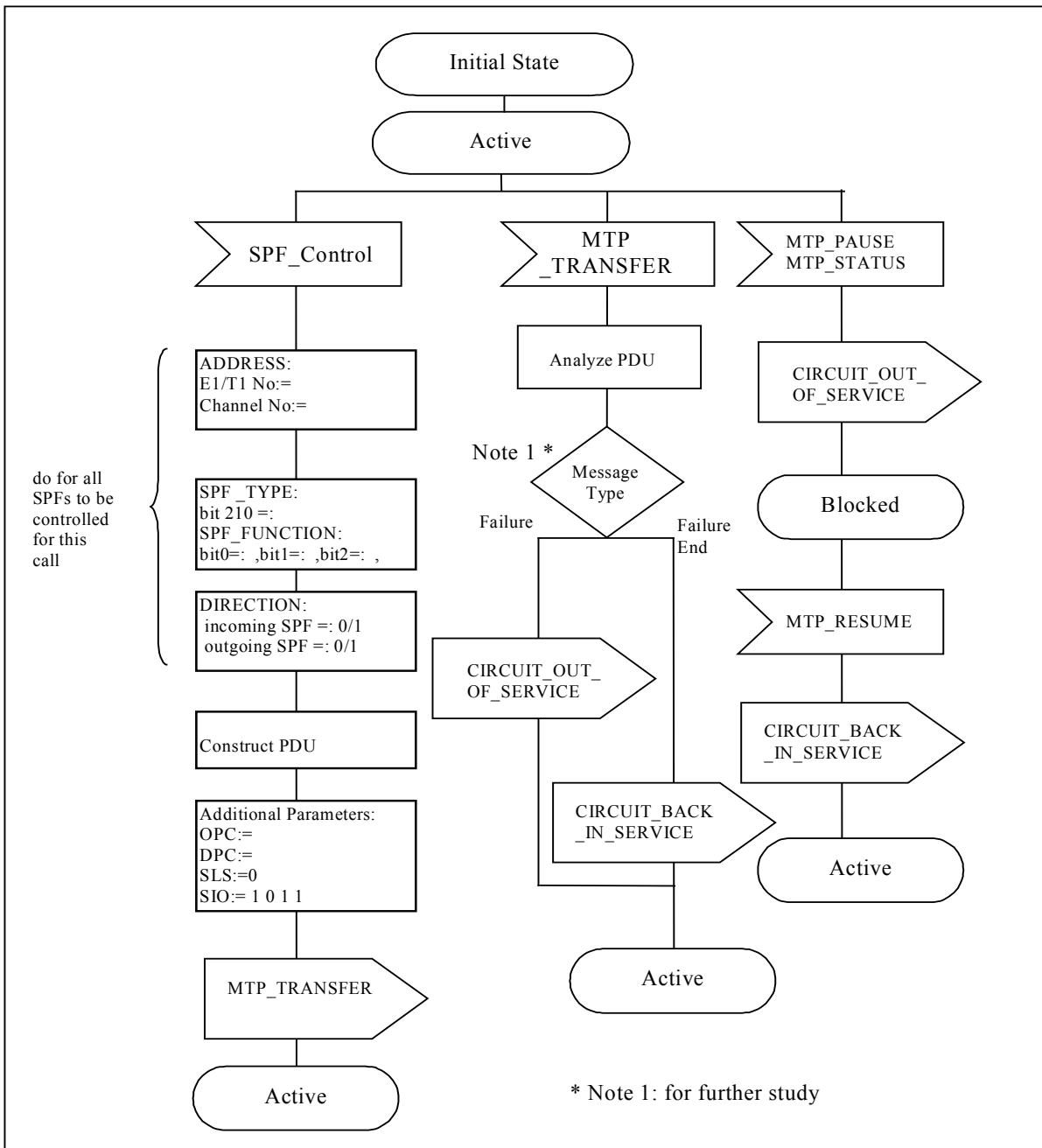
Figure G.4b/Q.55 – Finite state machine for SPNEUP in the ISC

SIGNAL   SPF_CONTROL_SIGNAL, MTP_TRANSFER, SPF_FAILURE,
                SPF_FAILURE_END, SPF_CHANNEL_FAILURE*,
                SPF_CHANNEL_FAILURE_END*

* *for further study*

SPF_FAILURE
SPF_FAILURE_END
SPF_CHANNEL FAILURE*
SPF_CHANNEL_FAILURE_END*

SPNEUP SPNE

SPF_CONTROL_SIGNAL

MTP_TRANSFER*

MTP_TRANSFER*
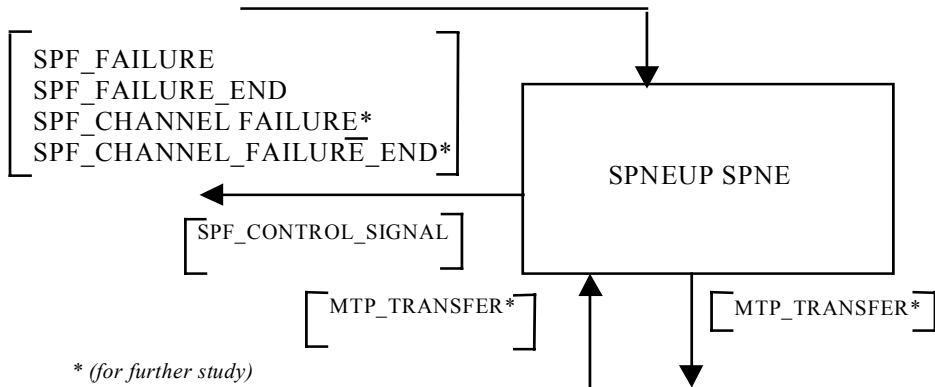
* *(for further study)*

Figure G.4c/Q.55 – Block diagram of SPNE User Part in the SPNE
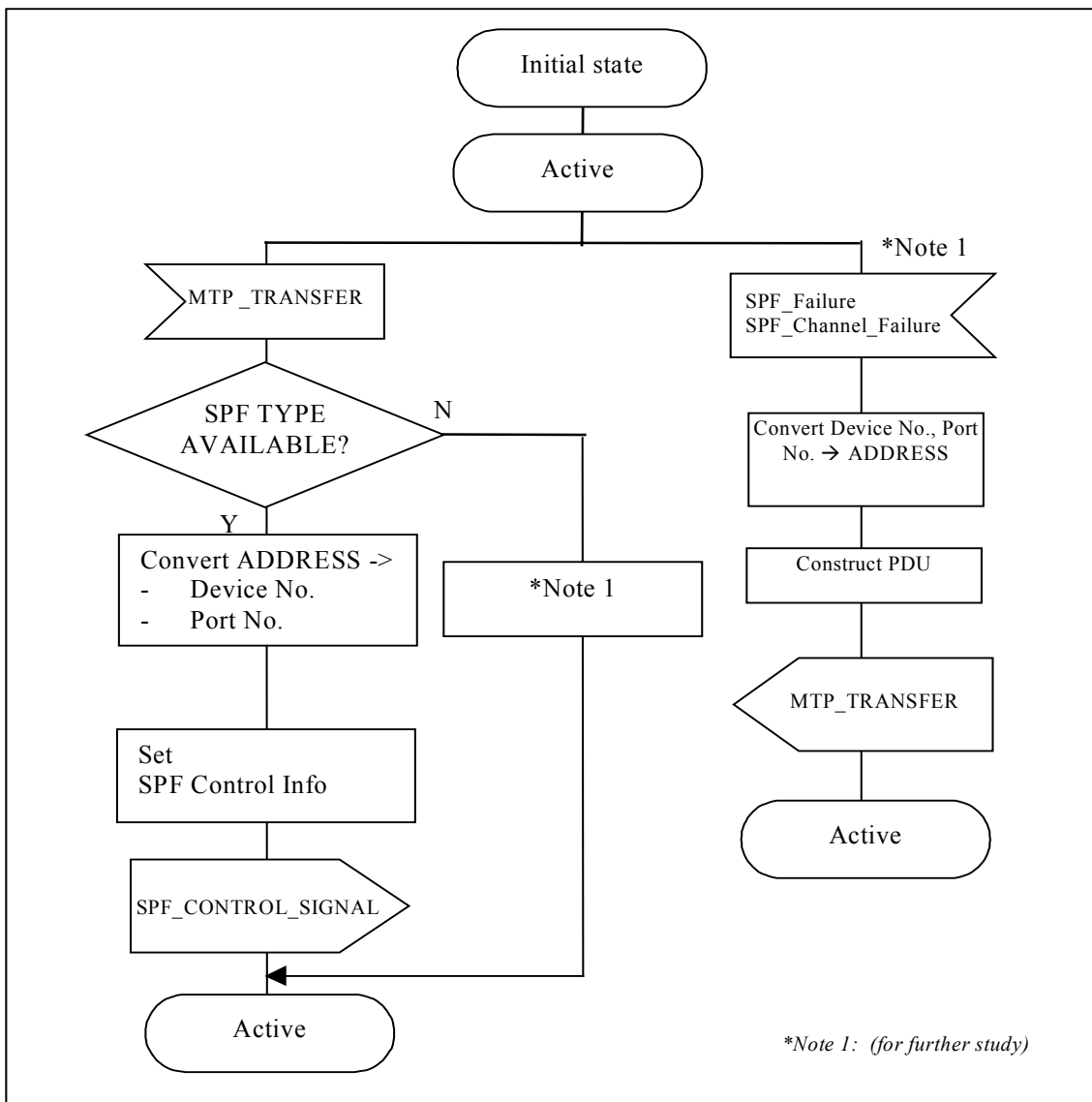
Figure G.4d/Q.55 – Finite State Machine for SPNEUP in the SPNE

ANNEX H

SPNE Protocol Data Units

This annex lists the protocol data units (PDUs) included in this ITU-T Recommendation. Each PDU can be addressed to a specific channel within an E1 or T1 facility. An outgoing SPF is capable of processing signals on the outgoing speech path, and an incoming SPF is capable of processing signals on the incoming speech path.

H.1   Echo cancellation

The following is a list of PDUs required to control network echo cancellers. See Table H.1.

Table H.1/Q.55 – ECD PDUs

Enable echo cancellation on channel n
Disable echo cancellation on channel n
Enable NLP on channel n
Disable NLP on channel n
Enable comfort noise on channel n
Disable comfort noise on channel n

H.2   Noise reduction

The following is a list of PDUs required to control noise reduction devices. See Table H.2.

Table H.2/Q.55 – NRD PDUs

Enable noise reduction of type m on channel n
Disable noise reduction on channel n

NOTE – Type of noise reduction algorithm (m) is determined and configured by the manufacturer or carrier and is outside the scope of this ITU-T Recommendation.

H.3   Automatic Level Control (ALC)

The following is a list of PDUs required to control automatic level controllers. See Table H.3.

Table H.3/Q.55 – ALC PDUs

Enable ALC of type m on channel n
Disable ALC of type m on channel n

NOTE – Type of ALC algorithm (m) is determined and configured by the manufacturer or carrier and is outside the scope of this ITU-T Recommendation.

H.4   Frequency Equalization (FE)

The following is a list of PDUs required to control frequency equalizers. See Table H.4.

Table H.4/Q.55 – Frequency equalizer PDUs

Enable FE of type m on channel n
Disable FE of type m on channel n

NOTE – Type of FE algorithm (m) is determined and configured by the manufacturer or carrier and is outside the scope of this ITU-T Recommendation.

H.5   A-law/μ-law conversion

The following is a list of PDUs required for A-law/μ-Law conversion equipment. See Table H.5.

Table H.5/Q.55 – A-law/μ-law PDUs

Convert from μ-Law to A-Law on channel n
Convert from A-Law to μ-Law on channel n
Disable law conversion

PDUs from the SPNE to the ISC are for further study.

APPENDIX I

Channel monitor (for further study)

A channel monitor is a device that is able to provide information on the nature or relative quality of a speech or voiceband data signal present on a voice circuit. Examples of such information include:

• echo return loss;

• echo delay;

• echo return loss enhancement;

• speech level;

• background noise level;

• speech activity;

• call type (e.g. Voice, Data, Fax);

• PCM offset.

APPENDIX II

Discussion of signalling protocols used on the DL 1544 kbit/s networks

II.1   Standards for the use of the data link channel 1544 kbit/s networks

Any new message protocol used on 1544 kbit/s facilities must be compatible with all existing standards. The DL is defined in G.704 as part of the 1544 kbit/s facility. Two applications are sited for the DL. First, G.704 specifies that DS-1 source and sink terminals can use the DL to send facility status information such as LOF, AIS and LOS. These messages are sent using predefined keywords and have the highest priority on the DL. These messages are sent continuously if one of these conditions occurs. Secondly, a Performance Report Message (PRM) is defined. The PRM is intended to convey facility performance statistics between two terminals. The PRM is 30 ms in length (15 bytes) and is sent once per second.

Further guidance for use of the DL can be found in ANSI T1.403-1995 and ANSI Technical Report TR-12. T1.403 provides additional guidelines as to the specific messages. TR-12 provides application guidance.

II.2   Retransmission of control data

Due to the structure of the 1544 kbit/s DL, multiple ESF frames are needed to create a message in the LAPD format (i.e. 184 data bits require 16 ESF frames). Echo cancellers may not buffer more than 8 frames per ITU-T G.165 and G.168. Therefore, the message cannot be blocked from retransmission toward the network. Consequentially, the originating message will transverse the entire network.

In cases where tandem switches are deployed, due to network design rules, it is desirable to disable any tandem echo cancellers. Since the message cannot be blocked, all cancellers on any path will be

conditioned in the same manner. However it should be noted that ITU-T Recommendation G.131 indicates that circuits equipped with echo cancellers can be connected together in tandem without significant speech path or echo performance degradation.

II.3   Synchronization

The SPNE control messages must be synchronized with the PRM in order to coexist. If these are not synchronized, then message contention must be addressed. Accordingly, the SPNE message could be delayed an additional 30 ms.

APPENDIX III

Call control capacity of the DL signalling channel

Within the DL, the high priority Performance Report message (PRM) is 30 ms in length (15 bytes) and is sent once per second. This message pre-empts SPNE PCC messages, and becomes the limiting factor if a message protocol is to be used on 1544 kbit/s facilities.

The PCC message protocol must be sent at least once for each call setup operation. For an echo canceller, one message is sent to enable the echo canceller and a second message to disable the echo canceller. In a worst case scenario, one message needs to be sent for each SPNE device to be controlled. At a 4 kbit/s signalling rate, the 64 bits (8 bytes × 8 bits) of the LAPD formatted 2-octet message are transmitted in 16 ms. Accordingly, 62 call control messages can be sent each second. Factoring in the 30 ms PRM time reduces this to 60 operations which equates to 30 calls per second for 1544 kbit/s facilities. Based on ITU-T Recommendation Q.543, the call rate should be 9.45 calls per DS-0 per hour. This is based on a 90 second hold time, peak traffic and ISDN services (worst case for Q.543). This figure was rounded up to 10 and doubled for margin resulting in 20 calls per DS-0 per hour. This equates to 0.13 or 0.16 calls/second for a single 1544 kbit/s or 2048 kbit/s facility, respectively. If all 8 SPNE functions need to be controlled on the same call, these figures would be multiplied by 8 yielding 1.04 or 1.28 calls/second for single 1544 kbit/s or 2048 kbit/s facility respectively. Comparing this to the 30 calls/per second capacity of the SPNE DL-based protocol, it can be seen that there is ample call capacity in the message structure in a worst-case control scenario even in the presence of the 1544 kbit/s PRM.

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