INTERNATIONAL TELECOMMUNICATION UNION

# ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

# Series Q

## Supplement 51

(12/2004)

SERIES Q: SWITCHING AND SIGNALLING

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# Signalling requirements for IP-QoS

ITU-T Q-series Recommendations – Supplement 51

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ITU-T Q-SERIES RECOMMENDATIONS

**SWITCHING AND SIGNALLING**



*For further details, please refer to the list of ITU-T Recommendations.*

# Supplement 51 to ITU-T Q-series Recommendations

## Signalling requirements for IP-QoS

**Summary**

This Supplement specifies IP-QoS signalling requirements for the development of new or enhanced specifications.

It identifies the capabilities for IP-QoS signalling. In addition, it describes the essential features and models for the development of functional entity actions in support of IP-QoS signalling.

**Source**

Supplement 51 to ITU-T Q-series Recommendations was agreed on 10 December 2004 by ITU-T Study Group 11 (2005-2008).

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The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

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## Supplement 51 to ITU-T Q-series Recommendations

# Signalling requirements for IP-QoS

## 1 Scope

This Supplement provides the requirements for signalling information regarding IP-based quality-of-service (QoS) at the interface between the user and the network (UNI), across interfaces between different networks (NNI), including access networks. These requirements and the signalling information elements identified will enable the development of a signalling protocol(s) capable of the request, negotiation and ultimately delivery of known IP QoS classes from UNI to UNI, spanning NNIs as required.

The signalling requirements also address signalling information related to traffic priority and admission control, as these are also central to truly comprehensive QoS.

This Supplement specifies the signalling requirements for control plane and transport control signalling in the support of Quality of Service, without presuming how these requirements may be met. It is based upon the following ITU-T Recs: Y.1221 [9], Y.1291 [8], Y.1540 [6], and Y.1541 [7].

Figure 1 depicts the scope of this Supplement. Note that the figure does not imply that signalling data and user data will necessarily flow on the same links from network to network.

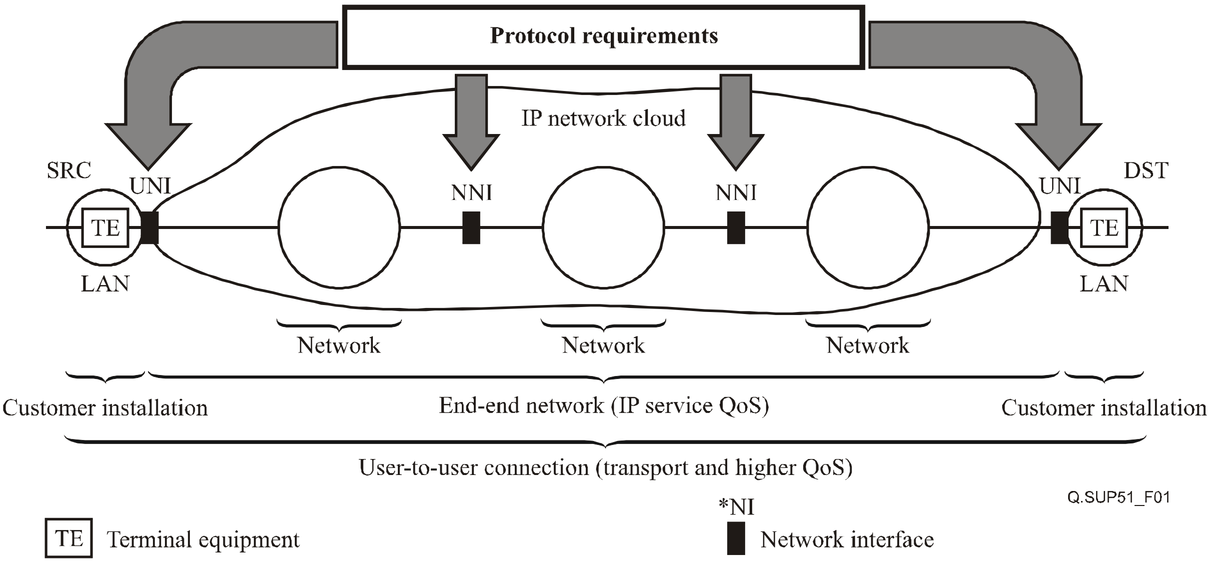



**Figure 1 – The Scope of QoS signalling requirements**

It is expected that continued study of IP QoS signalling requirements will address interworking/interoperability to allow hybrid signalling solutions.

## 2 Introduction

Although QoS is by definition (in multiple ISO, ITU-T and other standards) based on the experience of the service user, the mechanisms for achieving differentiated packet treatment are themselves taken all too often as being the same as "real" end-to-end QoS.

To meet specific network performance requirements such as those specified for the QoS classes of ITU-T Rec. Y.1541 [7], a network provider needs to implement services such as those specified in ITU-T Rec. Y.1221 [9].

To implement the transfer capabilities defined in ITU-T Rec. Y.1221 [9], a network needs to provide specific user plane functionality at UNI, NNI, and INI interfaces. A network may be provisioned to meet the performance requirements of ITU-T Rec. Y.1541 [7] either statically or dynamically on a per flow basis using a protocol that meets the requirements specified in this Supplement.

Static network provisioning is typically performed by a network engineering team using a network management system. Static provisioning typically takes into account both overall network performance requirements and performance requirements for individual customers based on traffic contracts between the customer and the network provider.

Dynamic network provisioning at a UNI and/or NNI node allows the ability to dynamically request a traffic contract for an IP flow (as defined in ITU-T Rec. Y.1221 [9]) from a specific source node to one or more destination nodes. In response to the request, the network determines if resources are available to satisfy the request and provision the network.

True QoS goes beyond just the delay and loss that can occur in the transport of IP packets. The requirements include:

– bandwidth/capacity needed by the application, and
– the priority with which such bandwidth will be maintained during congestion and with which it will be restored after various failure events.

As these aspects of QoS can be related to routing, they go beyond the resource management of the packet transport. To make the protocol envisioned by this Supplement comprehensive, requirements on priority and admission controls are also considered.

To achieve the "Hard QoS" guarantee, networks must incorporate the following functions:

1) Network resource management with QoS sensitive scalability.
2) Intra-domain and inter-domain routing with QoS sensitivity.
3) Session admission control with QoS sensitivity.

These functions must be provided whether path-coupled or path-decoupled signalling techniques are utilized within the network.

The requirements in this Supplement are intended to apply to implementations that operate using path-coupled QoS control mode, path-decoupled QoS control mode, or both modes in tandem.

The subject of QoS signalling has generated much interest in the industry. In particular, it is noted that some related work is under way in the IETF NSIS (Next Step in Signalling) Working Group focused on general IP signalling protocols that could be used to achieve different purposes such as QoS and security. The requirements of signalling protocols have been addressed in RFC 3726 [10], in which QoS has been considered as the first-use case. The effort within the IETF is complementary to the contents of this Supplement.

The IP QoS signalling solution needs to be scalable.

## 3 References

This Technical Report incorporates, by dated or undated reference, provision for referencing material from other publications. These references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this document only when incorporated into it by amendment or revision. For undated references, the latest edition of the publication applies.


[1] IETF RFC 791 (1981), *Internet Protocol*.

[2] IETF RFC 2460 (1998), *Internet Protocol, Version 6 (IPv6) Specification*.

[3] IETF RFC 2474 (1998), *Definition of the Differentiated Services Field (DS Field) in the IPv4 and IPv6 Headers*.

[4] IETF RFC 768 (1980), *User Datagram Protocol*.

[5] IETF RFC 793 (1981), *Transmission Control Protocol*.

[6] ITU-T Recommendation Y.1540 (2002), *Internet protocol data communication service – IP packet transfer and availability performance parameters*.

[7] ITU-T Recommendation Y.1541 (2002), *Network performance objectives for IP-based services*.

[8] ITU-T Recommendation Y.1291 (2004), *An architectural framework for support of Quality of Service in packet networks*.

[9] ITU-T Recommendation Y.1221 (2002), *Traffic control and congestion control in IP-based networks*.

[10] IETF RFC 3726 (2004), *Requirements for Signalling Protocols*.

[11] IETF RFC 3260 (2002), *New Terminology and Clarifications for Diffserv*.

[12] ITU-T Recommendation G.109 (1999), *Definition of categories of speech transmission quality*.

[13] ITU-T Recommendation G.1010 (2001), *End-user multimedia QoS categories.*

[14] ITU-T Recommendation P.911 (1998), *Subjective audiovisual quality assessment methods for multimedia applications*.

[15] ITU-T Recommendation Q.1224 (1997), *Distributed functional plane for intelligent network Capability Set 2*.


## 4 Definitions

**4.1 BCFE**: The BCFE is an entity that performs the Resource and Admission Control functions related to QoS requests as well as routing functions.

**4.2 IP service endpoint**: A functional entity which includes one type of IP signalling endpoint and the user.

**4.3 IP signalling endpoint**: The termination point of an IP signalling path.

**4.4 IP transport packet size**: Length of the payload of an IP transport protocol contained in an IP packet.

**4.5 network entity**: The network element responsible for terminating the IP signalling protocol.

**4.6 QoS class**: Identifies the category of the information that is received and transmitted in the U-plane.

**4.7** **SeCFE**: The SeCFE (Session Control Functional Entity) is an entity that provides the call/session control function.

**4.8** **SFE**: The SFE (Switching Functional Entity) is an entity that performs stream classification, i.e., QoS guarantee.

**4.9** **SvCFE**: The SvCFE (Service Control Functional Entity) is an entity that provides value-added service functionality.

**4.10** **Terminal Equipment (TE)**: A specific implementation of an IP signalling endpoint.

**4.11** **transport connection**: A bidirectional user plane association between two IP service endpoints at the transport layer.

**4.12** **transport sink address**: Contains the IP address and port number, where the sender expects to receive U-plane information.

**4.13** **unidirectional QoS path**: A unidirectional QoS path is a path along which the user data packets flow in the same direction.

**4.14** **user**: An entity served by the IP signalling protocol.

## 5 Abbreviations

| | |
|---|---|
| BCFE | Bearer Control Functional Entity |
| CC | Connection Control |
| CCI | Connection Control Interface |
| CN | Core Network |
| CPN | Customer Premises Network |
| DiffServ | Differentiated Services |
| FE | Functional Entity |
| GW | Gateway |
| IETF | Internet Engineering Task Force |
| IN | Intelligent Network |
| INI | Inter-Network Interface |
| IP | Internet Protocol |
| IPDV | IP Packet Delay Variation |
| IPLR | IP Packet Loss Ratio |
| IPTD | IP Packet Transfer Delay |
| MCU | Multipoint Control Unit |
| MPLS | Multi-Protocol Label Switching |
| NC | Network Control |
| NCI | Network Control Interface |
| NNI | Network-Network Interface |
| NSIS | Next Step in Signalling |
| QoS | Quality of Service |
| SC | Switch Control |

| | |
|---|---|
| SCI | Switching Control Interface |
| SeCFE | Session Control Functional Entity |
| SFE | Switching Functional Entity |
| SvCFE | Service Control Functional Entity |
| TE | Terminal Equipment |
| UDP | User Datagram Protocol |
| UNI | User-Network Interface |
| VOD | Video On Demand |
| VoIP | Voice over IP |

## 6 Functional model

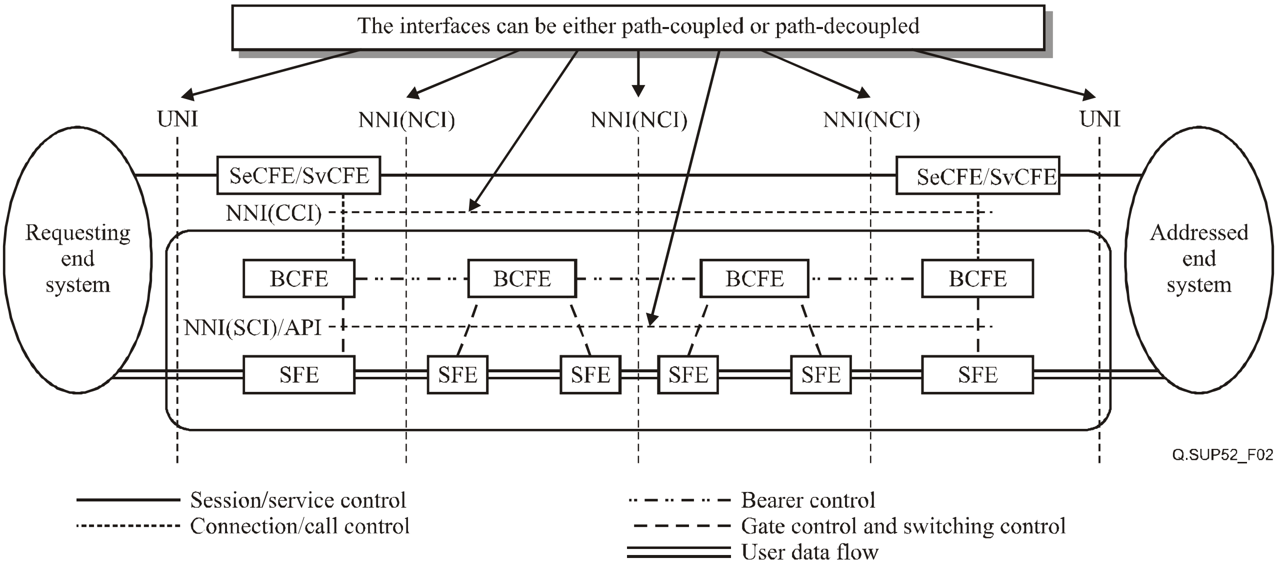



**Figure 2 – The functional model of IP QoS signalling requirements**

See Appendix I for the detail flows of the interfaces, Appendix II for an instance of functional model of IP QoS signalling requirements, and Appendix III for the description of trust relationships among functional entities. Such a description is considered important for deployment in a multi-operator environment.

Figure 2 depicts the functional model consisting of SeCFE, BCFE, SFE, CCIs and SCIs. It also shows an example of a service-dependent system by illustrating a Session Control FE (SeCFE) and its interface to the service-independent network. Other physical systems that can be used to provide services, such as an intelligent peripheral, could conceptually be included but are not illustrated.

The proposed modular IP QoS components and the interfaces that interconnect them relate to the functional model as follows:

a) **SeCFE/SvCFE** – An end user interacts with the SeCFE (Session Control Functional Entity)/SvCFE (Service Control Functional Entity) in order to request some service. The SeCFE/SvCFE initiates a QoS request, usually the SeCFE/SvCFE decides the parameters of a communications arrangement (such as bandwidth, quality of service, etc.). If an acceptable set of parameters can be negotiated, the SeCFE uses the services provided by the

BCFE to establish, maintain and disconnect the network resources necessary to provide the negotiated arrangement.

1) The SeCFE may appear in one of a number of forms, e.g., as a soft switch, an MCU, a VOD control server, etc. The SeCFE operates at the call/session layer, it performs call/session control, extracts QoS requirements for service connection, and initiates QoS requests to the BCFE of the bearer control plane in transport layer.
2) The SvCFE is located within the network domain of the serving node visited by the mobile user. This functional entity provides generic network-based services to all mobile customers. These services have been referred to as default IN services which may be different in each network domain. The SvCFE and the SeCFE associated with the visited serving node are always in the same network domain; therefore, the one-to-one signalling association between these two functional entities is never supported by an inter-domain NNI signalling capability. The network SvCFE performs processing and provides access to data that is specialized for a particular service application. SvCFE extends the generic negotiation and control capabilities provided by SeCFE to support specific end-user services. Within IN terminology, this function is also called the SCF, additional information of which can be found in ITU-T Rec. Q.1224 [15].

b) **BCFE** – BCFEs (Bearer Control Functional Entities) are responsible for establishing, modifying and releasing the network resources necessary to provide the negotiated arrangement. One connection controller interacts with a peer BCFE to establish and disconnect network facilities on a link-by-link basis. BCFE components provide a generic and flexible connection model that encompasses multimedia and multiparty call requirements. BCFEs control SFEs via an SC Interface.

The BCFE receives a QoS request from the SeCFE/SvCFE, based on a service stream. (For the MPLS case, the BCFE performs service routing. For the non-MPLS case, it performs the identification of the logical path.) After path-analysis, like service routing or the logical-path identification, it delivers the path-analysis results to the SFE.

The BCFE needs certain network topology information and resource status information in order to be able to evaluate QoS requests and generate QoS configuration data, depending on the selected QoS control mode. The nature of this information depends on the transport layer technology, the requirements and protocols for such an interface are out of the scope of this Supplement.

c) **SFE** – SFEs (Switching Functional Entities) cross-connect a virtual connection at one port with a virtual connection at another port. Via one or more cross-connects at various SFEs located between users, a virtual connection is created between the users. The characteristics of this virtual connection are based on the call parameters negotiated at the SeCFE/SvCFE level and the route is determined by BCFE level. Based on instructions received over the SCI, the SFE, controlled by the BCFE, creates and destroys cross-connects. (For the MPLS case, it also performs MPLS transfer.)

d) **Connection control interface** – The CCI is the interface between the call/session layer and bearer control plane of transport layer.

e) **Network control interface** – The NCI is the inter-BCFE interfaces for the cases where it is necessary for two BCFEs to communicate directly.

f) **Switching control interface** – The SCI is the interface between the bearer control plane of transport layer and transport plane of transport layer.

The functional elements are structured into 2 layers, namely the call and session layer and the transport layer. The transport layer is further subdivided into the bearer control plane and the transport plane. The bearer control plane is composed of the BCFEs. In particular, it does the resource calculation related to service request. (For the MPLS case, it is also responsible for path selection and resource allocation, which characterize the logical bearer network of this service type.) The transport plane is composed of the SFEs and the media source and sinks.

## 6.1 Path-Coupled

The term "Path-Coupled" refers to the situation in which the signalling forwarding path is the same as the user plane path. Figure 3 shows the various possible control and in-band (i.e., indications in packet headers) mechanisms.

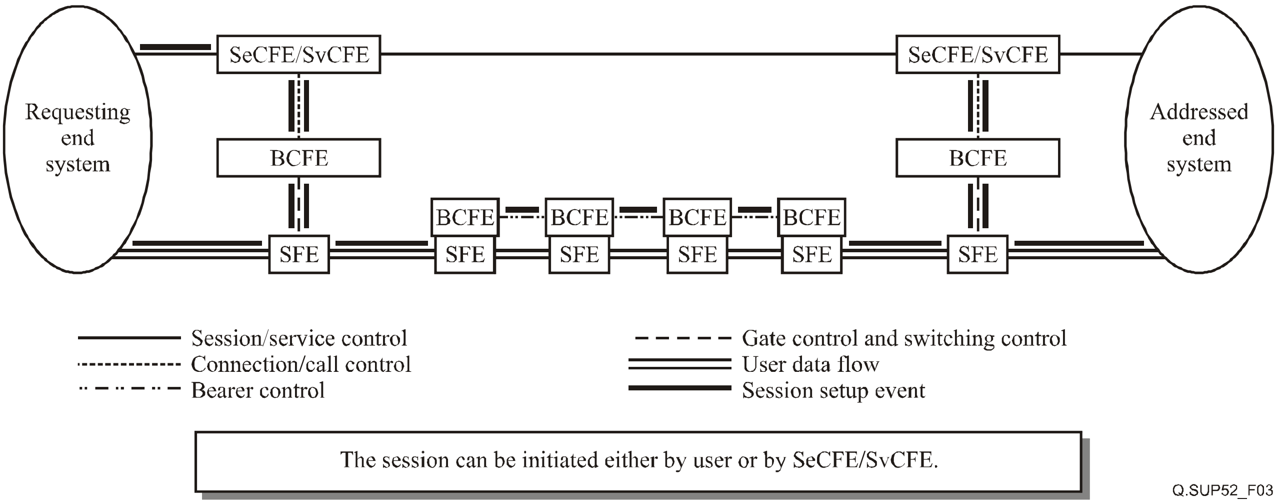



**Figure 3 – Path-coupled QoS control mode**

The call/session control signalling includes an indication of the QoS requirements for each session. The QoS requirements are realized using various mechanisms, e.g., packet fragmentation, over-provisioning, resource reservation (RSVP) or Diffserv. Different QoS mechanisms may be used on different sections of a session packet-forwarding path. There may be communication between call/session control nodes and packet-forwarding devices using a "gate" control protocol to control the QoS mechanism.

QoS signalling requirements are expressed in terms of attributes related to user-network signalling as well as network-network signalling. Major attributes include the following:

– the network QoS class (i.e., Table 1/Y.1541 [7]);
– the network capacity required, at both the application and network (i.e., ITU-T Rec. Y.1221 [9]) levels;
– the reliability/priority with which the service is to be sustained; and
– other elements of QoS.

Note that the complete set of classes for reliability/priority is yet to be defined.

This Supplement recognizes that an automated system for obtaining user-to-user QoS on IP networks, and on combinations of various network technologies, will require standard signalling protocols for communicating the requirements among the major entities. For the purposes of this Supplement, these entities are defined as:

1) Users and their end terminal equipment (TE); and
2) Network service providers/operators and their equipment, especially equipment implementing the interworking and signalling functions between networks, and between users and networks.

## 6.2 Path-decoupled

The term "path-decoupled" indicates that the signalling forwarding path is different from the user plane path.

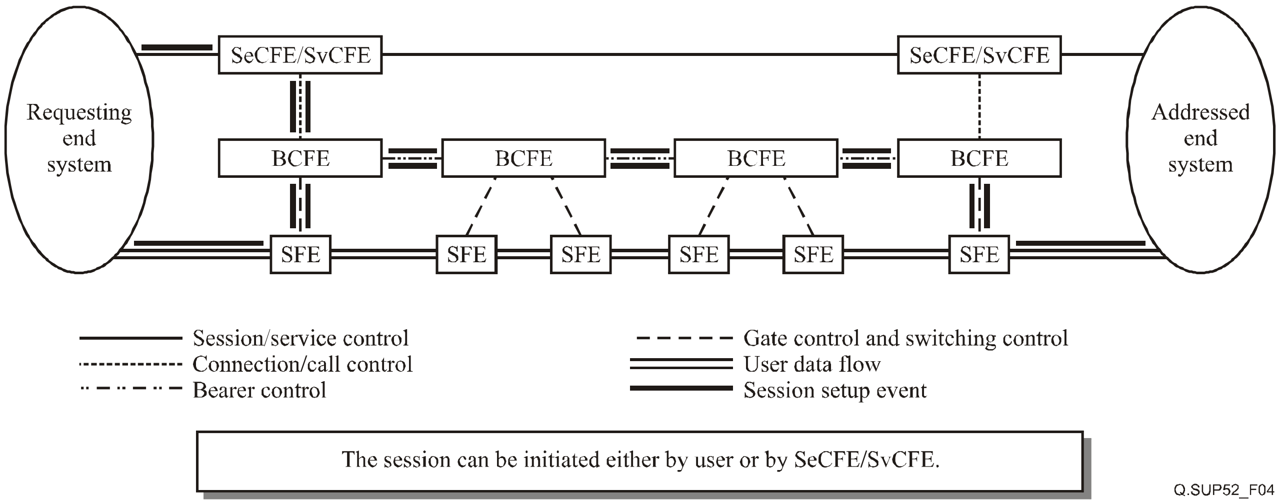



**Figure 4 – Path-decoupled QoS control mode**

Functionally, the framework is divided into the transport plane of transport layer, bearer control plane of transport layer and call/session control layer. The transport plane of transport layer is divided logically into basic transport plane and logical transport plane.

The basic transport plane means the IP network physical entity that is composed of the SFEs, bearing all types of IP service packets, including voice, fax, video, file transmission and web service.

In the case of the transport plane with the MPLS capability (this case is referred to as "the MPLS case" in what follows), the logical transport plane is planned and configured in advance with MPLS LSP technology.

For the transport plane without the MPLS capability (this case is referred to as "the non-MPLS case" in what follows), the logical transport plane means the networks that are planned and configured logically from the information of the routing topology on the transport plane. Each logical transport plane bears a specific service type or specific-QoS-level IP service packets, such as voice service or expedited forwarding service.

The bearer control plane of the transport layer is composed of the bearer control functional entities. It manages the network resources (bandwidth, priority, transfer delay, transfer delay jitter, etc.) of the transport plane, and controls the resource enablement, allocates the resources and routes for the service request of every QoS service stream, to meet the service stream QoS requirement.

The call/session layer is composed of session control functional entities or service control functional entities that handle the service subscriptions. It determines the service stream required QoS and requests the service stream bearer path from the bearer control plane of transport layer. The SeCFEs/SvCFEs include the soft switch that processes real-time communication call signalling such as VoIP and videotelephony, and the VoD server of the requested of video on demand, etc.

For easy management and stable network, the IP basic network needs to be divided into different management areas, which can be consistent with the division of the routing areas. In each management area, one BCFE uniformly manages the network resources, for the resource enablement control, resource allocation and routing in this management area. The resource managers in different management areas, through their signalling interaction, select a QoS-required path for the subscriber service streams across the management areas for the MPLS case.

In Figure 4 the BCFE serves as a physically independent control and management plane. The building blocks interact primarily through signalling at a per-flow level and on the basis of per-logic transport plane resource management. There is a clear signalling interface between control plane and data plane.

## 7 Requirements

Authentication of user and network peers is a prerequisite for QoS signalling. Authentication may be accomplished by static extension of the zone of trust, or through an authentication protocol, which is beyond the scope of these requirements.

### 7.1 User-network signalling

The following requirements apply to QoS signalling between users (or their terminal equipment) and the responsible network entity.

#### 7.1.1 Attributes of a user QoS request

It shall be possible to derive the following service level parameters as part of the process of requesting service:

1) QoS class from ITU-T Rec. Y.1541 [7][1];
2) peak rate (Rp);
3) peak bucket size (Bp);
4) sustainable rate (Rs);
5) sustainable bucket size (Bs);
6) maximum allowed packet size (M);
7) IP DS field as specified in RFC 2474 [3].

It should be possible to derive the following service level parameters as part of the process of requesting service:

1) the reliability/priority with which the service is to be sustained, and
2) other elements of QoS.

Note that the complete set of classes for reliability/priority is to be defined.

Users must be able to initiate requests for service quality with the following main attributes:

– the network QoS class (e.g., Table 1/Y.1541 [7]);
– the network capacity required, at both the application and network (e.g., ITU-T Rec. Y.1221 [9]) levels;
– the reliability/priority with which the service is to be sustained; and
– other elements of QoS.

Note that the complete set of classes for reliability/priority is to be defined.

[1] The values of IP loss ratio, IP transfer delay, and IP delay variation as specified in ITU-T Rec. Y.1221 [9] may be derived by specifying the QoS class from ITU-T Rec. Y.1541 [7] as a signalling parameter.

Optional attributes include the user application type and quality from among several quality categories, when such categories are available. The type of application may be completely specified from the chosen quality category.

Each of these attributes shall be signalled in independent fields in signalling messages.

Terminal Equipment (TE) should compose the detailed request on the user's behalf, possibly based on configurations set by the user or equipment installer. Many TE have the flexibility to match the user's request for application quality with network QoS classes by selecting parameters such as source coder type and packet size.

### 7.1.2 Omitting attributes of a user QoS request

Network QoS class, capacity, and reliability/priority are required attributes; others are optional. The network provider may assign default values for omitted attributes.

For example, speech quality categories have been defined in ITU-T Rec. G.109 [12], but there is no comparable standard range of quality categories for Web browsing, financial transactions, or many other applications of networks (each is associated with a limited quality range in ITU-T Rec. G.1010 [13]). ITU-T Rec. P.911 [14] tabulates quality categories for multimedia communication (also known as video/audio/data conferencing) and television applications. Users may simply wish to make requests for capacity, network QoS class, and reliability.

### 7.1.3 Form of a verifiable user QoS request

The user/TE must make its QoS request in terms the network understands, especially the parameters for network QoS. The network QoS classes and network capacity specifications in the signalling protocol must contain values that are verifiable by users (the classes in ITU-T Rec. Y.1541 [7] meet that requirement). TE may conduct measurements to ensure that the committed performance and capacity levels are achieved by the network(s).

### 7.1.4 Special case of user QoS request to support voiceband channels

When the user/TE request is for a voiceband channel (to support speech or voiceband modems), the QoS request (or other associated message) should contain the preferred voiceband codec and packet size. Other optional parameters may be included to indicate, for example, the use of silence suppression, the need for network echo cancellation, and alternate codecs/packet sizes.

Many of the capacity attributes will be determined by this codec choice. Also, the network operation benefits from knowledge of the codec when the need for voice transcoding can be identified (and possibly avoided). However, much of the negotiation of application parameters takes place beyond the network's purview.

### 7.1.5 Flow control for user QoS requests and re-requests

The TE must wait X seconds before re-submitting a request, and may have a maximum of Y simultaneous requests outstanding. Time-outs for re-submission will increase exponentially. The protocol must be "congestion-aware", using failed requests as implicit indications of congestion or using explicit notification of congestion, if available.

### 7.1.6 Network response to user QoS requests

Network service providers should be able to communicate the following messages and attributes (in the case of user-network interaction):

1) An identification code for the request exchange, to be used in this response and all messages that follow (such as user ACK, or release, and also in network-network messages). When used together with other information, such as Src address, each request can be uniquely referenced.
2) The simple acknowledgement and acceptance of user/TE requests.

3) The performance level expected. The ability to achieve a performance level that is better than an aspect of the QoS class response, if the network operator desires. This indication may be made for a single performance parameter, or for a combination of parameters.

4) The ability to reject a request and, at the same time, to offer a modified service level that can be met. The response may modify the request and may include commitments to an alternate QoS Class, a lower capacity, and other indications such as those in item 3.

The processing of each request and determination of acceptance require considerable work on behalf of the network provider/operator. However, these are simple tasks from the signalling point of view, and the rejections with alternatives are illustrated in Appendix V. Networks may wish to indicate a maximum time interval for which the response is valid.

#### 7.1.7 User answer to network QoS response

The final decision to accept or reject an offered service is left to the user/TE. This completes a request-offer-answer exchange.

### 7.2 QoS signalling at the network-network interface

This clause treats the case where multiple networks cooperate to realize the end-to-end connectivity desired. Beyond the applications considerations mentioned above, network providers/operators primarily deal with network QoS classes, network capacity, and reliability. network-network signalling is the principle way for networks to determine multi-network compliance with QoS classes, since fixed performance allocations are not currently possible on IP networks.

Network-Network signalling shall support the determination of the QoS class offered to the user/TE, by communicating both the network QoS class requested, and the extent to which each specified parameter is already consumed. This implies that each network knows the performance from the entrance node to the (most likely) exit node(s) for the network that has the best opportunity to complete the end-end path. Policies may also determine the next network chosen. The best-next network receives the network-network signalling request.

Networks shall determine if the desired capacity and reliability are available to support the specified network QoS class from entrance to exit node(s).

#### 7.2.1 Attributes of a network QoS request

The attributes of the network's request are:

– the network QoS class (e.g., Table 1/Y.1541 [7]), along with the consumption of individual objectives that are specified by the class;

– the network capacity required, at both the application and network (e.g., ITU-T Rec Y.1221 [9]) levels;

– the interconnecting point(s), where user/TE traffic will leave the requesting network and enter the next network;

– the reliability/priority with which the service is to be sustained; and

– other elements of QoS.

Note that the complete set of classes for reliability/priority is yet to be defined.

Optional attributes include the user application type and the quality category, when such categories are available and meaningful.

Each of these attributes shall be signalled in independent fields in signalling messages.

#### 7.2.2 Omitting attributes of a network QoS request

Network QoS class, capacity, and reliability/priority are required attributes; others are optional.

### 7.2.3 Performance requirements for QoS requests and re-requests

An important aspect of the requirements for a signalling protocol is the performance requirement associated with that protocol. The most important areas where signalling performance requirements need to be established is the average/maximum latency for the establishment of service and the average/maximum latency for the re-establishment of service in the event of a network failure. The latency requirements described above for the signalling protocol depend on the performance characteristics of the underlying transport network. Because of this, performance requirements for the transport network must be specified along with the latency requirements for the signalling protocol. The combination of these factors leads to the following formal performance requirements for the signalling protocol.

1) Networks designed to meet the signalling protocol requirements specified in this clause should be capable of supporting the network performance objectives of QoS class 2 in ITU-T Rec. Y.1541 [7].
2) Signalling protocol endpoints that generate signalling messages should be capable of setting the IP DS field of those messages to a value that is associated with the statistical bandwidth transfer capability defined in ITU-T Rec. Y.1221 [9].
3) The average delay from the time of a UNI or NNI request for service to the acceptance or rejection of this service request by the network should be <800 ms.
4) The maximum delay from the time of a UNI or NNI request for service to the acceptance or rejection of this service request by the network should be <1500 ms.
5) The average delay from the time of a network failure to the time of re-establishment of service at any UNI or NNI interface should be <800 ms. (This does not address restoration of failed links.)
6) The maximum delay from the time of a network failure to the time of re-establishment of service at any UNI or NNI interface should be <1500 ms.

### 7.2.4 Response to a network QoS request

Network providers shall be able to respond with the following messages and attributes (in the case of network-network interaction):

1) The ability to correlate all responses and subsequent requests to the original request is required. An identification code is one example.
2) The simple acknowledgement and acceptance of requests.
3) The ability to indicate a performance level that exceeds an aspect of the request/response is required, but the indication to other entities is a network option.
4) The terminating network supporting the destination UNI shall offer a modified service level if the original service level cannot be met. The modified service may include commitment to an alternate QoS class, a lower capacity, etc.

It is possible that a chain of network-network QoS requests will encounter a network that does not support the QoS signalling protocol or QoS classes in general. If this network is an essential section of the end-to-end path, then several results are possible. One is to reject the request, but at the same time offer an unspecified class (e.g., class 5 of ITU-T Rec. Y.1541 [7]), possibly with the indication of some additional parameter values.

When making entrance-to-exit performance commitments, only one of the interconnecting links will be included for all networks, except the first network which shall include both the link to the UNI and the link to the NNI (subsequent networks will include the exit link to the next interface, either NNI or UNI).

#### 7.2.5 Accumulating performance for additional requests

Signalling must communicate the consumption of the network (source-UNI to destination-UNI) QoS objectives. The fields used in signalling may take two forms, listed below, but the signalling messages must use one form consistently. See Appendix V for examples based on the Y.1541 [7] network QoS classes.

The forwarded request contains only the achieved values and the requested/achieved class number require signalling fields.

Each network communicates its contribution to the achieved performance level. A complete tabulation of the accumulated performance would allow corrective network actions if the requested class were not achieved.

### 7.3 QoS Release

Users and networks shall be able to signal when a previously requested network resource is no longer needed.

### 7.4 Performance

For reasons of signalling performance, the following areas should be addressed:

a) the number of messages required to establish, maintain and clear QoS requests should be kept to a minimum; and

b) the format of the IP signalling protocol information should be chosen to minimize message-processing delays at the endpoints.

### 7.5 Symmetry of information transfer capability

The QoS signalling protocol shall support symmetric QoS requests.

Asymmetric QoS requests are optional. That is, the end-to-end requests may be bidirectional where the information transfer capability in each direction might be different.

### 7.6 Contention resolution

The QoS signalling protocol shall be able to resolve all contentions with respect to resource allocation and collision.

### 7.7 Error reporting

The QoS signalling protocol shall include mechanisms for detecting and reporting signalling procedural errors or other failures detected by the TE/network to IP management. Service failures may also be reported to the user.

### 7.8 Unrecoverable failures

The TE and network entities shall include mechanisms for returning the QoS protocol instance to a stable state after detection of unrecoverable failures.

### 7.9 Forward and backward compatibility

The QoS signalling protocol shall include a forward compatibility mechanism and backward compatibility rules.

### 7.10 Parameters and values for transport connections

The signalling protocol(s) at UNI and NNI interfaces should be capable of specifying the following additional parameters as part of the process of requesting service:

1) IP header fields: source + destination address (RFC 791 [1], RFC 2460 [2]);
2) IP DS field (RFC 2474 [3], RFC 3260 [11]); and
3) Source + destination port as specified in RFC 768 [4] and RFC 793 [5].

### 7.11 User-initiated QoS resource modification

Either user may be able to modify the resources associated with an active transport connection, represented by the information contained in the transport connection messages.

Collision of connection resource modification requests shall be avoided by the served user.

Modification shall be performed with no loss of IP transport contents.

The use of the preferred transport connection messages is to avoid the need for subsequent modification of the connection resources immediately after the establishment.

User/TE (IP endpoints) should determine, through the use of end-end application level capability signalling, the ability and support to use resources beyond those currently in use. The support/lack of support of the capability to modify transport connection messages for a transport connection must be indicated by the originating IP endpoint. The terminating IP endpoint must indicate the support/lack of support of the modification capability of the transport connection messages. Only when both endpoints indicate modification support can modification be attempted.

This capability uses the following objects:

– Transport connection message modification support request,
– Transport connection message modification support response.

### 7.12 Emergency service

Emergency services shall be supported with the highest available quality of service depending on the regulatory environment.

### 7.13 Reliability/priority attributes

Reliability/priority attributes are the same for user-network and network-network signalling requirements. Reliability for a service can be expressed in the form of a priority level with which that service requires a particular type of network function (e.g., connection admission control priority). Hence, reliability can be requested in the form of a priority class for that specific network function. Two types of network functions apply for reliability/priority classes: connection admission control and network restoration.

From the viewpoint of signalling, there should be a limited number of priority classes for all network functions in order to ensure scalability (e.g., 4 classes). The signalling protocol needs to be able to provide the capability to effectively convey these priority requests once priority level attributes are established in standards forums. See Appendix V for more information on these attributes.

## 8 Interfaces description of requirements

### 8.1 Call/connection control interface

See Figure IV.1 for a typical process of QoS signalling in CC interface.

The QoS signalling between the call/session layer and the bearer control plane of transport layer should accomplish the following functions:

1) *Request for resources to support the service*

   Call/session layer initiates a QoS request to the bearer control plane of transport layer, with main parameters as follows:

   – Connection ID: The unique ID for each request.

     It is a requirement to have a "connection ID" to allow the sender and receiver to match a request with following responses, related modifications and cancellations. It is left for protocol design to determine which side generates that connection ID.

   – Stream information: information to identify an IP data stream.

   – QoS parameters: A description of the service quality requirements of a stream.

2) *Modification of resources to support service*

   With respect to some services, it may be necessary to modify the QoS requirements at anytime during the time the service is running. According to call/session layer requirements, bearer control plane of transport layer modifies the bandwidth that was applied for use the previous time. Multi-time modification is supported. Main parameters:

   – Connection ID: The unique ID for each request.

   – Stream information: information to identify an IP data stream.

   – QoS parameters: A description of the service quality requirements of a stream.

3) *Acceptance of resources to support service*

   Upon completing QoS resource allocation, bearer control plane of transport layer responds to the call/session layer by sending elements of success information. Main parameters are:

   – Connection ID.

   – Accepted QoS parameters: Among multi-optional QoS capabilities, the accepted QoS capability is selected.

4) *Rejection of resources to support service*

   In the case that the bearer control plane of transport layer cannot meet the QoS request of the call/session layer, it will send a rejection for resources to support service to the call/session layer. Main parameters:

   – Connection ID.

   – Rejection cause.

5) *Report about resources to support service*

   In the case of any change in the allocated bandwidth information (the resource seized by the connection is no longer available, etc.; for example), the bearer control plane of transport layer should report it to the call/session layer. Main parameters:

   – Connection ID.

   – Current status.

6) *Release of resources to support service*

   When a service is terminated, the call/session layer should initiate a request to bearer control plane of transport layer for releasing the resource that it has been requested to allocate. According to the call/session layer requirement, the bearer control plane of transport layer takes the bandwidth back. Main parameters:

   – Connection ID.

   – Release cause.

7) *Response to release of resources*

The cancellation of resources should be confirmed to the session. Main parameters are:

- Connection ID.
- Execution Results.

## 8.2 Network control interface

See Figure IV.2 for a typical process of the bearer control plane QoS signalling in NC interface.

The QoS signalling in the bearer control plane should accomplish the following functions:

1) *Request for resources to support service*

The current BCFE initiates a QoS request to the next hop BCFE for an interface, with the following main parameters:

- Connection ID: The unique ID for each request.

  It is a requirement to have a "connection ID" to allow the sender and receiver to match a request with following responses, related modifications and cancellations. It is left for protocol design to determine which side generates that connection ID.
- Stream information: information to identify an IP data stream.
- QoS parameters: A description of the service quality requirements of a stream. Many international standards are available for reference in this respect, hence no further description here.
- Path information selected in the local domain and the sequent domain (for the MPLS case): By means of consultation, data stream bearer path LSP sets are distributed between the BCFEs, so conditions of LSP paths selected in the local domain should be provided for each other among BCFEs, so that a peer BCFE can correctly select a transit path LSP. For a bidirectional path, both forward path and backward path are available, such as MPLS label stack.
- Address information of the inter-domain interface: The address of the egress interface in the local domain (for the non-MPLS case).

2) *Modification of resources to support service*

With respect to some services, it may be necessary to modify the QoS requirements at any time during the service running. According to the request by the upstream BCFE, a BCFE modifies the bandwidth that was applied for use the previous time. Multi-time modification is supported. Main parameters are:

- Connection ID: The unique ID for each request.
- Stream information: information to identify an IP data stream.
- QoS parameters: A description of the service quality requirements of a stream. Many international standards are available for reference in this respect, hence no further description here.
- Path information selected in the local domain (for the MPLS case).
- Address information of the inter-domain interface (for the non-MPLS case).

3) *Acceptance of request for resources to support service*

Upon allocating the local domain resources, the BCFE responds by sending elements of success information to the upstream BCFE. Main parameters are:

- Connection ID.
- Accepted QoS parameters: Among multi-optional QoS capabilities, the accepted QoS capability is selected.

- Path information selected in the local domain and the sequent domain (for the MPLS case).
- Address information of the inter-domain interface: The address of the egress interface in the local domain (for the non-MPLS case).

4) *Rejection of request for resources to support service*

   When the BCFE finds out that the QoS request of the upper BCFE cannot be satisfied, it will send a rejection response to the upper BCFE. Main parameters are:
   - Connection ID.
   - Rejection cause.

5) *Report about resources to support service*

   In case of any change in the allocated bandwidth information (the resource seized by the connection is no longer available, etc.; for example), BCFE should report it to the upstream BCFE. Main parameters are:
   - Connection ID.
   - Current status.

6) *Release of resources to support service*

   The upstream BCFE requests the downstream BCFE for releasing the resource that has been requested for allocation. Main parameters are:
   - Connection ID.
   - Release cause.

7) *Response to release for resources*

   The cancellation of resources should be confirmed to the bearer control of the transport layer. Main parameters are:
   - Connection ID.
   - Execution results.

## 8.3 Switch control interface

See Figure IV.3 for a typical process of QoS signalling in SC interface.

Since this interface carries the configuration information related to QoS requests, the parameters of these messages may vary for different network layer technologies.

This interface transports the QoS parameters after being translated into network technology-dependent parameters. There are the following requirements for QoS signalling interface between the bearer control plane of transport layer and the transport plane of transport layer.

1) *QoS configuration information delivery*

   According to the request of the session/call layer, or an adjacent BCFE, the BCFE determines a service route and delivers the final strategy to the corresponding SFE. Main parameters are:
   - Connection ID.
   - Stream information: information to identify an IP data stream.
   - QoS parameters.
   - Other technology-specific information (e.g., selected information of the entire path, and delivered-is-complete path information that has been allocated for the MPLS case).

2) *QoS configuration information modification*

With respect to some services, it may be necessary to modify the QoS requirements at any time during the service running. According to the request by the session/call layer, or an adjacent BCFE, a BCFE modifies the bandwidth that was applied for use the previous time. The BCFE determines a service route, and delivers the modified strategy to the corresponding SFE. BCFE and SFE support multi-time modification. Main parameters are:

– Connection ID.
– Stream information: information to identify an IP data stream;
– QoS parameters.
– Other technology-specific information (e.g., selected information of the entire path, and delivered is complete path information that has been allocated for the MPLS case).

3) *QoS configuration response*

The SFE sets QoS configuration information, and returns a success/failure indication. Main parameters are:

– Connection ID.
– Execution results.

4) *Resource status report*

This message is sent in the event of changes in the SFE resource information (e.g., SFE fault, LSP is not available, etc.); the BCFE will maintain the related bandwidth information. Main parameters are:

– Resource identifier (i.e., the LSP identifier, in the MPLS case).
– Current status.

5) *QoS configuration cancellation*

When a connection is finished, the configuration information delivered on the connection should be cancelled. Main parameters are:

– Connection ID.
– Cause code.

# Appendix I

# IP signalling flows

Note that the section of IP Signalling Flows is in the main body in some other TRQ(s).

***The signalling information flows contained in the appendices represent a non-exhaustive set of alternatives in support of the requirements contained in the main body of this Supplement.***

## I.1 Path-coupled bearer control

The following diagrams illustrate the establishment (successful), connection resource modification (successful) of a QoS path.

### I.1.1 Successful path-coupled transport connection establishment information flows

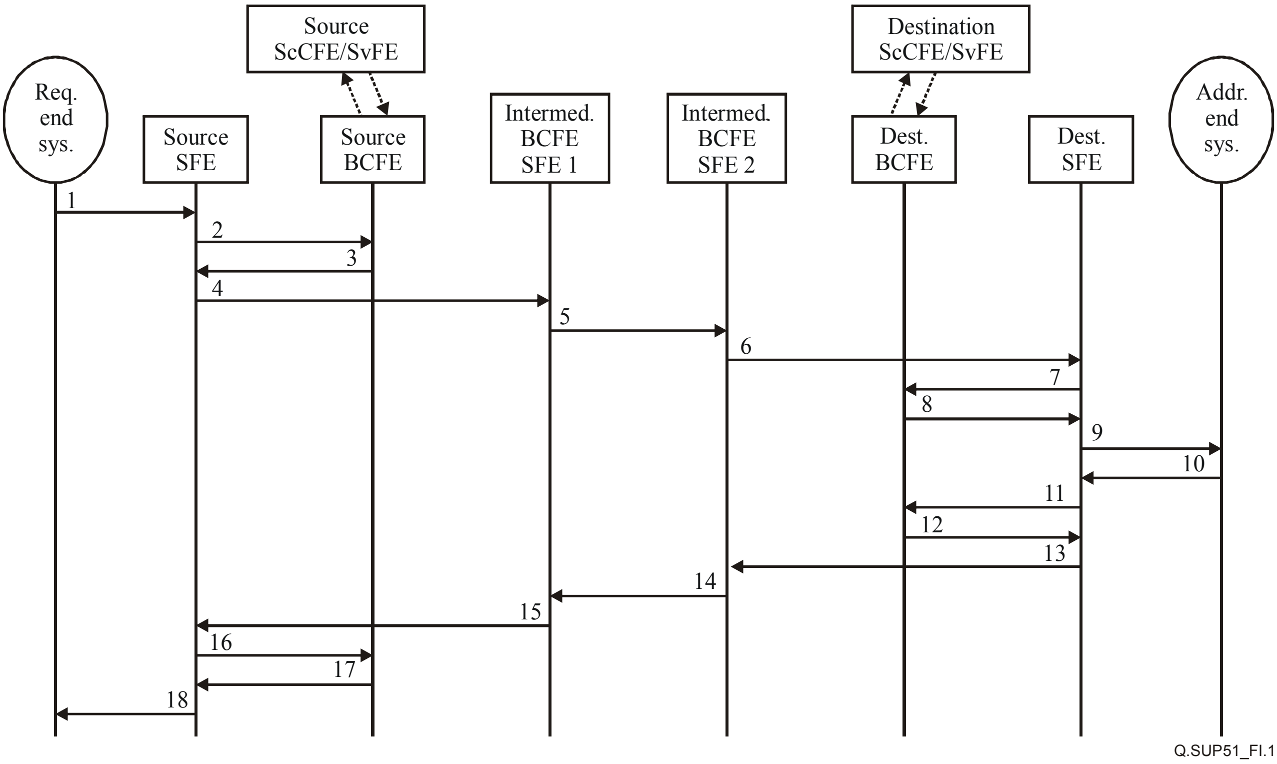



**Figure I.1 – Successful path-coupled transport connection establishment information flows**

Below is the descriptive text associated with the path-coupled information flow illustrated in Figure I.1.

1 IP Setup-Request.ready Originating end system to Source SFE

——————————————————>

| User information | Connection information |
|---|---|
| IP served user-generated reference | Signalling transport connection characteristics |
| Served user transport information | Signalling transport preferred connection characteristics (optional) |
| | Signalling transport connection characteristics modification support request |
| | QoS class |
| | IP transport type |
| | IP sink address of A |
| | Called end point address transport |
| | Priority indicator |

**Initiation of information flow**: The requesting endpoint starts to establish an IP network connection.

**Processing upon receipt**: The addressed endpoint assures that enough resources in the endpoint remain for the new IP network connection. It then issues Information Flow 2 on the next leg.

2 IP Setup-Request.ready Source SFE to source BCFE

——————————————————>

| User information | Connection information |
|---|---|
| IP served user-generated reference | Signalling transport connection characteristics |
| Served user transport information | Signalling transport preferred connection characteristics (optional) |
| | Signalling transport connection characteristics modification support request |
| | QoS class |
| | IP transport type |
| | IP sink address of A |
| | Called end point address transport |
| | Priority indicator |

**Initiation of information flow:**

**Processing upon receipt:**

3 IP Setup-Request.ready Source BCFE to source SFE

<————————————————————

| **User information** | **Connection information** |
|---|---|
| IP served user-generated reference | Signalling transport connection characteristics |
| Served user transport information | Signalling transport preferred connection characteristics (optional) |
| | Signalling transport connection characteristics modification support request |
| | QoS class |
| | IP transport type |
| | IP sink address of A |
| | Called end point address transport |
| | Priority indicator |
| | Path-mode indicator |

**Initiation of information flow:**

**Processing upon receipt:**

4 IP Setup-Request.ready Source SFE to intermediate BCFE/SFE1

————————————————————>

| **User information** | **Connection information** |
|---|---|
| IP served user-generated reference | Signalling transport connection characteristics |
| Served user transport information | Signalling transport preferred connection characteristics (optional) |
| | Signalling transport connection characteristics modification support request |
| | QoS class |
| | IP transport type |
| | IP sink address of A |
| | Called end point address transport |
| | Priority indicator |

**Initiation of information flow:**

**Processing upon receipt:**

5 IP Setup-Request.ready Intermediate BCFE/SFE1 to intermediate BCFE/SFE2

——————————————————>

| User information | Connection information |
|---|---|
| IP served user-generated reference | Signalling transport connection characteristics |
| Served user transport information | Signalling transport preferred connection characteristics (optional) |
| | Signalling transport connection characteristics modification support request |
| | QoS class |
| | IP transport type |
| | IP sink address of A |
| | Called end point address transport |
| | Priority indicator |

**Initiation of information flow:**

**Processing upon receipt:**

6 IP Setup-Request.ready Intermediate BCFE/SFE2 to destination SFE

——————————————————>

| User information | Connection information |
|---|---|
| IP served user-generated reference | Signalling transport connection characteristics |
| Served user transport information | Signalling transport preferred connection characteristics (optional) |
| | Signalling transport connection characteristics modification support request |
| | QoS class |
| | IP transport type |
| | IP sink address of A |
| | Called end point address transport |
| | Priority indicator |

**Initiation of information flow:**

**Processing upon receipt:**

7 IP Setup-Request.ready Destination SFE to destination BCFE

<——————————————————

| User information | Connection information |
|---|---|
| IP served user-generated reference | Signalling transport connection characteristics |
| Served user transport information | Signalling transport preferred connection characteristics (optional) |
| | Signalling transport connection characteristics modification support request |
| | QoS class |
| | IP transport type |
| | IP sink address of A |
| | Called end point address transport |
| | Priority indicator |

**Initiation of information flow:**

**Processing upon receipt:**

8 IP Setup-Request.ready Destination BCFE to destination SFE

——————————————————>

| User information | Connection information |
|---|---|
| IP served user-generated reference | Signalling transport connection characteristics |
| Served user transport information | Signalling transport preferred connection characteristics (optional) |
| | Signalling transport connection characteristics modification support request |
| | QoS class |
| | IP transport type |
| | IP sink address of A |
| | Called end point address transport |
| | Priority indicator |
| | Path-mode indicator |

**Initiation of information flow:**

**Processing upon receipt:**

9 IP Setup-Request.ready Destination SFE to destination end system

————————————————————>

| User information | Connection information |
|---|---|
| IP served user-generated reference | Signalling transport connection characteristics |
| Served user transport information | Signalling transport preferred connection characteristics (optional) |
| | Signalling transport connection characteristics modification support request |
| | QoS class |
| | IP transport type |
| | IP sink address of A |
| | Called end point address transport |
| | Priority indicator |

**Initiation of information flow:**

**Processing upon receipt:**

10 IP Setup-Request.commit Destination end system to destination SFE

<————————————————————

| User information | Connection information |
|---|---|
| (none) | Signalling transport connection characteristics modification support response |
| | IP sink address of A |
| | IP sink address of B |

**Processing upon receipt:**

11 IP Setup-Request.commit Destination SFE to destination BCFE

<————————————————————

| User information | Connection information |
|---|---|
| (none) | Signalling transport connection characteristics modification support response |
| | IP sink address of A |
| | IP sink address of B |

**Processing upon receipt:**

12 IP Setup-Request.commit Destination BCFE to destination SFE

————————————————————>

| User information | Connection information |
|---|---|
| (none) | Signalling transport connection characteristics modification support response |
| | IP sink address of A |
| | IP sink address of B |

**Processing upon receipt:**

13 IP Setup-Request.commit Destination SFE to intermediate BCFE/SFE2

<——————————————————

| **User information** | **Connection information** |
|---|---|
| (none) | Signalling transport connection characteristics modification support response<br>IP sink address of A<br>IP sink address of B |

**Processing upon receipt:**

14 IP Setup-Request.commit Intermediate BCFE/SFE2 to intermediate BCFE/SFE1

<——————————————————

| **User information** | **Connection information** |
|---|---|
| (none) | Signalling transport connection characteristics modification support response<br>IP sink address of A<br>IP sink address of B |

**Processing upon receipt:**

15 IP Setup-Request.commit Intermediate BCFE/SFE1 to source SFE

<——————————————————

| **User information** | **Connection information** |
|---|---|
| (none) | Signalling transport connection characteristics modification support response<br>IP sink address of A<br>IP sink address of B |

16 IP Setup-Request.commit Source SFE to source BCFE

——————————————————>

| **User information** | **Connection information** |
|---|---|
| (none) | Signalling transport connection characteristics modification support response<br>IP sink address of A<br>IP sink address of B |

17 IP Setup-Request.commit Source BCFE to source SFE

<——————————————————

| **User information** | **Connection information** |
|---|---|
| (none) | Signalling transport connection characteristics modification support response<br>IP sink address of A<br>IP sink address of B |

18 IP Setup-Request.commit Source SFE to originating end system

<——————————————————

| User information | Connection information |
|---|---|
| (none) | Signalling transport connection Characteristics modification support response<br>IP sink address of A<br>IP sink address of B |

**Processing upon receipt**: The requesting endpoint informs the IP served user about the completion of the requested IP network connection establishment.

### I.1.2 Successful path-coupled, with QoS request modification transport connection establishment information flows

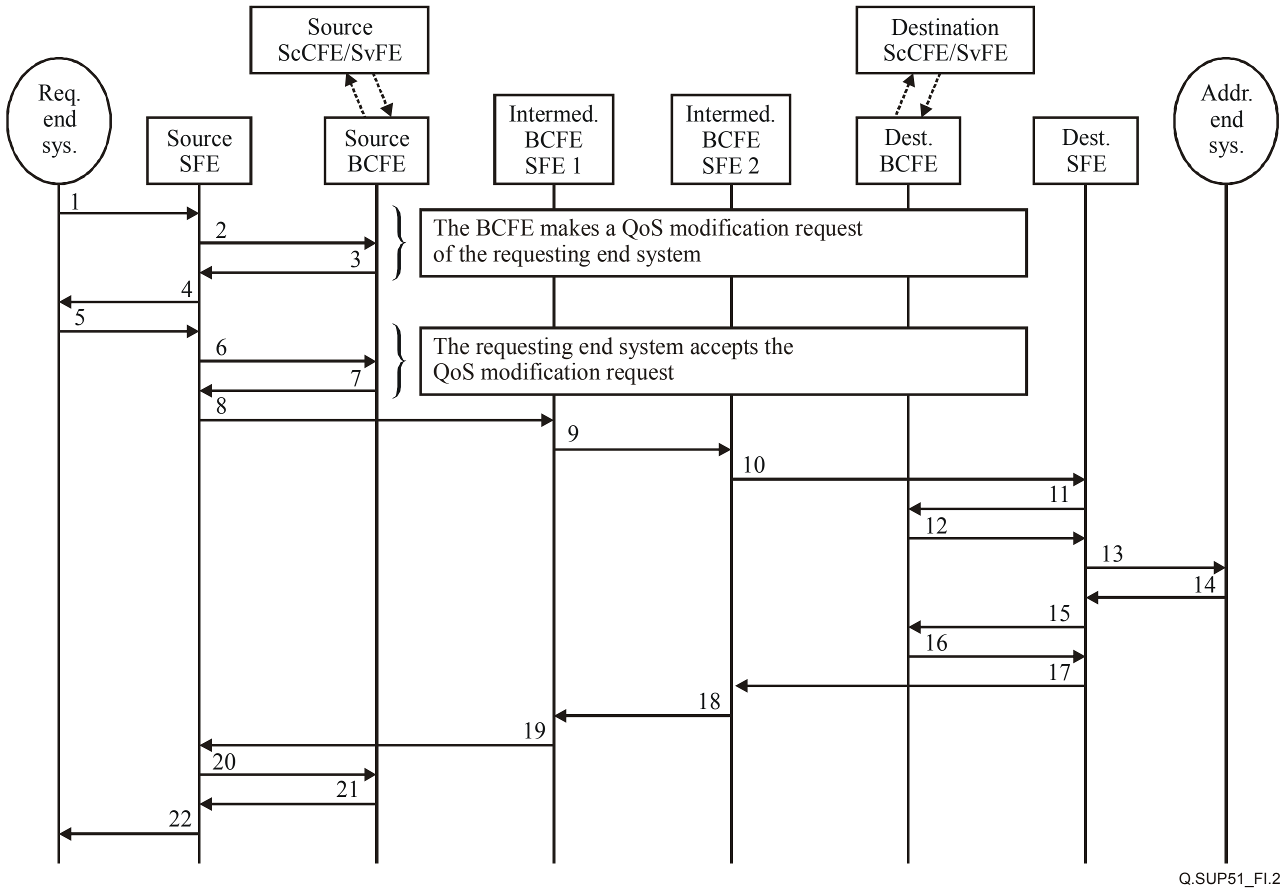



**Figure I.2 – Successful path-coupled, with QoS request modification transport connection establishment information flows**

Below is the descriptive text associated with the path-coupled, with QoS request modification information flow illustrated in Figure I.2.

1 IP Setup-Request.ready Originating end system to source SFE

——————————————————>

| User information | Connection information |
|---|---|
| IP served user-generated reference | Signalling transport connection characteristics |
| Served user transport information | Signalling transport preferred connection characteristics (optional) |
| | Signalling transport connection characteristics modification support request |
| | QoS class |
| | IP transport type |
| | IP sink address of A |
| | Called end point address transport |
| | Priority indicator |

**Initiation of information flow**: The requesting endpoint starts to establish an IP network connection.

**Processing upon receipt**: The addressed endpoint assures that enough resources in the endpoint remain for the new IP network connection. It then issues Information Flow 2 on the next leg.

2 IP Setup-Request.ready Source SFE to source BCFE

——————————————————>

| User information | Connection information |
|---|---|
| IP served user-generated reference | Signalling transport connection characteristics |
| Served user transport information | Signalling transport preferred connection characteristics (optional) |
| | Signalling transport connection characteristics modification support request |
| | QoS class |
| | IP transport type |
| | IP sink address of A |
| | Called end point address transport |
| | Priority indicator |

**Initiation of information flow:**

**Processing upon receipt:**

3 IP Modify-request Source BCFE to source SFE

<——————————————————

| User information | Connection information |
|---|---|
| IP served user-generated reference | QoS modification request |
| Served user transport information | |

**Initiation of information flow:**

**Processing upon receipt:**

4 IP Modify-request Source SFE to originating end system

<————————————————————

| User information | Connection information |
|---|---|
| IP served user-generated reference | QoS modification request |
| Served user transport information | |

**Initiation of information flow:**

**Processing upon receipt:**

5 IP Accept-MODrequest Originating end system to source SFE

————————————————————>

| User information | Connection information |
|---|---|
| IP served user-generated reference | Signalling transport connection characteristics |
| Served user transport information | Signalling transport preferred connection characteristics (optional) |
| | Signalling transport connection characteristics modification support request |
| | QoS class |
| | IP transport type |
| | IP sink address of A |
| | Called end point address transport |
| | Priority indicator |

**Initiation of information flow:**

**Processing upon receipt:**

6 IP Accept-MODrequest Source SFE to source BCFE

————————————————————>

| User information | Connection information |
|---|---|
| IP served user-generated reference | Signalling transport connection characteristics |
| Served user transport information | Signalling transport preferred connection characteristics (optional) |
| | Signalling transport connection characteristics modification support request |
| | QoS class |
| | IP transport type |
| | IP sink address of A |
| | Called end point address transport |
| | Priority indicator |

**Initiation of information flow:**

**Processing upon receipt:**

7 IP Setup-Request.ready Source BCFE to source SFE

<——————————————————

| User information | Connection information |
|---|---|
| IP served user-generated reference | Signalling transport connection characteristics |
| Served user transport information | Signalling transport preferred connection characteristics (optional) |
| | Signalling transport connection characteristics modification support request |
| | QoS class |
| | IP transport type |
| | IP sink address of A |
| | Called end point address transport |
| | Priority indicator |
| | Path-mode indicator |

**Initiation of information flow:**

**Processing upon receipt:**

8 IP Setup-Request.ready Source SFE to intermediate BCFE/SFE1

——————————————————>

| User information | Connection information |
|---|---|
| IP served user-generated reference | Signalling transport connection characteristics |
| Served user transport information | Signalling transport preferred connection characteristics (optional) |
| | Signalling transport connection characteristics modification support request |
| | QoS class |
| | IP transport type |
| | IP sink address of A |
| | Called end point address transport |
| | Priority indicator |

**Initiation of information flow:**

**Processing upon receipt:**

9 IP Setup-Request.ready Intermediate BCFE/SFE1 to intermediate BCFE/SFE2

——————————————————————>

| User information | Connection information |
|---|---|
| IP served user-generated reference | Signalling transport connection characteristics |
| Served user transport information | Signalling transport preferred connection characteristics (optional) |
| | Signalling transport connection characteristics modification support request |
| | QoS class |
| | IP transport type |
| | IP sink address of A |
| | Called end point address transport |
| | Priority indicator |

**Initiation of information flow:**

**Processing upon receipt:**

10 IP Setup-Request.ready Intermediate BCFE/SFE2 to destination SFE

——————————————————————>

| User information | Connection information |
|---|---|
| IP served user-generated reference | Signalling transport connection characteristics |
| Served user transport information | Signalling transport Preferred connection characteristics (optional) |
| | Signalling transport connection characteristics modification support request |
| | QoS class |
| | IP transport type |
| | IP sink address of A |
| | Called end point address transport |
| | Priority indicator |

**Initiation of information flow:**

**Processing upon receipt:**

11 IP Setup-Request.ready Destination SFE to destination BCFE

<————————————————————

| User information | Connection information |
|---|---|
| IP served user-generated reference | Signalling transport connection characteristics |
| Served user transport information | Signalling transport preferred connection characteristics (optional) |
| | Signalling transport connection characteristics modification support request |
| | QoS class |
| | IP transport type |
| | IP sink address of A |
| | Called end point address transport |
| | Priority indicator |

**Initiation of information flow:**

**Processing upon receipt:**

12 IP Setup-Request.ready Destination BCFE to destination SFE

————————————————————>

| User information | Connection information |
|---|---|
| IP served user-generated reference | Signalling transport connection characteristics |
| Served user transport information | Signalling transport preferred connection characteristics (optional) |
| | Signalling transport connection characteristics modification support request |
| | QoS class |
| | IP transport type |
| | IP sink address of A |
| | Called end point address transport |
| | Priority indicator |
| | Path-mode indicator |

**Initiation of information flow:**

**Processing upon receipt:**

13 IP Setup-Request.ready Destination SFE to destination end system

——————————————————>

| **User information** | **Connection information** |
|---|---|
| IP served user-generated reference | Signalling transport connection characteristics |
| Served user transport information | Signalling transport preferred connection characteristics (optional) |
| | Signalling transport connection characteristics modification support request |
| | QoS class |
| | IP transport type |
| | IP sink address of A |
| | Called end point address transport |
| | Priority indicator |

**Initiation of information flow:**

**Processing upon receipt:**

14 IP Setup-Request.commit Destination end system to destination SFE

<——————————————————

| **User information** | **Connection information** |
|---|---|
| (none) | Signalling transport connection characteristics modification support response |
| | IP sink address of A |
| | IP sink address of B |

**Processing upon receipt:**

15 IP Setup-Request.commit Destination SFE to destination BCFE

<——————————————————

| **User information** | **Connection information** |
|---|---|
| (none) | Signalling transport connection characteristics modification support response |
| | IP sink address of A |
| | IP sink address of B |

**Processing upon receipt:**

16 IP Setup-Request.commit Destination BCFE to destination SFE

——————————————————>

| **User information** | **Connection information** |
|---|---|
| (none) | Signalling transport connection characteristics modification support response |
| | IP sink address of A |
| | IP sink address of B |

**Processing upon receipt:**

17 IP Setup-Request.commit Destination SFE to intermediate BCFE/SFE2

<————————————————————

**User information** **Connection information**

(none)

Signalling transport connection characteristics modification support response

IP sink address of A

IP sink address of B

**Processing upon receipt:**

18 IP Setup-Request.commit Intermediate BCFE/SFE2 to intermediate BCFE/SFE1

<————————————————————

**User information** **Connection information**

(none)

Signalling transport connection characteristics modification support response

IP sink address of A

IP sink address of B

**Processing upon receipt:**

19 IP Setup-Request.commit Intermediate BCFE/SFE1 to source SFE

<————————————————————

**User information** **Connection information**

(none)

Signalling transport connection characteristics modification support response

IP sink address of A

IP sink address of B

20 IP Setup-Request.commit Source SFE to source BCFE

————————————————————>

**User information** **Connection information**

(none)

Signalling transport connection characteristics modification support response

IP sink address of A

IP sink address of B

21 IP Setup-Request.commit Source BCFE to source SFE

<————————————————————

**User information** **Connection information**

(none)

Signalling transport connection characteristics modification support response

IP sink address of A

IP sink address of B

22 IP Setup-Request.commit Source SFE to originating end system

<———————————————————

| User information | Connection information |
|---|---|
| (none) | Signalling transport connection characteristics modification support response<br>IP sink address of A<br>IP sink address of B |

**Processing upon receipt**: The requesting endpoint informs the IP served user about the completion of the requested IP network connection establishment

## I.2 Path-decoupled bearer control

Within the signalling flows, the following functional entities have certain roles. They are described below.

| | |
|---|---|
| Destination BCFE | The destination BCFE receives a QoS request based on a service stream, sent by the previous hop BCFE. When it finds out that the destination IP of the service stream belongs to the BCFE domain that is under its administration, if the request is a bidirectional one, the destination BCFE will deliver the routing result of the QoS path from the destination to the source directly to the edge router, and return the response message of the QoS path from the source to the destination to the previous hop BCFE. |
| Destination SFE | The destination SFE is an SFE to which a certain service stream destination belongs. The destination SFE transmits a data packet directly to a user or transfers it to another domain. |
| Initiator BCFE | The Initiator BCFE receives a QoS request based on a service stream, sent by the SeCFE or SvCFE. For the MPLS case it performs service routing, while for the non-MPLS case it performs the identification of the logical path. |
| Intermediate BCFE | The intermediate BCFE receives a QoS request based on a service stream, sent by the previous hop BCFE, queries the BCFE route table, and provides distribution of resources in the local domain. |
| Source BCFE | The source BCFE receives a QoS request based on a service stream, sent by the SeCFE or SvCFE or the previous hop source-seeking BCFE. |
| Source-seeking BCFE | The source-seeking BCFE receives a QoS request based on a service stream, sent by the previous hop BCFE, and queries the "Source BCFE" route to find out the next hop BCFE, to which it will transfer the request. The difference between the source-seeking BCFE and the intermediate BCFE is that the former transfers a request for resources according to the source address home of the service stream. |

| | |
|---|---|
| Source SFE | The source SFE is an SFE to which a certain service stream belongs. It performs stream classification. It may implement a session admission control strategy according to QoS commands. |

With respect to some requests, it is necessary to allocate QoS paths from the caller parties to the called parties, and vice versa. In order to accelerate the QoS signalling process, the signalling process for paths in two directions to be allocated for one request may be provided.

### I.2.1 BCFE source addressing information flows

In order to hide the network topology of the bearer control layer to the service control layer, the SeCFE/SvCFE does not need to know where the source BCFE for each call is specifically located. The SeCFE/SvCFE only needs to initiate a request to any BCFE and the request will be transferred to the source BCFE via the source-seeking BCFE process, so that a normal process of the request for resources can be started.

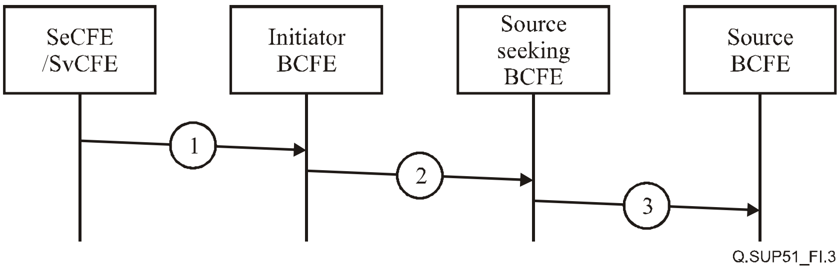



**Figure I.3 – BCFE source addressing information flows**

The flows illustrated in Figure I.3 are as follows:

1 IP Setup-Request.ready SeCFE/SvCFE to initiator BCFE

——————————————————>

| User information | Connection information |
|---|---|
| IP flows description information | Connection ID |
| Service type (optional) | QoS parameter |

**Processing upon receipt**: It performs the seeking of the real source BCFE. The initiator BCFE checks whether the source address of flow information in the QoS request belongs to the management of the Administrant Domain which the initiator BCFE takes charge of. When it finds that the source address of flow information in the QoS request does not belong to its Administrant Domain, it issues Information Flow 2.

2 IP Setup-Request.ready Initiator BCFE to source-seeking BCFE

——————————————————>

| User information | Connection information |
|---|---|
| IP flows description information | Connection ID |
| Service type (optional) | QoS parameter |

**Processing upon receipt**: The source-seeking BCFE checks whether the source address of flow information in the QoS request belongs to the management of the Administrant Domain which the source-seeking BCFE takes charge of. When it finds that the source address of flow information in the QoS request does not belong to its Administrant Domain, it acts as a source-seeking BCFE. The source-seeking BCFE queries the "Source BCFE" route to find out the next hop BCFE, to which it will transfer the request. Then it issues Information Flow 3.

3 IP Setup-Request.ready Source-seeking BCFE to source BCFE

——————————————————>

| User information | Connection information |
|---|---|
| IP flows description information | Connection ID |
| Service type (optional) | QoS parameter |

**Processing upon receipt**: The BCFE checks whether the source address of flow information in the QoS request belongs to the management of the Administrant Domain which the BCFE takes charge of. When it finds that the source address of flow information in the QoS request belongs to its Administrant Domain, the process of addressing source BCFE is completed and this BCFE acts as a source BCFE.

### I.2.2 Unidirectional QoS path establishment information flows

There are two approaches in the QoS path establishment procedures. The difference is the existence of the provisional response from BCFE to SeCFE/SvCFE, by which the BCFE notifies to SeCFE/SvCFE that the resource allocation is successful, just before confirming the local policies to the corresponding SFE. When the SeCFE/SvCFE receives the provisional response, it changes the state of the service control from "waiting for the successful completion of resource allocation" to the next state by issuing the awaited service control messages. This approach can be applied when the resource management is integrated with service control in which the completion of the resource allocation is required before the progress and completion of the session establishment. Some VoIP services may require the completion of resource allocation before the called party's state transition into the alerting.

In Figure I.4, the scenario where the resource request is processed without the provisional response is called "1-phase case". If the request is processed with this response it is called "2-phase case".

NOTE 1 – The flows drawn in dashed lines are used only in the 2-phase case.

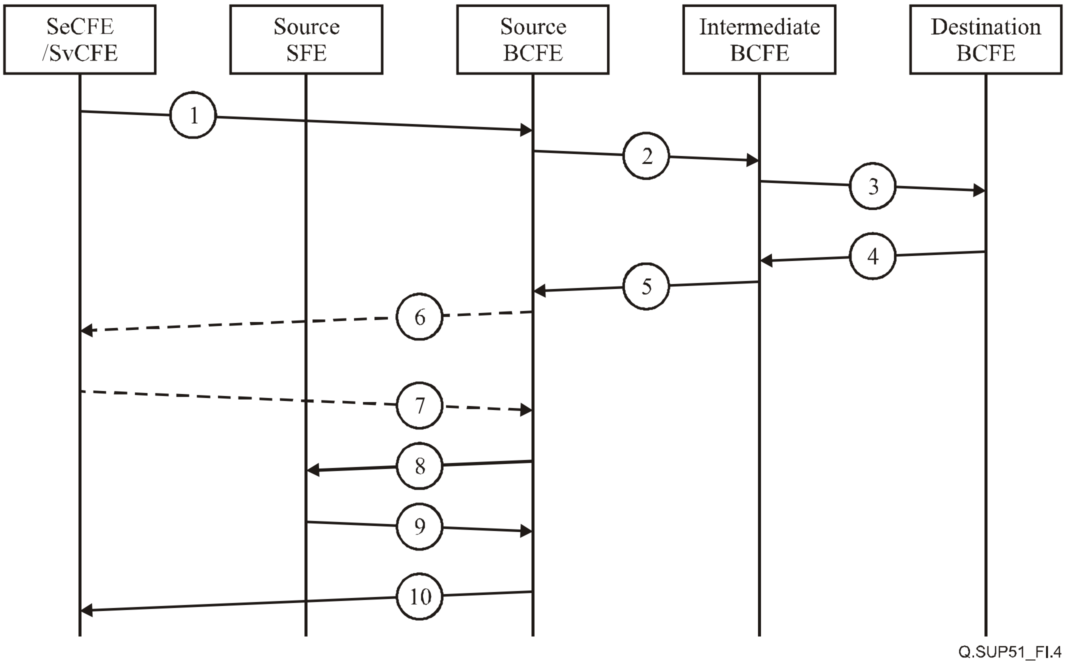



**Figure I.4 – Forward unidirectional QoS path establishment information flows**

The flows illustrated in Figure I.4 are as follows:

1 IP Setup-Request.ready SeCFE/SvCFE to source BCFE

——————————————————>

| User information | Connection information |
|---|---|
| IP flows description information | Connection ID |
| Service type (optional) | QoS parameter |

**Initiation of information flow**: When the SeCFE/SvCFE receives the request to establish an IP connection and finds a set of information required for the resource request (e.g., IP flows descriptions information, Service type (optional), Connection ID, and QoS parameter), the SeCFE/SvCFE issues the Information Flow 1 as a resource request.

**Processing upon receipt**: The source BCFE (also an initiator BCFE) allocates the path resources of the local domain. It then issues Information Flow 2.

2 IP Setup-Request.ready Source BCFE to intermediate BCFE

——————————————————>

| User information | Connection information |
|---|---|
| IP flows description information | Connection ID |
| Service type (optional) | QoS parameter |
| | Policy-based routing information selected in the local domain and the sequent domain (for the MPLS case) |
| | Address information of the inter-domain interface (for the non-MPLS case) |

**Processing upon receipt**: The intermediate BCFE allocates the intermediate path resources. It then issues Information Flow 3.

3 IP Setup-Request.ready Intermediate BCFE to destination BCFE

——————————————————>

| User information | Connection information |
|---|---|
| IP flows description information | Connection ID |
| Service type (optional) | QoS parameter |
| | Policy-based routing information selected in the local domain and the sequent domain (for the MPLS case) |
| | Address information of the inter-domain interface (for the non-MPLS case) |

**Processing upon receipt**: The result of the destination BCFE route decides the final path resource. The destination BCFE responds to the intermediate BCFE. It then issues Information Flow 4.

4 IP Setup-Request.commit Destination BCFE to intermediate BCFE

<——————————————————

| User information | Connection information |
|---|---|
| IP flows description information | Connection ID |
| Service type (optional) | Accepted QoS parameter |
| | Policy-based routing information selected in the local domain and the sequent domain (for the MPLS case) |
| | Address information of the inter-domain interface (for the non-MPLS case) |

**Processing upon receipt**: The intermediate BCFE responds to the source BCFE. It then issues Information Flow 5.

5 IP Setup-Request.commit Intermediate BCFE to source BCFE

<——————————————————

| User information | Connection information |
|---|---|
| IP flows description information | Connection ID |
| Service type (optional) | Accepted QoS parameter |
| | Policy-based routing information selected in the local domain and the sequent domain (for the MPLS case) |
| | Address information of the inter-domain interface (for the non-MPLS case) |

**Processing upon receipt**: It then issues Information Flow 6.

6 IP Setup-Request.commit Source BCFE to SeCFE/SvCFE (Optional)

<——————————————————

| User information | Connection information |
|---|---|
| IP flows description information | Connection ID |
| | Accepted QoS parameters |

**Processing upon receipt**: The SeCFE/SvCFE then informs the results of the resource allocation to its peer entity which performs the session control signalling. Upon receiving the request to cut through the IP connection with the allocated resources from the entity of session control signalling, the SeCFE/SvCFE then issues Information Flow 7 to the source BCFE.

7 IP Setup-Request.commit SeCFE/SvCFE to source BCFE (Optional)

———————————————————>

| User information | Connection information |
|---|---|
| | Connection ID |

**Processing upon receipt**: The source BCFE then issues Information Flow 8 to the source SFE. Until this time, based on the results of a piece of complete path resource information, the source BCFE forms a piece of stream QoS configuration information to deliver a piece of configuration information to the source SFE.

8 IP Setup-Request.commit Source BCFE to source SFE

<———————————————————

| User information | Connection information |
|---|---|
| IP flows description information | Connection ID |
| Service type (optional) | Accepted QoS parameter |
| | Selected information of the entire path and complete policy-based routing information that has been allocated (for the MPLS case). |

**Processing upon receipt**: The source SFE installs the configuration information to control the data stream transfer. It then issues Information Flow 9.

9 IP Setup-Request.commit Source SFE to source BCFE

———————————————————>

| User information | Connection information |
|---|---|
| (None) | Connection ID |
| | Execution results |

**Processing upon receipt**: It then issues Information Flow 10.

10 IP Setup-Request.commit Source BCFE to SeCFE/SvCFE

<———————————————————

| User information | Connection information |
|---|---|
| IP flows description information | Connection ID |
| | Accepted QoS parameters |

**Processing upon receipt**: The SeCFE/SvCFE informs the results of the cut-through to the entity which performs the session control signalling between the requesting QoS TE and the addressed QoS TE.

NOTE 2 – With regard to the interworking between the resource control flows applied to the CC interface and the session control flows applied among the requesting QoS TE, SeCFE/SvCFE, and the addressed QoS TE, it depends on the procedural requirement for the service signalling, e.g., the negotiation of QoS requirements among the requesting/addressed QoS TE and the SeCFE/SvCFE.

### I.2.3 Bidirectional QoS path establishment information flows

There are two methods to establish bidirectional QoS path-supporting symmetric QoS requests, one is to allocate the path of the two directions at one time, which can be applied in the case where the transport plane has a capability to perform the explicit routing for reducing the time of the signalling procedures (see I.2.3.1); the other is to use two unidirectional information flows (see I.2.3.2).

The differences between unified-allocated forward-and-backward-resource information flows and separately-allocated forward-and-backward-resource information flows are:

– Path information of two directions should be needed for the source BCFE and intermediate BCFE to initiate a resource request. For a bidirectional path with unified-allocated forward-and-backward-resource information flows, both forward and backward paths are needed.

– Path information of two directions should also be needed for the destination BCFE and intermediate BCFE to initiate a resource response.

– The destination BCFE needs to deliver a piece of QoS configuration information from the called to the caller to the destination SFE.

#### I.2.3.1 Unified-allocated forward-and-backward-resource information flows

NOTE 1 – The flows drawn in dashed lines in Figure I.5 are used only in the 2-phase case.

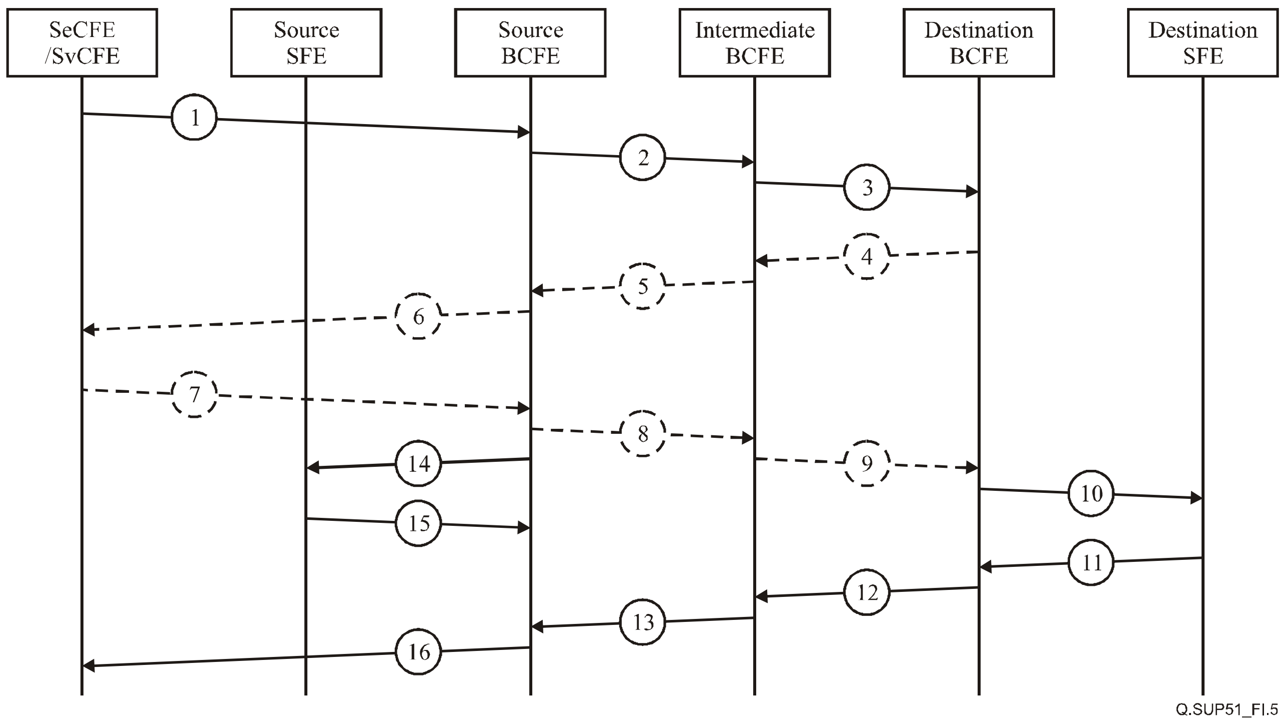



**Figure I.5 – Bidirectional QoS path establishment information flows with unified-allocated signalling path**

There are two separate subgroups of signalling flows: in the 2-phase case, group A consists of the messages (8, 9, 10, 11, 12, 13), where 8 is the first flow of group A; in the 1-phase case, group A consists of the messages (2, 3, 10, 11, 12, 13), where 2 is the first flow of group A. Group B consists of the messages (14, 15), where 14 is the first flow of group B. Only after the last messages of both groups (i.e., 13 and 15) reach the source BCFE, message 16 can be submitted.

The flows illustrated in Figure I.5 are as follows:

1 IP Setup-Request.ready SeCFE/SvCFE to source BCFE

——————————————————>

| User information | Connection information |
|---|---|
| IP flows description information | Connection ID |
| Service type (optional) | QoS parameter |

**Processing upon receipt**: The source BCFE allocates the path resources of the local domain. It then issues Information Flow 2.

2 IP Setup-Request.ready Source BCFE to intermediate BCFE

——————————————————>

| User information | Connection information |
|---|---|
| IP flows description information | Connection ID |
| Service type (optional) | QoS parameter |
| | Policy-based routing information selected in the local domain and the sequent domain (for the MPLS case) |
| | Address information of the inter-domain interface (for the non-MPLS case) |

**Processing upon receipt**: The intermediate BCFE allocates the intermediate path resources. It then issues Information Flow 3.

3 IP Setup-Request.ready Intermediate BCFE to destination BCFE

——————————————————>

| User information | Connection information |
|---|---|
| IP flows description information | Connection ID |
| Service type (optional) | QoS parameter |
| | Policy-based routing information selected in the local domain and the sequent domain (for the MPLS case) |
| | Address information of the inter-domain interface (for the non-MPLS case) |

**Processing upon receipt**: The result of the destination BCFE route decides the final path resource. The BCFE responds to the intermediate BCFE. It then issues Information Flow 4.

4 IP Setup-Request.commit Destination BCFE to intermediate BCFE (only in 2-phase case)

<——————————————————

| User information | Connection information |
|---|---|
| IP flows description information | Connection ID |
| Service type (optional) | Accepted QoS parameter |
| | Policy-based routing information selected in the local domain and the sequent domain (for the MPLS case) |
| | Address information of the inter-domain interface (for the non-MPLS case) |

**Processing upon receipt**: The intermediate BCFE responds to the source BCFE. It then issues Information Flow 5.

5 IP Setup-Request.commit Intermediate BCFE to source BCFE (only in 2-phase case)

<——————————————————

| User information | Connection information |
|---|---|
| IP flows description information | Connection ID |
| Service type (optional) | Accepted QoS parameter |
| | Policy-based routing information selected in the local domain and the sequent domain (for the MPLS case) |
| | Address information of the inter-domain interface (for the non-MPLS case) |

**Processing upon receipt**: The source BCFE issues Information Flow 6.

6 IP Setup-Request.commit Source BCFE to SeCFE/SvCFE (only in 2-phase case)

<——————————————————

| User information | Connection information |
|---|---|
| IP flows description information | Connection ID |
| | Accepted QoS parameters |

**Processing upon receipt**: The SeCFE/SvCFE then informs the results of the resource allocation to the entity which performs the session control signalling between the source QoS TE and the sink QoS TE. Upon receiving the request to cut through the IP connection with the allocated resources from the entity of session control signalling, the SeCFE/SvCFE then issues Information Flow 13 to the source BCFE.

7 IP Setup-Request.commit SeCFE/SvCFE to source BCFE (only in 2-phase case)

——————————————————>

| User information | Connection information |
|---|---|
| | Connection ID |

**Processing upon receipt**: The source BCFE then issues Information Flow 8 and Information Flow 14 at the same time. Flow 14 is issued in order to control the stream QoS configuration information of the source SFE and Flow 8 is to control the configuration information of the opposite side SFE.

8 IP Setup-Request.ready Source BCFE to intermediate BCFE (only in 2-phase case)

——————————————————>

| User information | Connection information |
|---|---|
| IP flows description information | Connection ID |
| Service type (optional) | QoS parameter |
| | Policy-based routing information selected in the local domain and the sequent domain (for the MPLS case) |
| | Address information of the inter-domain interface (for the non-MPLS case) |

**Processing upon receipt**: The intermediate BCFE finds out the next hop until the destination BCFE. It then issues Information Flow 9.

| | | |
|---|---|---|
| 9 | IP Setup-Request.ready | Intermediate BCFE to destination BCFE (only in 2-phase case) |

——————————————————>

| User information | Connection information |
|---|---|
| IP flows description information | Connection ID |
| Service type (optional) | QoS parameter |
| | Policy-based routing information selected in the local domain and the sequent domain (for the MPLS case) |
| | Address information of the inter-domain interface (for the non-MPLS case) |

**Processing upon receipt**: The destination BCFE controls the destination SFE for the stream with the direction from the destination SFE to the source SFE. Upon getting a piece of complete path resource information, the destination BCFE forms a piece of stream QoS configuration information to deliver a piece of configuration information to the destination SFE. It then issues Information Flow 10.

| | | |
|---|---|---|
| 10 | IP Setup-Request.ready | Destination BCFE to destination SFE |

——————————————————>

| User information | Connection information |
|---|---|
| IP flows description information | Connection ID |
| Service type (optional) | Accepted QoS parameter |
| | Selected information of the entire path and complete policy-based routing information that has been allocated (for the MPLS case). |

**Processing upon receipt**: The destination SFE installs the configuration information to control the data stream transfer. It then issues Information Flow 11.

| | | |
|---|---|---|
| 11 | IP Setup-Request.commit | Destination SFE to destination BCFE |

<——————————————————

| User information | Connection information |
|---|---|
| (None) | Connection ID |
| | Execution results |

**Processing upon receipt**: The destination BCFE responds to the intermediate BCFE. It then issues Information Flow 12.

| | | |
|---|---|---|
| 12 | IP Setup-Request.commit | Destination BCFE to intermediate BCFE |

<——————————————————

| User information | Connection information |
|---|---|
| IP flows description information | Connection ID |
| Service type (optional) | Accepted QoS parameter |
| | Policy-based routing information selected in the local domain and the sequent domain (for the MPLS case) |
| | Address information of the inter-domain interface (for the non-MPLS case) |

**Processing upon receipt**: The intermediate BCFE responds to the source BCFE. It then issues Information Flow 13.

13 IP Setup-Request.commit Intermediate BCFE to source BCFE

<——————————————————————

| User information | Connection information |
|---|---|
| IP flows description information | Connection ID |
| Service type (optional) | Accepted QoS parameter |
| | Policy-based routing information selected in the local domain and the subsequent domain (for the MPLS case) |
| | Address information of the inter-domain interface (for the non-MPLS case) |

**Processing upon receipt**: After receiving Information Flow 13, which is the response for "backward message flows", as well as Information Flow 15, which is the response for "forward message flows", the source and initiator BCFE issues Information Flow 16.

14 IP Setup-Request.commit Source BCFE to source SFE

<——————————————————————

| User information | Connection information |
|---|---|
| IP flows description information | Connection ID |
| Service type (optional) | Accepted QoS parameter |
| | Selected information of the entire path and complete policy-based routing information that has been allocated (for the MPLS case). |

**Processing upon receipt**: The source SFE installs the configuration information to control the data stream transfer. It then issues Information Flow 15.

15 IP Setup-Request.commit Source SFE to source BCFE

——————————————————————>

| User information | Connection information |
|---|---|
| (None) | Connection ID |
| | Execution results |

**Processing upon receipt**: After receiving Information Flow 13, which is the response for "forward message flows", as well as Information Flow 15, which is the response for "backward message flows", and means that resources have been allocated in both direction, the source and initiator BCFE issues Information Flow 16.

16 IP Setup-Request.commit Source BCFE to SeCFE/SvCFE

<——————————————————————

| User information | Connection information |
|---|---|
| IP flows description information | Connection ID |
| | Accepted QoS parameters |

**Processing upon receipt**: The SeCFE/SvCFE informs the results of the cut-through to the entity which performs the session control signalling between the Source QoS TE and the Sink QoS TE.

NOTE 2 – As regards the interworking between the resource control flows applied to the CC interface and the session control flows applied among the source QoS TE, SeCFE/SvCFE, and the sink QoS TE, it depends on the procedural requirement for the service signalling, e.g., the negotiation of QoS requirements among the source/sink QoS TE and the SeCFE/SvCFE.

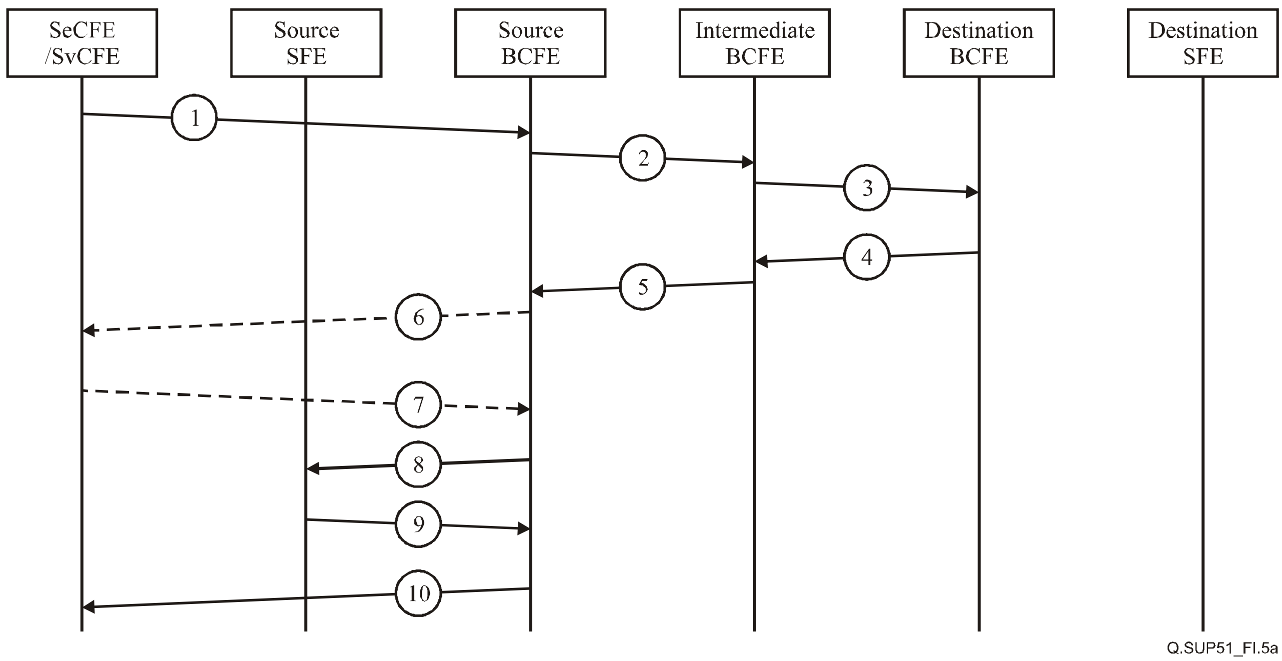
### I.2.3.2 Separately-allocated forward-and-backward-resource information flows

Figure I.6 shows the separately-allocated forward-and-backward-resource information flows. For the backward information flows, if both of calling and called part SeCFE/SvCFE take part in the procedure, we can use the second figure; if only one of the calling and called part SeCFE/SvCFE take part in the procedure, we can use the third figure.

In the case of one of the calling and called part SeCFE/SvCFE taking part in the procedure, this is performed with two parallel unidirectional information flows described in section I.2.2 except the following points;

- Information flow 1 is shared between both cases. Information 10 is also identical. In the 2-phase case, information flows 6 and 7 are also shared with each diagram.
- The BCFE receiving information flow 1 splits the signalling sequence into two sequences with opposite directions. In the 2-phase case, this split is also performed after receiving information flow 7.
- The BCFE receiving information flow 1 also waits for the response of each sequence (information flows 9 and S8), and then consolidates these two signalling sequences into a single sequence. In the 2-phase case, this consolidation is also performed before issuing information flow 6.
- For performing the resource control in the direction where the initiating BCFE is not the source BCFE, the source BCFE seeking flows (described in section I.2.1) are applied as described with information flows (S1, S2, S3, S4, S5, S6, S7, S8).

NOTE – The flows drawn in dashed lines in Figure I.6 are used only in the 2-phase case.



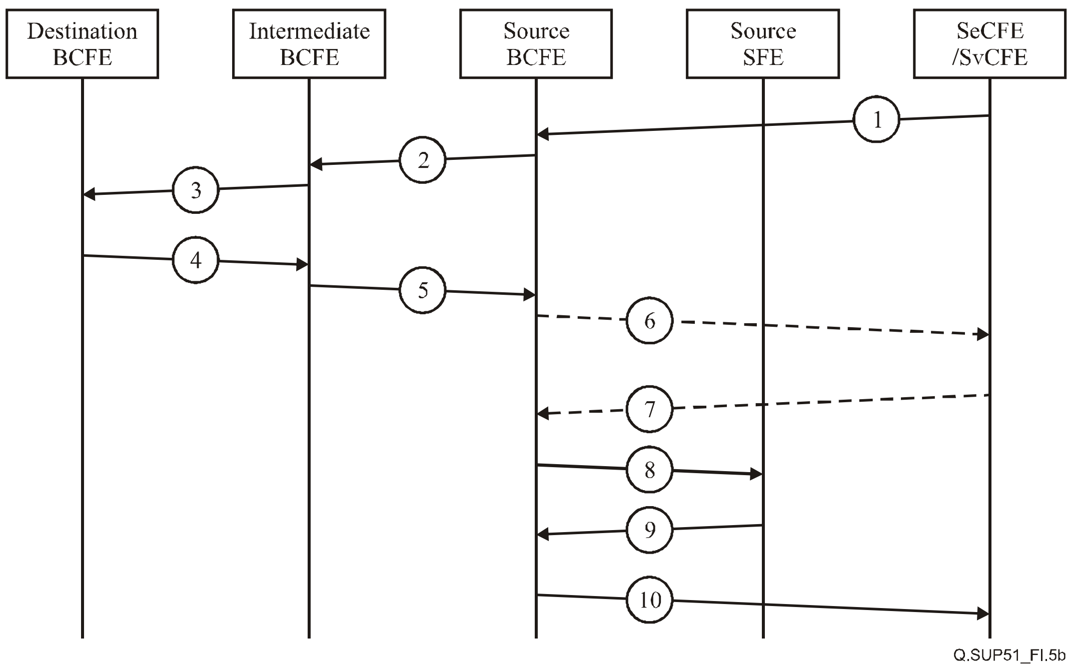




**Figure I.6 – Separately-allocated forward-and-backward-resource information flows *(start)***

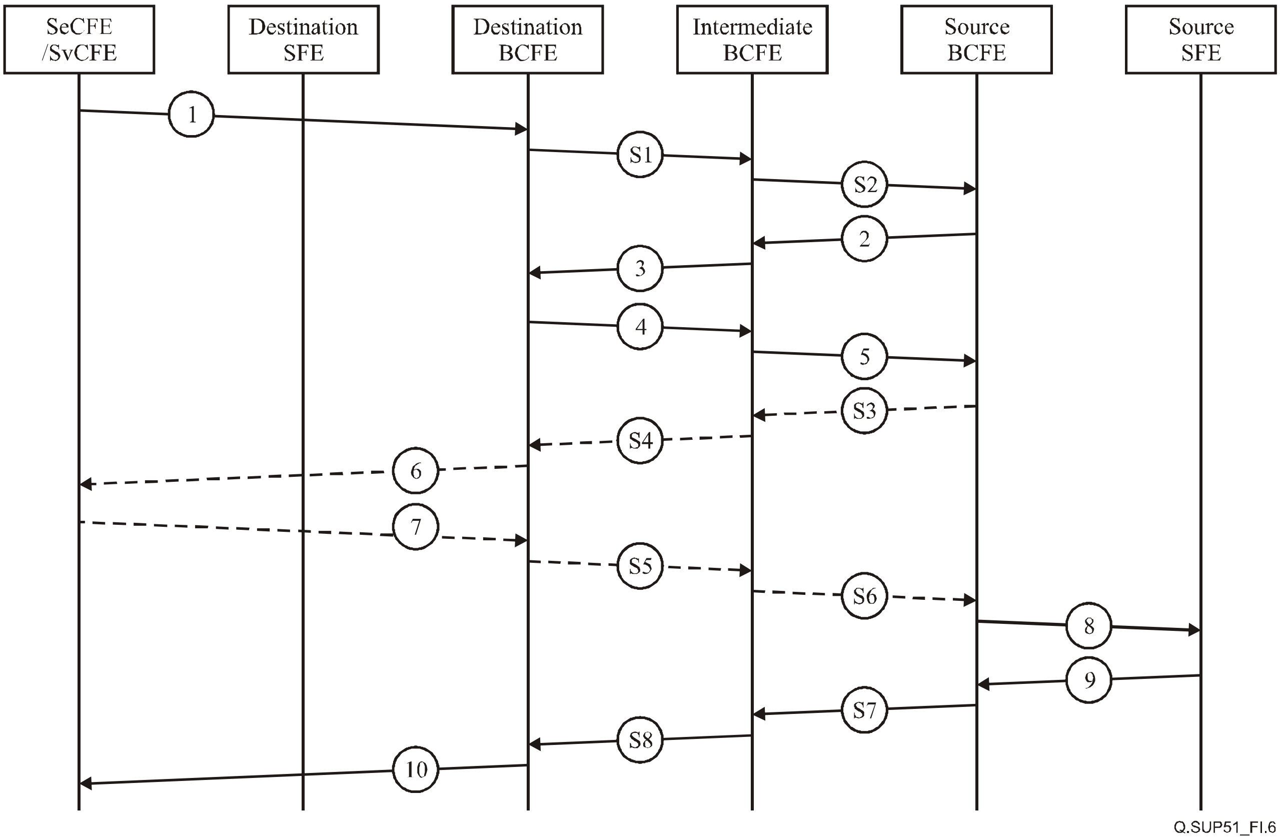



**Figure I.6 – Separately-allocated forward-and-backward-resource information flows *(end)***

# Appendix II

## An instance of functional model of IP QoS signalling requirements

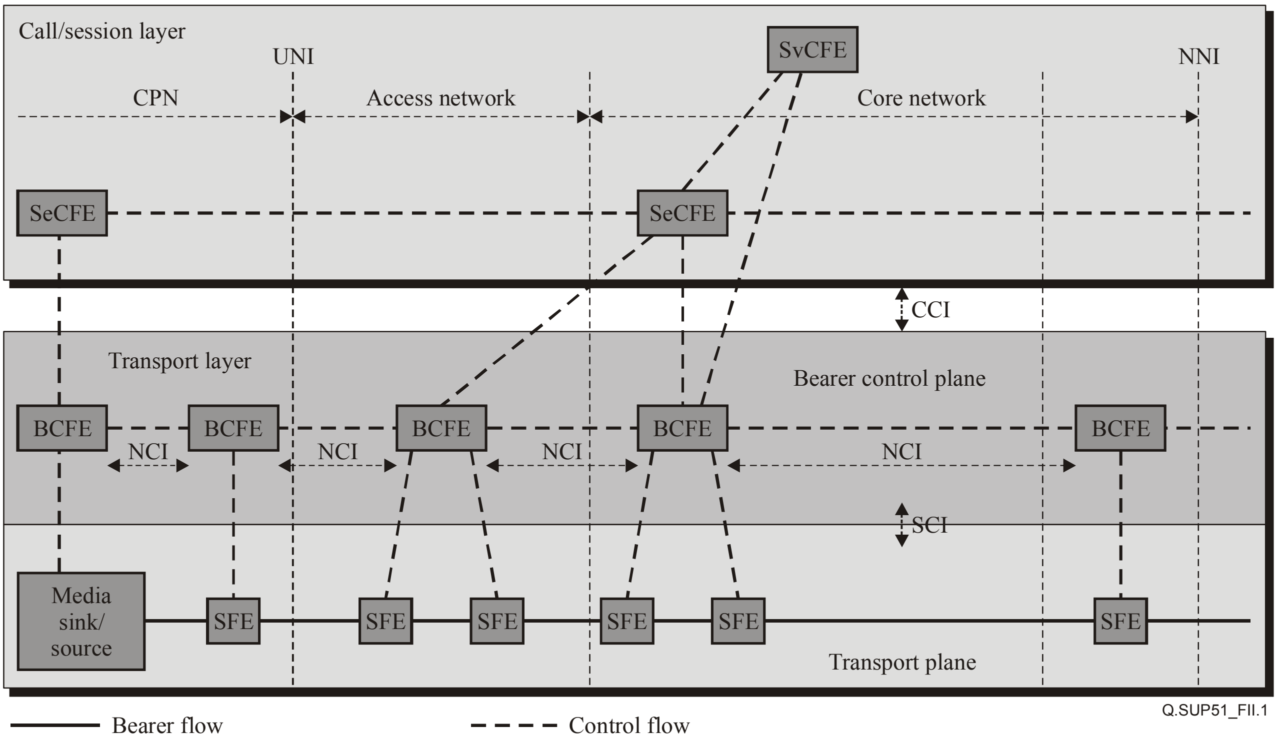



**Figure II.1 – The functional model of IP QoS signalling requirements**

# Appendix III

## Multi-operator scenario

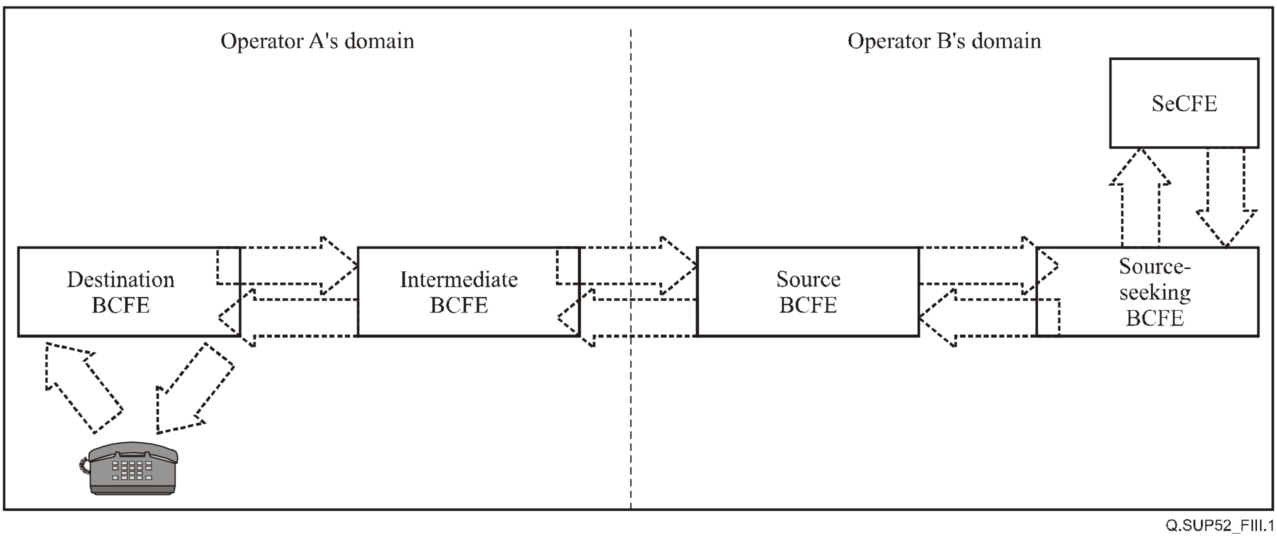



**Figure III.1 – Multi-operator scenario**

In Figure III.1 operator A is responsible for the terminating section of the IP stream. Only the QoS bearer setup requests are shown. Operator B offers the network service at call/session control level and initiates QoS requests.

Operator A is responsible for:

– Taking into consideration the QoS requests generated by operator B;
– Informing operator B of the available QoS parameters for the call/session;
– Enforcing the agreed QoS parameters within the network domain which it manages.

Operator B is responsible for:

– Generating appropriate QoS requests in accordance with the service offered to the end user;
– Enforcing the agreed QoS parameters within the network domain which it manages.

In this scenario, the end-end efficiency depends on the cooperation of operators A and B who would establish mutual agreements in order for the service to be rendered. A trusted relationship is therefore assumed between BCFEs belonging to different operators. In order to achieve this requirement, additional security features not described in this Supplement (e.g., mutual authentication), may be necessary.

# Appendix IV

## Typical process of QoS signalling in interfaces

Figure IV.1 shows a typical process of QoS signalling in CC interface:

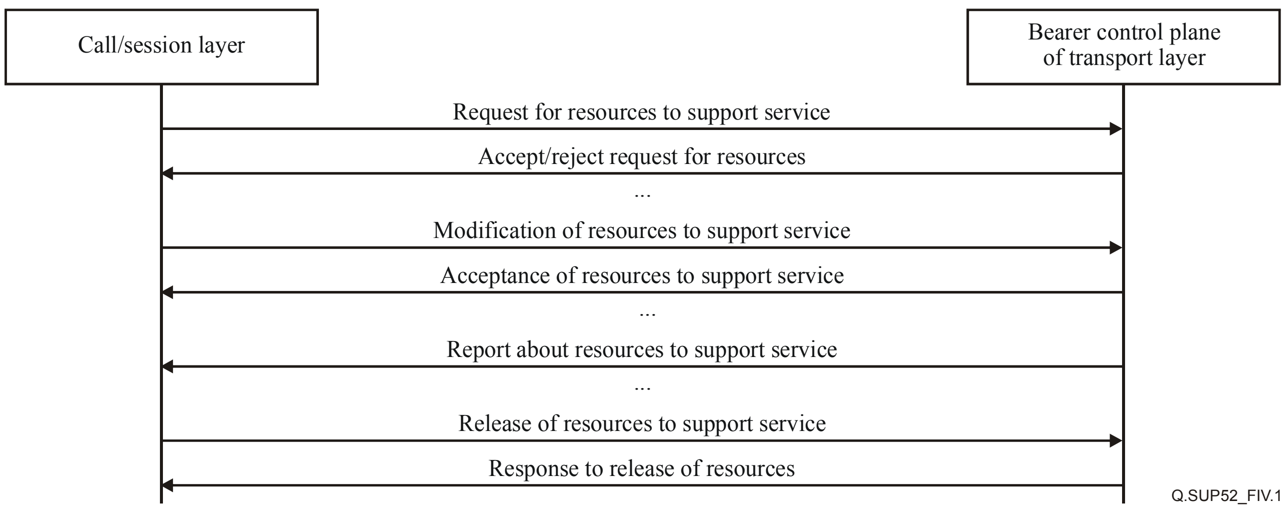



**Figure IV.1 – Process of QoS signalling in CC interface**

Figure IV.2 shows a typical process of the bearer control plane QoS signalling in NC interface.

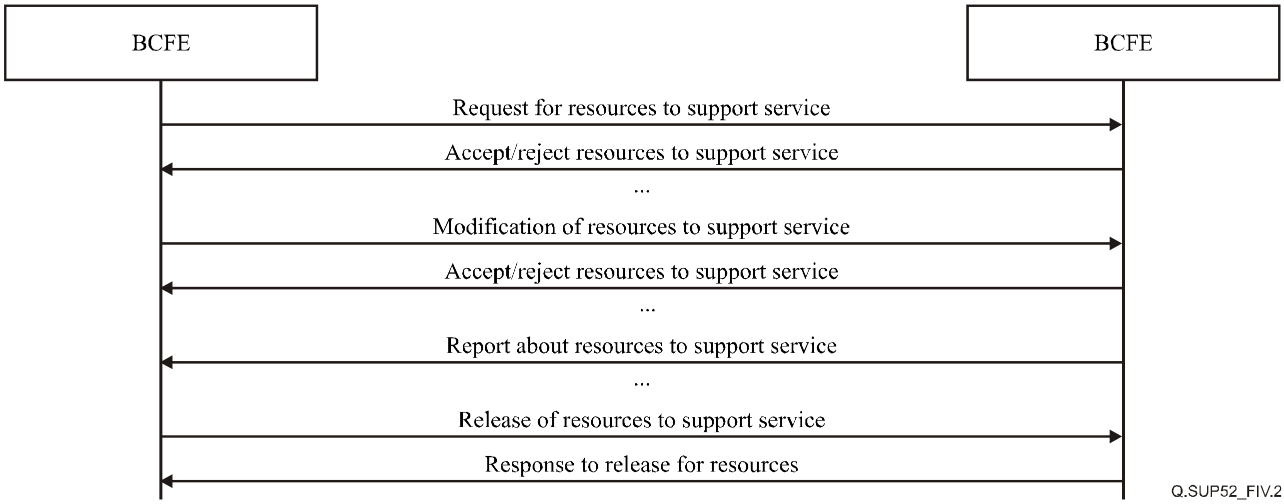



**Figure IV.2 – Process of bearer control plane QoS signalling in NC interface**

Figure IV.3 shows a typical process of QoS signalling in SC interface.

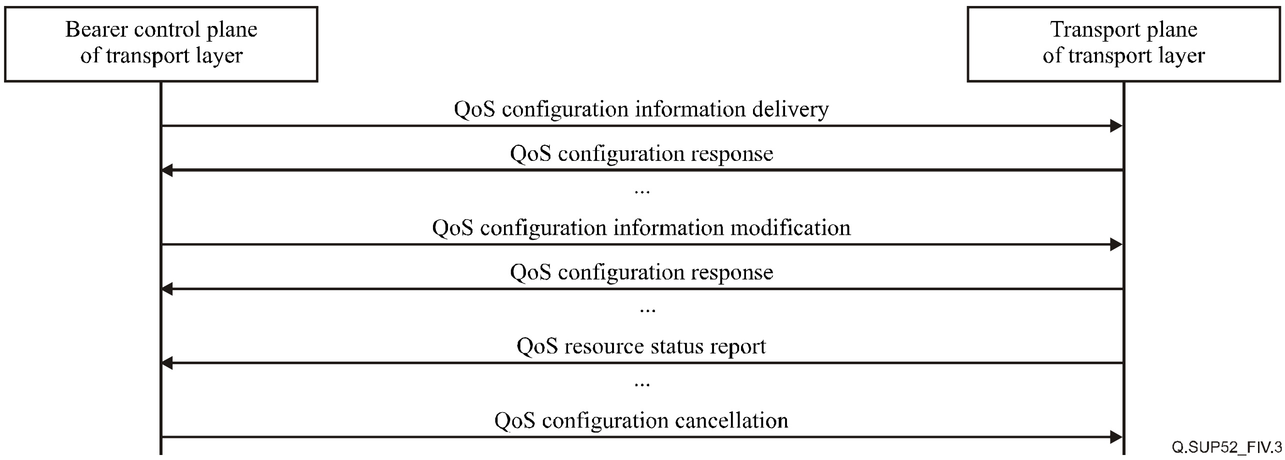



**Figure IV.3 – Process of QoS signalling in SC interface**

# Appendix V

# Examples to support QoS signalling requirements based on Y.1541 network QoS classes, and additional information on reliability/priority

## V.1 User-network signalling in support of network QoS class

An example of network response 3 (see 7.1.6) (QoS class acceptance and parameter level indication) is a case where the network provider commits to the requested class and indicates the achieved performance for delay and delay variation supporting the class 0 objectives. The values indicated are simply estimates of performance, and the only binding commitment is to the QoS class. In the following tables, acceptance of the QoS class indicates commitment to its objectives.

**Table V.1 – Example of QoS Class acceptance with specified parameter indications**

| Field name | Value | Mandatory field? |
|---|---|---|
| QoS class requested | Class 0 | Yes |
| QoS class response | Accept | Yes |
| Mean transfer delay (IPTD) | 80 ms | No |
| 99.9% – min Delay Var. (IPDV) | 20 ms | No |
| Loss (IPLR) | | No |
| Errored packets (IPER) | | No |

An example of network response 4 (see 7.1.6) (QoS class rejection and alternate class commitment and indications) is a case where the network provider rejects the requested class and offers another class with a specified parameter indication for delay.

**Table V.2 – Example of QoS class rejection with alternative offer and indications**

| Field name | Value | Mandatory field? |
|---|---|---|
| QoS Class requested | Class 0 | Yes |
| QoS class response | Reject | Yes |
| QoS class offered | Class 1 | No |
| Mean transfer delay (IPTD) | 180 ms | No |
| 99.9% – min Delay Var. (IPDV) | | No |
| Loss (IPLR) | | No |
| Errored packets (IPER) | | No |

## V.2 Network-network signalling

Signalling must communicate the consumption of the network (source-UNI to destination-UNI) QoS objectives. The fields used in signalling may take several forms:

**Table V.3 – Example of accumulating and signalling current performance**

| | Requested | Currently achieved |
|---|---|---|
| QoS class | Class 0 | Class 0 |
| Mean transfer delay (IPTD) | 100 ms | 20 ms |
| 99.9% – min Delay Var. (IPDV) | 0 ms | 10 ms |
| Loss (IPLR) | $10^{-3}$ | $<10^{-3}$ |
| Errored packets (IPER) | $10^{-4}$ | $<10^{-4}$ |
| Status of parameter indications | | Allowed |

Note that the requested parameter values are fully specified by the QoS class, but are included in this table for simple comparison. Only the achieved values and the requested/achieved class number require signalling fields.

The network receiving this message determines its performance from entrance node to the destination, or to the most likely exit node to the best-next network. The network would add its contribution to the currently achieved fields (according to a specified set of summation rules for each parameter), and send these fields on to the next network or back toward the requesting user. Participating networks can indicate their willingness to indicate specific parameter values (where a single negative preference overrides others). In case the requested QoS class is not achieved, the response can contain the committed performance in excess of the offered class, using the currently achieved values.

The ability for each network to enter and communicate its contribution to the achieved performance level is a network option, an example of which is shown in Table V.4:

**Table V.4 – Example of accumulating and signalling current performance**

| | Requested | Network 1 | Network 2 | Currently achieved |
|---|---|---|---|---|
| QoS class | Class 0 | Class 0 | Class 0 | Class 0 |
| Mean transfer delay (IPTD) | 100 ms | 20 ms | 10 ms | 30 ms |
| 99.9% – min Delay Var. (IPDV) | 50 ms | 10 ms | 10 ms | 15 ms |
| Loss (IPLR) | $10^{-3}$ | $<10^{-3}$ | $<10^{-3}$ | $<10^{-3}$ |
| Errored packets (IPER) | $10^{-4}$ | $<10^{-4}$ | $<10^{-4}$ | $<10^{-4}$ |
| Status of parameter indications | | Allowed | Allowed | Allowed |

A complete tabulation of the accumulated performance would allow corrective network actions if the requested class were not achieved.

Summation rules are simple for transfer delay. Average values for each network are added to the currently achieved value. More study is needed to determine the summation rules for delay variation and other parameters.

### V.3 Future development of classes to support reliability and priority attributes

Reliability/priority attributes are the same for user-network and network-network signalling requirements. No formal standards exist with respect to the qualitative (e.g., number of priority classes) or quantitative (e.g., time-to-restore) aspects of reliability. To that extent, the following assumptions are made in determining reliability attributes:

– Reliability for a service can be expressed as a priority with which that service requires a particular type of network function (e.g., connection admission control priority). Hence, reliability can be requested in the form of a priority class for that specific network function.
– From the viewpoint of signalling, there will be a limited number of priority classes for all network functions in order to ensure scalability (e.g., 4 classes).

Two types of priority class attributes are defined:

– Connection admission control priority class: The urgency with which a service connection is desired (e.g., high, normal, best effort).
– Restoration priority class: The urgency with which a service requires successful restoration under failure conditions (e.g., high, normal, best effort).

# Appendix VI

# Path-coupled and path-decoupled interoperability scenarios and scenarios with/without the participation of SeCFE/SvCFE

[Editor's note:

The description of mixed scenarios does not raise new requirement, but instead describes a "best current practice" how to combine both modes and

The description of Scenarios with/without the participation of SeCFE/SvCFE also gives only an example how signalling may be used. As this requirement paper should remain protocol-neutral, no mentioning of protocols belongs into the main part. ]

### VI.1 Path-coupled and path-decoupled interoperability scenarios

The path-coupled and path-decoupled interoperability scenarios are shown in Table VI.1.

**Table VI.1 – Interworking/interoperability scenarios**

| Interworking scenario | UNI | NNI | NNI | UNI |
|---|---|---|---|---|
| 1 | Path-coupled | Path-coupled | Path-coupled | Path-decoupled |
| 2 | Path-coupled | Path-decoupled | Path-decoupled | Path-coupled |
| 3 | Path-coupled | Path-decoupled | Path-decoupled | Path-decoupled |
| 4 | Path-decoupled | Path-coupled | Path-coupled | Path-coupled |
| 5 | Path-decoupled | Path-coupled | Path-coupled | Path-decoupled |
| 6 | Path-decoupled | Path-decoupled | Path-decoupled | Path-coupled |
| 7 | Path-coupled | Path-coupled | Path-decoupled | Path-decoupled |
| 8 | Path-decoupled | Path-coupled | Path-decoupled | Path-coupled |

## VI.2 Scenarios with/without the participation of SeCFE/SvCFE

Figure VI.1 illustrates the scenario without the participation of SeCFE/SvCFE (e.g., Internet web browsing, http, email, etc.).

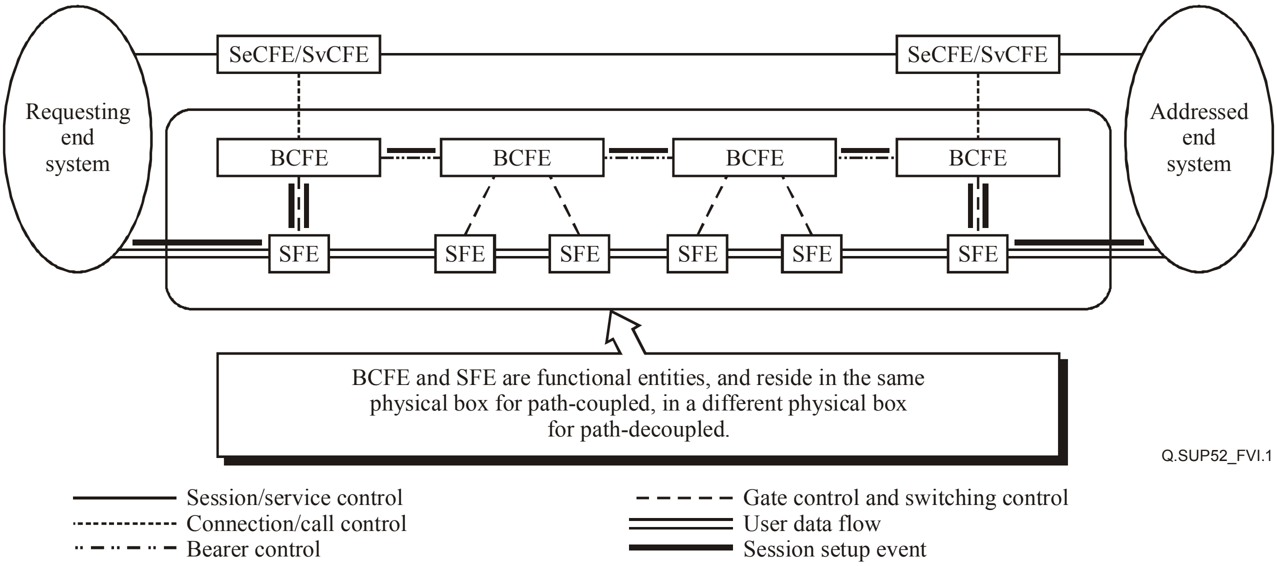



**Figure VI.1 – Scenarios without the participation of SeCFE/SvCFE**

Figure VI.2 illustrates the scenario with the participation of SeCFE/SvCFE.

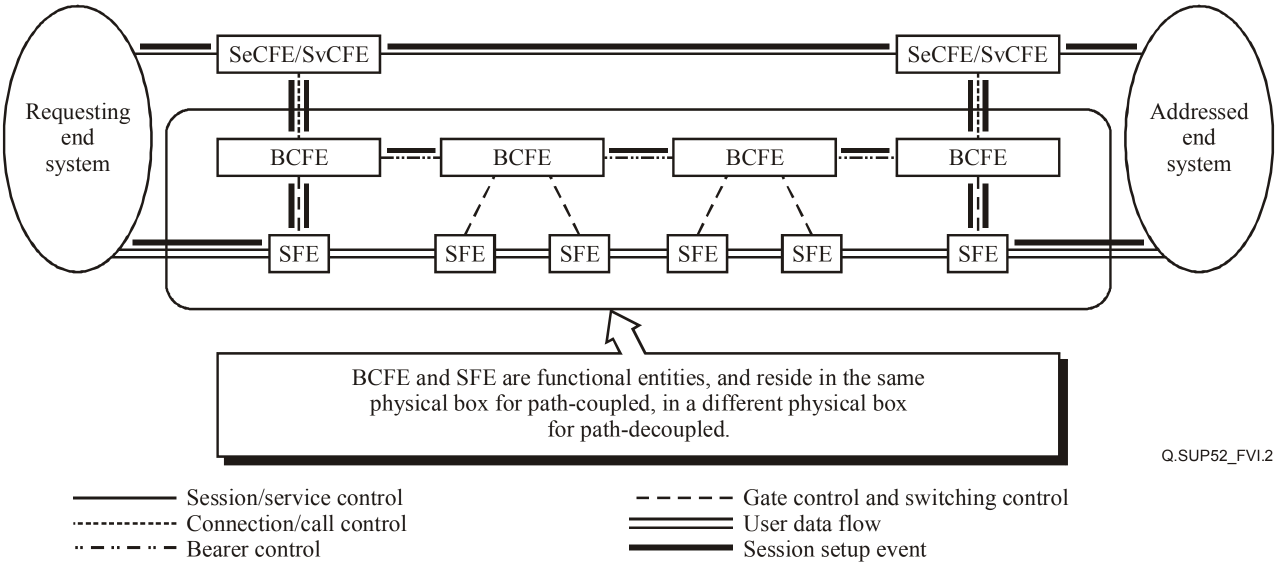



**Figure VI.2 – Scenarios with the participation of SeCFE/SvCFE**

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Printed in Switzerland
Geneva, 2005