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Draft for Development

Open Systems Interconnection: internal organization of the network layer (ISO/DP 8648)

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This publication is not to be regarded as a British Standard.

It is being issued in the Draft for Development series of publications and is of a provisional nature because the subject matter is in the process of ongoing development within the International Standards Committee (ISO/TC 97/SC 6 Telecommunications and Information Exchange between Systems).

It should be applied on this provisional basis, so that information and experience of its practical application may be obtained.

A review of this Draft for Development will be carried out not later than two years after its publication. Notification of the start of the review period, with a request for the submission of comments from users of this Draft for Development will be made in an announcement in the appropriate issue of *BSI News*. Observations which it is felt should receive attention before the official call for comments will be welcomed.

According to the replies received, the responsible BSI Committee will judge whether the Draft for Development can be converted into a British Standard or what other action should be taken.

National foreword

This Draft for Development has been prepared under the direction of the Office and Information Standards Committee.

The primary objective of this Draft for Development is to give advance guidance to product and systems designers concerned with the Network Layer of the Basic Reference Model for Open Systems Interconnection (OSI).

The text of the Draft for Development is identical with the second Draft Proposal ISO/DP 8648 (reference ISO/TC 97/SC 6 N3457) issued February 1985 by the International Organization for Standardization (ISO).

For ease of reproduction the ISO text has been reproduced unchanged.

The UK has actively participated through BSI Technical Committee OIS/6 in the development of the ISO Draft Proposal. The Technical Committee will review any agreed amendments or addenda to the ISO text and will, where appropriate, update the text of this Draft for Development via an amendment or revision. When the ISO draft reaches an appropriate level of agreement and stability, this Draft for Development may then be converted to a British Standard.

A brief summary of the Network Layer, to assist comprehension of the interrelationship between the various Network Layer publications, is attached as national appendix A.

A Department of Trade and Industry IT Standards Unit Technical Guide, TG 100/1, 'Intercept recommendations for the OSI Network Layer' is currently available from the DTI HQ Library, Room LG37, 1 Victoria Street, London SW1H 0ET.

For information, a list of published British Standards and Drafts for Development (together with those scheduled for publication at the time of publication of this Draft for Development) for OSI, data communications and computer graphics is attached as national appendix B. Press releases for new OSI, data communications and computer graphics British Standards publications will be issued to the computing press, and details of all new publications will be recorded in full in *BSI News*.

Terminology and conventions. The text of the Draft Proposal has been approved as suitable for publication as a Draft for Development without deviation. Some terminology and certain conventions are not identical with those used in Drafts for Development; attention is drawn especially to the following.

Wherever the words 'International Standard' appear, referring to this Draft for Development, they should be read as 'Draft for Development'.

Wherever page numbers are quoted, they are ISO page numbers.

Cross-references

International standards	Corresponding British Standards
ISO 7498-1984	BS 6568 : 1984 Description of basic reference model for open systems interconnection (Identical)
ISO 7498 DAD 1	DD 125 : 1985 Basic reference model for open systems interconnection: connectionless-mode transmission (ISO 7498 DAD 1) (Identical)
ISO/DP 8509	DD 108 : 1985 Open Systems Interconnection: service conventions (ISO/DP 8509) (Identical)

International standards	Corresponding British Standards
ISO/DIS 8348	DD 119 : 1985 Open Systems Interconnection: connection-mode network service definition (ISO/DIS 8348) (Identical)
ISO/DIS 8348 DAD 1	DD 118 : 1985 Open Systems Interconnection: protocol for providing the connectionless-mode network service (ISO/DIS 8473) incorporating the connectionless-mode service addendum (ISO/DIS 8348 DAD 1) National appendix A (Identical)
ISO/DIS 8208	DD 117 : 1985 Open Systems Interconnection: X.25 packet level protocol for data terminal equipment (ISO/DIS 8208) (Identical)
ISO/DIS 8802/2	DD 99 Logical link control for local area networks Part 1 : 1985 Technical specification (ISO/DP 8802/2) (Identical)
ISO/DIS 8802/3	DD 98 CSMA/CD local area networks Part 1 : 1984 Technical specification (ISO/DP 8802/3) (Identical)
ISO/DIS 8802/4	DD 100 Token bus local area networks Part 1 : 1985 Technical specification (ISO/DP 8802/4) (Identical)
ISO/DP 8802/5	DD 136 Token ring local area networks *Part 1 Technical specification (ISO/DP 8802/5) (Identical)
ISO/DP 8802/6	BS 6531 10 Mbps slotted ring local area network Parts 1 to 7 (Technically equivalent) BS 6532 Data terminal equipment for attachment to 10 Mbps slotted ring local area network Parts 1 and 2 (Technically equivalent)

*In preparation.

0. INTRODUCTION

This document defines an architectural organization of the Network layer of the OSI Reference Model. It is concerned with the architectural organization of Network Layer entities in open systems, and with the ways in which this architectural organization can be mapped to "real world" components (e.g. "real" networks, switches, transmission media, etc.).

The architectural organization defined in this document identifies and categorizes the way in which functions can be performed within the Network Layer by Network Layer protocols. In so doing, it provides a uniform framework for describing how different Network Layer protocols, operating either individually or cooperatively, can be used to provide the OSI Network Service. By focusing attention on the common functional elements of Network Layer protocols, this framework is intended to:

- a) Simplify the use of Network Layer protocols to provide the Network Service in different situations;
- b) Limit the uncoordinated proliferation of Network Layer protocols with overlapping functions; and
- c) Clarify the requirements for, and guide the development of, future Network Layer protocol standards.

This detailed internal structure is necessary in the case of the Network Layer for two reasons:

1. The Network Layer provides its users with a uniform Network Service, regardless of potentially wide variations in underlying "real-world" network services, technologies, and administrative organization; it is important to understand how the underlying components are organized and interact within the Network Layer, and how they can be efficiently and effectively used.
2. ISO 7498 specifies that the Network Layer performs routing and relaying functions and may contain entities residing in intermediate systems as well as in end systems. It is necessary to describe events that take place within the Network Layer in both types of entities i.e. in end systems (within which the Network Service is provided to NS users) and in intermediate systems (within which Network entities providing these relay and routing functions do not necessarily provide the Network Service to NS users).

[ISO page 3]

1. SCOPE AND FIELD OF APPLICATION

This document provides an architectural model of the OSI Network Layer as a framework for OSI Network Layer standardization, allowing incorporation of existing network standards within the OSI architecture. This framework encourages the design of real subnetworks that fully support the OSI Network Service and also accommodates the participation, in the OSI environment, of real subnetworks that do not fully support the OSI Network Service.

This document is intended for use both in the design and application of Network Layer protocols, Network Layer relay entities, and Network layer entities in end systems which are involved in providing the OSI Network Service.

It shall be used to:

- a) provide a common set of concepts and terminology for use in Network Layer standards (such standards shall reference this document);
- b) analyze Network layer functionality and classify Network Layer protocols;
- c) specify how "real networks" should be used in supporting or providing the OSI Network Service, in particular, in circumstances where multiple "real networks" are to be interconnected and used.

The organization defined herein does not address Network Layer management; in particular it is not concerned with the relationships among Network layer entities which may be required for Network Layer management purposes. In addition, this document does not specify the operational requirements for relay functions in intermediate systems, nor address how specific combinations of permitted functions might be practically and efficiently utilized. These are potentially the subjects of separate specifications related to the Network Layer.

[ISO page 4]

2. REFERENCES

- ISO 7498 Information Processing Systems - Open Systems Interconnection - Basic Reference Model
- DAD1 7498 Information Processing Systems - Open Systems Interconnection - Addendum to the Basic Reference Model Covering Connectionless Data Transmission.
- DP 8509 Information Processing Systems - Open Systems Interconnection - Service Conventions.
- DIS 8348 Information Processing Systems - Data Communications - Network Service Definition
- DAD1 8348 Information Processing Systems - Data Communications - Addendum to the Network Service Definition Covering Connectionless-mode Transmission
- DIS 8208 Information Processing Systems - Data Communications - X.25 Packet Level Protocol for Data Terminal Equipment
- DIS 8802/2 Information Processing Systems - Data Communications - Local Area Networks Logical Link Control
- DIS 8802/3 Information Processing Systems - Data Communications - Local Area Networks CSMA/CD Access Method and Physical Layer Specifications
- DIS 8802/4 Information Processing Systems - Data Communications - Local Area Networks Token-Passing Bus Access Method and Physical Layer Specifications
- DP 8802/5 Information Processing Systems - Data Communications - Local Area Networks Token Ring Access Method and Physical Layer Specifications
- DP 8802/6 Information Processing Systems - Data Communications - Local Area Networks Slotted Ring Access Method and Physical Layer Specifications

[ISO page 5]

This publication is a Draft for Development and is therefore not to be regarded as a British Standard. See page 2.

3. DEFINITIONS

3.1 Reference Model Definitions

This document uses the following definitions from ISO 7498:

- a) OSI Network layer
- b) OSI Network Service
- c) OSI Network Service access point
- d) OSI Network Service access point address
- e) OSI Network entity
- f) Network relay
- g) Routing
- h) Service
- j) Protocol
- k) Protocol Control Information

3.2 Service Conventions Definitions

For the purpose of this document, the following definitions from the OSI Service Conventions (DP 8509) apply:

- l) Service user
- m) Service provider

3.3 Network Layer Architecture Definitions

For the purpose of this document, the following definitions apply:

- n) real subnetwork: a collection of equipment and physical media which forms an autonomous whole and which can be used to interconnect real systems for purposes of communication.
- p) subnetwork: the abstraction of a real subnetwork.
- q) interworking unit: one or more items of equipment, or a part of an item of equipment, whose operation allows interconnection of other real world components.

Note: Such equipment may be integrated into the two real subnetworks which are being interconnected.

- r) relay system: an abstraction of the equipment forming an interworking unit.

[ISO page 6]

- s) intermediate system: an abstraction of a system providing a Network relay function (that is, a system which receives data from one correspondent Network entity and forwards it to another correspondent Network entity).
- t) data transmission service: the set of capabilities available from a real subnetwork which may be utilized by users of the real subnetwork for the purpose of sending and receiving data;

Note: this service is defined between the points where each user is connected to and accesses the real subnetwork; e.g. a DTE/DCE interface, and should not be confused with the notion of a service at a layer boundary as defined in ISO 7498.

4. ABBREVIATIONS

For the purpose of this document, the following abbreviations apply:

CO-NS	Connection-Mode Network Service
CL-NS	Connectionless-Mode Network Service
ISDN	Integrated Services Digital Network
IWU	Interworking Unit
NSAP	Network Service Access Point
PCI	Protocol Control Information
PDN	Public Data Network
SAP	Service Access Point
SNACp	Subnetwork Access Protocol
SNDCP	Subnetwork Dependent Convergence Protocol
SNICP	Subnetwork Independent Convergence Protocol

[ISO page 8]

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5. NETWORK LAYER CONCEPTS AND TERMINOLOGY

This clause gives precise meaning to a number of terms used in the OSI Network Layer standards which have a range of interpretation in more general usage.

5.1 Real World Objects and Abstract Elements

The Internal Organization of the Network Layer relates "real world" objects which must be dealt with to a set of abstract elements. There may be a variety of mappings between an abstract element and the physical equipment used to realize it. The description of such mappings requires a clear distinction between architectural terms and real world terms. The correspondence between such terms, as used in this document, is summarized in Table 5-1.

Throughout this clause and in Clause 8, diagrams are used to illustrate various configurations of interest in the Network Layer. Each diagram has two components. Real world objects are depicted at the top of each diagram, while representation of the corresponding abstract element is depicted at the bottom. Table 5-1 shows the graphical representations of the real world objects and abstract elements used in the diagrams.

Note: In figure 5-5, and those which follow it in this document, the graphical representation of abstract elements contains additional detail (e.g. to illustrate OSI layers, protocol roles, etc.)

5.2 End Systems and Intermediate Systems

End systems and intermediate systems are abstractions of equipment which fulfil the requirements of the OSI standards necessary to provide the function of an open system (Reference ISO 7498). An intermediate system performs only functions allocated to the first three layers of the Reference Model. Interworking Units and real subnetworks are real world examples of equipment fulfilling the intermediate system role. An end system must additionally provide the functions of the higher layers above the Network Layer. A real end system is any piece of equipment or collection of pieces of equipment which fulfils this end system role. The Network Layer entity or entities within an end system must provide basically the same Network Layer functions as those in intermediate systems, with the exception of relaying functions which are performed by intermediate systems only.

REAL WORLD OBJECT	GRAPHICAL REPRESENTATION OF REAL WORLD OBJECT	CORRESPONDING ABSTRACT ELEMENT	GRAPHICAL REPRESENTATION OF ABSTRACT ELEMENT
REAL SYSTEM		SYSTEM	
REAL OPEN SYSTEM		OPEN SYSTEM	
INTERWORKING UNIT	IWU	RELAY SYSTEM (SEE NOTE)	INTERMEDIATE SYSTEM
REAL SUBNETWORK	REAL SUBNETWORK	SUBNETWORK (SEE NOTE)	INTERMEDIATE SYSTEM
REAL END SYSTEM		END SYSTEM	END SYSTEM

NOTE: THE ABSTRACT TERM "INTERMEDIATE SYSTEM" IS USED TO REFER TO EITHER A NETWORK LAYER RELAY SYSTEM OR A SUBNETWORK.

TABLE 5-1. CORRESPONDENCE BETWEEN REAL WORLD OBJECTS AND ABSTRACT ELEMENTS

[ISO page 10]

The same collection of physical equipment may be capable of operating as a real end system or as an interworking unit, or as both simultaneously, depending on the circumstances of its use. In a particular circumstance, then, the functions being invoked correspond to those of an abstract end system (and) or an intermediate system.

An end system may communicate with another end system either:

- a) directly, without an intervening intermediate system (see Figure 5-1); or
- b) through one or more intervening intermediate systems (see Figure 5-2).

In this context, communication "directly" refers to communication what involves only the Network entities in the two communicating end systems. Communication "through one or more intermediate systems" refers to communication that involves one or more Network Layer relay entities, in addition to the Network entities in the two communicating end systems.

In either case no constraints are placed on the way in which relays at lower layers (e.g. Data Link relays or Physical relays) might be used to provide communication between Network entities.

An intermediate system is an abstraction of:

- a) a real subnetwork (e.g. as in Figure 5-2);
- b) an interworking unit, connecting two or more real subnetworks (see clause 5.5 and Figure 5-4 below where only the case of two real subnetworks is shown); or
- c) a real subnetwork with associated interworking unit (see clause 5.5 and Figure 5-3 below).

In some cases, it may be useful to identify and distinguish the abstract functionality of a real subnetwork from that of an interworking unit. In such circumstances, the abstract terms "subnetwork" and "relay system" may be used, respectively, to refer to these specific types of intermediate systems. (As described in following clauses 5.3 and 5.5).

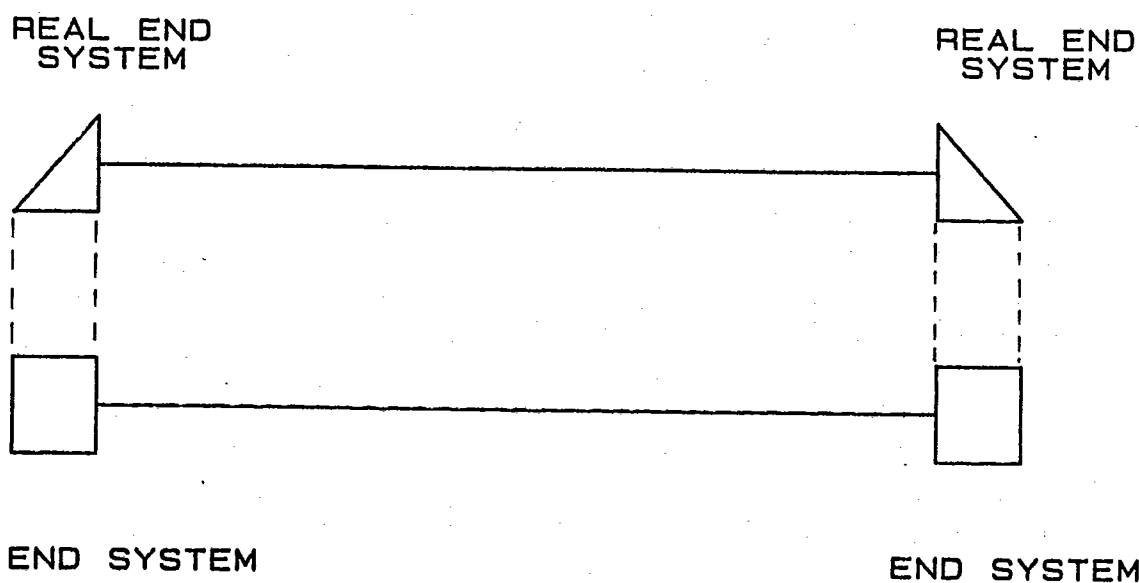


FIGURE 5-1. "DIRECT" COMMUNICATION BETWEEN END SYSTEMS (WITHOUT AN INTERMEDIATE SYSTEM).

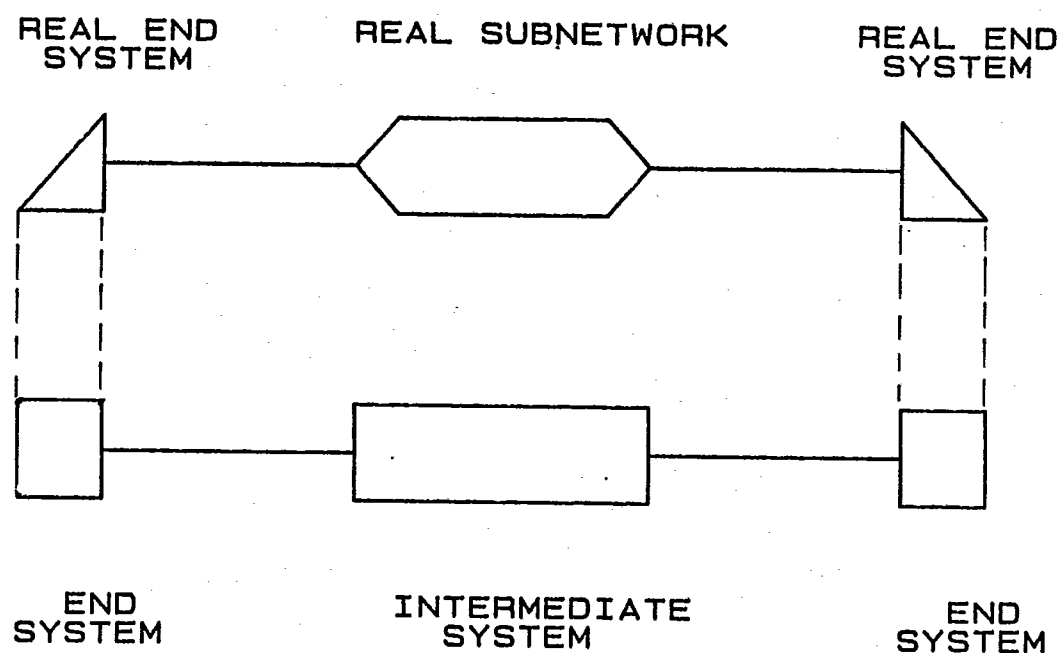


FIGURE 5-2. END SYSTEMS COMMUNICATING THROUGH AN INTERMEDIATE SYSTEM.

[ISO page 12]

DD 135:1985

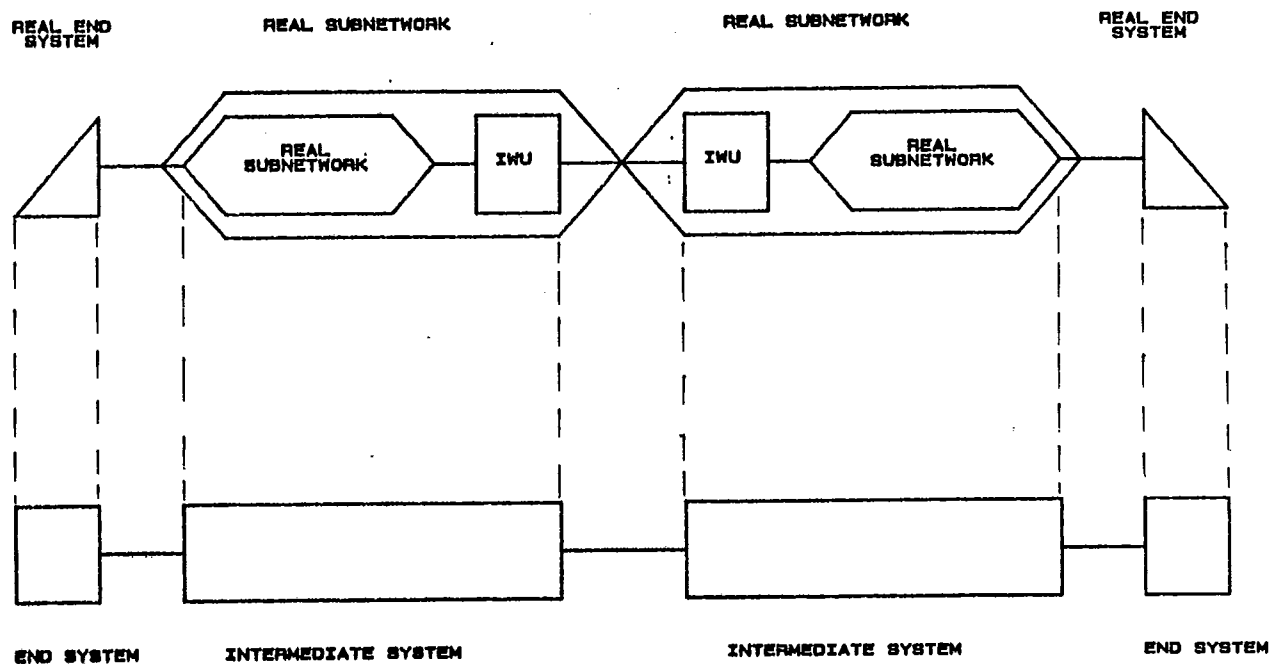


FIGURE 5-3. INTERCONNECTION OF REAL SUBNETWORKS THAT INCLUDE INTEGRAL INTERWORKING UNIT FUNCTIONALITY

A) REPRESENTATION OF EACH REAL SUBNETWORK AND INTERWORKING FUNCTION AS AN INTERMEDIATE SYSTEM

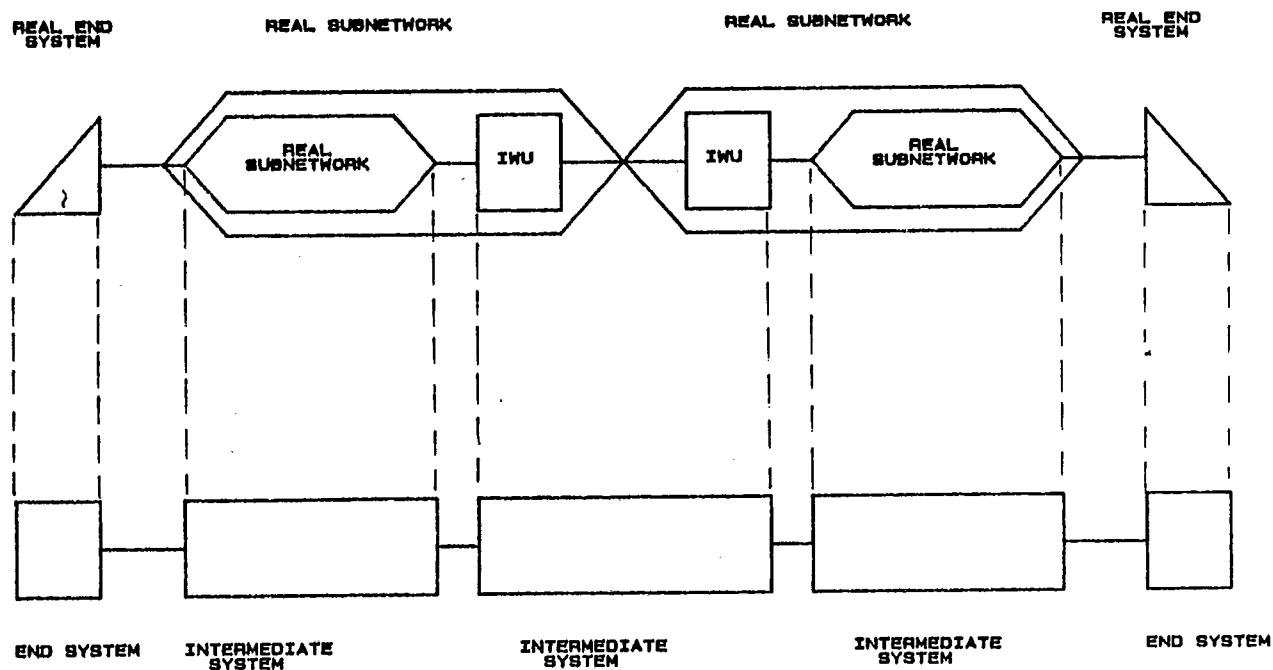


FIGURE 5-3. INTERCONNECTION OF REAL SUBNETWORKS THAT INCLUDE INTEGRAL INTERWORKING UNIT FUNCTIONALITY

B) REPRESENTATION OF COMBINED INTERWORKING FUNCTIONS AS A SEPARATE INTERMEDIATE SYSTEM

[ISO page 13]

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5.3 Real Subnetworks and Subnetworks

A real subnetwork is a collection of equipment and physical media which forms an autonomous whole and which can be used to interconnect other real systems for purposes of communications. (Refer to Figure 5-2). Examples of real subnetworks include:

- commonly recognized, carrier supplied public networks;
- privately supplied and utilized networks;
- local area networks;
- any of the above, with associated interfacing equipment and/or interworking unit(s), considered together as forming a real subnetwork.

All the pieces of equipment comprising such a real subnetwork can be represented by a single abstract subnetwork (or intermediate system). It is important to note that a collection of physical equipment of the types listed above, and represented here as a "subnetwork", is commonly called a "network".

The externally visible properties of some real subnetworks are described by separate standards and Recommendations such as the CCITT X.21 circuit-switching and X.25 packet-switching Recommendations, or the ISO Local Area Network standards. More than one real subnetwork may be involved in an interconnection of other real systems. The term "subnetwork" may be applied recursively to collections of subnetworks interconnected in such a way that, to an attaching system, they can be viewed and treated as a single subnetwork.

5.4 "OSI Subnetworks"

A real subnetwork may be defined in such a way that it fully supports OSI Network Service; that is, the functions of the real subnetwork, suitably exploited by the real end systems that are attached to it, are fully equivalent in the abstract to those of the OSI Network Service (see note below and clause 5.6). A real subnetwork which has this property is referred to as an "OSI Subnetwork" (see CCITT Recommendation X.300). In having the capability to fully support the OSI Network Service, a real subnetwork must support all mandatory elements of the Network Service. It may additionally support any provider option of the Network Service but is not required to do so.

Note: The operation of an OSI Subnetwork in fully supporting the OSI Network Service is distinguished by the operation of a single Network Layer protocol between end systems connected to the OSI Subnetwork (see clause 6.7).

5.5 Relay Systems and Interworking Units

A relay system is an abstraction of a piece of equipment (or collection of equipment) commonly referred to in the real world as a interworking unit. The purpose of an interworking unit is to facilitate the interconnection of distinct real subnetworks.

An interworking unit may reside within the authority of a real subnetwork supplier or may be administered by some other party. In cases where an interworking unit is physically separate from the real subnetworks it interconnects, the interworking unit may be represented as a separate intermediate system (see Figure 5-4). An interworking unit may also be incorporated as an integral part of each real subnetwork being interconnected. In such a case, each real subnetwork and its associated interworking unit may be represented as a single intermediate system (see Figure 5-3(a)). Alternatively each real subnetwork individually may be represented as an intermediate system connected by another intermediate system which represents the functionality of the combined intervening interworking units (Figure 5-3(b)).

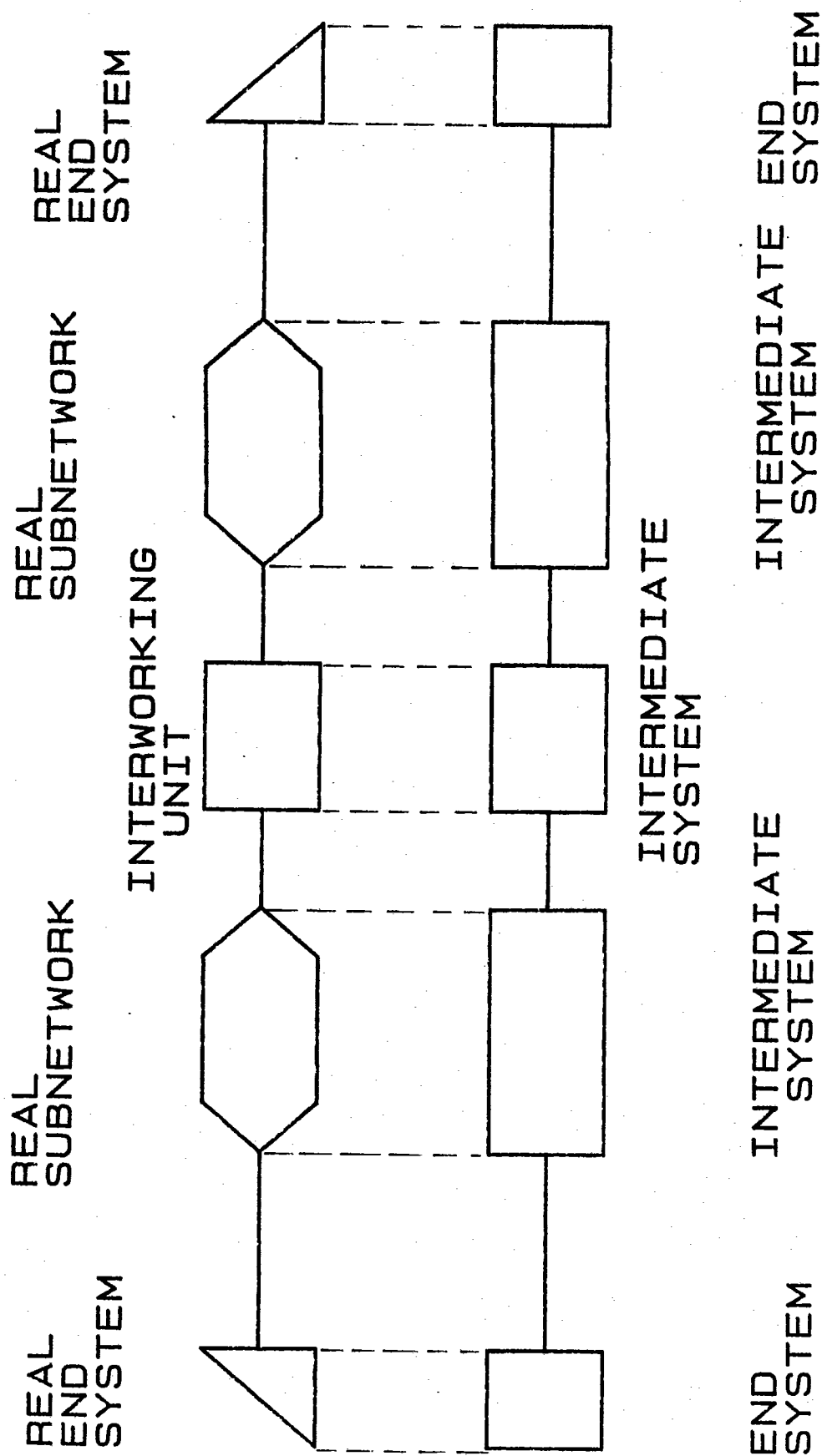


FIGURE 5-4. INTERCONNECTION OF REAL SUBNETWORKS BY A SEPARATE INTERWORKING UNIT

[ISO page 16]