INTERNATIONAL TELECOMMUNICATION UNION

# CCITT

# I.311

THE INTERNATIONAL
TELEGRAPH AND TELEPHONE
CONSULTATIVE COMMITTEE

## INTEGRATED SERVICES DIGITAL NETWORK (ISDN)

## OVERALL NETWORK ASPECTS AND FUNCTIONS, ISDN USER-NETWORK INTERFACES

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## B-ISDN GENERAL NETWORK ASPECTS

## Recommendation I.311

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Geneva, 1991

## FOREWORD

The CCITT (the International Telegraph and Telephone Consultative Committee) is a permanent organ of the International Telecommunication Union (ITU). CCITT is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The Plenary Assembly of CCITT which meets every four years, establishes the topics for study and approves Recommendations prepared by its Study Groups. The approval of Recommendations by the members of CCITT between Plenary Assemblies is covered by the procedure laid down in CCITT Resolution No. 2 (Melbourne, 1988).

Recommendation I.311 was prepared by Study Group XVIII and was approved under the Resolution No. 2 procedure on the 5th of April 1991.

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CCITT NOTES

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

2) A list of abbreviations used in this Recommendation can be found in Annex A.

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**Preamble to B-ISDN Recommendations**

In 1990, CCITT SG XVIII approved a first set of Recommendations on B-ISDN. These are:

I.113 – Vocabulary of terms for broadband aspects of ISDN

I.121 – Broadband aspects of ISDN

I.150 – B-ISDN asynchronous transfer mode functional characteristics

I.211 – B-ISDN service aspects

I.311 – B-ISDN general network aspects

I.321 – B-ISDN Protocol Reference Model and its application

I.327 – B-ISDN functional architecture

I.361 – B-ISDN ATM Layer specification

I.362 – B-ISDN ATM Adaptation Layer (AAL) functional description

I.363 – B-ISDN ATM Adaptation Layer (AAL) specification

I.413 – B-ISDN user-network interface

I.432 – B-ISDN user-network interface – Physical Layer specification

I.610 – Operation and maintenance principles of B-ISDN access

These Recommendations address general B-ISDN aspects as well as specific service- and network-oriented issues, the fundamental characteristics of the asynchronous transfer mode (ATM), a first set of relevant ATM oriented parameters and their application at the user-network interface as well as impact on operation and maintenance of the B-ISDN access. They are an integral part of the well established I-Series Recommendations. The set of Recommendations are intended to serve as a consolidated basis for ongoing work relative to B-ISDN both within CCITT and in other organizations. They may also be used as a first basis towards the development of network elements.

CCITT will continue to further develop and complete these Recommendations in areas where there are unresolved issues and develop additional Recommendations on B-ISDN in the I-Series and other series in the future.

**Recommendation I.311**

## B-ISDN GENERAL NETWORK ASPECTS

## 1 Introduction

This Recommendation describes networking techniques, signalling principles, traffic control and resources management for B-ISDN.

## 2 Networking techniques

### 2.1 *Introduction*

B-ISDN networking techniques include network layering aspects and applications of the Virtual Path (VP) and Virtual Channel (VC).

### 2.2 *Network layering*

B-ISDN network layering includes the hierarchical relationship between the Physical Layer, the ATM Layer (i.e. VP and VC) and layers above.

#### 2.2.1 *General*

An ATM transport network is structured as two layers, namely the ATM Layer and the Physical Layer.

The transport functions of the ATM Layer are subdivided into two levels, the VC level and the VP level.

The transport functions of the Physical Layer are subdivided into three levels, the transmission path level, the digital section level and the regenerator section level. The transport functions of the ATM Layer should be independent of Physical Layer implementation.

#### 2.2.2 *ATM layer*

Each ATM cell contains a label in its header to explicitly identify the VC to which the cell belongs. This label consists of two parts – a virtual channel identifier (VCI) and a virtual path identifier (VPI).

##### 2.2.2.1 *Virtual channel level*

A virtual channel (VC) is a generic term used to describe a unidirectional communication capability for the transport of ATM cells.

A VCI identifies a particular VC link for a given virtual path connection (VPC). A specific value of VCI is assigned each time a VC is switched in the network. A VC link is a unidirectional capability for the transport of ATM cells between two consecutive ATM entities where the VCI value is translated. A VC link is originated or terminated by the assignment or removal of the VCI value.

Routing functions of virtual channels are done at a VC switch. This routing involves translation of the VCI values of the incoming VC links into the VCI values of the outgoing VC links.

Virtual channel links are concatenated to form a virtual channel connection (VCC). A VCC extends between two VCC endpoints or, in the case of point-to-multipoint arrangements, more than two VCC endpoints. A VCC endpoint is the point where the cell information field is exchanged between the ATM Layer and the user of the ATM Layer service.

At the VC level, VCCs are provided for the purpose of user-user, user-network, or network-network information transfer. Cell sequence integrity is preserved by the ATM Layer for cells belonging to the same VCC.

#### 2.2.2.2 *Virtual path level*

A virtual path (VP) is a generic term for a bundle of virtual channel links: all the VC links in a bundle have the same endpoints.

A VPI identifies a group of VC links, at a given reference point, that share the same VPC. A specific value of VPI is assigned each time a VP is switched in the network. A VP link is a unidirectional capability for the transport of ATM cells between two consecutive ATM entities where the VPI value is translated. A VP link is originated or terminated by the assignment or removal of the VPI value.

Routing functions for VPs are performed at a VP switch. This routing involves translation of the VPI values of the incoming VP links into the VPI values of the outgoing VP links.

VP links are concatenated to form a VPC. A VPC extends between two VPC endpoints or, in the case of point-to-multipoint arrangements, there are more than two VPC endpoints. A VPC endpoint is the point where the VCIs are originated, translated or terminated.

At the VP level, VPCs are provided for the purpose of user-user, user-network and network-network information transfer.

When VCs are switched, the VPC supporting the incoming VC links must be terminated first and a new outgoing VPC must be created. Cell sequence integrity is preserved for each VC link within a VPC.

### 2.2.3 *Physical Layer*

#### 2.2.3.1 *Transmission path level*

The transmission path extends between network elements that assemble and disassemble the payload of a transmission system. Cell delineation and header error control functions are required at the end point of each transmission path.

#### 2.2.3.2 *Digital section level*

The digital section extends between network elements which assemble and disassemble a continuous bit or byte stream.

2.2.3.3 *Regenerator section level*

The regenerator section is a portion of a digital section.

Figure 1/I.311 shows the relationship between the virtual channel, the virtual path and the transmission path.

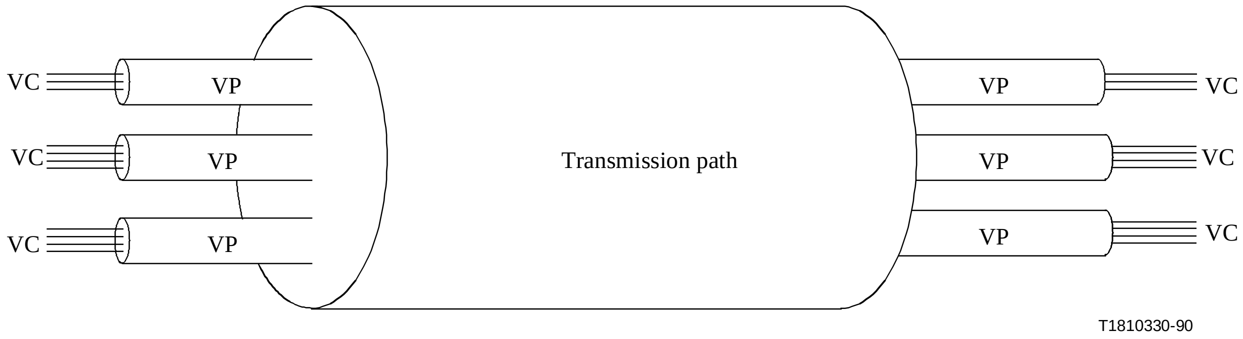



FIGURE 1/I.311

**Relationship between the VC, the VP and the transmission path**

Figure 2/I.311 shows the hierarchy consisting of the VC level, the VP level and the Physical Layer.

| | |
|---|---|
| Higher layers | |
| ATM Layer | VC level |
| | VP level |
| Physical Layer | Transmission path level |
| | Digital section level |
| | Regenerator section level |

FIGURE 2/I.311

**Hierarchy of the ATM transport network**

Figure 3/I.311 shows the hierarchical layer-to-layer relationship in the ATM transport network. A connection in a certain level provides services to a link in the next higher level.

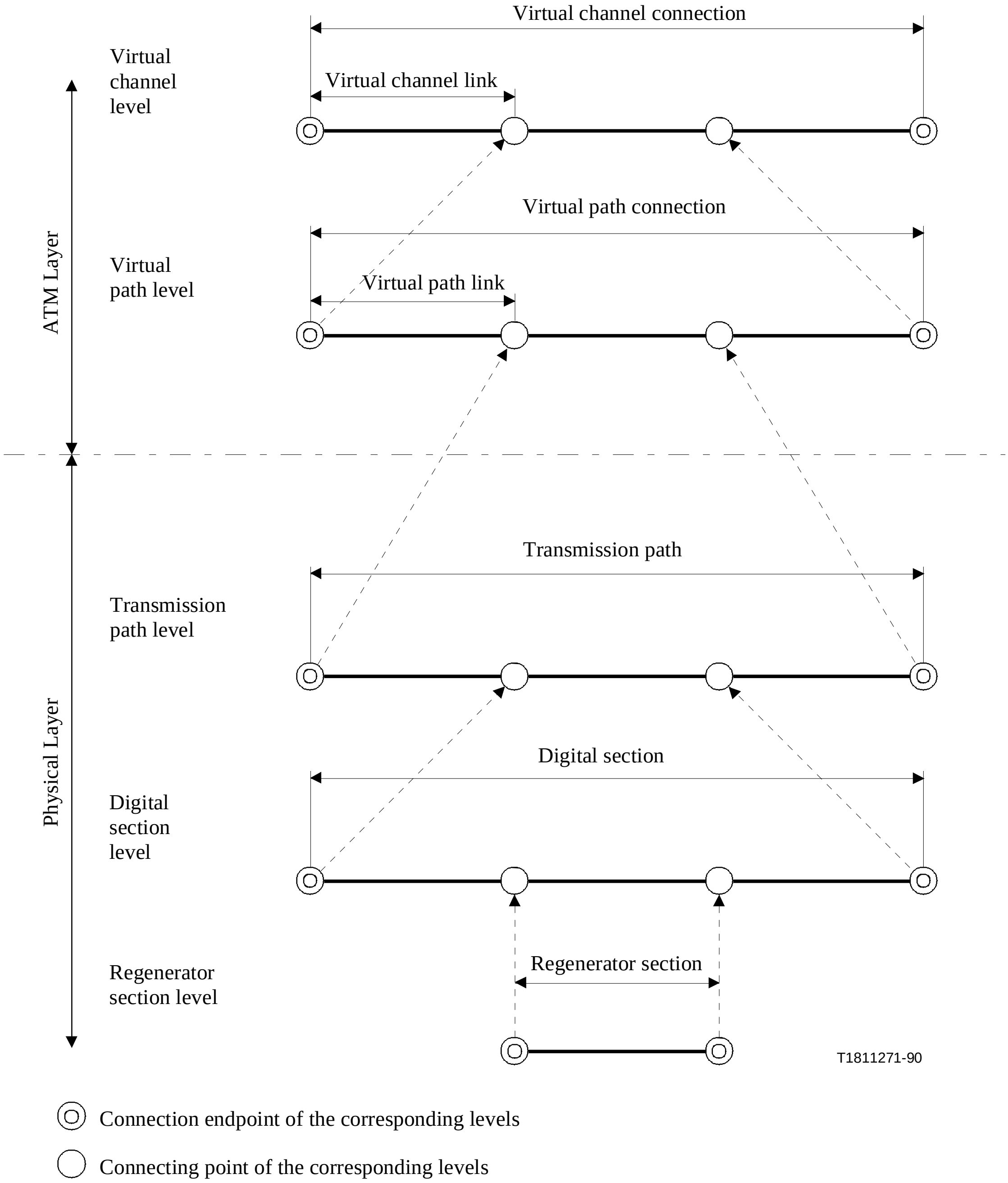
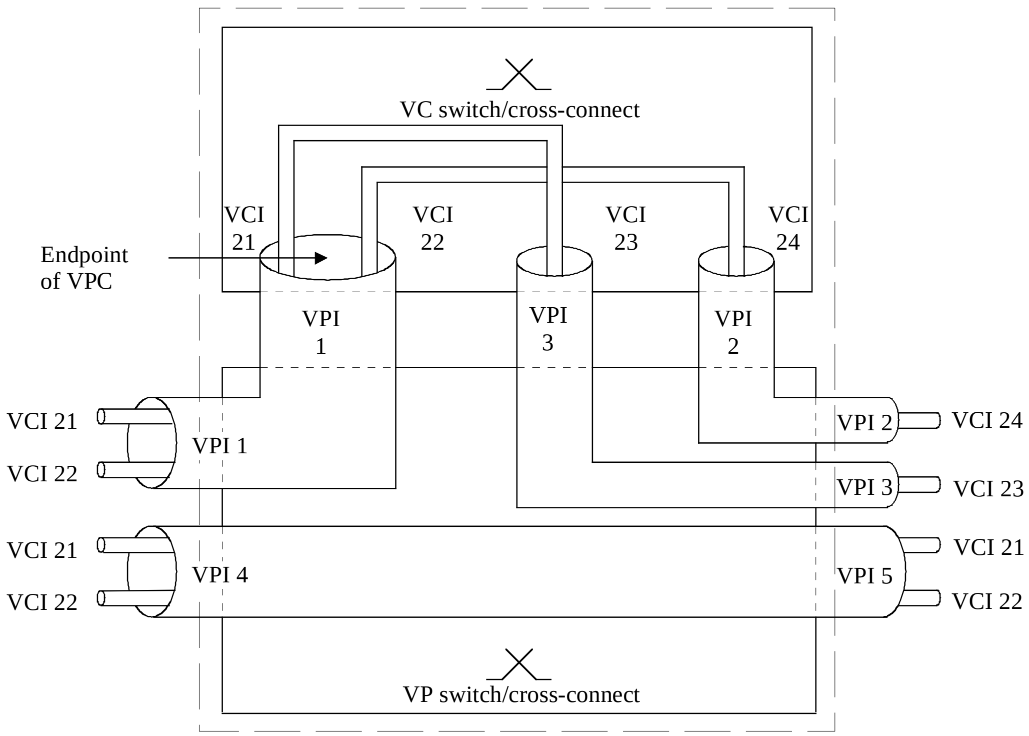



FIGURE 3/I.311

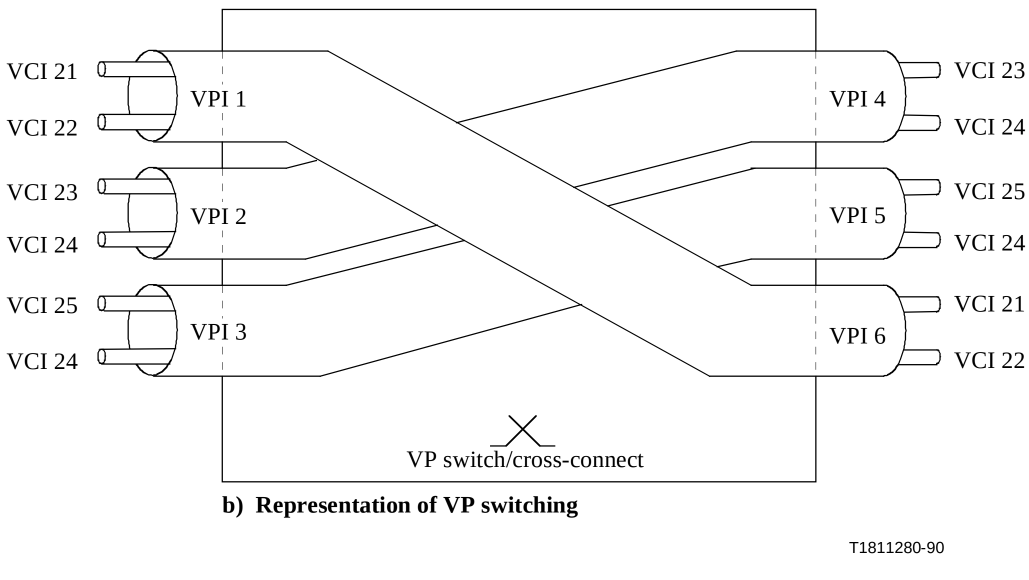
**Hierarchical layer-to-layer relationship**

Annex A contains examples of a VCC supported by a cell-based (Figure A-1/I.311) and a SDH-based (Figure A-2/I.311) ATM transport network.

Figure 4/I.311 contains a representation of the VP and VC switching hierarchy using the modelling of Figure 1/I.311. VPI values are modified in switching blocks for VPs and VCI values are modified in switching blocks for VCs.




**a) Representation of VC and VP switching**




**b) Representation of VP switching**

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FIGURE 4/I.311

**Representation of the VP and VC switching hierarchy**

2.3 *Use of virtual channel connections and virtual path connections*

2.3.1 *Applications of virtual channel connections*

The following applications of VCCs have been identified:

1) *User-user application*

In this application, the VCC extends between $T_B$ or $S_B$ reference points. ATM network elements transport all the cells associated with the VCC along the same route. The VCI value may be translated at an ATM network element where a VPC endpoint is located.

2) *User-network application*

In this application, the VCC extends between a $T_B$ or $S_B$ reference point and a network node. The user-network application of a VCC can be used to provide customer equipment (CEQ) access to a network element [for example, local connection related function (CRF)].

3) *Network-network application*

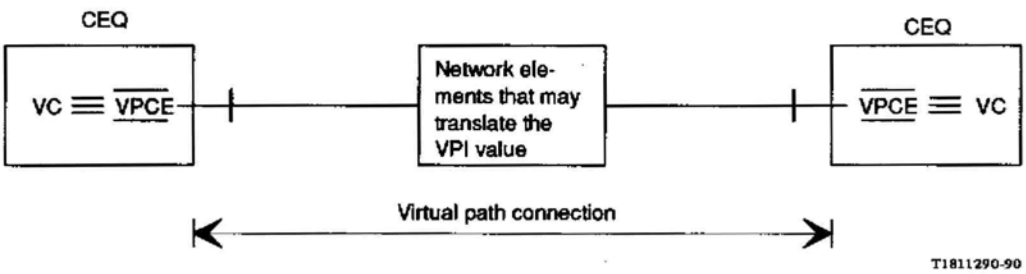
In this application, the VCC extends between two network nodes. The network-network application of this VCC includes network traffic management and routing.

2.3.2 *Applications of the virtual path connections*

The following applications of the VPCs have been identified:

1) *User-user application*

In this application, the VPC extends between $T_B$ or $S_B$ reference points. The user-user application of the VPC, shown in Figure 5/I.311, provides customers with virtual path connections. The ATM network elements transport all the cells associated with a VPC along the same route. The VPI values are translated at the ATM network elements that provide functions such as cross-connect or switching.




VPCE Virtual path connection endpoint
CEQ Customer equipment

FIGURE 5/I.311
**User-user application of the virtual path connection**

2) *User-network application*

In this application, the VPC extends between a $T_B$ or $S_B$ reference point and a network node. The user-network application of VPC, shown in Figure 6/I.311, can be used to aggregate CEQ access traffic to a network element (for example: local CRF).

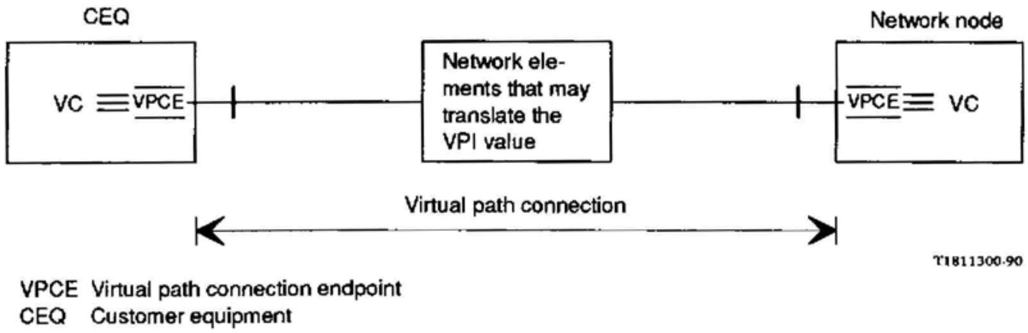



FIGURE 6/I.311
**User-network application of the virtual path connection**

3) *Network-network application*

In this application, the VPC extends between two network nodes. The network-network application of the VPC, shown in Figure 7/I.311, includes network traffic management and routing. At the network nodes where the VPC is terminated, the VCs within the VP are switched or cross-connected to VCs within other VPs.

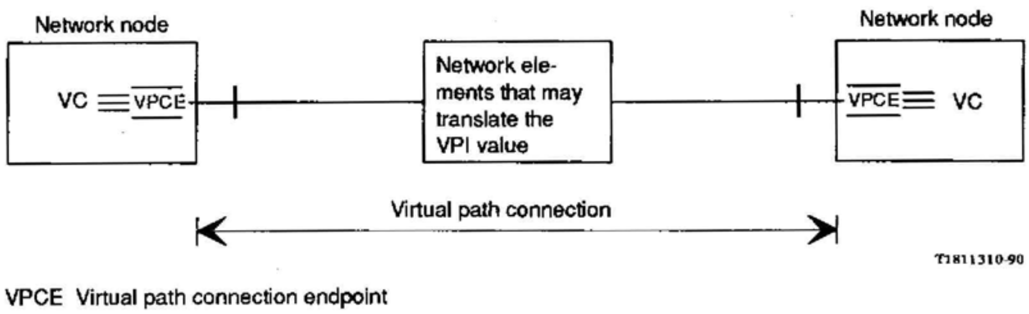



FIGURE 7/I.311
**Network-network application of the virtual path connection**

## 3 B-ISDN signalling principles

### 3.1 *Introduction*

In B-ISDN, the use of ATM allows for a multiplicity of service types/characteristics and for the logical separation of signalling from user information streams. A user may have multiple signalling entities connected to the network call control management via separate ATM virtual channel connections. The following sections identify the signalling capabilities needed in B-ISDN and the requirements for establishing signalling communication paths.

### 3.2 *Capabilities required for B-ISDN signalling*

#### 3.2.1 *Capabilities to control ATM virtual channel and virtual path connections for information transfer*

a) Establishment, maintaining and release of ATM VCCs and VPCs for information transfer. The establishment can be on-demand, semi-permanent or permanent, and should comply with the requested connection characteristics (e.g. bandwidth, quality of service).

b) Support of communication configurations on a point-to-point, multipoint and broadcast basis.

c) Negotiation of the traffic characteristics of a connection at connection establishment.

d) Ability to renegotiate source traffic characteristics of an already established connection.

#### 3.2.2 *Capability to support simple multiparty and multiconnection call*

a) Support of symmetric and asymmetric simple calls (e.g. low or zero bandwidths in one direction and high bandwidths in the other).

b) Simultaneous establishment and removal of multiple connections associated with a call.

c) Addition and removal of a connection to and from an existing call.

d) Addition and removal of a party to and from a multiparty call.

e) Capability to correlate, when requested, connections composing a multiconnection call.

*Note* – This correlation is handled by the origination and destination B-ISDN switches, which may be public or private.

f) Reconfiguration of a multiparty call including an already existing call or splitting the original multiparty call into more calls.

*Note* – The simultaneous establishment of multiple connections should not be significantly slower than the establishment of a single connection.

#### 3.2.3 *Others*

a) Capability to reconfigure an already established connection, for instance, to pass through some intermediate processing entity such as a conference bridge.

b) Support interworking between different coding schemes.

c) Support interworking with non B-ISDN services, e.g. services supported by PSTN or 64 kbit/s based ISDN.

Further signalling requirements may be possible and are for further study.

### 3.3 *Signalling virtual channels*

#### 3.3.1 *Signalling virtual channels at the user access*

The requirements for signalling virtual channels at the user access are as follows:

##### 3.3.1.1 *Point-to-point signalling virtual channels*

For point-to-point signalling, one virtual channel connection in each direction is allocated to each signalling endpoint. The use of the same VPI/VCI value in both directions of communications is for further study.

*Note* – Whether there is one signalling endpoint per terminal or whether there are multiple endpoints per terminal, requires further study.

##### 3.3.1.2 *Selective broadcast signalling virtual channels*

One virtual channel connection for selective broadcast signalling is allocated to each service profile. The concept of service profile as related to supplementary services is given in Recommendation Q.932, Annex A. The scope and definition of service profiles for B-ISDN need further study.

The service profile concept provides flexibility when configuring broadcast signalling virtual channel connections. The provision of service profiles is a network option.

The following service profile configurations have been identified and require further study:

– only one service profile on an interface;

– only one service profile for all signalling endpoints using the same service on an interface;

– a default service profile to be used by all signalling endpoints that do not specify a service profile identifier as part of their signalling VCI request (i.e. the support of service profile could be optional for a signalling endpoint);

– one service profile per signalling endpoint;

– one service profile for all signalling endpoints of one terminal.

*Note* – Selective broadcast signalling virtual channel connections will apply in the network-to-user direction only.

##### 3.3.1.3 *General broadcast signalling virtual channel*

The general broadcast signalling virtual channel connection is used for broadcast signalling independent of service profiles. It is identified by a standardized VPI and VCI value. The functions to be provided by this virtual channel are for further study.

#### 3.3.2 *Signalling virtual channels in the network*

Requirements for signalling virtual channels in the network are for further study.

### 3.3.3 *Meta-signalling at the user access*

In order to establish, check and release the point-to-point and selective broadcast signalling virtual channel connections, that are needed across an interface, meta-signalling procedures are provided. For each direction, meta-signalling is carried in a permanent virtual channel connection having a standardized VPI and VCI value (see Recommendation I.361, § 2.2.3). This channel is called the meta-signalling virtual channel. Meta-signalling is located in Layer Management.

The meta-signalling function will be required to:

– manage the allocation of capacity to signalling channels;

– establish, release and check the status of signalling channels;

– provide the means to associate the request with a service profile (the scope and definition of service profile for B-ISDN needs further study);

– provide the means to distinguish between simultaneous requests.

Other possible uses and functions of meta-signalling are for further study.

### 3.3.4 *Meta-signalling in the network*

The necessity and requirements for meta-signalling in the network are for further study.

### 3.3.5 *Signalling configurations*

Figure 8/I.311 illustrates three possible signalling configurations.

*Case A:* The customer uses signalling procedures to establish VCCs to other customers. The meta-signalling channel is used to establish a signalling channel (or channels) between the CEQ and the local CRF. The local CRF provides an interconnection function based on using the VPI and the VCI in the ATM cell header.

*Case B:* The customer has VPCs through the local CRF to other nodes (local CRF, transit CRF or CEQ). These VPCs could be established:

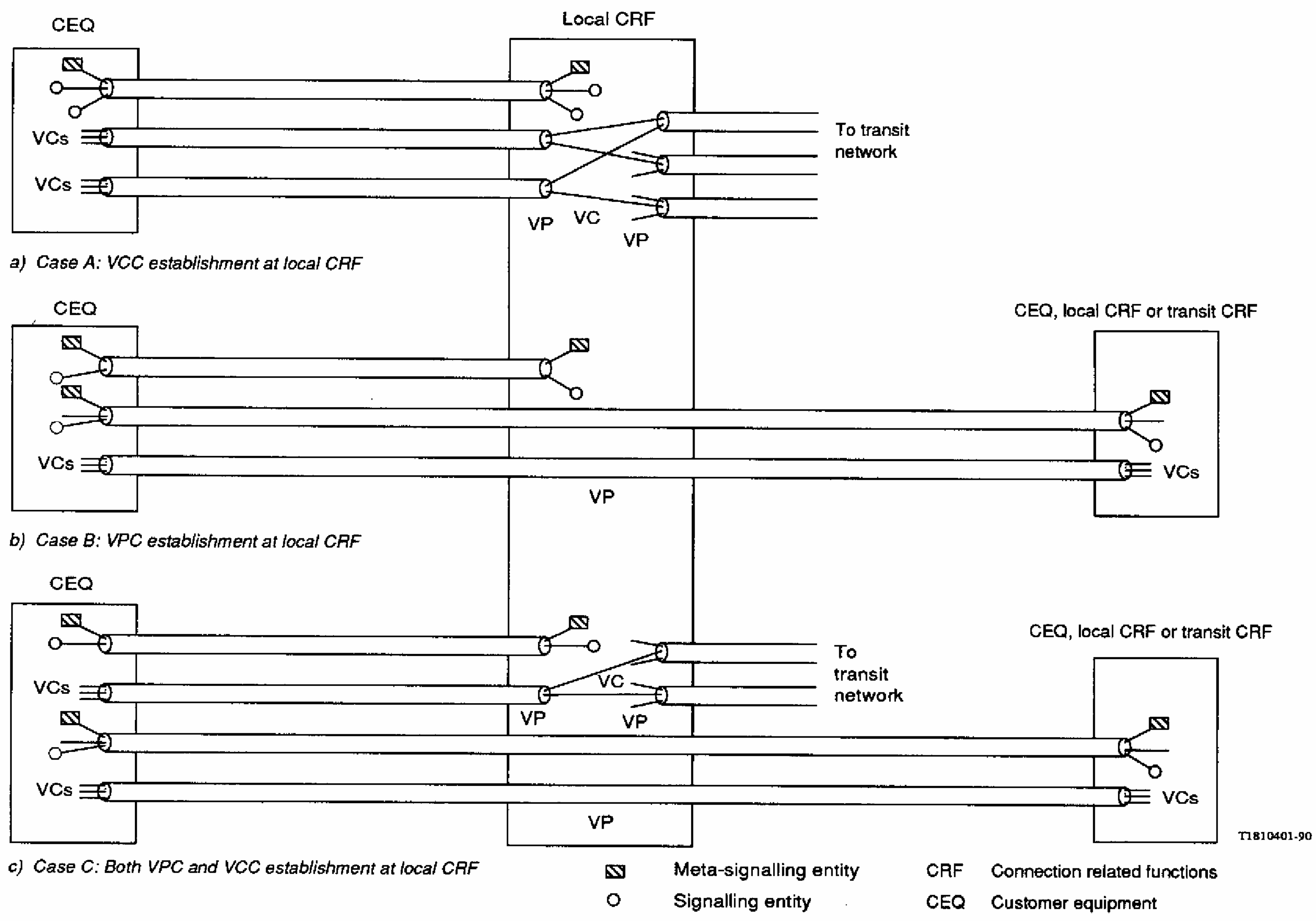
a) without using signalling procedures (e.g. by subscription),

b) using signalling procedures on a demand basis.

When a VP connection is established by using signalling procedures, the CEQ uses the meta-signalling channel to the local CRF to establish a signalling channel (or channels) which may be used to establish the VPCs. VC links within a VPC are established by using signalling procedures between the CEQ and the node terminating the VPC. The procedures for establishing a signalling channel or channels between the nodes terminating the VPC are for further study. The local CRF provides an interconnection function based on using only the VPI portion of the ATM cell header.

*Case C:* The customer has VPCs through the local CRF to other nodes (local CRF, transit CRF or CEQ) and additional VPCs that terminate at the local CRF, which are used to provide VCs to other nodes. In this case, the CEQ uses the meta-signalling channel to the local CRF to establish a signalling channel (or channels), which are then used to establish VPCs or VCCs to other nodes. The local CRF provides an interconnection function based on using only the VPI portion of the ATM cell header for those VPCs that do not terminate at the local CRF, and based on both the VPI and VCI for those VPCs that do terminate at the local CRF.

*Note* – The procedures for establishing a signalling channel(s) and the necessity of meta-signalling for CEQ to transit CRF or CEQ to CEQ signalling communication are for further study.




*Note 1* — The implementation of local and transit CRF is not subject to CCITT standardization. The CRF provides interconnection of ATM cells using routing information in the VPI and/or VCI.

*Note 2* — The procedures for establishing a signalling channel(s) and the necessity of meta-signalling for CEQ to transit CRF or CEQ to CEQ signalling communication are for further study.

FIGURE 8/I.311

**Possible VPC/VCC establishment and signalling configurations**

Figure 9/I.311 illustrates an example of a VCC and a VPC and the relationship of user-network and internodal signalling procedures. In this example, user-network signalling is carried on one VPC designated as the VPC for carrying meta-signalling. Other signalling channels on this VPC are established using procedures over the meta-signalling channel.

Internodal signalling messages may be carried between network nodes over virtual channel connections designated for internodal signalling. The procedures for allocating these VCCs are for further study.

In some cases, signalling may be required over VPCs established between the CEQ and another node, as shown in Case B and in Case C, Figure 8/I.311, in order to establish VCCs within those VPCs. The procedure for establishing these signalling channels is for further study.

In the upper portion of Figure 9/I.311, a virtual channel connection is illustrated between the CEQ on the left and the CEQ on the right side. This VCC is established by using user-network and internodal signalling procedures.

Two VP connections are illustrated in the lower portion of Figure 9/I.311 between the CEQ on the left and the CEQ on the right. One VPC contains a meta-signalling channel (see Note 2, Figure 9/I.311), which is used to establish additional signalling channels within that VPC. This VPC between the two CEQs may carry other non-signalling traffic. After signalling channels are established, signalling procedures are used to establish VCCs within VPCs between the two CEQs.

### 3.4 *Requirements for signalling procedures*

For further study.

## 4 Traffic control and resource management

### 4.1 *Traffic control*

The B-ISDN, which is based on the ATM technique, is designed to transport a wide variety of traffic classes satisfying the required performance in terms of user and network requirements. To cope with these requirements, an ATM-based network will provide several levels of traffic control capabilities such as:

– connection admission control;

– usage parameter control;

– priority control;

– congestion control.

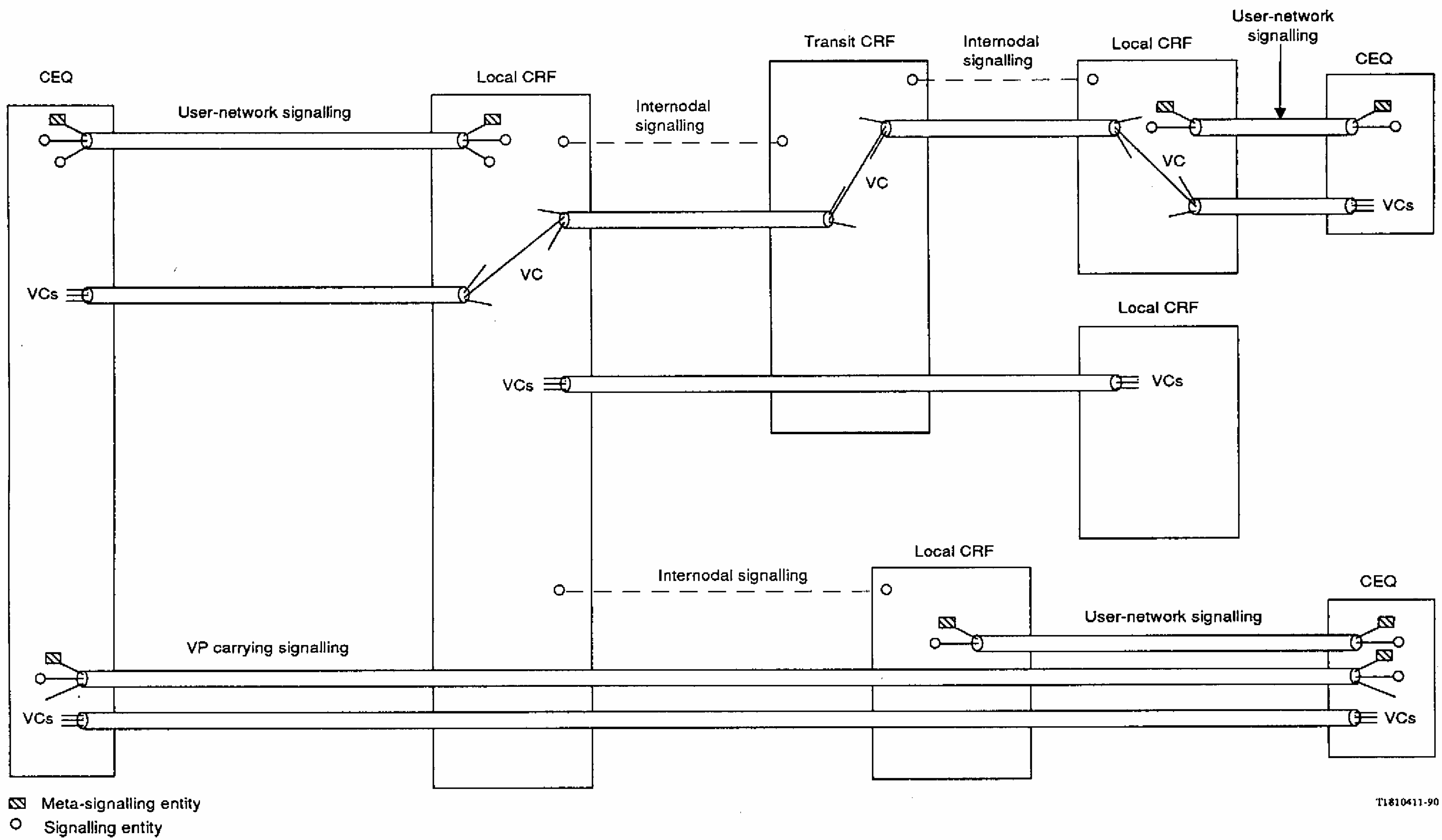
In addition, internodal usage parameter control may be needed.

As a general requirement, it is desirable that a high level of consistency should be achieved between the above traffic control capabilities.

#### 4.1.1 *Connection admission control*

##### 4.1.1.1 *General*

Connection admission control is defined as the set of actions taken by the network at the call set-up phase (or during call renegotiation phase) in order to establish whether a (virtual channel/virtual path) connection can be accepted or rejected.




*Note 1* — The implementation of local and transit CRF is not subject to CCITT standardization. The CRF provides interconnection of ATM cells using routing information in the VPI and VCI.

*Note 2* — The procedures for establishing signalling channel(s) and the necessity of meta-signalling for CEQ to transit CRF or CEQ to CEQ signalling communication are for further studfy.

FIGURE 9/I.311

**Relationship of VP/VC connections to user-network and internodal signalling**

On the basis of the connection admission control outcome in an ATM-based network, a call (or call renegotiation) request is accepted only when sufficient resources are available to establish the call through the whole network at its required quality of service (QOS) and to maintain the agreed QOS of existing calls.

In a B-ISDN environment a call can require more than one connection (e.g. for multimedia or multiparty services such as videotelephony or videoconferencing). In this case, connection admission control procedures should be performed for each VCC or VPC.

In the case of a demand service, the signalling messages sent by a user to establish a call will convey at least the following types of information:

– source traffic characteristics;

– required QOS class.

In the case of permanent or reserved service (e.g. using a permanent virtual path connection or a permanent virtual channel connection), this information is indicated with an appropriate OAM procedure, either on-line (e.g. signalling) or off-line (e.g. service order) basis.

Connection admission control makes use of this information to determine:

– whether the connection can be accepted or not;

– traffic parameters needed by usage parameter control;

– allocation of network resources.

The role of priority control in connection admission control is for further study. Further information on priority control can be found in § 4.1.4.

#### 4.1.1.2 *Source traffic characteristics*

Methods for characterizing traffic are for further study. More than one method may be desirable. The traffic characteristics used may include measures that describe:

– Average Rate;

– Peak Rate;

– Burstiness; and

– Peak Duration.

Some of the above-mentioned parameters are correlated (e.g. the Average and Peak Rate with the Burstiness).

#### 4.1.1.3 *Required QOS class*

A user indicates a QOS class from the QOS classes which the network provides.

Specific QOS classes are the subject for further study.

#### 4.1.1.4 *Negotiation of traffic characteristics*

The user will negotiate the traffic characteristics of a call with the network at call establishment. These characteristics may be renegotiated during the lifetime of the call at the request of the user. The network may limit the frequency of these renegotiations.

The renegotiation procedure and the impact on network element complexity require further study.

#### 4.1.2 *Usage parameter control*

##### 4.1.2.1 *General*

Usage parameter control is defined as the set of actions taken by the network to monitor and control (user's) traffic in terms of traffic volume and cell routing validity. Its main purpose is to protect network resources from malicious as well as unintentional misbehaviour which can affect the QOS of other already established connections by detecting violations of negotiated parameters.

*Note* – Due to equipment faults (e.g. in usage parameter control devices and/or other network elements) the controlled traffic characteristics could be different from the values agreed during the call set-up phase. To cope with these situations specific procedures of the management plane should be designed (e.g. in order to isolate the faulty link). The impact of these malfunctioning situations on the usage parameter control needs further study.

Usage parameter control will apply only during the information transfer phase of a connection. Connection monitoring encompasses all connections crossing the UNI, including signalling.

The monitoring task for usage parameter control is performed by various combinations of the following actions:

1) checking the validity of VPI and VCI values;

2) monitoring the traffic volume entering the network from active VP connections in order to ensure that parameters agreed upon are not violated;

3) monitoring the traffic volume entering the network from active VC connections in order to ensure that parameters agreed upon are not violated;

4) monitoring the total volume of the accepted traffic on the access link.

The specific monitoring actions to be taken depend on the access network configuration.

A specific control algorithm has not been standardized. However, a number of desirable features of the control algorithm can be identified, as follows:

– capability of detecting any illegal traffic situation;

– selectivity over the range of checked parameters (i.e. the algorithm could determine whether the user behaviour is within an acceptance region);

– rapid response time to parameter violations;

– simplicity of implementation.

The need for and the definition of an exact algorithm requires further study.

##### 4.1.2.2 *Parameters subject to control*

Possible parameters that may be subject to control are:

– Average Rate;

– Peak Rate;

– Burstiness; and

– Peak Duration.

Some of the above parameters are correlated (e.g. the Average and Peak Rate with the Burstiness). Whether all these parameters or a subset should be subject to control requires further study.

#### 4.1.2.3 *Location of the usage parameter control function*

Usage parameter control is performed on VCs or VPs at the access point where they are terminated within the network. Four possibilities can be identified as shown in Figure 10/I.311.

*Note* – In the following cases, CRF (VC) stands for virtual channel connection related function and CRF (VP) stands for virtual path connection related function.

*Case A:* The user is connected directly to the CRF (VC). Parameter control is performed within the CRF on VCs before the switching function is executed (actions 1 and 3 of § 4.1.2.1).

*Case B:* The user is connected to the CRF (VC) via a concentrator. Parameter control is performed within the concentrator on VCs only (actions 1 and 3 of § 4.1.2.1).

*Case C:* The user is connected to the CRF (VC) via CRF (VP). Usage parameter control is performed within the CRF (VP) on VPs only (actions 1 and 2 of § 4.1.2.1) and within the CRF (VC) on VCs only (actions 1 and 3 of § 4.1.2.1). VC usage parameter control will be done by other network providers when CRF (VC) is required.

*Case D:* The user is connected to a user via CRF (VP). Usage parameter control is performed within the CRF (VP) on VPs only (actions 1 and 2 of § 4.1.2.1).

If a remote statistical multiplexer is used in the access link and if such equipment is not able to perform the usage parameter control function on VPs or VCs, then usage parameter control based on the traffic characteristics of the superimposed traffic on each incoming link will be performed by the statistical multiplexer (action 4 of § 4.1.2.1). In this case, in order to protect the network from malicious user behaviour, (e.g. routing of large bandwidth channels towards destinations for which small bandwidth channels were reserved) a usage parameter control function on VPs or VCs (actions 1, 2 and 3 of § 4.1.2.1) should always be performed within the CRF. Whether this case implies a fifth possibility to locate the usage parameter control is for further study.

#### 4.1.2.4 *Action to be taken by the usage parameter control function*

If a customer exceeds the agreed parameters, a simple action of usage parameter control would be to discard those cells which violate the traffic parameters. In this case, the main objective is reached: a customer will never be able to get more cells into the network than the agreement allows for.

There is a practical uncertainty in determining the values of the controlled parameters. Hence, in order to have adequate control performance, tolerances of controlling performance parameters need to be defined. The definition of these tolerances is for further study.

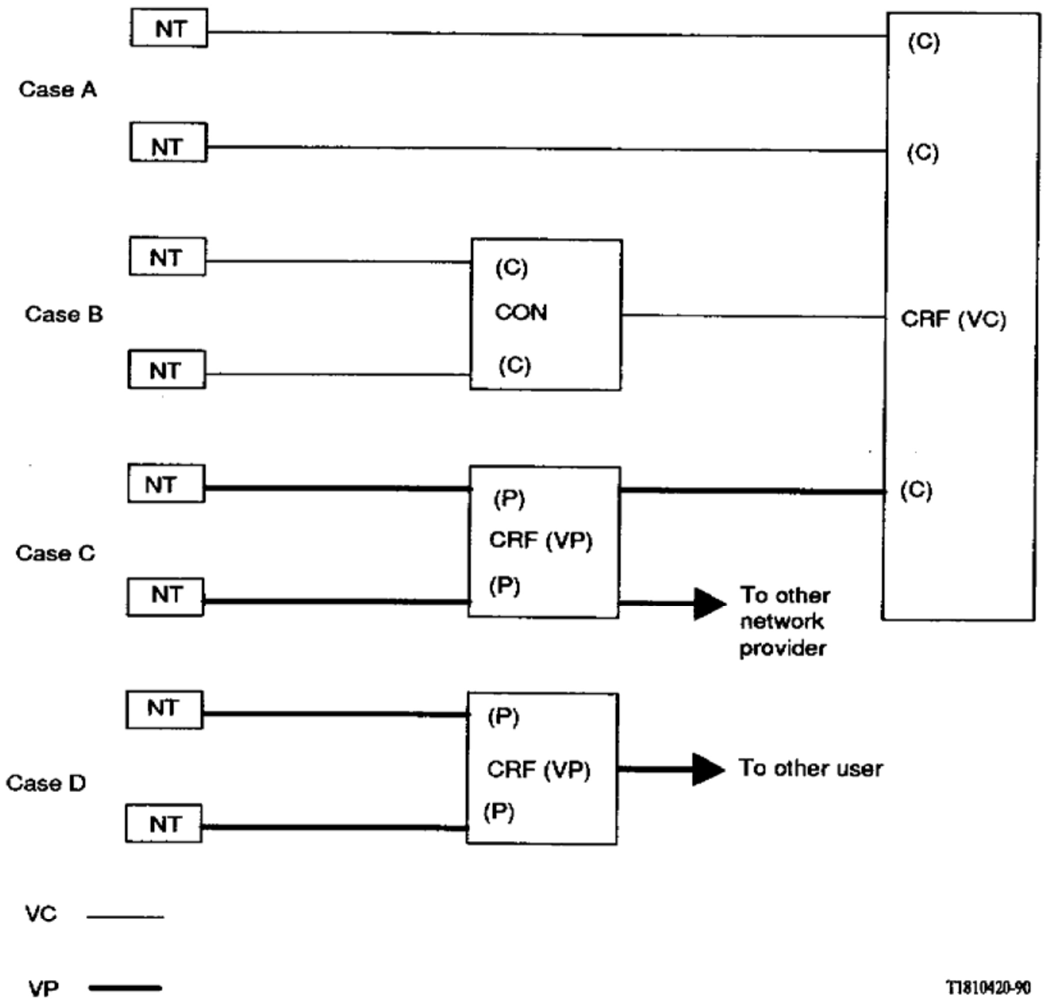
In addition to the action to discard the cells that exceed the pre-negotiated values, as options, two other actions could be performed:

i) tagging of violating cells;

ii) releasing the connection.

### 4.1.3 *Inter-network usage parameter control*

It may be required to control the volume of traffic coming from other networks at the entry of an ATM-based network. The need for, and how to perform this function is for further study.




| | |
|---|---|
| CON | Concentrator |
| CRF | Connection related function |
| CRF (VC) | Virtual channel connection related function |
| CRF (VP) | Virtual path connection related function |
| (C) | VC usage parameter control |
| (P) | VP usage parameter control |

FIGURE 10/I.311

**Location of the usage parameter control function**

#### 4.1.4 *Priority control*

The user may allow different priority traffic flows by using the cell loss priority bit (see Recommendation I.150). The role of this and other priority control mechanisms in the control and management of traffic is for further study.

#### 4.1.5 *Congestion control*

##### 4.1.5.1 *General*

In B-ISDN, congestion is defined as a state of network elements (e.g. switches, concentrators, transmission links) in which, due to traffic overload and/or control resource overload, the network is not able to guarantee the negotiated QOS to the already established connections and to the new connection requests.

In general congestion can be caused by:

– unpredictable statistical fluctuations of traffic flows,

– fault conditions within the network.

As a result, congestion control is defined as the set of actions taken by the network in all the relevant network elements to minimize congestion effects and to avoid the congestion state spreading. The capabilities described in this Recommendation:

i) connection admission control (described in § 4.1.1),

ii) usage parameter control (described in § 4.1.2),

are regarded as congestion control capabilities. Additional congestion control capabilities are for further study.

##### 4.1.5.2 *Congestion control techniques*

A range of congestion control techniques will be used in the B-ISDN to assist maintenance of QOS of connections.

Possible useful techniques (that require further study to determine details) are:

i) Connection admission control that reacts to, and takes account of, the measured load on the network.

ii) Variation of usage monitored parameters by the network. For example, reduction of the peak rate available to the user.

iii) Fast allocation of capacity. In response to a user request to send a burst, the network allocates capacity for the burst and then returns to a lower allocated capacity. Usage monitored parameters would be adjusted accordingly (for example, increasing the peak rate available to the user during the higher capacity allocation);

iv) Existing congestion control techniques (e.g. as defined in Frame Mode Bearer Service) may be applicable. Further study is required for the application in B-ISDN;

v) Other techniques are for further study.

The impact on standardization of the use of these techniques (e.g. the impact on user-network signalling and control plane) requires further study.

*Note* – An alternative scheme is based on no network participation (e.g. window flow control techniques). In this case an adaptive protocol may be used end-to-end. This will reduce the users generated traffic when the network discards cells during congestion.

### 4.2 *Resource management*

#### 4.2.1 *Resource management control for virtual channels within a virtual path connection*

Where VC links within a VPC require a range of QOS, the VPC is provided with a QOS suitable for the most demanding VC link carried. For example, if one of the VC links within a VPC requires the allocation of the peak bit rate equal to a significant proportion of the VPC capacity, then assurance of the QOS of this virtual channel link may require that all other virtual channel links within this VPC also have an allocation of the peak capacity. The way this will be managed is for further study. However, the cell loss priority bit may be used to distinguish two levels of cell loss (see Recommendation I.150, § 4.3.2.3) on a VPC. The impact of cell loss priority on the management of the capacity of the VPC requires further study.

From § 2.3.2, the application of VPCs which have been identified are:

a) *user-user applications:* the VPC extends between a pair of $T_B$ reference points;

b) *user-network application:* the VPC extends between a $T_B$ reference point and a network node;

c) *network-network application:* the VPC extends between network nodes.

*In the case of a):* Since the network has no knowledge of the QOS of the VCs within the VP connection, it is the users' responsibility to determine in accordance with the network capabilities the necessary QOS for his VP connection.

*In the cases of b) and c):* The network is aware of the QOS of the VCs carried within the VP connection and has to accommodate it.

Statistical multiplexing of VC links within a VPC, where the instantaneous aggregate peak of all VC links may exceed the virtual path connection capacity, is only possible when all virtual channel links within the virtual path connection can tolerate the QOS that results from this statistical multiplexing. The way this is managed is for further study.

As a consequence, when statistical multiplexing of virtual channel links is required by the network operator, virtual path connections may be used in order to separate a particular type of traffic, thereby preventing its statistical multiplexing with other types of traffic. This requirement for separation implies that more than one virtual path connection may be necessary between network origination/destination pairs to carry a full range of QOS between them. Implications of this are for further study.

## ANNEX A

(to Recommendation I.311)

**Example of a VCC supported by a cell-based, and by an SDH-based, ATM transport network**

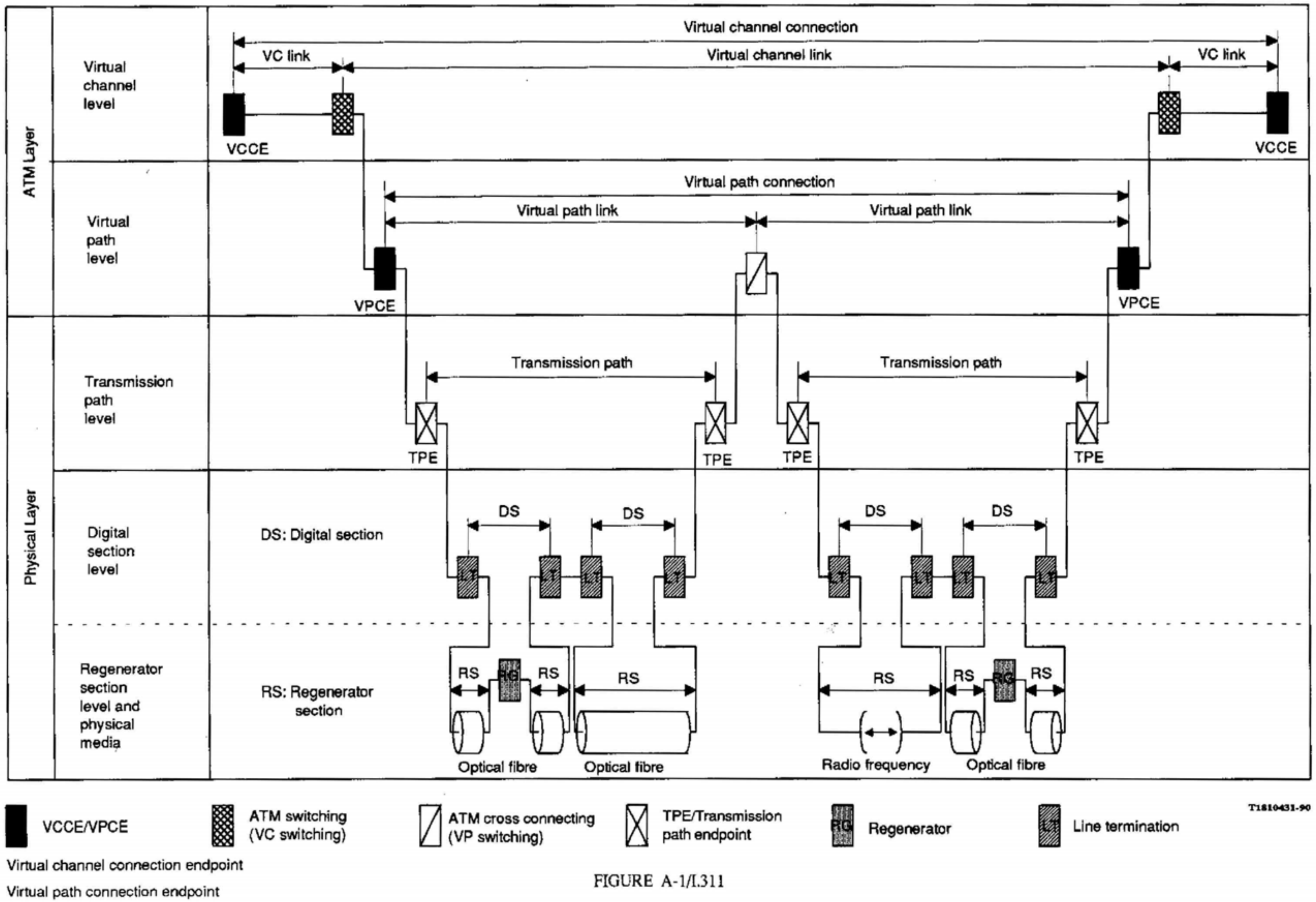



FIGURE A-1/I.311

**An example of a VCC supported by a cell-based ATM transport network**

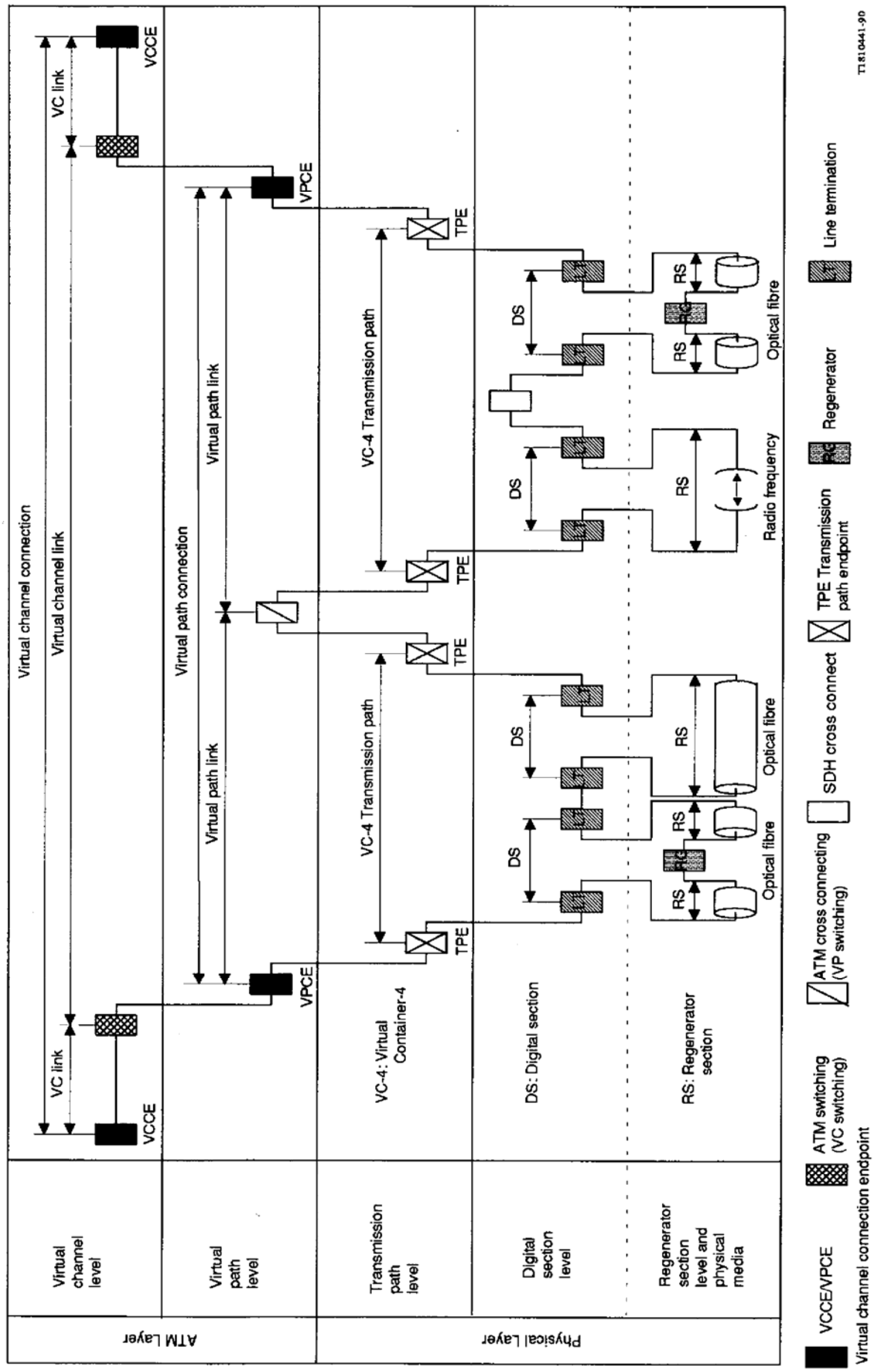



FIGURE A-2/I.311

**An example of a VCC supported by an SDH-based ATM transport network**

## ANNEX B

(to Recommendation I.311)

**Alphabetical list of abbreviations used in this Recommendation**

| | |
|---|---|
| CEQ | Customer equipment |
| CON | Concentrator |
| CRF | Connection related function |
| CRF (VC) | Virtual channel connection related function |
| CRF (VP) | Virtual path connection related function |
| RS | Regenerator section |
| TPE | Transmission path endpoint |
| VC | Virtual channel |
| VCC | Virtual channel connection |
| VCCE | Virtual channel connection endpoint |
| VCI | Virtual channel identifier |
| VP | Virtual path |
| VPC | Virtual path connection |
| VPCE | Virtual path connection endpoint |
| VPI | Virtual path identifier |

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