ECMA

EUROPEAN COMPUTER MANUFACTURERS ASSOCIATION

OSI SUB-NETWORK INTERCONNECTION SCENARIOS PERMITTED WITHIN THE FRAMEWORK OF THE ISO-OSI REFERENCE MODEL

TR/25

March 1985

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1 SCOPE

This ECMA Technical Report :

- isolates the OSI interconnection scenario categories (OSC's) permitted within the framework of the ISO-OSI Reference Model as extended to include connectionless Network Service,
- defines the functionality of sub-layers 3b and 3c of the Network Layer for each scenario as a basis for development of the protocols needed at those sub-layers,
- gives the criteria for selection of an appropriate class of Transport Protocol for each scenario to provide a connection-oriented Transport Service (see Note 1),
- gives a status report on the work being done in ECMA to meet the protocol requirements identified above.

Additionally, this Technical Report identifies in an Annex a scenario that is outside the scope of the Reference Model but is one offering a pragmatic solution to the problem of interworking between incompatible connection-oriented and connectionless network domains that individually represent interconnection scenarios that are within the scope of the Reference Model.

NOTE 1

The case of connectionless Transport Protocol is the subject of continuing study.

2 REFERENCES

ISO 7498	Information Processing Systems - Open Systems Interconnection - Basic Reference Model
ISO/97/16 N1917	ISO 7478 DAD 1 Addendum to ISO 7498 Covering Connectionless Mode Transmission
ISO/8072	Information Processing Systems - Open Systems Interconnection - Transport Service Definition *(1984 Status : DIS)*
ISO/8073	Information Processing Systems - Open Systems Interconnection - Connection Oriented Transport Protocol Specification *(1984 Status : DIS)*
ISO/8348	Information Processing Systems - Data Communications - Network Service Definition *(1984 Status : DIS)*
ISO/97/6 N2969	ISO/DIS 8348 DAD 1 Addendum to the Network Service Definition Covering Connectionless Mode Transmission

ISO/97/6 N3141	Information Processing Systems - Data Communication - Internal Organization of the Network Layer
ECMA TR/13	Network Layer Principles
ECMA TR/14	Local Area Networks - Layer 1 to 4 Architecture and Protocols
ECMA TR/21	Local Area Networks - Interworking Units for Distributed Systems
ECMA-72	Transport Protocol
ECMA-92	Connectionless Internetwork Protocol

3 TERMINOLOGY

3.1 OSI Terms

The following terms used in this Technical Report have the definitions given in ISO 7498.

Address
Connection
System
Real Open System
Open System
Protocol
Protocol Data Unit
Service
Service Data Unit
Service Access Point

3.2 TR Specific Terms

For the purpose of this Technical Report the following additional definitions apply.

3.2.1 Distributed End Systems

An End System which is constructed from logically and physically separate parts.

3.2.2 Distributed System Interworking-Unit

A distributed End System component which functions as an interworking-unit to support the lower four layers of a Distributed End System.

3.2.3 End System

An Open System which contains all seven layers of the Open Systems Interconnection architecture.

3.2.4 Internetwork Protocol

A sub-network independent convergence protocol combined with relay and routing functions.

3.2.5 Sub-Network Service

The set of functions provided by a sub-network.

3.2.6 Sub-Network Service Access Point

The point at which sub-network services are provided by a sub-network entity.

3.3 Acronyms

The following acronyms are used in this Technical Report.

CL	Connectionless
CO	Connection-Oriented
DES	Distributed End System
DES/C	Distributed End System Component
DSI	Distributed Systems Interworking-Unit
ES	End System
H	Harmonized
HP	Harmonization Protocol
INP	Internetwork Protocol
IWU	Interworking-Unit
LAN	Local Area Network
NS	Network Service
NSAP	Network Service Access Point
OSC	OSI Interconnection Scenario Category
OSI	Open Systems Interconnection
RM	Reference Model
SNSDU	Sub-Network Service Data Unit
SN	Sub-Network
SNS	Sub-Network Service
SPM	Sub-Network Physical Medium
TP	Transport Protocol
TS	Transport Service
TSAP	Transport Service Access Point

4 GENERAL

The Network Layer of the OSI Reference Model for Open Systems Interconnection is defined for the purpose of achieving the interconnection of heterogeneous sub-networks.

Two types of sub-network exist to be interconnected within this framework. These types are referred to as connection-oriented and connectionless.

The services offered by heterogeneous sub-networks of the same type and those offered by sub-networks of different types must be harmonized before they can be interconnected. Such harmonization may require implementation of a service harmonization protocol over each sub-network.

This Technical Report proposes a categorization scheme for the sub-network interconnection scenarios permitted within the framework of OSI as a basis for study of the harmonization protocol requirements within each scenario.

5 ISO-OSI Reference Model

The issue of sub-network interconnection within the framework of OSI is complicated by the following factors :

a) The ISO Reference Model makes provision for connection-oriented and connectionless network services, and hence allows sub-networks offering one or other or both of these types of service.

b) The RM requires all functions associated with the interconnection of sub-networks, irrespective of the services they offer, to be performed as Network Layer functions.

c) The RM requires the same service to be seen by the systems at both ends of a concatenation of sub-networks.

Of these factors b) and c) require, in any mixed configuration of CO and CL sub-networks, the services of one or other of the sub-network classes to be converted to or (which amounts to the same thing) carried over the other.

Factor a) excludes the selection of either service as having precedence over the other in this carrying over process.

Consequently, the only solution satisfying all the possibilities allowed by the RM within the constraints imposed by the RM is to require both classes of sub-network to be enhanced to provide both types of service.

This is the only general solution able to fully meet the OSI objective of a completely open Network Service.

However, for political and economic reasons this general solution cannot be universally imposed. Less drastic solutions must be found to satisfy the specific sub-network interconnection scenarios of practical interest.

6 INTERCONNECTION SCENARIO CATEGORIES

The range of possible OSI Interconnection Scenario Categories is the following :

ISO-OSI Scenario Category	Sub-Network Combination	OSI Network Service required from the combination
OSC1	CO/CO	CO
OSC2	CL/CL	CL
OSC3	CO/CL	CO
OSC4	CO/CL	CL
OSCx	CO/CO	CL
OSCy	CL/CL	CO

OSC's 1 and 4 are dealt with in the following clauses.

OSC's x and y are listed for the sake of completeness. They are not considered in detail but may be dealt with by considering the sub-network combinations first as examples of OSC1 or OSC2 respectively and then as single sub-networks to which the principles of scenarios 4 and 3 respectively can be applied recursively.

Annex A considers the practical difficulties associated with applying the principles of scenarios 4 and 3 recursively to solve the problem of interconnection of CO and CL network domains, where the domains individually represent a permitted scenario but no agreement exists between domain authorities as to the Network Service to be provided globally. OSC5 making use of an interworking-unit operating at the Transport Layer is identified as pragmatic solution to this problem.

6.1 OSC1 (CO to CO Interconnection for a Global CO Service)

The approach being followed is that of sub-network service harmonization on a sub-network by sub-network (hop by hop) basis. The approach requires, for each cooperating sub-network, the definition of an harmonization protocol capable of raising the level of service offered by each sub-network to that of the OSI CO Network Service.

The layered model of an interworking-unit corresponding to this approach is given by figure 1.

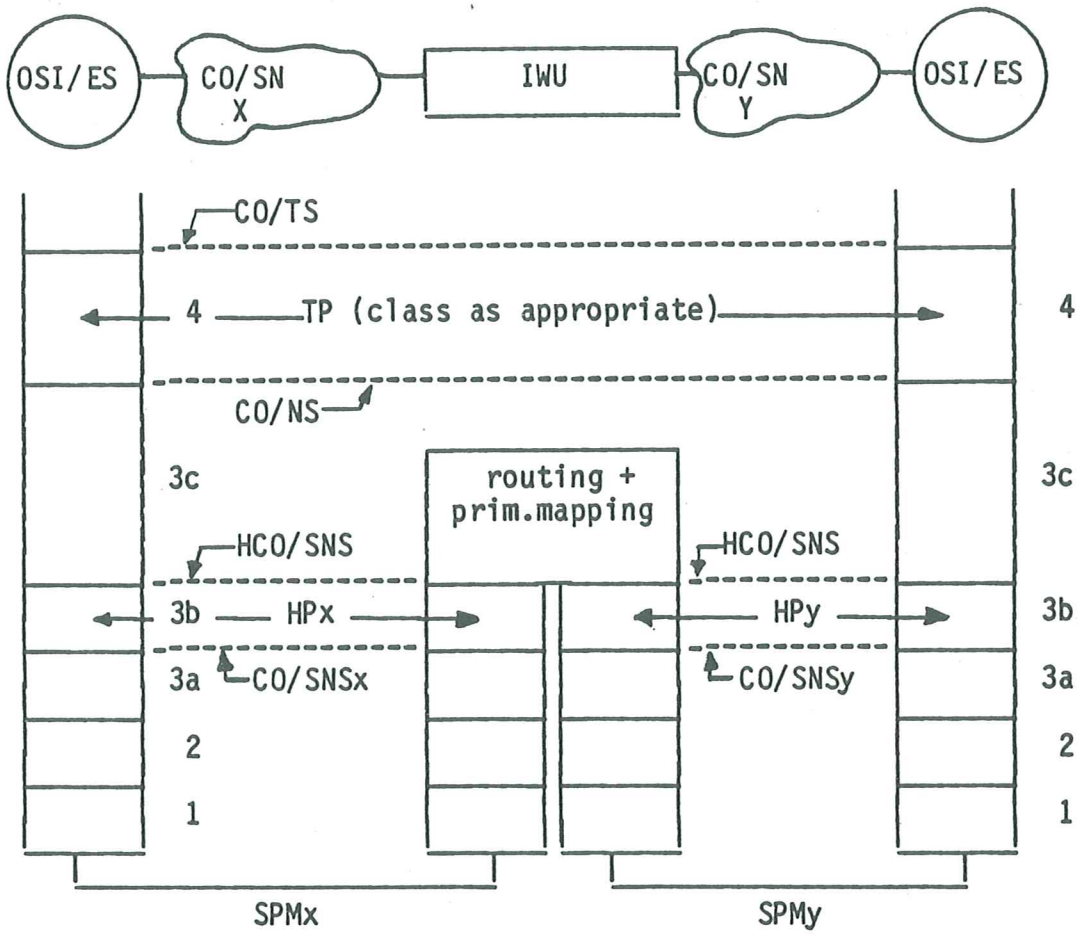

Figure 1 - Layered Structure for Connection Oriented/Connection Oriented Interworking within the OSI Network Layer to achieve a Connection Oriented Network Service (OSC1).

This figure illustrates the interconnection of two sub-networks but the same general principles apply irrespective of the number of CO sub-networks involved in the global connection.

No detail is given of the protocols operating at layers 1 and 2 and sub-layer 3a. These protocols are sub-network specific.

6.1.1 Functionality of Sub-Layer 3c

Sub-layer 3c operates to provide a relay and routing function at the inter-sub-network (as opposed to intra-sub-network) level. The information used to perform this function is transferred in the form of parameters of (harmonized) sub-network service primitives. The parameters may comprise address, routing, quality of service and possibly other information.

6.1.2 Functionality of Sub-layer 3b

A feature of figure 1 is that it embodies possibly different distributions of functionality between sub-layers 3a and 3b for the different sub-networks X and Y. These different distributions arise out of the differences between the sub-networks in terms both of the abstract primitives that define their services and the qualities of service they offer.

Interconnection demands only harmonization of service primitives. Harmonization of quality of service may or may not be performed dependent on economic or other factors.

6.1.3 Transport Protocol Class Selection

Following from 6.1.2 a layer 4 Transport Protocol class must be selected in accordance with the TS user required quality of service and whatever global quality of Network Service is actually achieved in practive by the cooperating networks.

6.1.4 Areas of Standardization by ECMA

ECMA has developed Standard ECMA-72 to meet the requirement for a Transport Protocol offering different levels of quality of service enhancement over global Network Connections.

6.2 OSC2 (CL to CL Interconnection for a Global CL Service)

The approach being adopted is to define a standard CL Internetwork Protocol for implementation over all sub-networks equally in a sub-network independent manner.

The distinguishing feature of this approach is that the Internetwork Protocol assumes a minimal level of underlying sub-network service and represents an independent (sub) layer of protocol carried transparently over each of the interconnected sub-networks.

The layered model of an IWU corresponding to this approach is illustrated by figure 2.

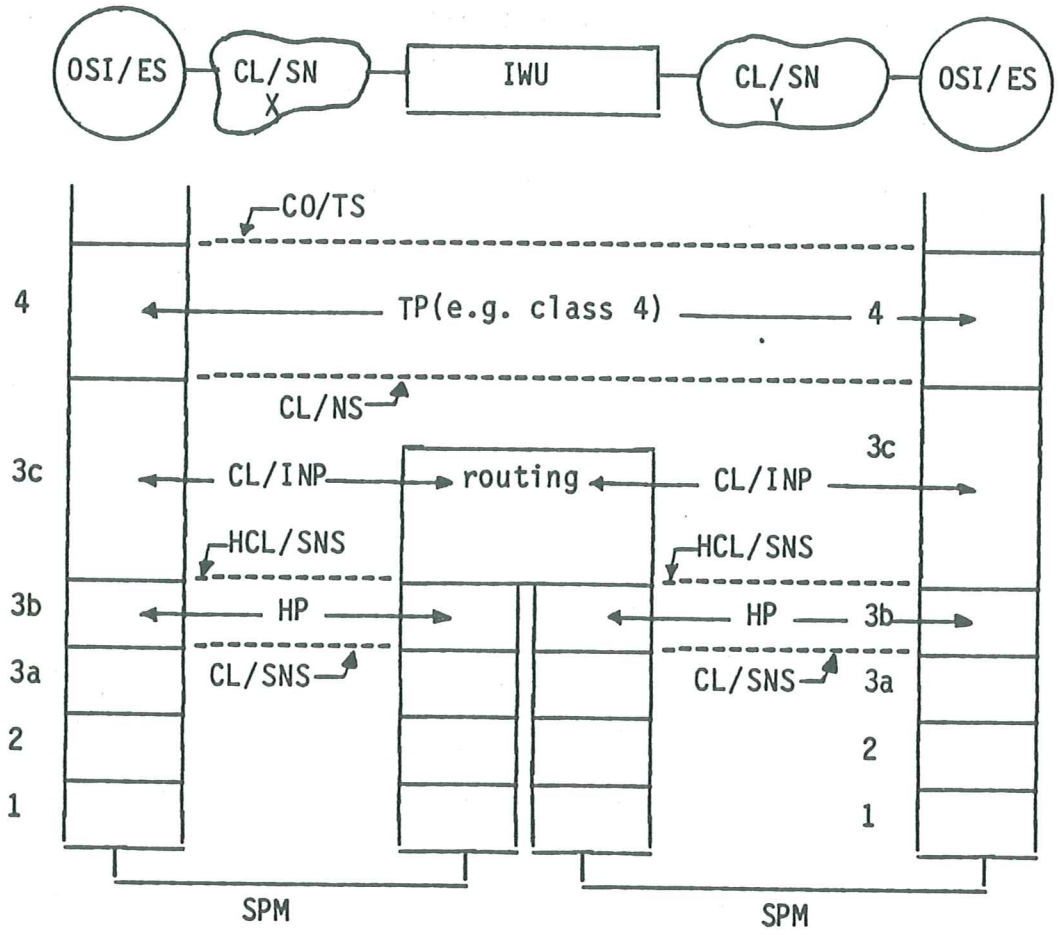

Figure 2 - Layered Structure for Connectionless/Connectionless Interworking within the OSI Network Layer to achieve a Connectionless Network Service (OSC2).

This figure again illustrates the interconnection of two sub-networks but can be extended to any number.

6.2.1 Functionality of Sub-Layer 3c

The basic functionality of sub-layer 3c for OSC2 is the same as that for OSC1. The information used to perform the function is transferred as Internetwork Protocol header information.

6.2.2 Functionality of Sub-layer 3b

In general the functionality of sub-layer 3b is restricted to enhancing the sub-network service on a hop-by-hop basis to support SNSDUs each long enough to carry at least the Internetwork Protocol header information.

6.2.3 Transport Protocol Class Selection

The ECMA-72 Transport Protocol class 4 should be used in this scenario, assuming that the connectionless Network Service has the characteristics defined in ISO/DIS 8348 DAD 1.

6.2.4 Areas of Standardization by ECMA

ECMA has developed Standard ECMA-92 for the Connectionless Internetwork Protocol for operation at sub-layer 3c.

No sub-layer 3b harmonization protocols have yet been defined for this scenario, no immediate requirement being seen for the interconnection of dissimilar (in the sense of 6.2.2) CL sub-networks.

6.3 OSC3 (CO to CL Interconnection for a Global CO Service)

For this scenario OSC1 interconnection rules predominate. All CL sub-networks within the global domain must be given the appearance of CO sub-networks to support the 3c relay and routing function of figure 1.

Accordingly, sub-network dependent CO harmonization must be defined for implementation over CL sub-networks in accordance with the quality of service they offer relative to the quality of service provided by the CO sub-networks with which they are required to interwork.

The layered model of an IWU for this scenario is illustrated by figure 3.

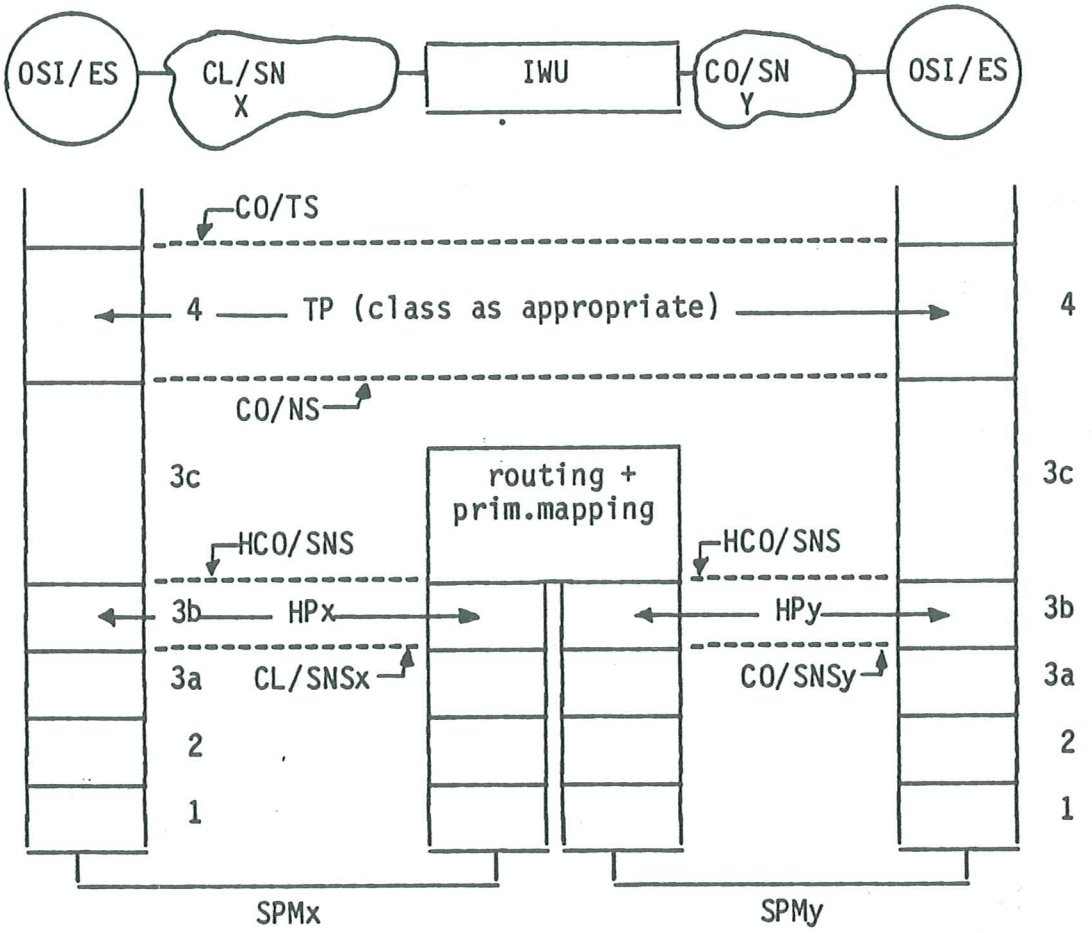

Figure 3 - Layered Structure for Connectionless/Connection Oriented Interworking within the OSI Network Layer to achieve a Connection Oriented Network Service (OSC3).

6.3.1 Functionality of Sub-layer 3c

See 6.1.1

6.3.2 Functionality of Sub-layer 3b

For sub-network Y considerations as for 6.1.2 apply. For sub-network X a CO harmonization protocol must be implemented over the underlying CL sub-network service.

6.3.3 Transport Protocol Class Selection

See 6.1.3

6.3.4 Areas of Standardization by ECMA

ECMA has yet to study the harmonization protocol requirements for this scenario. One proposal being considered is a protocol based on a suitably modified version of the ECMA-72 Transport Protocol.

6.3.5 Scenario 3 Example

The example given by figure 4 shows how an ES in the CL network domain could be made to operate both with other ES's in the CL domain using a CL network Service and with ES's in a CO domain using a CO Network Service.

This is achieved by means of a CO harmonization protocol extending the CO domain over the CL domain to the ES's in the CL domain that are required to co-exist in both domains.

It should be noted that an application (AP) residing in the CL/CO ES is able to communicate with applications in other CL/CO ES's in the CL domain using either a CO or a CL network Service.

It should also be noted that CL/IWU's are transparent to the CO harmonization protocol extending the CO domain thereby enabling CL/CO ES's to be attached to any network forming the CL domain.

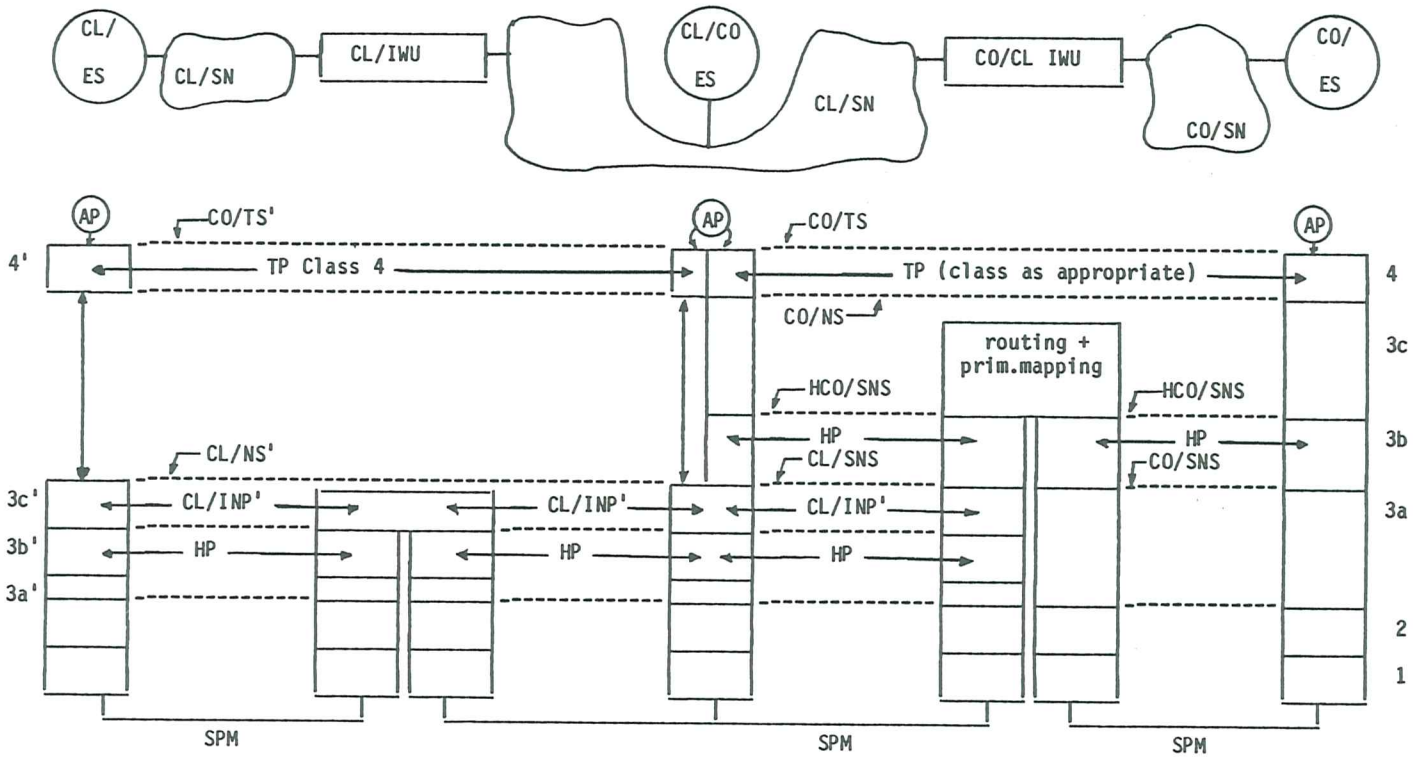

Figure 4 - Layered Structure for Connectionless Network Domain/Connection Oriented Sub-Network Interworking within the OSI Network Layer (OSC 3.1) - CL Interworking between CL/ES and CL/CO ES, CO Interworking between CO/ES and CL/CO ES.

6.4 OSC4 (CO to CL Interconnection for a Global CL Service)

For this scenario OSC2 rules predominate. All CO sub-networks within the global domain must be given the appearance of CL sub-networks to support the 3c internetwork Protocol sub-layer of figure 2.

Accordingly the 3b sub-layer function is primarily that of providing a CO to CL service mapping function.

The layered model of an IWU for this scenario is illustrated by figure 5.

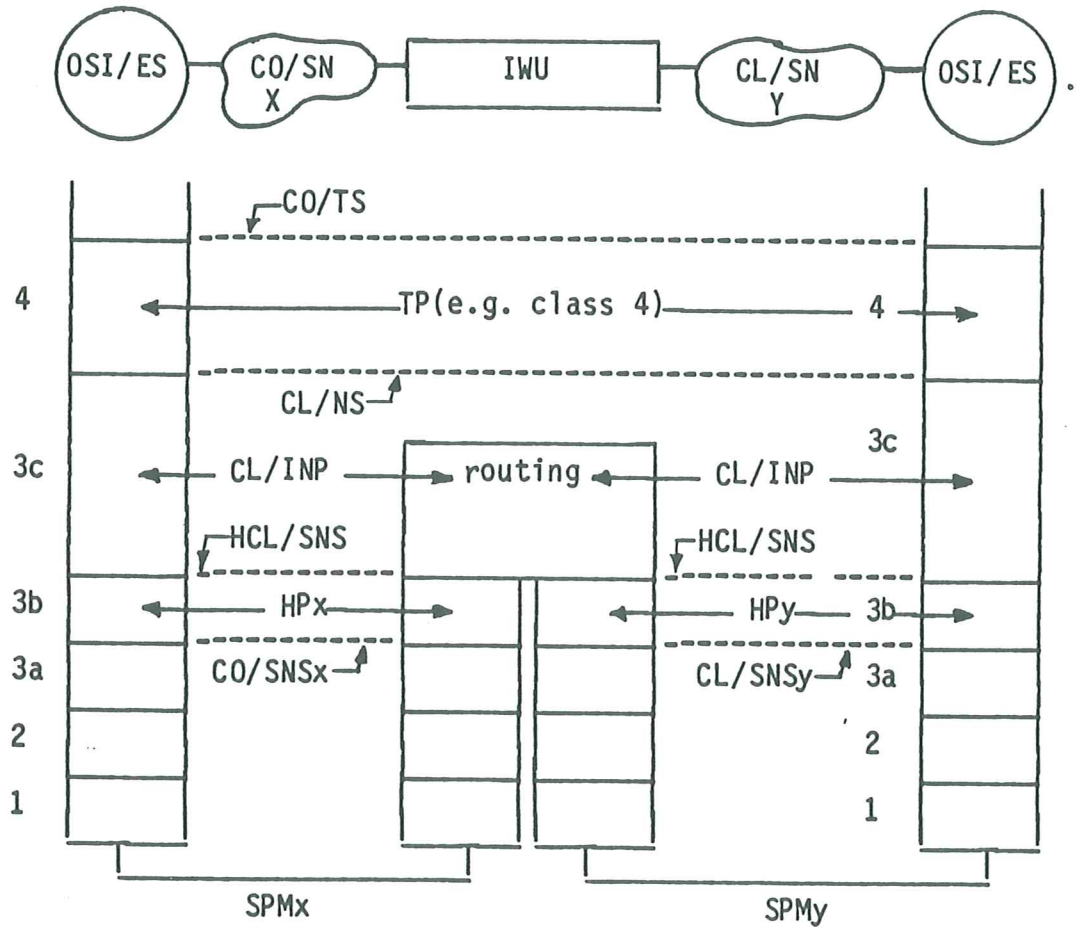

Figure 5 - Layered Structure for Connection Oriented/Connectionless Interworking within the OSI Network Layer to achieve a Connectionless Network Service (OSC4).

6.4.1 Functionality of Sub-layer 3c

See 6.2.1

6.4.2 Functionality of Sub-layer 3b

For sub-network X the requirement is for a definition of the way in which the CL Internetwork Protocol is carried over the underlying CO sub-network service.

For sub-network Y the same consideration apply as for 6.2.2.

6.4.3 Transport Protocol Class Selection

See 6.2.3

6.4.4 Areas of Standardization by ECMA

ECMA has yet to study in detail, for sub-network X, the sub-layer 3b requirement.

ANNEX A

OSC5 (Interworking between CL and CO Network Domains)

A.1 Introduction

The scenario described in this Annex designated OSC5 is not in conformance with the Transport Layer functions described in the OSI Reference Model. However, a pragmatic need has been identified by some ECMA members for the form of interconnection described here, pending a satisfactory solution to the problem of connection-oriented and connectionless interworking in the Network layer. The scenario described here is to be regarded as purely interim until such a solution is developed.

A.2 OSC5

The scenario is identified for the purposes of providing a solution to the problem of achieving interworking between two network domains, each made up of a mixture of CL and CO networks, one domain offering a CL service and the other a CO service.

In principle it would be possible to interconnect two such domains by applying the principles of OSC's 3 and 4 recursively, each domain being created in effect as a single sub-network.

However, application of the recursion principle demands agreement between the domain authorities as to the overall service, CO/CL or both, to be provided globally.

Failing the possibility of achieving agreement at the network Layer, alternative means must be devised to achieve global interworking.

Such a means can be provided through an interworking-unit operating at the Transport Layer. Scenario 5 is defined to cover this case. The layered model of an interworking-unit between CO and CL domains is illustrated in fig. A.1.

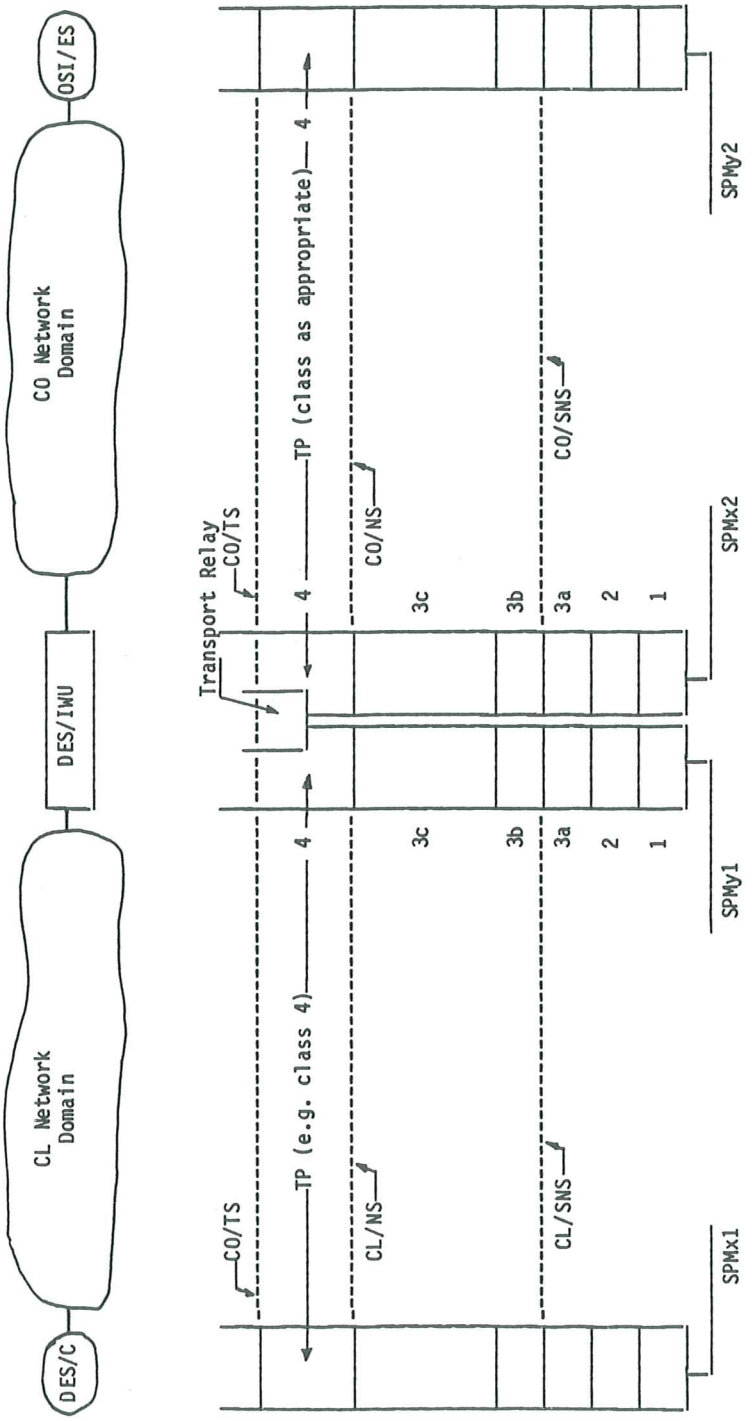

Figure A.1 - Layered Structure for Connectionless/Connection Oriented Domain Interworking within the OSI Transport Layer (OSC5).

A.2.1 Field of Application of OSC5

Interworking at the Transport Layer requires, under the terms of the Reference Model, each domain to be regarded in its entirety as an Open System viewed from the other domain.

Accordingly, the scenario has application only where it is required or where it is reasonable to regard a domain in its entirety as an Open System.

A LAN configuration supporting a distributed Open System is seen by ECMA as a case where it is useful so to regard a network domain.

A.2.2 Areas of Standardization by ECMA

ECMA has studied the requirements of a Distributed System Interworking-Unit embodying a form of transport relaying. This work is not seen as a proper subject for ECMA standardization but as providing material which has been published in ECMA TR/21.

A.3 Examples of Distributed End Systems Using a Single LAN

The figures which are appended hereafter give examples for Distributed End Systems. The separation of the End System into physically distributed parts has been performed at the OSI Transport Service boundary, so that the OSI layers 1-4 are performed by the Distributed End System Interworking-Unit and the higher layers are performed by some Distributed End System Component. The communication between Distributed End System Components and the IWU is realized according to ECMA TR/14. The IWU provides for the necessary routing and mapping functions.

The figures in particular show :

OSC5.1 Interconnection of LAN and X.25 in Teletex Environment (see fig. A.2)

OSC5.2 Interconnection of LAN and X.21 in Teletex Environment (see fig. A.3)

OSC5.3 Interconnection of LAN via X.25 (see fig. A.4) (only one half of the symmetric configuration is shown)

OSC5.4 Interconnection of LAN via X.21 (see fig. A.5) (only one half of the symmetric configuration is shown)

OSC5.5 Interconnection of LAN via Concatenated X.25/X.21 (see fig. A.6) (only one half of the symmetric configuration is shown)

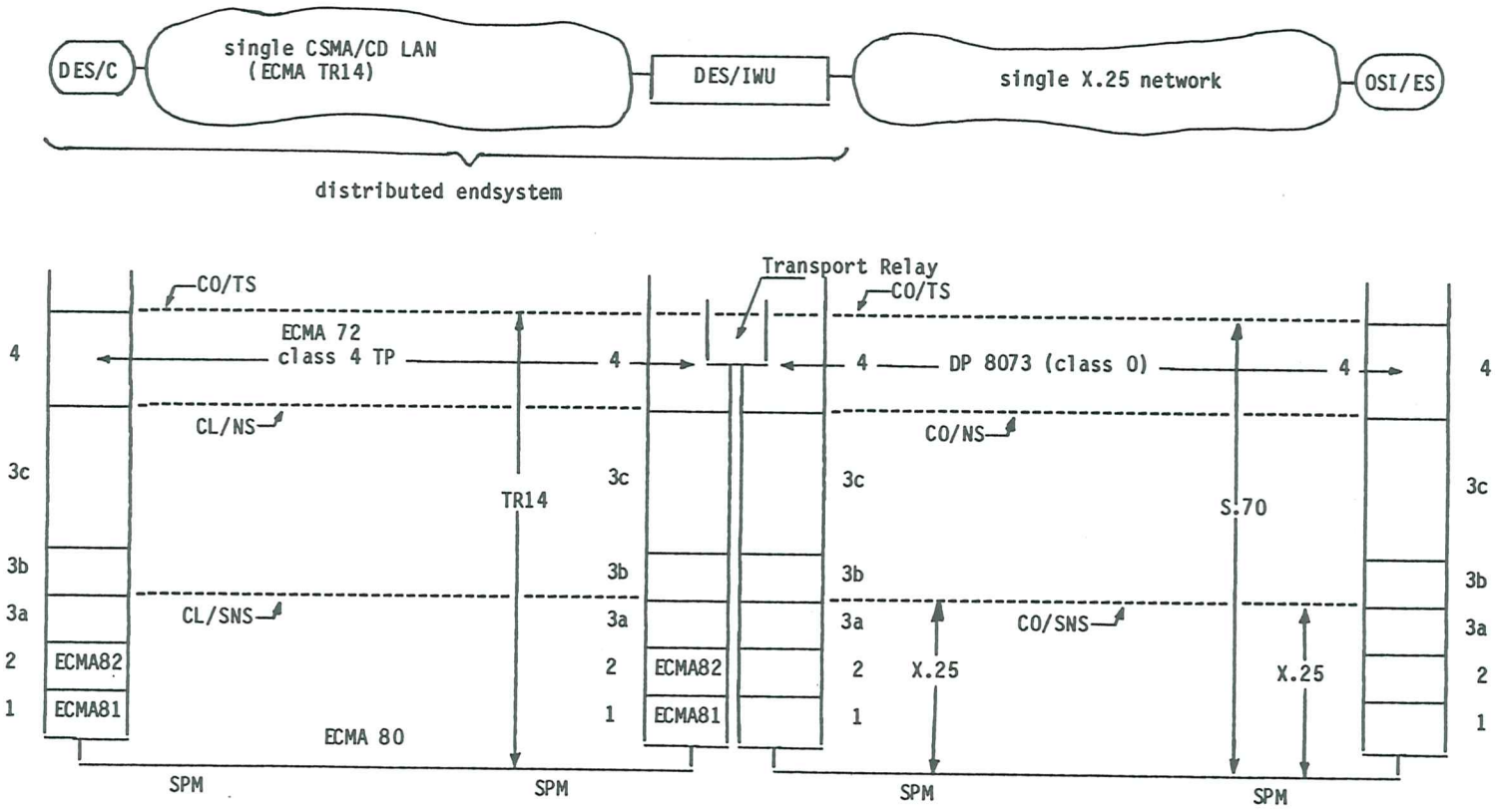

Figure A.2 - Layered Structure for LAN/X.25 Interworking in Teletex Environment within the OSI Transport Layer (OSC5.1)

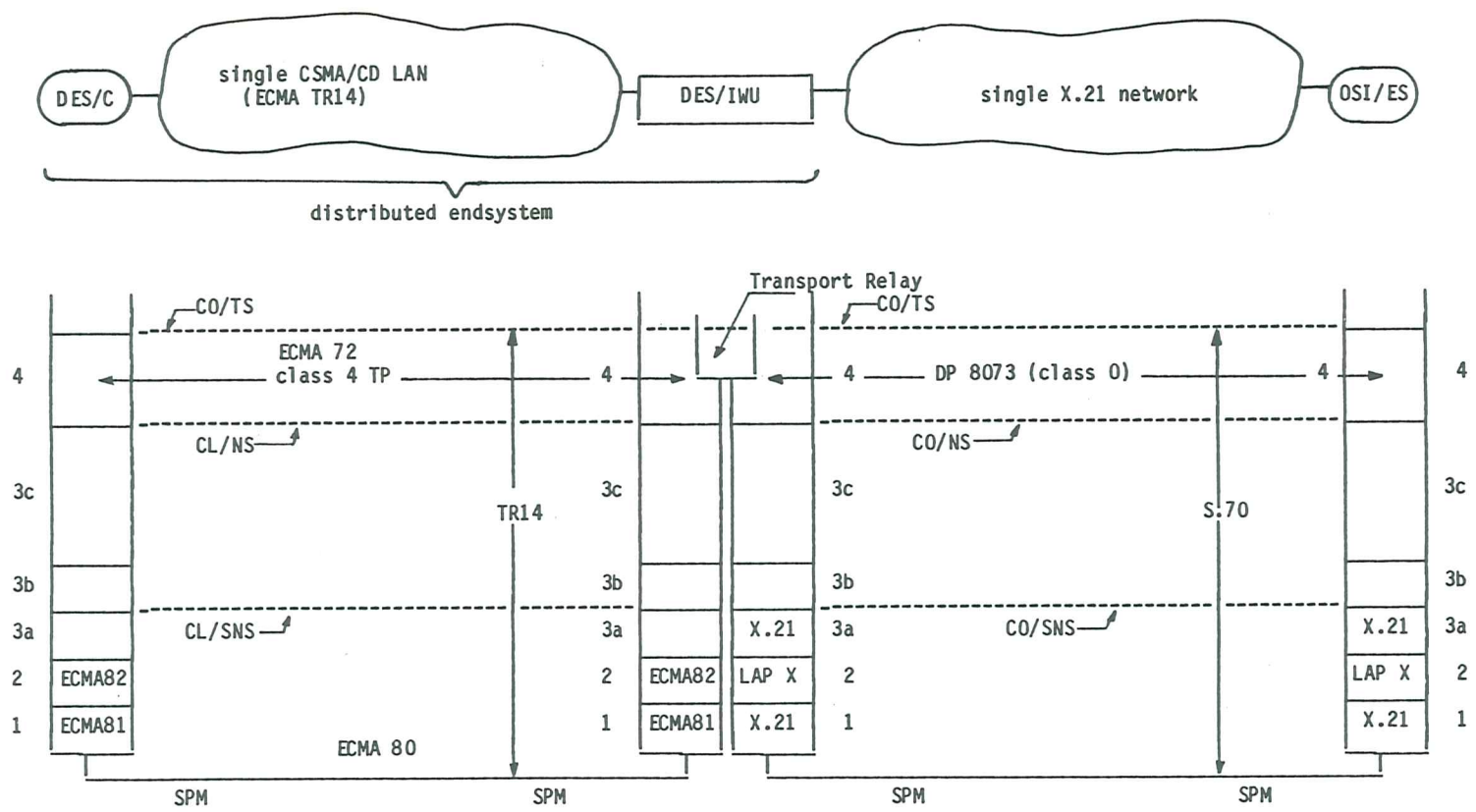

Figure A.3 - Layered Structure for LAN/X.21 Interworking in Teletex Environment within the OSI Transport Layer (OSC 5.2)

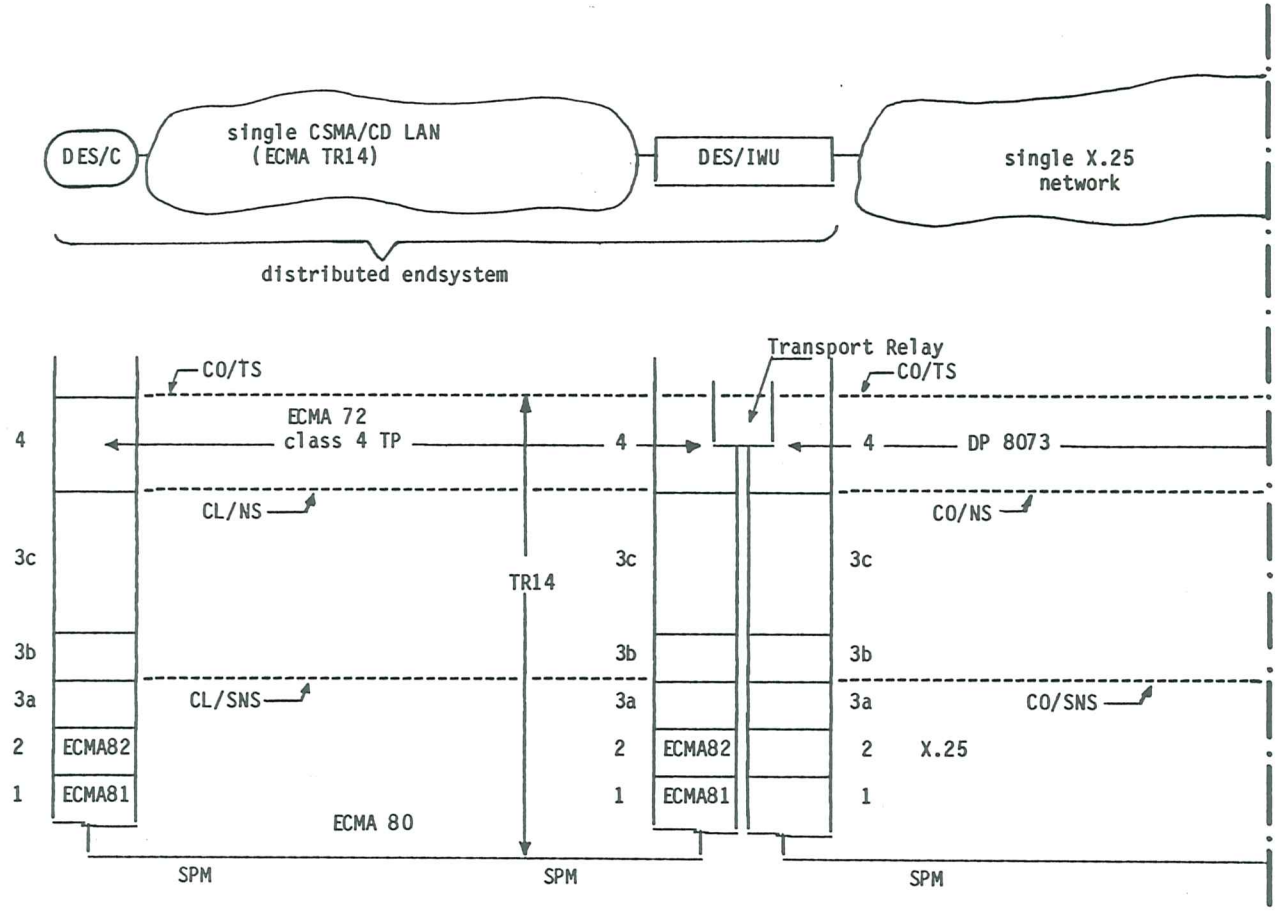

Figure A.4 - Layered Structure for LAN/LAN Interworking via X.25 Network within the OSI Transport Layer (OSC5.3)

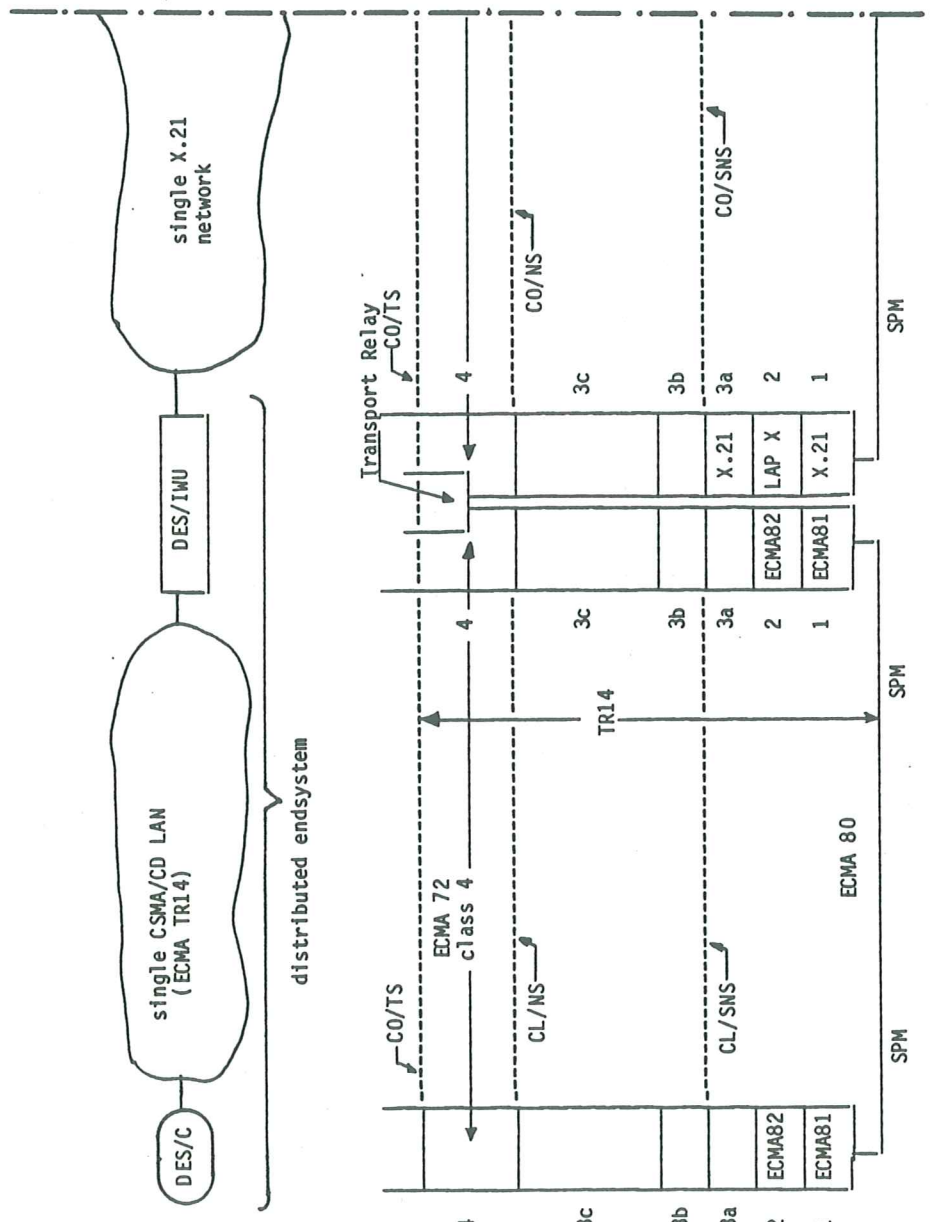

Figure A.5 - Layered Structure for LAN/LAN Interworking via X.21 Network within the OSI Transport Layer (OSC5.4)

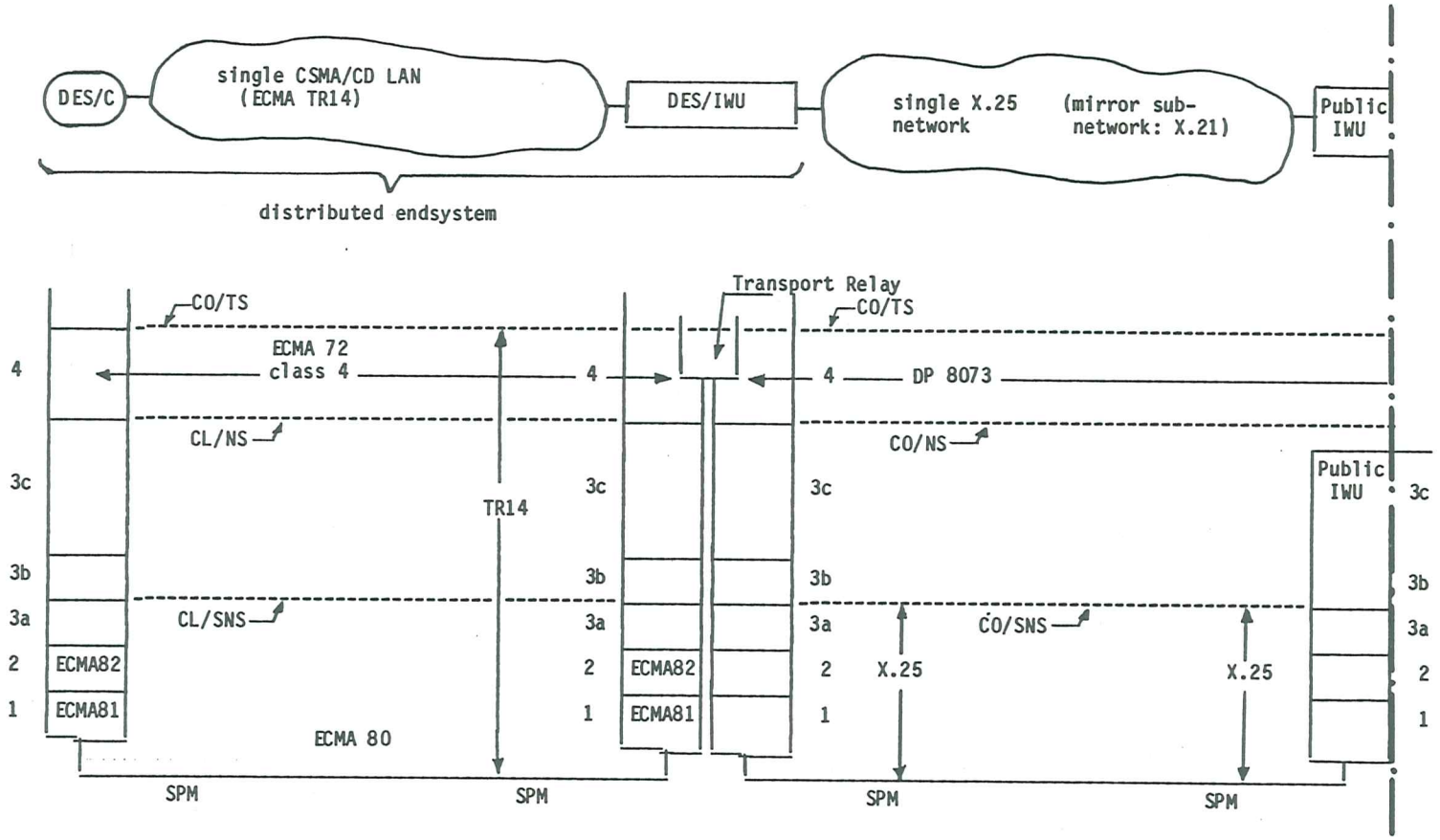

Figure A.6 - Layered Structure for LAN/LAN Interworking via Concatenated X.25/X.21 Networks within the OSI Transport Layer (OSC5.5)

A.4 Example of Interconnection of a Connectionless Domain with a Connection-Oriented Domain via a Transport Relay

The example which is given in the figure hereafter shows how scenario 1 and 2 can be interconnected by applying a transport relay.

This example clearly shows how applications (APs), which reside in DES components, attached to the CL domain, may communicate with APs which reside in DES components.

The complexity of the sub-network configuration is the same as given in Annex A.3 but the complexity of the protocol structure to be implemented in a DES component is comparably low.

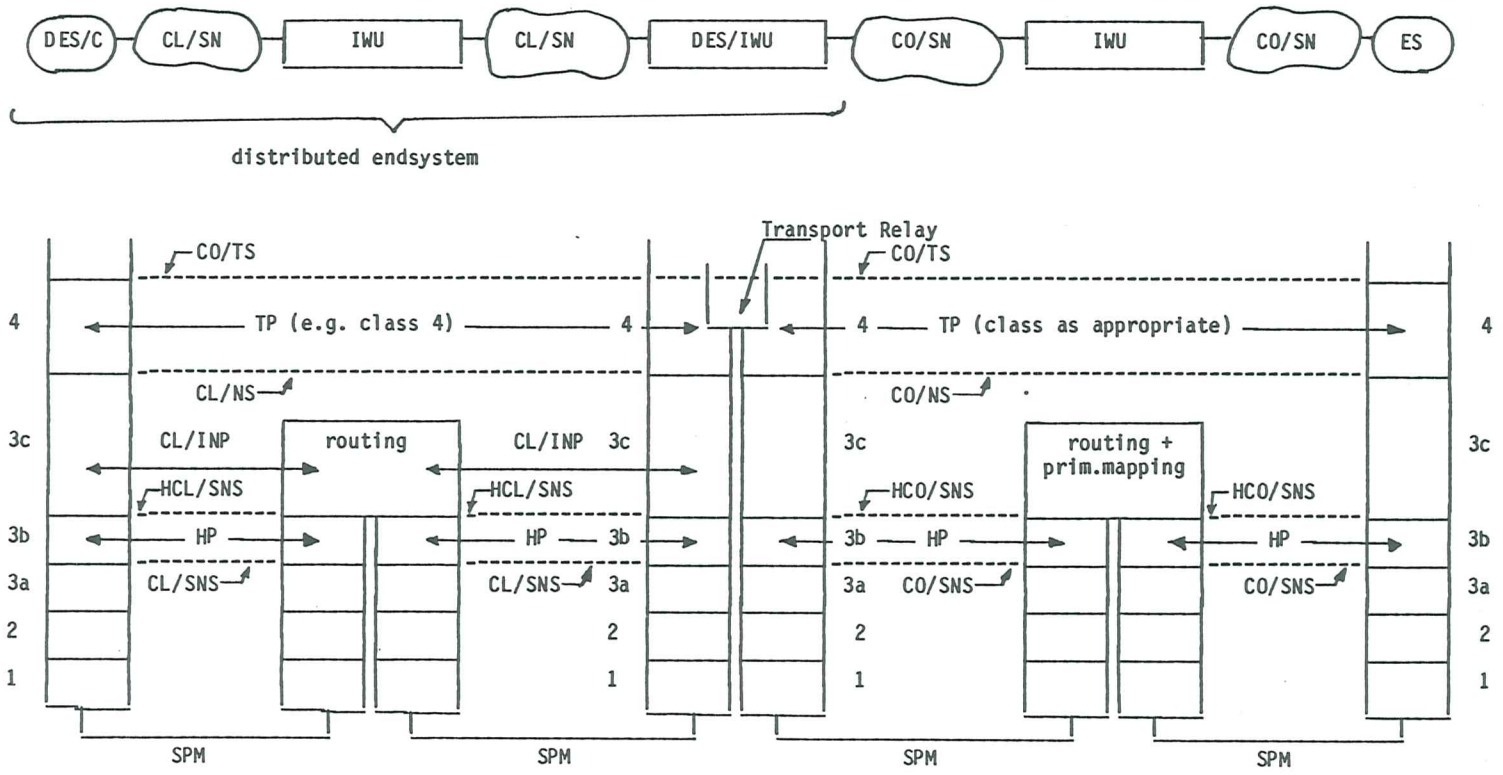

Figure A.7 - Layered Structure Connection Oriented/Connectionless Domain Interworking within the OSI Transport Layer (OSC 5.6)