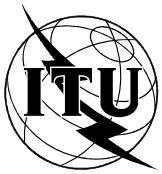

INTERNATIONAL TELECOMMUNICATION UNION

CCITT

THE INTERNATIONAL
TELEGRAPH AND TELEPHONE
CONSULTATIVE COMMITTEE

M.36

(11/1988)

SERIES M: GENERAL MAINTENANCE PRINCIPLES

Maintenance of international transmission systems and telephone circuits – Introduction

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PRINCIPLES FOR THE MAINTENANCE OF ISDNs

Reedition of CCITT Recommendation M.36 published in the Blue Book, Fascicle IV.1 (1988)

NOTES

1 CCITT Recommendation M.36 was published in Fascicle IV.1 of the *Blue Book*. This file is an extract from the *Blue Book*. While the presentation and layout of the text might be slightly different from the *Blue Book* version, the contents of the file are identical to the *Blue Book* version and copyright conditions remain unchanged (see below).

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

Recommendation M.36

PRINCIPLES FOR THE MAINTENANCE OF ISDNs

1 General

The purpose of this Recommendation is to apply general maintenance principles to determine the maintenance strategy to be adopted by Administrations and other maintenance service providers (MSP) in order to maintain ISDNs.

In providing this guidance, due consideration has been given to the principles identified in Recommendations M.20, M.30, M.32 and M.34 and to the activities identified in the I.600-Series Recommendations [1].

1.1 *Scope of application*

1) considering that Recommendation M.20 defines the maintenance philosophy for telecommunications networks;

2) considering that Recommendation M.30 defines the principles for the telecommunications management network (TMN);

3) considering that Recommendation I.601 [2] describes reference configurations, general architecture for maintenance of ISDN subscriber access and subscriber installation, which are applied in:

   – Recommendation I.602 [3] for the ISDN subscriber installations,

   – Recommendation I.603 [4] for the ISDN subscriber basic accesses,

   – Recommendation I.604 [5] for the ISDN subscriber primary rate accesses,

   – Recommendation I.605 [6] for the static multiplexed basic rate accesses,

   – Recommendation I.606 (under study) for the ISDN subscriber higher rate access;

4) considering that Recommendations Q.940 [7] and Q.942 (under study) describe the model, service elements and protocols to be provided at the ISDN user/network interfaces for management;

5) considering that Recommendation M.550 provides the maintenance limits for digital paths and sections to achieve the performance objectives given in Recommendation G.821 [8],

this Recommendation defines the ISDN maintenance concepts to be applied for the maintenance of subscriber installations, networks, including the transit network, and interworking between ISDNs and other networks, including both existing and future public and private networks.

This Recommendation takes into consideration basic ISDN features such as:

– open communication via the S/T reference points;

– portability of terminals between S/T reference points, from subscriber installation to subscriber installation, and from ISDN to ISDN.

2 Overview

2.1 *General maintenance principles for ISDN*

The fundamental maintenance strategy is to rely on performance monitoring wherever possible in order to apply the controlled maintenance principles of Recommendation M.20.

The maintenance capabilities provided must allow for the clear differentiation of troubles between subscriber and network equipment.

The maintenance capabilities provided must allow for clear differentiation between faults and legitimate subscriber activities.

A MSP should be able to localize the fault in his domain without disturbing the network or other domains. This should be possible locally and remotely, i.e., across networks and between any allowed management entities.

Testing will be needed both to supplement the performance monitoring for trouble detection and to provide additional trouble localization ability.

The subscriber installation should be able to receive failure or performance information if sent from the network side. The network should be able to receive failure or performance information from the subscriber side.

A capability should be provided to control the status of the subscriber access and of the subscriber equipment during maintenance operations.

The subscriber installation (or its MSP) should be able to receive information, if sent from the network, about the maintenance status of its access.

Only the Administration may initiate maintenance action within the subscriber access.

The subscriber or his MSP, either private or Administration, may initiate maintenance action within the subscriber installation.

2.2 *Supervision of the subscriber access and end-to-end performance measuring*

For maintenance purposes, each maintenance entity (ME) and maintenance entity assembly (MEA) provides its own performance measuring according to Recommendation M.20. The generated anomaly and defect informations allows decision and identification of ME or MEA in the degraded or unacceptable functioning state, and reporting that state to the associated management entity.

The network can only measure the performance of MEs and MEAs. The problem of how to combine the performance of the MEs and MEAs of the transit network with that of the subscriber accesses to determine the end-to-end performance as seen by the subscriber is for further study.

2.3 *Management reference models*

2.3.1 *Reference definitions*

2.3.2 **subscriber access maintenance center (SAMC)**

An SAMC represents a group of functions, network equipment elements and staff controlled by the Administration, which together have the responsibility and capability for maintenance functions and maintenance actions within the subscriber access.

2.3.2.1 **subscriber access maintenance entity (SAME)**

The SAME controls the subscriber access maintenance functions and provides communications for such activities. The SAME might be distributed.

Example of SAME functions:

– control loopbacks in an NT1 or LT;

– supervise the service state of the subscriber access;

– provide access to subscriber access performance information.

2.3.2.2 **subscriber installation maintenance entity (SIME)**

An SIME represents a group of dedicated functions contained within the functional groups (as specified in Recommendation I.411 [9]) of the subscriber installation (i.e. TE1 and NT2) which have, for example, the following purposes:

– interaction with the (human) user;

– handling of maintenance protocol from the SAME and/or a MSP;

– control of internal testing and maintenance mechanisms.

It is considered that the functions of the SIME may be distributed throughout the protocol layers implemented in the subscriber equipment and management/maintenance entities, including NT1 functions in some applications, but the precise architecture and protocol of the SIME is not a subject of this Recommendation.

Examples of SIME functions:

– control TE loopbacks;

– identify TE service capability;

– control generation of test signals for maintenance of subscriber installation wiring;

– provide access to performance data within subscriber installation, e.g. layer two and three protocol performance;

– security screen requests from MSPs.

2.3.2.3 **maintenance service provider (MSP)**

The MSP represents a group of functions, equipment and maintenance staff, that together have the responsibility for maintaining the subscriber installation or a part of the subscriber installation. A MSP cannot control the maintenance functions of the subscriber access. If authorized, it can request information from the SAMC about the subscriber access.

1) Agreement and responsibility for maintenance between the subscriber and the MSP for each part or parts of the subscriber installation should be made at the time of subscription to the maintenance service (this may take the form of a commercial contract). In any case, provision to allow a customer to change the maintenance service provider(s) is recommended. The subscriber may choose not to make such an agreement with a MSP.

2) Maintenance service providers can be

   – private providers,

   – the Administration,

   – the subscriber.

3) Private MSPs that are connected to ISDN by a S/T interface are referred to as external MSPs. Administration MSPs may also be connected via S/T interface or by other means as described below.

4) The interfaces between ISDNs and MSPs are for further study.

5) It is the sole responsibility of a subscriber installation and not of the network to ensure that an unauthorized MSP cannot obtain access to maintenance functions in the subscriber installation.

Examples of MSP functions:

– request SIME maintenance activity;

– request SAMC maintenance information that is allowed;

– provide test responders.

2.3.2.4 **operation, administration and maintenance centre (OAMC)**

The OAMC is an Administration's centre with the responsibility for the general operation, administration and maintenance of the network. It includes both staff and associated operations systems. The functions may be distributed among many centres and OSs.

Examples of OAMC functions:

– request SAME to control loopback activation;

– supervise the bringing into service of subscriber access;

– obtain performance information on the subscriber access from the SAME;

– manage teleservices provided to a subscriber;

– screen requests from MSPs for authorization.

The SAMC is composed of the SAME and part of the OAMC.

2.3.2.5 *Management entities*

Management entities are groups of capabilities that collectively provide management functions, such as operations, administration, maintenance and provisioning. For the network part, the functions may be implemented by a combination of capabilities in network elements and operations systems. For the subscriber part, management functions may be contained within the subscriber installations.

2.3.3 *Reference maintenance configuration*

Shown in Figure 1/M.36 is the reference maintenance configuration, which gives the relationship between the subscriber installation and subscriber access to be maintained and the various maintenance centers, entities and providers.

This reference model shows the possible physical interconnection between Terminal Equipment (TE), Local Exchanges (LE), OAMC and MSPs.

The lines between physical devices containing each functional entity represent physical communications paths over which the management information may flow. It is envisioned that the higher layer protocols for management and maintenance would be the same. See Figure 7/I.601 [2] for another representation of this communication. Service primitives are required to facilitate interworking with a variety of lower layer protocols. Further study is needed to define these service primitives. Thus, the connections between the various entities could be provided by D-channels, X.25 networks, Signalling System No. 7, or leased lines.

In this reference configuration, the subscriber access is maintained by a SAMC. Local or remote users or MSPs may communicate with the SAMC to request certain maintenance functions under its control. The SAME provides the communications interface for network local management functions and contains the control functions for such local activity. The SAME functions may either be entirely part of the local exchange or may be distributed between the LE and an OAMC.

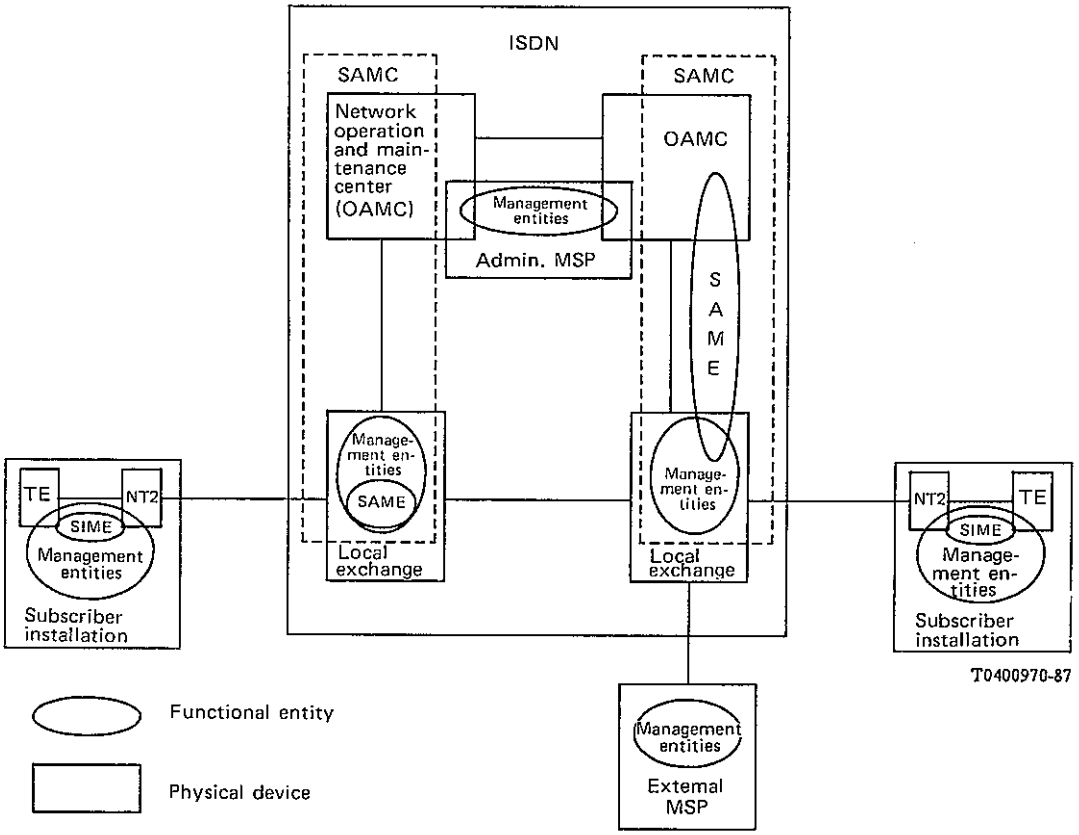


FIGURE 1/M.36

Network physical model for maintenance information transfer among O&M (operation and management) entities

2.3.4 *Relationship to telecommunications management network*

The telecommunications management network (TMN) is intended to provide an Administration with an independent communications network to carry its management (operations, administration and maintenance) messages to and from its operations system (OSs) to the telecommunications network it manages, including its ISDN and associated network elements. Figure 2/M.36 shows an example of one possible relationship of a TMN to the ISDN that is shown in Figure 1/M.36.

In Figure 2/M.36, the TMN would carry management messages between the OAMC (including an Administration MSP, if provided) and the ISDN over a Q-type TMN interface (see Recommendation M.30 for a description of the TMN interfaces). The TMN would also provide the communications for an Administration's externally provided MSP using the TMN PQ-DCN protocol suite (as defined in Recommendation M.30) over a T-type physical ISDN interface.

A private MSP may be connected directly to the ISDN via a T-type interface. It may also be connected to the TMN by interworking via other network interworking interfaces that are under study.

While supporting the ISDN, the TMN is also supporting other management functions for the Administration, including the maintenance of transmission system equipment.

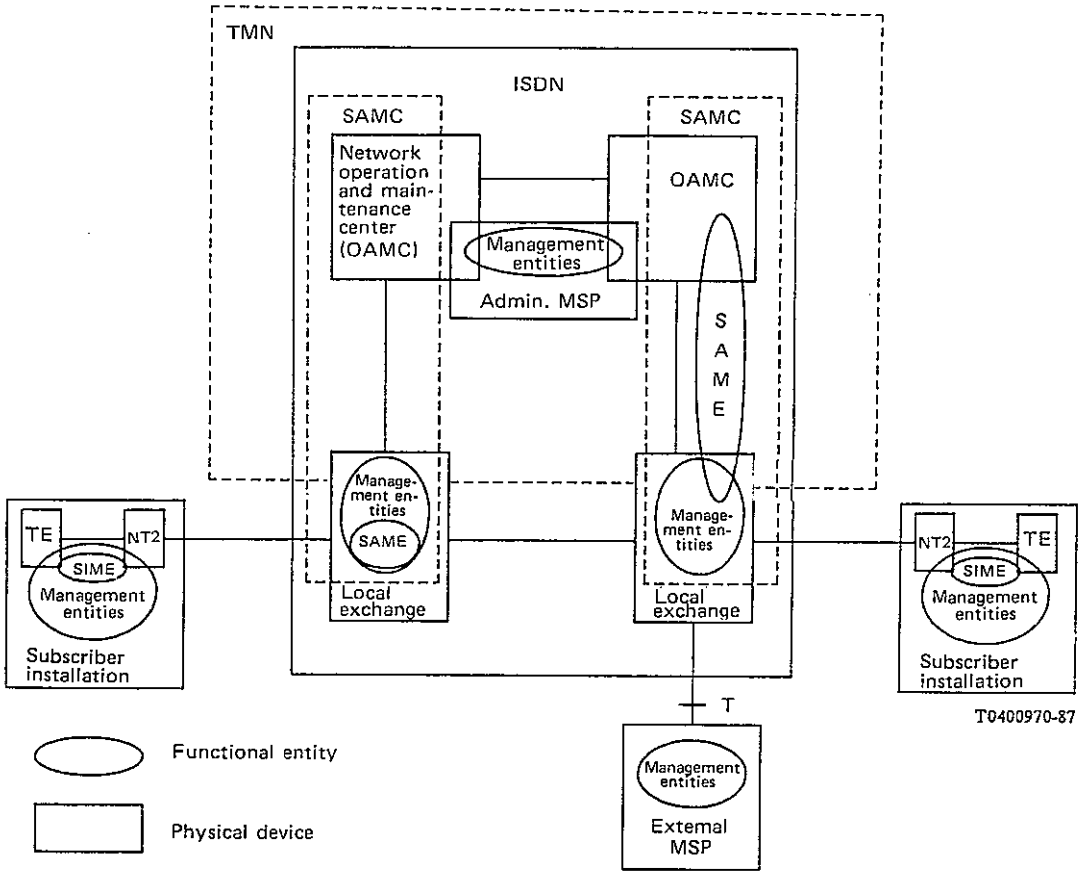


FIGURE 2/M.36

Relationship of a TMN to an ISDN

2.3.5 *Communications reference models*

Communications between functional groups is required for the maintenance of ISDNs. The communications configurations for maintenance of the subscriber access and the subscriber installation are shown in Recommendation I.601 [2]. Configurations for the transit part and for end-to-end ISDN maintenance are for further study.

2.4 *ISDN management protocol principles*

2.4.1 *General review*

The different management functions which may be contained, for example, in the SAMC, SIME, MSP, etc., are implemented in one or several real systems. A **real system** is a set of one or more computers, associated software, etc., that form an autonomous whole capable of performing information processing and/or information transfer. Each real system contains one or more management entities that supports management functions. A real open system is a real system which complies with the requirements of Recommendation X.200 [10] in its communication with other real systems.

Note – Two different modeling concepts are applicable to ISDN management protocol:

– ISDN protocol reference model (ISDN PRM), as defined in Recommendation I.320 [11];

– reference model of open systems interconnection for CCITT Applications (OSI PRM), defined in Recommendation X.200 [10].

These two reference models have the following commonalities:

– both the ISDN PRM and the OSI PRM organize communications functions into layers and describe the relation of these layers with respect to each other;

– the concepts and the associated terminology, which have been introduced in Recommendations X.200 [10] and X.210 [12] are fully applicable to the ISDN PRM. They include the concept of layer, layer service, and the notions of service primitives, peer entities and peer protocol.

2.4.2 *Requirements for ISDN maintenance activities*

Maintenance of ISDN equipments and interfaces is part of the general management process in an ISDN management entity. It is intended that maintenance of ISDN equipments by remote MPS through ISDN interfaces should follow the principles of Recommendation X.200 and of open systems management, which are under study.

Systems management is achieved through a set of application processes running in different management entities that communicate together and play complementary roles to provide management activities.

Within a management entity, system management functions are controlled and performed by the *system management element*. The system management element can be seen as a set of application processes communicating with remote application processes by the use of one or more application layer entities. An application process is an element within a management entity which performs the information processing for a particular application.

The definitions of the functions among management entities needed to maintain the ISDNs according to the principles stated in this Recommendation are for further study.

3 Basic rate access

3.1 *Basic rate access maintenance models*

Three access configurations are described below, along with a common subscriber equipment arrangement that applies to all three models. For each model, the maintenance entities are identified using reference points to delimit them. Some of these reference points are or may become standard interfaces. The ownership boundaries between network and customer are outside the scope of this Recommendation.

Because the D-channels shown in the models below all route through several MEs (maintenance entities), they are not MEs themselves but will be treated as maintenance entity assemblies. The D-channels carry several protocol layers that will be treated using the management and maintenance protocols that are under study. These include a definition of a layer management entity concept for each of the layers.

Other models are possible, but only a few, representative models are included here. Models including leased lines and digital crossconnect systems are left for further study.

3.1.1 *Simple model*

This model, shown in Figure 3/M.36, is similar to that shown in Figure 2/M.20. In the model, the V1 interface may be replaced by a function, such as a loopback point in a combined LT/ET, while still providing a boundary between MEs.

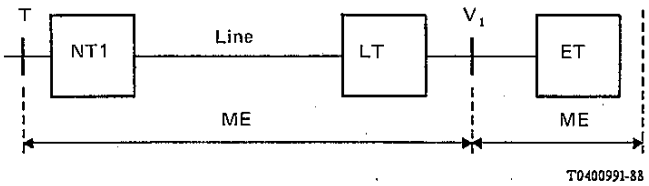
3.1.2 *Subscriber equipment arrangements*

This model is shown in Figure 4/M.36.

3.1.3 *Multiplexed interface*

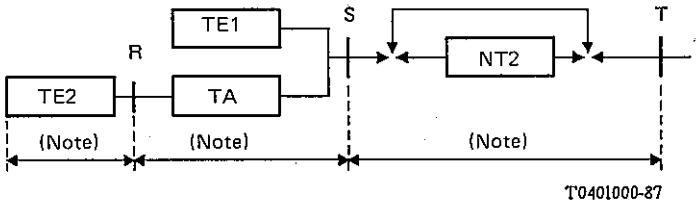
This model is shown in Figure 5/M.36.

In this case, several basic rate accesses using V_1 reference points are multiplexed or concentrated to interface the exchange termination. For static multiplexing, a V_6 interface is applied. For dynamic multiplexing (multiplexing on the D-channel) or concentrating (dynamic assignment of the B-channels), a V_2 interface is applied. The V_2 and V_6 interfaces are defined in Recommendation Q.512 [13]. Performance monitoring is applied to the digital section of the basic rate access (between T interface and V_1 reference point) and between the multiplex/concentrator and the exchange termination.



Note – The network boundary of some Administrations excludes the NT1; this may require modifications to the MEs shown.

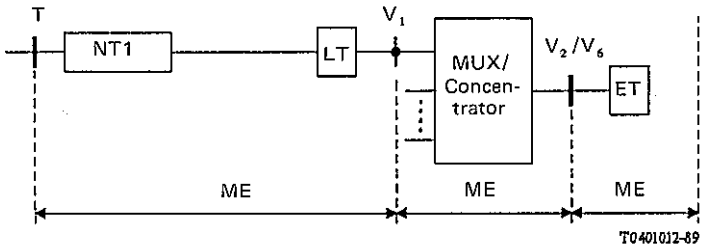
FIGURE 3/M.36
Simple basic rate access model



Note – The MEs for the subscriber installation are for further study.

FIGURE 4/M.36

Subscriber equipment arrangements



Note – The network boundary of some Administrations excludes the NT1; this may require modifications to the MEs shown.

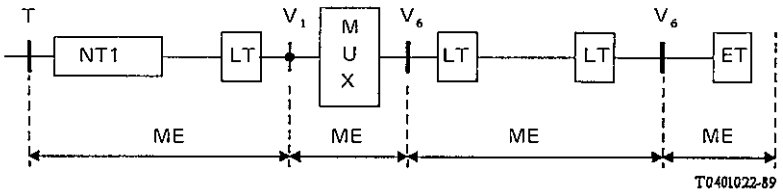
FIGURE 5/M.36

Multiplexed basic rate access model

3.1.4 *Remote multiplexed interface*

The model is shown in Figure 6/M.36.

This is similar to the previous model except that it is extended between the multiplex and the ET by one or more digital links which may route over higher order links.



Note – The network boundary of some Administrations excludes the NT1; this may require modifications to the MEs shown.

FIGURE 6/M.36

Remote multiplexed basic rate access model

3.1.5 *Basic rate leased lines*

This is for further study.

3.2 *Required capabilities*

3.2.1 *Transmission format maintenance features (layer 1)*

The format will be such as to support performance monitoring in both directions of transmission. Specifically, there will be error detection in each direction computed across the digital signal, for example, with CRC (cyclic redundancy check) or other error detection methods.

Transmission errors detected at the LT are converted to near-end error (NEE) indications. Transmission errors detected at the NT are converted to far-end error (FEE) indications and sent back to the LT. This enables performance for both directions to be assessed by the Administration.

A function of the C-channel may be to provide support of maintenance functions such as loopback activation and performance monitoring data gathering.

3.2.2 *Maintenance states and control*

This is an area for further study, including:

– restricting access to some capabilities to network or customer;

– security issues.

3.2.3 *Performance monitoring capabilities (layer 1)*

It shall be possible to report the performance information from the exchange to the OAMC (see § 3.2.3.2). It shall be possible to reset the parameter counts. Other issues under study include:

– combining all links in subscriber access;

– parameter consistency;

– identifying maintenance phases impacted by PM (performance monitoring).

3.2.3.1 *Maintenance entities monitored*

It shall be possible to monitor the NT to LT links.

3.2.3.2 *Required performance monitoring parameters and history*

The following principles apply to performance monitoring parameters and history:

a) parameters should be counted separately in each direction when feasible to help isolate troubles and to better estimate network service provided to users;

b) to support different maintenance uses, parameters should be counted for short durations (e.g., 15 minutes to one hour) and longer durations (e.g. 24 hours) as specified in Recommendation M.550;

c) error counts and when they occur should be retained to help deal with intermittent troubles;

d) thresholding, covered in Recommendations M.34 and M.550;

e) the threshold values should be settable by the OAMC;

f) performance information should be reported from the exchange to the OAMC:

   – when threshold crossings occur;

   – on demand from the OAMC.

3.2.4 *Testing capabilities*

Testing should introduce minimal disruption on other B- and D-channels, and should not disrupt the subscriber's terminal equipment. Other testing capabilities are for further study.

3.4.2.1 *Loopbacks*

The loopback capabilities for basic rate access, including types, locations, and control domains, are given in Recommendations I.602 [3] and I.604 [4].

3.2.4.2 *Test lines*

For further study.

3.2.4.3 *Test and monitor points*

For further study.

3.2.4.4 *Self tests and diagnostics*

For further study.

3.2.5 *Supervision and verification of protocol implementations*

The principles for the supervision and verification of ISDN access protocol implementations are:

a) Protocol errors due to implementation problems or other failures need to be detected. This may be based on the logging and counting of protocol violations;

b) Protocol problems need to be sectionalized, analyzed, and isolated. The following techniques may be used:

   – access to log of protocol violation information;

   – monitoring of the layer 2 frames and the layer 3 messages;

   – test access and protocol testing.

See Recommendation I.603 [4] for more information.

4 Primary rate access

4.1 *Primary rate access maintenance models*

Four primary rate access configurations are shown below, along with one figure showing four customer premises configurations, that can apply to any of the access models.

Maintenance entries are not indicated for these configurations, because there are several different implementations of primary rate access. The definitions of MEs is for further study.

4.1.1 *Simple access model*

The simple case of primary rate access from the NT2 directly to the exchange is shown in Figure 7/M.36. A variant of this model includes higher order links.

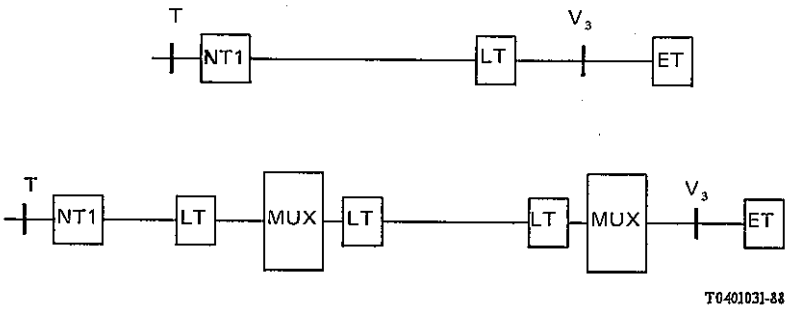


FIGURE 7/M.36

Simple primary rate access model

4.1.2 *Subscriber configurations*

There are several subscriber configurations that can appear behind any of the NT1s shown in the primary rate cases, as shown in Figure 8/M.36.

The first is the simplest case of separate NT1 and NT2, followed by a primary rate TE. Another case is with the NT1 and NT2 combined into one unit. A third case is a NT2 which is a PBX on which terminate several basic rate access lines connecting TEs to the PBX. A final case is one in which the NT2 is a multiplexer on which terminate several basic rate access lines connecting TEs to the multiplex.

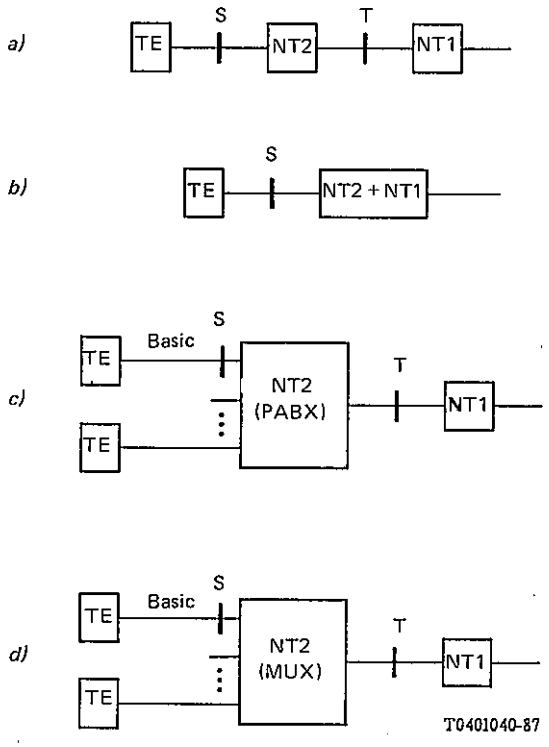


FIGURE 8/M.36

Primary rate subscriber configuration model

4.1.3 *Digital crossconnect system (DCS)*

A model introducing a new network element, the digital crossconnect system (DCS), in the simple access model is shown in Figure 9/M.36.

The DCS is a static crossconnect of B-channels, routing some to the exchange and some to the leased circuit network. Processing of the D-channel by the DCS is for further study, as discussed in Annex A.

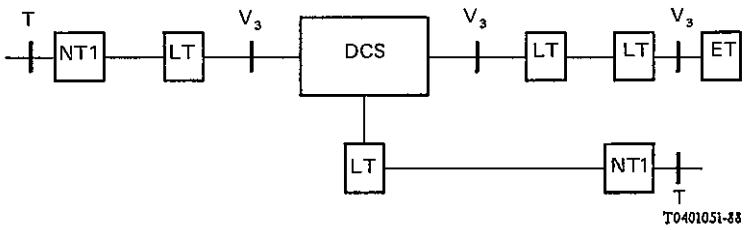


FIGURE 9/M.36

Primary rate access with DCS model

4.1.4 *Primary rate leased circuits*

In this case, all the B- and D-channels traverse the network from one NT2 to the other, without being terminated on a network switch. The network simply provides transport for a private ISDN, as shown in Figure 10/M.36.

FIGURE 10/M.36

Leased circuit primary rate access model

4.2 *Required capabilities*

4.2.1 *Transmission format maintenance features*

For further study.

4.2.2 *Maintenance states and control*

For further study.

4.2.3 *Performance monitoring capabilities*

4.2.3.1 *Maintenance entities monitored*

For further study.

4.2.3.2 *Required performance monitoring parameters and history*

For further study. Includes layer 1 and layer 2 monitoring.

4.2.4 *Testing capabilities*

4.2.4.1 *Loopbacks*

The loopback capabilities for primary rate access, including types, locations, and control domains, are given in Recommendations I.602 [3] and I.604 [5].

4.2.4.2 *Test lines*

For further study.

4.2.4.3 *Test and monitor points*

For further study.

4.2.4.4 *Self tests and diagnostics*

For further study.

4.2.5 *Supervision and verification of protocol implementations*

The principles for the supervision and verification of ISDN access protocol implementations are:

a) protocol errors due to implementation problems or other failures need to be detected. This may be based on the logging and counting of protocol violations;

b) protocol problems need to be sectionalized, analyzed, and isolated. The following techniques may be used:

- access to log of protocol violation information;
- monitoring of the layer 2 frames and the layer 3 messages;
- test access and protocol testing.

See Recommendation I.604 [5] for more information.

5 Broadband ISDN access

For further study.

6 End-to-end maintenance

6.1 *End-to-end models*

This section provides two examples of end-to-end ISDN connections. Figure 11/M.36 shows connection examples where a call from one subscriber access (primary or basic rate) is switched through the public network to another subscriber access.

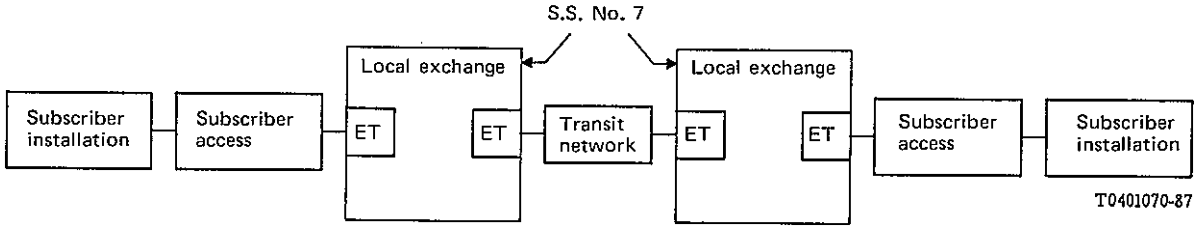


FIGURE 11/M.36

End-to-end public switched ISDN connection

Figure 12/M.36 shows an end-to-end leased circuit arrangement example where at each end a subscriber primary rate access is connected to a DCS. From the DCSs, B-channels are connected both to the switched and to provide an end-to-end connection between the subscriber locations.

A variation on this example would have a second primary rate access, without a D-channel, connected end-to-end via a DCS. In this case there is a possibility of a hidden fault between the DCSs that is not reported to either end and is not detected via the loss of the D-channel. Thus, this is a configuration where a continuity check is required to detect the fault.

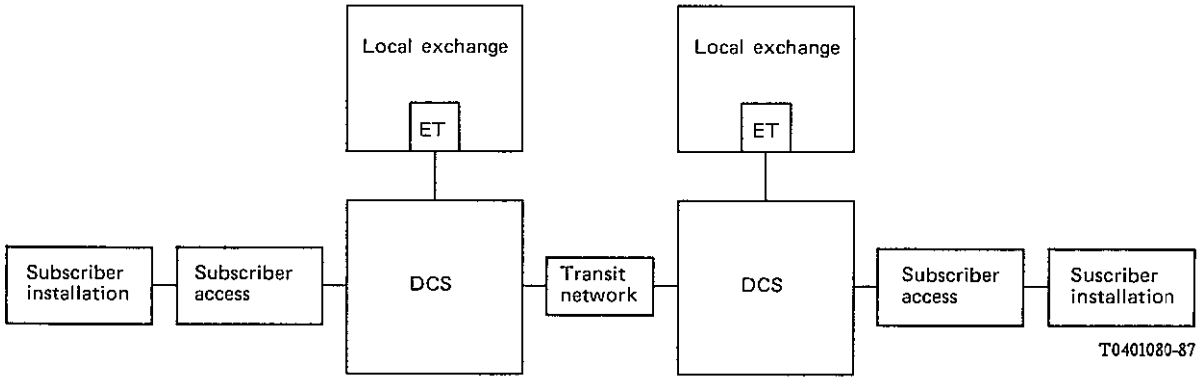


FIGURE 12/M.36

End-to-end leased circuit connection

6.2 *ISDN interworking model*

Primary or basic rate subscribers via their ISDN access may wish to interwork with other networks – with the public switched telephone network (PSTN), with a packet switched data network (PSDN) and with another public or private ISDN. A model for this interworking is shown in Figure 13/M.36.

An example of the interworking unit (IWU) would be a modem pool used in the PSTN case. Maintenance of interworking is for further study.

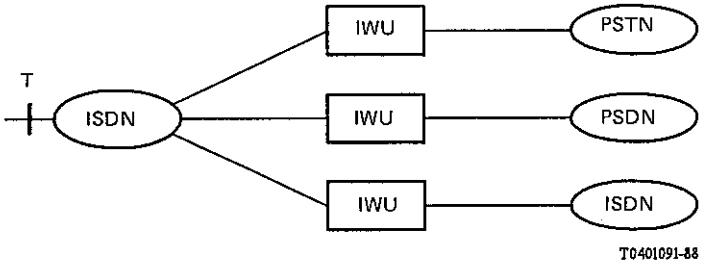


FIGURE 13/M.36

ISDN interworking model

6.3 *Terminal equipment functions for remote operations*

For further study.

6.4 *Network to network interworking functions for maintenance*

For further study.

ANNEX A

(to Recommendation M.36)

Digital crossconnect system considerations for ISDN

DCSs may also process the D-channel. They may break the D-channel layer 2, so that there are two tandem layer 2 links between the NT2 and the ET. The DCS routes layer 3 packets from the NT2 either to the exchange or to the leased network based on the routing of the associated B-channel. Thus, the DCS may also act as a packet crossconnect for the D-channel.

However, the DCS does not perform switch functions. Its crossconnect function is controlled over a separate administrative link, not over the D-channel with Q.931 [14] call control. This model also includes leased circuits.

The B-channels traverse the network without terminating on a switch. The associated D-channel information can be carried in the leased network in the same digital paths as the B-channels, or separately from the B-channels, on the Signalling System No. 7 signalling network.

References

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