SU = Storage for user side monitor
——— = Mandatory
····· = Optional

FIGURE A.4/I.604

Digital link with CRC monitoring in NT1

A.4.2NT1 functions

Functions allocated to the NT1 are listed below:

- detection of loss of signal or loss of frame alignment at either side;

- generation of AIS toward either side when signal or frame alignment on opposite side is lost;

- monitor CRC from both directions;

- store information derived from the CRC monitoring.

The information derived from the CRC monitoring and stored in the NT1 may be retrieved from either the NT2 or ET. The means of this retrieval is for further study.

A.4.3NT2 function

In addition to the functions described in § 3.2.2, NT2s may also, optionally, have the capability of retrieving from the NT1 the stored information derived from CRC monitoring.

A.4.4ET function

In addition to the functions described in § 3.2.3, ETs may also, optionally, have the capability of retrieving from the NT1 the stored information derived from CRC monitoring.

## A.4 Digital link with CRC monitoring in the NT1 (Option 4)

### A.4.1 Definition

The transmission equipment used between interfaces at the T and V reference points could be new equipment with CRC monitoring in the NT1 (see Figure A.4/I.604). In this case, the digital link is said to be "with CRC monitoring in the NT1".

Legend: L = Local CRC error information
R = Remote CRC error information
M = CRC monitor
G = CRC generator
SN = Storage for network side monitor

FIGURE A.3/I.604

Digital link with CRC processing and reporting in the LT and NT1

### A.3.2 LT functions

Functions allocated to the LT are listed below:

### A.3.3 NT1 functions

Functions allocated to the NT1 are listed below:

A.2.3NT2 functions

Functions allocated to the NT2 are given in § 3.2.2 of Recommendation I.604.

A.3Digital link with CRC processing in the LT and NT1 (Option 3)

A.3.1Definition

The transmission equipment used between interfaces at the T and V reference points may be new equipment with CRC processing, treatment and reporting of the results of that processing in the NT1 and the LT (see Figure A.3/I.604). In this case the digital link is said to be with "CRC processing and reporting in the NT1 and the LT".

Note - CRC error reporting may require storage and processing function in NT2, NT1, LT and ET.

Legend: L = Local CRC error information
R = Remote CRC error information
M = CRC monitor
G = CRC generator
T = CRC error treatment and reporting
——— = Mandatory
····· = Optional

Legend: L = Local CRC error information
R = Remote CRC error information
M = CRC monitor
G = CRC generator
——— = Mandatory
····· = Optional

Note 1 - Optional in 1544 kbit/s systems.

Note 2 - CRC error reporting may require storage functions in the NT2, NT1 and ET.

FIGURE A.2/I.604

Digital link without CRC processing in NT1

A.2.2 Digital link functions

FIGURE A.1/I.604

Digital link without CRC processing

A.1.2Digital link functions

Functions allocated to the digital link are listed below:

- detection of loss of incoming signal on either side and inside the transmission section, and generation of AIS "downstream";

- detection of AIS inside the transmission section and generation of AIS "downstream".

- detection of defect and anomaly in the digital link.

A.1.3NT2 functions

Functions allocated to the NT2 are given in § 3.2.2 of Recommendation I.604.

A.2Digital link with CRC processing in the NT1 (Option 2)

A.2.1Definition

The transmission equipment used between interfaces at the T and V referencepoints could be new equipment with CRC processing in the NT1 (see Figure A.2/I.604). In this case, the digital link is said to be with "CRC processing in the NT1".

ANNEX A

(to Recommendation I.604)

Subscriber access option

## A.1 Digital link without CRC processing (option 1)

### A.1.1 Definition

The transmission equipment used between interfaces at the T and V reference points (multiplexers, NT1-LT) could be existing equipment which have standard functions of supervision and defect and fault detections.

In this case, the digital link is said to be "without CRC processing": the CRC procedure is between ET and NT2 (see Figure A.1/I.604).

Legend: L = Local CRC error information
R = Remote CRC error information
M = CRC monitor
G = CRC generator
——— = Mandatory
····· = Optional

Note - CRC error reporting may require storage functions in the NT2 and ET.

The use and definition of additional signals for transmission direction indication, extension of remote CRC reporting mechanisms and specific equipment signals is for further study.

7.Logistic delay time

See Recommendation M.20.

8.Failure connection

See Recommendation M.20.

9.Verification

The verification that the failure has been corrected is performed on demand of the staff.

Tests described in §§ 3, 6 and 11 may be used.

10.Restoration

Failure localization in the case of option 4 refers to the capability to distinguish between a failure occurring either:

- between NT2 and NT1; or

- between NT1 and ET.

This localization may be achieved by either the NT2 or the ET obtaining additional information from the NT1. The means to obtain this information is for further study.

6.4.1.1Failure localization performed by the NT2

In options 2 and 3 the combination of CRC error information and RAI received from the interface allows the NT2 to localize a fault in the upstream direction of the access as follows:

- receipt of RAI by the NT2 with no, or a very small number of reported CRC errors indicates a failure inside the network; or

- receipt of RAI by the NT2 with constantly, or a very high number of, reported CRC errors indicates a fault between NT2 and NT1.

This capability is not provided by option 1.

Concerning the downstream direction of the access, failure localization can be made in options 1, 2 and 3, by distinguishing between the following conditions at the receiving side of the NT2:

- AIS, indicating a fault inside the network; or

- loss of incoming signal or loss of frame alignment, indicating a failure between NT1 and NT2.

6.4.1.2Failure localization performed by the ET

The failure localization capability of the ET depends on the CRC option used in the access, on the fault detection and reporting capability of the equipment installed (see §§ 6.4, 6.4.2 and 6.5) and the provision of optional loopbacks as given in Table 1/I.604. For further information about different CRC options applied in the access see Annex A to this Recommendation.

6.4.2Further failure localization

For more precise localization, further techniques may be necessary, e.g. line parameter measurements.

This is for further study.

6.4.3Additional signals

Note - SAME functions may be distributed in different equipment.

FIGURE 4/I.604

Example of network architecture for the failure localization
within the subscriber primary rate link

6.4.1 Initial failure localization performed by the ET and/or NT2 (TE)

The initial failure localization capability depends on the CRC option used in the network. For further information about different CRC options which may be applied in the access see Annex A to this Recommendation.

In general, CRC error information and fault indication signals may be used by either the NT2 or ET to deduce the location of some failures in operational conditions.

Failure localization in the case of option 2 refers to the capability to distinguish between a failure occurring either:

- between NT2 and NT1; or

- between NT1 and ET.

Failure localization in the case of option 3 refers to the capability to distinguish between a failure occurring either:

- between NT2 and NT1; or

- between NT1 and LT; or

- between LT and ET.

Note 1 - These layer 1 signals may not be in the frame signals. They may be line signals.

Note 2 - In the case of using existing digital systems, a manual loopback may replace loopback 2. This loopback is implemented between NT2 and NT1 and is controlled by the user on demand of the network staff.

6.4Failure localization mechanisms

If a subscriber access failure is confirmed by the exchange and if the failure is not located in the exchange, then:

- either the loopback 2 can be established under control of the exchange,then:
  - if the loopback 2 is successful, the exchange considers the subscriber access to be functioning correctly;
  - if the loopback 2 is unsuccessful, the exchange reports to the OAMC;
- or, if the loopback 2 cannot be established under control of the exchange, then the exchange informs the OAMC that the digital link is affected by a failure.

In the case of failed maintenance entity being detected, then an automatic localization process is initiated. This process could localize the failure within the digital link by the use of loopbacks or subscriber access fault information.

FIGURE 3/I.604

Location of the loopbacks for the maintenance of the general equipment configuration of the subscriber primary rate access

Note 1 - The digital section may contain one or more regenerators shown as "REG" in this figure.

6.3.2 Characteristics of loopbacks

The characteristics of the loopbacks are given in Table 1/I.604.

TABLE 1/I.604

Characteristics of the loopbacks for primary rate subscriber access

## 6. Failure localization

### 6.1 Automatic confirmation of failure within the subscriber primary rate access

An automatic test procedure to confirm a detected possible failure condition within the subscriber access should be provided. It shall be initiated by an automatic reaction of the exchange, following abnormal conditions which have been detected by the processes presented above, i.e. continuous supervision of layer 1, supervision of layers 2 and 3 of the D-Channel protocol.

If failures are detected in the D-Channel layers 2 and 3 communication, clear differentiation between failures within the subscriber installation and within the subscriber access should be possible.

### 6.2 Identification of failed maintenance entities

#### 6.2.1 General

Such a function has to be made on demand or automatically following the indication of failure conditions by the network or following a subscriber complaint. It is necessary, before undertaking the appropriate action, to identify (i.e. to know) the maintenance entity affected by the failure.

#### 6.2.2 Objectives

The main objective of this function, which is controlled by the SAMC, is to indicate to the SAMC whether the failure is:

- within the ET;
- within the digital transmission link (NT1 to LT);
- within the subscriber installation.

### 6.3 Loopbacks for maintenance of the subscriber primary rate access

#### 6.3.1 Location of loopbacks

Possible loopback locations for failure localization and verification controlled by the SAMC are shown in Figure 3/I.604.

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5.3Generation of defect indication signals by the NT2

The NT2 functions are listed in § 3.2.2.

The generation of RAI toward the ET is used to indicate the loss of incoming layer 1 capability.

5.4Generation of defect indication signals by the subscriber access

The digital link functions are listed in the annex to this Recommendation for each option within the access.

5.5Generation of defect indication signals by the exchange termination

The exchange termination functions are listed in section 3.2.3.

The generation of RAI toward the NT1 is used to indicate the loss of incoming layer 1 capability.

5.6Transmission quality monitoring by the exchange

5.6.1Error performance parameters

According to Recommendations M.20 and M.550, the anomaly and defect indications are treated on a statistical basis.

5.6.2Error performance evaluations

The access is considered by the local exchange to be "unavailable", "unacceptable" or "degraded" according to Recommendation M.550.

5.7Failure information from the exchange

A defect confirmed by the exchange and related to a subscriber access and/or a subscriber installation shall be reported to the SAMC in a message.

The detection of a degraded or unacceptable quality level or of the unavailability of the access by the exchange shall be reported to the SAMC in a message.

The message could be presented after an automatic identification of a failed Maintenance Entity (ME) has been made (see § 6).

5.8Failure information to the subscriber installation

The detection of a degraded or unacceptable quality level by the exchange may be reported to the user by the transmission of a state indication.

The exchange termination has the option to evaluate the transmission performance based on the statistical treatment of the local and remote CRC error reports and on the fault indications.

The transmission performance evaluation is based on a permanent processing of the elementary results presented by the continuous error monitoring of the digital transmission link.

The result of this processing will give information on the transmission quality level (normal quality, degraded quality, unacceptable quality) and on the unavailability of the access (see § 5.6).

3.3Automatic supervision of layers 2 and 3 of the D-Channel protocol

This covers supervision of activities of layers 2 and 3 of the D-Channel protocol. Automatic supervision of layers 2 and 3 will be made by self-acting mechanisms implemented in the network (e.g. in the ET).

There are three categories of automatic supervision which may be performed by layer 2 and layer 3 of the D-Channel protocols;

- service provision incapability detection (e.g. incapability of layer 2 to establish a data link connection);

- protocol misoperation detection;

- error monitoring (e.g. the layer 2 CRC check procedure can detect the occurrence of an errored frame).

These events (defined in Recommendations I.440 and I.450) should be recorded.

4.System protection

When a confirmed fault is detected which has an adverse effect on the availability and/or functionality of network equipment, the access is considered "out of service due to failure" and call attempts may be rejected to prevent further damage or to remove the adverse effect (see draft Recommendation I.601).

5.Failure indication

5.1Default indication signals

a) AIS - as defined in Recommendation I.431.

b) RAI - as defined in Recommendation I.431.

5.2State tables

State tables associated with failures in the primary rate access are given in

- detection of loss of frame alignment;
- detection of AIS and RAI;
- generation of frame signal;
- CRC code generation;
- RAI generation;
- CRC monitoring of the incoming signal (network-to-user);
- detection of CRC error information (user-to-network);
- CRC error reporting to the network (optional in 1544 kbit/s).

3.2.3Exchange termination functions

The functions which are allocated to the ET are listed below:

- detection of loss of incoming signal;
- detection of loss of frame alignment;
- detection of AIS: generation of AIS (optional in 1544 kbit/s);
- detection of RAI;
- generation of frame signal;
- CRC code generation;
- RAI generation;
- CRC monitoring of the incoming signal (user-to-network);
- detection of the CRC error information (network-to-user);
- CRC error reporting to the user (optional in 1544 kbit/s).

The exchange termination may optionally detect the CRC error information reported by the user side.

The generation of RAI towards NT2 upon detection by ET of a fault in the input direction (loss of signal, loss of frame alignment, detection of AIS).

Note - The digital sections may include one or more regenerators.

FIGURE 2/I.604

Examples of equipment configurations in the ISDN
subscriber primary rate access

## 3. Failure detection

### 3.1 General

Unlike the ISDN basic access, the digital section of the ISDN subscriber primary rate access is never deactivated (as seen by the exchange), continuous automatic supervision of the correct functioning of layer 1 up to NT2 is always operating. This supervision is called Continuous Automatic Supervision of layer 1.

Automatic supervision of the correct functioning of the D-Channel layers 2 and 3 is also operating. This supervision is called automatic supervision of layers 2 and 3 of the D-Channel protocol.

### 3.2 Automatic supervision

#### 3.2.1 Objectives

This supervision is realized by continuous automatic mechanisms located in various pieces of equipment of the ISDN primary rate access.

These automatic mechanisms are never deactivated and generally based on the operation of CRC information which is given by the CRC procedure associated with the link between the customer and the local exchange. These mechanisms are complemented by the detection of malfunctioning of particular items e.g. loss of power supply, loss of incoming signal, loss of frame alignment. Minimum functions which could be allocated to the subscriber installation and exchange termination are listed below. Further detail for these functions and those of the digital section are found in Annex A where various options concerning the handling of CRC functions are described.

#### 3.2.2 NT2 termination functions

The functions allocated to the NT2 are listed below:

- detection of loss of incoming signal;

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# APPLICATION OF MAINTENANCE PRINCIPLES TO ISDN PRIMARY RATE ACCESSES

## 1.Scope of application

This Recommendation covers the maintenance of that part of the ISDN subscriber primary rate access, controlled by the network, follows the maintenance principles as defined in Recommendation M.20 and applies to the primary rate access connected to the local exchange.

Notes related to Figure 1/I.604

Note 1 - The subscriber access contains a digital link which can use different varieties of transmission techniques and media. Figure 2/I.604 shows examples of configurations made by using existing digital line systems and multiplexers complying with G.700 and G.900-Series of Recommendations.

Note 2 - A local exchange should be able to connect different types of digital line systems and different types of subscriber installations at V3 interfaces complying with Recommendation Q.512.

Note 3 - The use of different types of digital line systems shall not affect the subscriber installation complying with Recommendation I.431.

Note 4 - The subscriber access shall comply with the CRC procedure defined in Recommendations G.704 and G.706.

Note 5 - In some countries the subscriber installation is allowed to control certain maintenance functions in the subscriber access.