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GENERAL RECOMMENDATIONS ON TELEPHONE SWITCHING AND SIGNALLING

INTELLIGENT NETWORK

INTELLIGENT NETWORK DISTRIBUTED FUNCTIONAL PLANE ARCHITECTURE

ITU-T Recommendation Q.1204

(Previously "CCITT Recommendation")

FOREWORD

The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of the International Telecommunication Union. The ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Conference (WTSC), which meets every four years, established the topics for study by the ITU-T Study Groups which, in their turn, produce Recommendations on these topics.

ITU-T Recommendation Q.1204 was prepared by the ITU-T Study Group XI (1988-1993) and was approved by the WTSC (Helsinki, March 1-12, 1993).

NOTES

1 As a consequence of a reform process within the International Telecommunication Union (ITU), the CCITT ceased to exist as of 28 February 1993. In its place, the ITU Telecommunication Standardization Sector (ITU-T) was created as of 1 March 1993. Similarly, in this reform process, the CCIR and the IFRB have been replaced by the Radiocommunication Sector.

In order not to delay publication of this Recommendation, no change has been made in the text to references containing the acronyms "CCITT, CCIR or IFRB" or their associated entities such as Plenary Assembly, Secretariat, etc. Future editions of this Recommendation will contain the proper terminology related to the new ITU structure.

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

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SUMMARY

This Recommendation defines a general intelligent network (IN) distributed functional plane (DFP) architecture within the overall framework of the IN conceptual model described in Recommendation I.312/Q.1201. As such, this Recommendation provides the basis for developing the Q.12x4 Recommendations to specify the IN DFP for a given capability set x (CS-x).

This Recommendation provides the basis for Q.12x4 Recommendations by:

- defining the IN DFP architecture in terms of groupings of functionality, referred to as functional entities, and the information that flows between functional entities, referred to as relationships;
- identifying study subjects for the modelling of functional entities related to IN-supported call/service logic processing to determine the nature of the relationships between them; and
- providing tools for the modelling of functional entities in a manner consistent with IN objectives, as appropriate for a given CS.

While the IN DFP architecture and modelling tools in this Recommendation have proven extremely useful in processing IN standardization, they do not necessarily represent an ultimate view of IN evolution. As such, this Recommendation represents a current understanding that may require future enhancements as the ultimate view of IN is refined.

Within the Q.120x-Series Recommendations, this Recommendation describes the distribution of global functional plane functionality defined in Recommendation I.329/Q.1203 (i.e. service independent building blocks) in a service and vendor/implementation independent manner. This provides the flexibility to allocate distributed functionality into multiple physical network configurations, as described in Recommendation Q.1205, and to evolve IN from an initial CS (e.g. CS-1) to some future CS-n. It also provides a framework from which IN protocols are specified, as described in Recommendation Q.1208.

Recommendation Q.1204

INTELLIGENT NETWORK DISTRIBUTED FUNCTIONAL PLANE ARCHITECTURE

(Helsinki, 1993)

1 General

The requirements and assumptions for the IN distributed functional plane (DFP) architecture are as follows:

a) The DFP architecture is consistent with the framework defined by the IN conceptual model:

   – it identifies the specific elements and the relationship between them that are necessary to support the objectives of IN;

   – the DFP architecture models the functions to be performed in IN structured networks.

b) The DFP architecture provides the flexibility to support a large variety of services and facilitates the evolution of IN by organizing the functional capabilities in an open-ended and modular structure to achieve service independence.

c) The DFP architecture is vendor/implementation independent, thereby providing the flexibility for multiple physical networking configuration and placing no constraints on national network architecture beyond the network and interface standards which will be developed for IN structured networks.

d) The definition of the DFP architecture initially accommodates service execution capabilities and will accommodate service creation and service and network management capabilities when they become available.

2 Distributed funtional plane model

Figure 2-1 identifies the IN DFP model.

2.1 Explanation of diagram

2.1.1 Functional entities

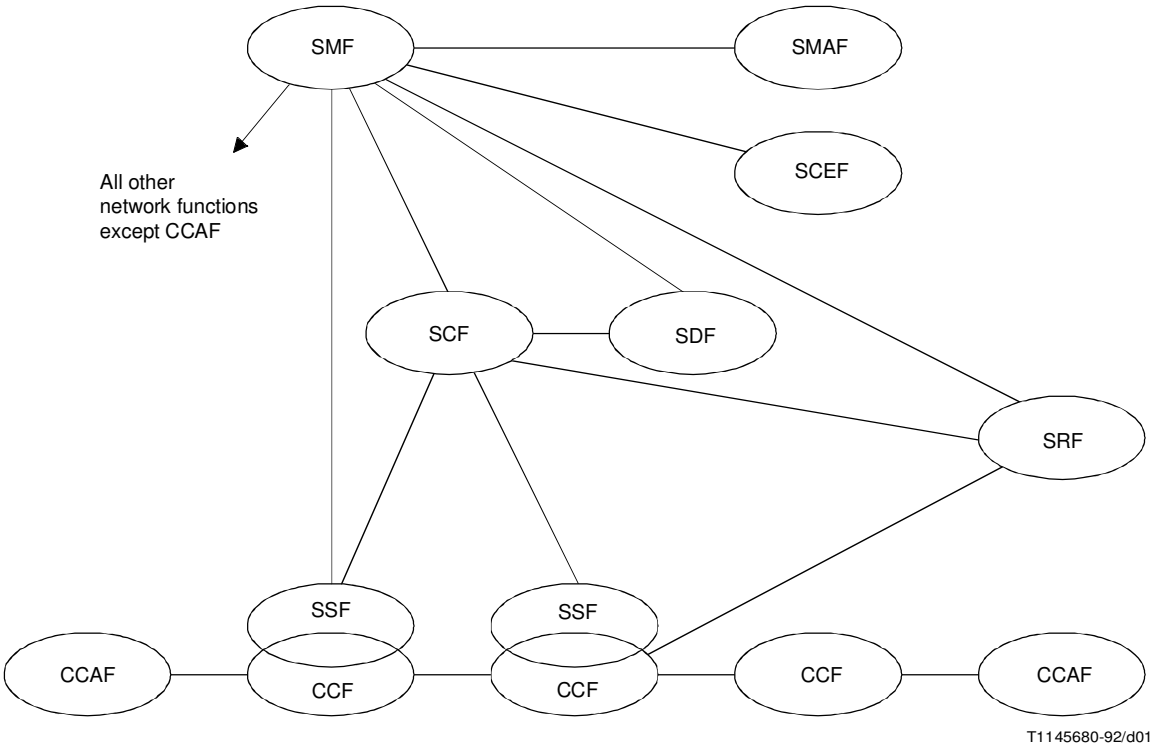
A functional entity is a unique group of functions in a single location and a subset of the total set of functions required to provide a service. One or more functional entities can be located in the same physical entity. Different functional entities contain different functions, and may also contain one or more of the same functions. In addition, one functional entity cannot be split between two physical entities; the functional entity is mapped entirely within a single physical entity. Finally, duplicate instances of a functional entity can be mapped to different physical entities, though not the same physical entity.

Functional entities are represented by ovals in the functional model diagram.

Functional entities are assigned unique FUNCTIONAL ENTITY IDENTIFIERS (e.g. CCF, for call control function).

Functional entity descriptions do not include utility/housekeeping functions which are not directly involved in providing a service. This explains why there is no functional entity identified to describe the communication between functional entities.

The physical location of a function is not the only criteria for grouping functions into a functional entity. Functional entity grouping criteria should take into consideration all technological and business requirements.



CCAF Call control agent function
CCF Call control function
SCEF Service creation environment function
SCF Service control function
SDF Service data function
SMAF Service management access function
SMF Service management function
SRF Specialised resource function
SSF Service switching function

NOTES

1 The two SSF/CCF have identical functionality and are only shown for some procedures like assist.

2 The definitions of CCAF and CCF are based on corresponding Q.71 ISDN definitions, but may be modified for use in IN.

FIGURE 2-1/Q.1204

IN distributed functional plane model

2.1.2 Relationships

Each interaction between a communicating pair of functional entities in the model is termed an “information flow”. The relationship between any communicating pair of functional entities in the model is defined by a set of information flows.

Functional entity relationships are the lines between functional entities in the functional model diagram.

Relationships may have TYPE identifiers assigned, which uniquely identify specific sets of information flows within the model (e.g. r1, r2, etc.). The same relationship type may occur more than once in a functional model.

If the model does not show a line between functional entities, there is no identified relationship which requires standardization between them.

If a communicating pair of functional entities is located in physically separate entities, the relationship between them defines the information transfer requirements for a protocol between the physical entities.

2.3 Definition of functional entities related to IN service execution

The CCA function (CCAF): The CCAF is the call control agent (CCA) function that provides access for users. It is the interface between user and network call control functions. It

a) provides for user access, interacting with the user to establish, maintain, modify and release, as required, a call or instance of service;

b) accesses the service-providing capabilities of the call control function (CCF), using service requests (e.g. setup, transfer, hold, etc.) for the establishment, manipulation and release of a call or instance of service;

c) receives indications relating to the call or service from the CCF and relays them to the user as required;

d) maintains call/service state information as perceived by this functional entity.

The CC function (CCF): The CCF is the call control (CC) function in the network that provides call/connection processing and control. It

a) establishes, manipulates and releases call/connection instances as "requested" by the CCAF;

b) provides the capability to associate and relate CCAF functional entities that are involved in a particular call and/or connection instance (that may be on SSF requests);

c) manages the relationship between CCAF functional entities involved in a call (e.g. supervises the overall perspective of the call and/or connection instance);

d) provides trigger mechanisms to access IN functionality (e.g. passes events to the SSF);

e) is managed, updated and/or otherwise administered for its IN-related functions (i.e. trigger mechanisms) by a service management function (SMF).

The SS function (SSF): The SSF is the service switching (SS) function, which, associated with the CCF, provides the set of functions required for interaction between the CCF and a service control function (SCF). It

a) extends the logic of the CCF to include recognition of service control triggers and to interact with the SCF;

b) manages signalling between the CCF and the SCF;

c) modifies call/connection processing functions (in the CCF) as required to process requests for IN provided service usage under the control of the SCF;

d) is managed, updated and/or otherwise administered by an SMF.

The SC function (SCF): The SCF is a function that commands call control functions in the processing of IN provided and/or custom service requests. The SCF may interact with other functional entities to access additional logic or to obtain information (service or user data) required to process a call/service logic instance. It

a) interfaces and interacts with service switching function/call control function, specialized resource function (SRF) and service data function (SDF) functional entities;

b) contains the logic and processing capability required to handle IN provided service attempts;

c) interfaces and interacts with other SCFs, if necessary;

d) is managed, updated and/or otherwise administered by an SMF.

The SD function (SDF): The SDF contains customer and network data for real time access by the SCF in the execution of an IN provided service. It

a) interfaces and interacts with SCFs as required;

b) interfaces and interacts with other SDFs, if necessary;

c) is managed, updated and/or otherwise administered by an SMF.

NOTE – The SDF contains data relating directly to the provision or operation of IN provided services. Thus it does not necessarily encompass data provided by a third party such as credit information, but may provide access to these data.

The SR function (SRF): The SRF provides the specialized resources required for the execution of IN provided services (e.g. digit receivers, announcements, conference bridges, etc.). It

a) interfaces and interacts with SCF and SSF (and with the CCF);

b) is managed, updated and/or otherwise administered by an SMF;

c) may contain the logic and processing capability to receive/send and convert information received from users;

d) may contain functionality similar to the CCF to manage bearer connections to the specialized resources.

2.4 Definition of IN service creation/management related functional entities

service creation environment function (SCEF): This function allows services provided in an intelligent network to be defined, developed, tested and input to SMF. Output of this function would include service logic, service management logic, service data template and service trigger information.

service management access function (SMAF): This function provides an interface between service managers and the SMF.

It allows service managers to manage their services (through access to the SMF).

service management function (SMF): This function allows deployment and provision of IN provided services and allows the support of ongoing operation.

Particularly, for a given service, it allows coordination of different SCF and SDF instances, e.g.:

– billing and statistic information are received from the SCFs, and made available to authorized service managers through the SMAF;

– modifications in service data are distributed in SDFs, and it keeps track of the reference service data values.

The SMF manages, updates and/or administers service related information in SRF, SSF and CCF.

NOTE – The relation between TMN (see Recommendation M.30), SMAF and SMF is for further study.

3 Functional entity call/service logic processing models

3.1 General

IN call/service logic processing encompasses call and connection processing in the SSF/CCF, service logic execution in the SCF, and the use of supporting resources and data in the SRF and SDF, respectively. This subclause describes this IN call/service logic processing in terms of call modelling and modelling of service logic processing.

– Call modelling provides a high-level service and vendor/implementation independent abstraction of IN call and connection processing in the SSF and CCF. This abstraction provides an observable view of SSF/CCF activities and resources to the SCF, enabling the SCF to interact with the SSF in the course of executing service logic.

– The modelling of service logic processing provides an abstraction of SCF activities and resources needed to support this service logic execution, as well as an abstraction of SRF and SDF activities and resources accessible to the SCF.

Since this modelling only provides an observable (i.e. external) view of SSF/CCF, SCF, SRF, and SDF activities and resources, this modelling does not imply an obligation to vendors to implement functional entities into products as a one-to-one mapping of functional entity model components.

3.2 Modelling objectives/criteria

3.2.1 Call modelling objectives/criteria

The general call modelling objectives/criteria are given below. The call model should:

a) provide a high-level vendor/implementation independent abstraction of call and connection processing that implies:

   – a generic call model supporting all user access technologies under consideration for a given capability set; and

   – uniformity of functions across multiple vendor products;

b) present an observable view of an SSF/CCF to an SCF;

c) take into account the existing base of evolvable network technology and the longer term need in its continuing evolution by providing an overall IN call and connection processing structure from which useable, coherent subsets of capabilities, as well as optional capabilities, can be defined as appropriate for a given capability set;

d) provide a framework for defining the information flows (relationships) between an SSF and an SCF, without any assumptions about the physical implementation or distribution of functions:

   – this implies the need to support one or more concurrent instances of the SCF interacting with an SSF/CCF on a single call attempt (given in item g));

e) provide a framework for defining triggering requirements;

f) provide a framework for ensuring correct sequencing of functions within an SSF/CCF; and

g) provide rules of representing and handling service logic instance interactions to support:

   – multiple concurrent instances of IN service logic on a single call;

   – concurrent instances of IN service logic and non-IN service logic (e.g. existing switch-based features logic) on a single call.

3.2.2 Modelling of service logic processing objectives/criteria

The general objectives/criteria for modelling of service logic processing are given below. This modelling should:

a) provide a high-level vendor/implementation independent abstraction of service logic processing in the SCF, specialized resources in the SRF, and service data in the SDF that implies uniformity of functions across multiple vendor products;

b) characterize the capabilities of an SRF and SDF made available to an SCF;

c) take into account the existing base of evolvable network technology and the longer term need in its continuing evolution by providing an overall IN service logic processing structure from which useable, coherent subsets of capabilities, as well as optional capabilities, can be defined as appropriate for a given capability set;

d) provide a framework for defining the information flows (relationships) between an SRF and an SCF and between an SDF and an SCF, without any assumptions about the physical implementation or distribution of functions.

3.3 General assumptions

3.3.1 Scope of functional entity call/service logic processing models

The scope of call modelling will focus on SSF/CCF call/service processing functions, as well as other functions required to support an IN call (i.e. specialized resource functions, status monitoring functions, data management functions, and traffic management functions). This functionality encompasses the management of IN service logic instances influencing SSF/CCF call and connection processing resources, SRF specialized resources, and SDF service data, as well as the following SSF/CCF functions: basic connection management, call management, and the management of service logic instance interactions in the SSF/CCF.

The call/service logic processing models, in their continuing evolution, should be able to support the needs described in 3.1/Q.1201 (Evolution of IN).

3.3.2 Relation to IN conceptual model

Functional entity call/service logic processing models address functional entities and their relationships in the distributed functional plane. Their mapping to the SIBs in the global functional plane should be provided in the stage 2 description of the SIBs.

3.3.3 Use of functional entity call/service logic processing models

Functional entity call/service logic processing models provide a tool used by IN architects to model a call and to understand and describe the distribution of functions between functional entities and functional entity relationships. The observable call/service processing functions described by functional entity modelling efforts can be used by service designers to facilitate the creation of service logic. These functions are reusable (e.g. in the form of SIBs), in that the same function can be reused for a variety of IN-supported service features. In addition, given that a robust service feature interaction mechanism can be supported by the call/service logic processing models, service designers would not be constrained by previously defined IN-supported services/service features, and would also be able to reuse previously defined IN-supported service features to create new ones.

3.3.4 Other considerations

Taking into account the call modelling objectives/criteria described in 3.2, functional entity call/service logic processing models should also address the following needs:

a) understand and define the distributed functional plane architecture;

b) define the scope of modelling efforts for the various capability sets under study;

c) establish appropriate rules for representing and handling service logic instance interactions.

3.4 Overview of call/service logic processing related functional entities

The distributed functional plane functional entities related to call modelling and service execution are shown in Figure 3-1. The relationships between these functional entities are also shown. The functional entities and relationships of particular concern to call modelling include the CCAF, the SSF/CCF, the SRF and the relationship between the SSF/CCF and the SCF. These functional entities and their relationships will be studied in terms of functional entity call/service logic processing models to identify and define functional distribution and information flows between these functional entities.

The SSF and CCF are being treated together. Since there is extensive mutual interaction between the two functional entities, it is anticipated that they may both be mapped into the same physical entity. As such, it is assumed that the relationship between them (i.e. the information flows) is not externally visible.

Additional subjects for study have also been identified for two cases in which multiple instances of one functional entity interact with another functional entity. These cases are shown in Figures 3-2 and 3-3. In the first case, in which multiple SCFs can interact with one SSF, the SSF may have to be able to manage interactions between IN service logic instances realized in different SCFs that are simultaneously active on a single call. In the second case, in which one SCF can interact with multiple SSFs, the SCF may have to be able to manage IN call and connection processing among multiple SSFs.

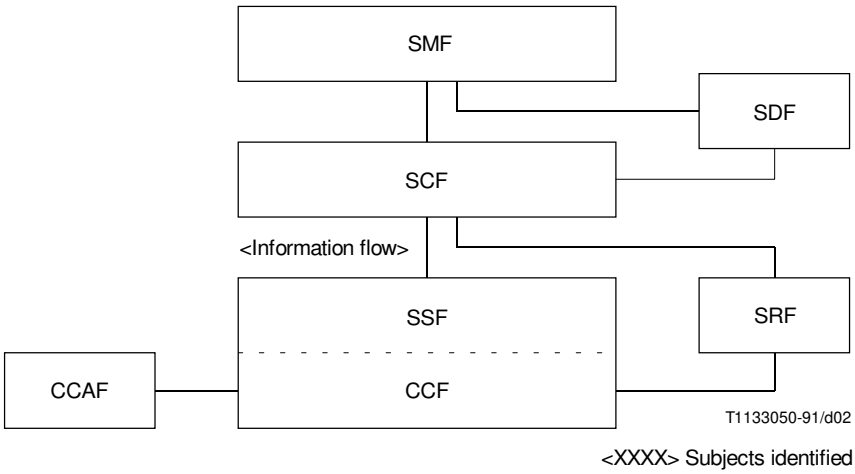


FIGURE 3-1/Q.1204

Overview of call/service logic processing functional entities

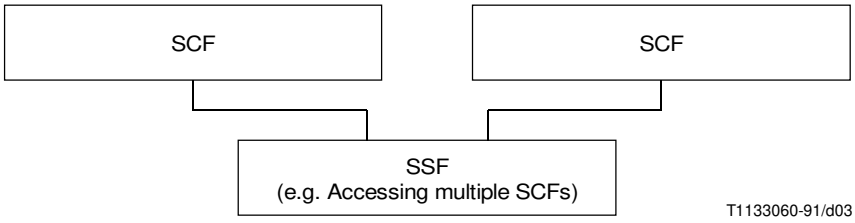


FIGURE 3-2/Q.1204

Multiplicity in interaction between SSF and SCFs

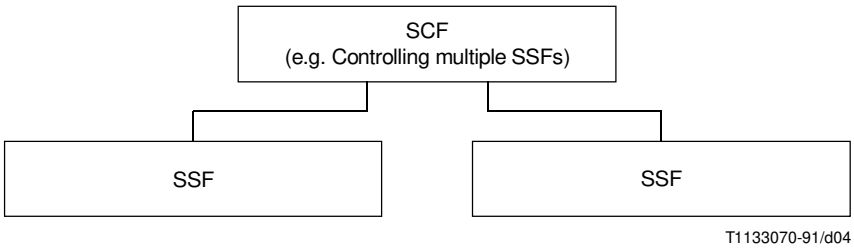


FIGURE 3-3/Q.1204

Multiplicity in interaction between SCF and SSFs

The role of the call/service logic processing functional entities in the distributed functional plane architecture is as follows. Users access the call/service processing functions of the SSF/CCF via the CCAF functional entity. The CCAF receives call setup/service requests from users and passes them to the SSF/CCF for processing, independent of user access arrangements. In the course of processing these requests, the SSF/CCF may detect events (e.g. "off-hook" indicator or service feature activator) that can lead to the invocation of an instance of service logic. This instance of service logic may provide IN-supported service features, as supported by service logic processing programs (SLPs) in an SCF, or it may provide non-IN supported service features, as supported by the SSF/CCF itself. Based on existing conditions and pre-specified criteria, the SSF/CCF determines if its own service logic should handle the event, or if SLPs in an SCF should handle the event. In the latter case, it reports the event to the SCF, along with the state of the call/service attempt at the time the event was detected. The SCF then invokes instances of the appropriate SLPs, and interacts with the SSF/CCF to provide instances of IN-supported service features to users. To do so, the SCF can request the SSF/CCF to perform certain call and connection processing functions, and can request the SSF/CCF to make use of resources in the SRF. In addition, it can request the SDF to perform related service data processing functions.

Examples of call/connection processing functions accessible to the SCF from the SSF/CCF include functions to:

a) Influence the flow of call processing (e.g. provide serial calling or generate signalling events);

b) Access and change information related to call processing (e.g. address translation);

c) Manipulate the connectivity of the call (e.g. place a party on hold, forwarding, conferencing);

d) Monitor for events related to call processing and connectivity manipulation.

Examples of specialized resource functions accessible to the SCF from the SRF include functions to:

e) Send information to users participating in a call (e.g. prompts, announcements);

f) Receive information from users participating in a call (e.g. authorization codes);

g) Modify user information (e.g. text to speech synthesis, protocol conversion);

h) Provide specialized connection resources (e.g. audio conference bridge, information distribution bridge).

Examples of service data processing functions accessible to the SCF from the SDF include functions to:

i) Access service information (e.g. subscription data parameters);

j) Update service information (e.g. sum of charging).

3.5 Call/service logic processing functional entity models

To address the call/service logic processing subjects identified in 3.1 through 3.4 for a given capability set, functional entity models are described in the context of the objectives, scope, and contraints of that capability set. To advance the understanding of these call/service logic processing subjects through functional entity modelling, IN studies have developed a number of models and modelling techniques as useful tools, independent of a given capability set. The annexes to this Recommendation provide some of these tools as a framework for this functional entity modelling.

While these tools have proven extremely useful in progressing IN standardization, they do not necessarily represent an ultimate view of IN evolution. For example, the call modelling studies in Annex A currently address connection-oriented call processing; their applicability to connectionless call processing requires further study. In addition, these studies are subject to future improvement. As such, these annexes represent a current understanding that may require future enhancements.

Annex A provides an example of an overall basic call state model for existing switch processing of a basic two-party call. This model can be analysed to identify points in basic call and connection processing when IN service logic instances are permitted to interact with basic call and connection control capabilities.

Annex B describes an object-oriented finite state machine modelling approach for describing the dynamic aspects of functional entities. This approach is useful in describing an external view of a functional entity and its relationships with other functional entities.

Annex C describes an overall representation of a call to understand how functional entities may view and manage the call, and how interactions between multiple functional entities with respect to the same call may be managed.

4 Relationship between functional entities

4.1 General

In support of the execution of a specific IN-supported service feature, functional entities in the distributed functional plane must invoke capabilities provided by other functional entities, (e.g. the SCF must invoke capabilities provided by the SSF). In order for one functional entity (termed the client functional entity) to invoke the capabilities provided by another functional entity (termed the server functional entity), a relationship must be established between the two functional entities concerned.

A relationship between two functional entities can only be established by the client functional entity, though both functional entities can act as clients under different circumstances. In the former case, for example, the relationship between the SCF and the SDF to retrieve or update information can only be established at the request of the SCF. However, in the latter case of the SCF-SSF relationship, this may be established at the request of either functional entity (e.g. by the SCF to request the SSF to initiate a call, or by the SSF to request call processing instructions from the SCF). A relationship between two functional entities can be terminated by either of the two functional entities concerned.

One functional entity may have more than one relationship established simultaneously with other functional entities.

4.2 Relationships

IN service control and service management relationships may be established between the following functional entities in the distributed functional plane:

- SCF-SSF
- SCF-SRF
- SCF-SDF
- SCF-SCF
- SDF-SDF
- SMF-SSF
- SMF-CCF
- SMF-SRF
- SMF-SDF
- SMF-SCF
- SMF-SCEF
- SMF-SMAF

4.3 Information flows between functional entities

Information flows between two functional entities either consist of a client request/server response pair or of a client request alone.

5 Mapping the global functional plane to the distributed functional plane

5.1 Mapping requirements

- The mapping of the global functional plane to the distributed functional plane must be consistent with the IN conceptual model.
- The mapping of the global functional plane to the distributed functional plane must use the stage 2 description methodology based on the Recommendation I.130.
- The mapping of the global functional plane to the distributed functional plane must allow for realization of each SIB identified in the Global Functional Plane in at least one functional entity of the distributed functional plane.
- The mapping of the global functional plane to the distributed functional plane must allow for realization of both network- and service Inter-working.
- The mapping of the global functional plane to the distributed functional plane must allow for accommodation of the service execution capabilities (initially), as well as for the service creation, service management, and network management capabilities, when these are introduced in the future.
- The description of the basic call process (BCP) should be completely consistent with the BCSMs that represent the call model in the distributed functional plane.

5.2 Relationship to IN conceptual model

A set of SLPs in the global functional plane is represented by a set of distributed SLPs located at the functional entities, which are summarized in the next subclauses.

Particularly, each SIB is realized in the distributed functional plane by a sequence of specific functional entity actions (FEAs) performed by the functional entities. Some of these FEAs result in information flows between functional entities, which is illustrated in Figure 5-1.

In addition, an example that illustrates the mapping of several previously identified SIBs is presented in 5.3.

In the DFP, the BCP can be realized in a pair of BCSMs that consists of the originating BCSM and terminating BCSM.

5.3 An example of mapping some selected SIBs to functional entities

Table 5-1 presents an example of mapping of SIBs to functional entities. In this table, for each SIB, the involved functional entities are marked with an "X".

TABLE 5-1/Q.1204

Example mapping of SIBs to functional entities

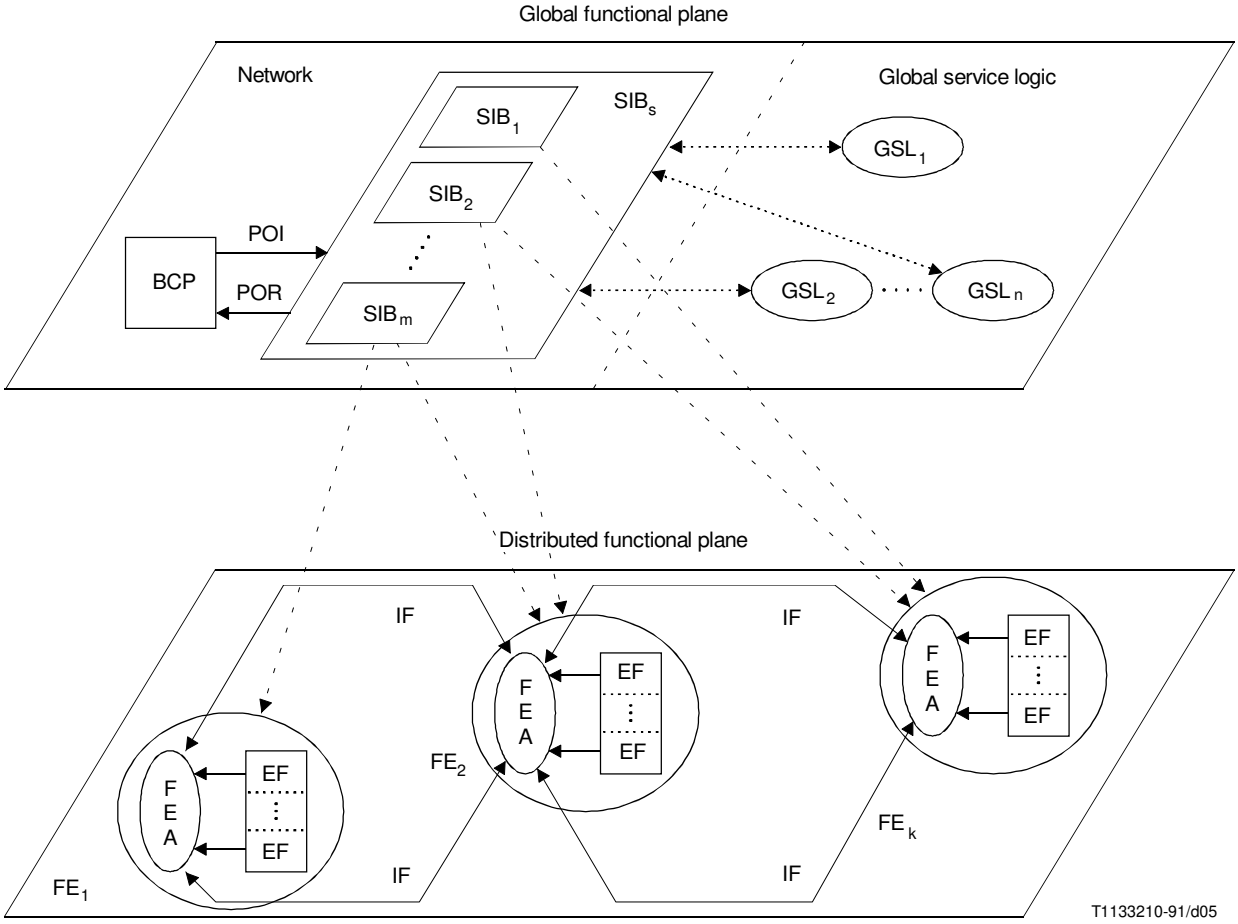
SIBs	Functional entities			
	Functional entity 1	Functional entity 2	Functional entity 3	Functional entity 4
SIB 1	X	X		
SIB 2		X		X
SIB m	X	X	X	

Table 5-2 presents an example of mapping of information flows to SIBs. In this table, for each information flow, the involved SIBs are marked with an "X".

TABLE 5-2/Q.1204

Example mapping of information flows to SIBs

Information flows	SIBs			
	SIB 1	SIB 2	SIB 3	SIB 4
Information flow 1	X		X	
Information flow 2		X		X
Information flow N	X			X



BCP Basic call process
EF Elementary function
FE Functional entity
FEA Functional entity action
GSL Global service logic
IF Information flow
POI Point of initiation
POR Point of return
SIB Service-independent building block

FIGURE 5-1/Q.1204

Mapping of the global functional plane to distributed functional plane

Annex A

Example basic call state model (BCSM)

(This annex forms an integral part of this Recommendation)

A.1 General

The BCSM is a high-level finite state machine description of CCF activities required to establish and maintain communication paths for users. As such, it identifies a set of basic call and connection activities in a CCF and shows how these activities are joined together to process a basic call and connection (i.e. establish and maintain a communication path for a user). The relationship between basic call and connection separation and the BCSM described in this subclause is for further study.

Many aspects of the BCSM are not externally visible to IN service logic instances. However, aspects of the BCSM that are reflected upward to the SSF are visible to IN service logic instances. Only these aspects of the BCSM will be the subject of standardization. As such, the BCSM is primarily an explanatory tool for providing a representation of CCF activities that can be analysed to determine which aspects of the BCSM will be visible to IN service logic instances, if any, and what level of abstraction and granularity is appropriate for this visibility.

The BCSM identifies points in basic call and connection processing when IN service logic instances are permitted to interact with basic call and connection control capabilities. In particular, it provides a framework for describing basic call and connection events that can lead to the invocation of IN service logic instances or should be reported to active IN service logic instances, for describing those points in call and connection processing at which these events are detected, and for describing those points in call and connection processing when the transfer of control can occur.

Figure A.1 shows the components that have been identified to describe a BCSM, to include: points in call (PICs), detection points (DPs), transitions, and events. PICs identify CCF activities required to complete one or more basic call/connection states of interest to IN service logic instances. DPs indicate points in basic call and connection processing at which transfer of control can occur. Transitions indicate the normal flow of basic call/connection processing from one PIC to another. Events cause transitions into and out of PICs.

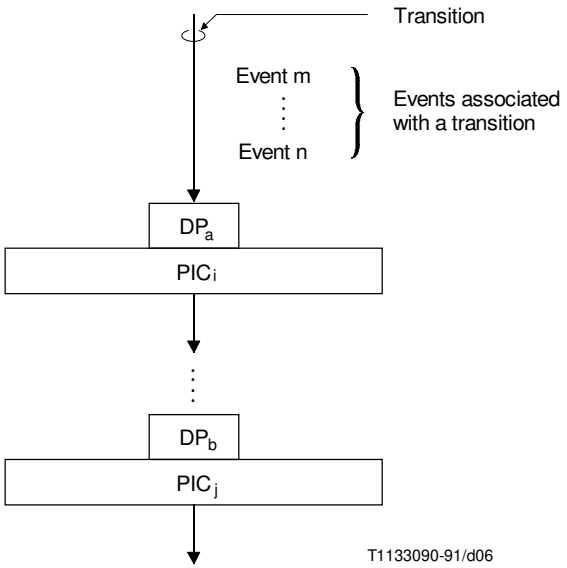


FIGURE A.1/Q.1204

BCSM components

Given a target description of a BCSM using these components, different subsets of PICs, DPs, transitions, and events can be identified to align with specific capability sets as they are defined. In addition, though CCAF functionality is not explicitly modelled in the BCSM, a mapping is required between access signalling events and BCSM events, for each access arrangement supported by a given capability set. Since the BCSM is generic, it may describe events that do not apply to certain access arrangements. It is important to understand how each access arrangement applies to the BCSM, and may be desirable to show in separate representations the aspects of the BCSM that apply to each arrangement.

An example of an overall BCSM for existing switch processing of a basic two-party call is described in this subclause and is illustrated in Figures A.2 and A.3. The example does not imply the aspects of the BCSM that are visible to IN service logic instances, or the nature of the information flows between the SSF/CCF and SCF. This example may not represent the ultimate evolution of the BCSM for CS-N, but does provide a starting point for identifying PICs and DPs for a given capability set, based on service requirements.

A.2 Example BCSM description

In the following descriptions, the PICs are related at a high level to Q.931 ISDN Call States. This is not intended to be a detailed formal definition of the relation between the PICs and Q.931 ISDN Call States, but is intended as a point of reference to use in understanding the PICs. In particular, there are a number of possible ways in which the Q.931 call states may be traversed in certain situations which are not considered below.

In order to maintain uniqueness of DP names between the originating and terminating half BCSMs, "O" and "T" is prefixed to certain originating and terminating DP names, respectively.

Certain PICs correspond to switch-based service feature functionality, and thus are not ubiquitous among all switching systems. They are denoted "optional" to reflect the current understanding. For future capability sets, it may be desirable to incorporate this functionality fully into the BCSM, depending on the benchmark set of services for given capability sets.

For ease of reference, the DPs associated with the transition implied by each entry and exit event for each PIC are listed along with the PIC descriptions. Any exit event detected in PIC processing is for further study.

a) *Example originating BCSM*

The originating half of the BCSM corresponds to that portion of the BCSM associated with the originating party. It is shown in Figure A.2. The description for each of the PICs in the originating half of the BCSM are described below:

1. O_Null

   Entry event: Disconnect and clearing of a previous call. (DPs 20 – O_Disconnect_Complete or 21 – O_Abandon & O_Calling_Party_Disconnect)

   Function: Interface (line/trunk) is idled (no call exists, no call reference exists, etc.). Supervision is being provided.

   Exit event: Indication of desire to place outgoing call received from originating party (e.g. offhook, Q.931 Setup message, ISDN–UP IAM message). (DP 1 – Origination_Attempt)

   Corresponding Q.931 call state: 0. Null.

2. Authorize_Origination_Attempt (optional)

   Entry event: Indication of desire to place outgoing call received from originating party. (DP 1 – Origination_Attempt)

   Function: Authority/ability of originating party to place outgoing call with given properties (e.g. bearer capability, line restrictions) is being verified. The types of authorization to be performed may vary for different types of originating resources (e.g. for lines vs. trunks).

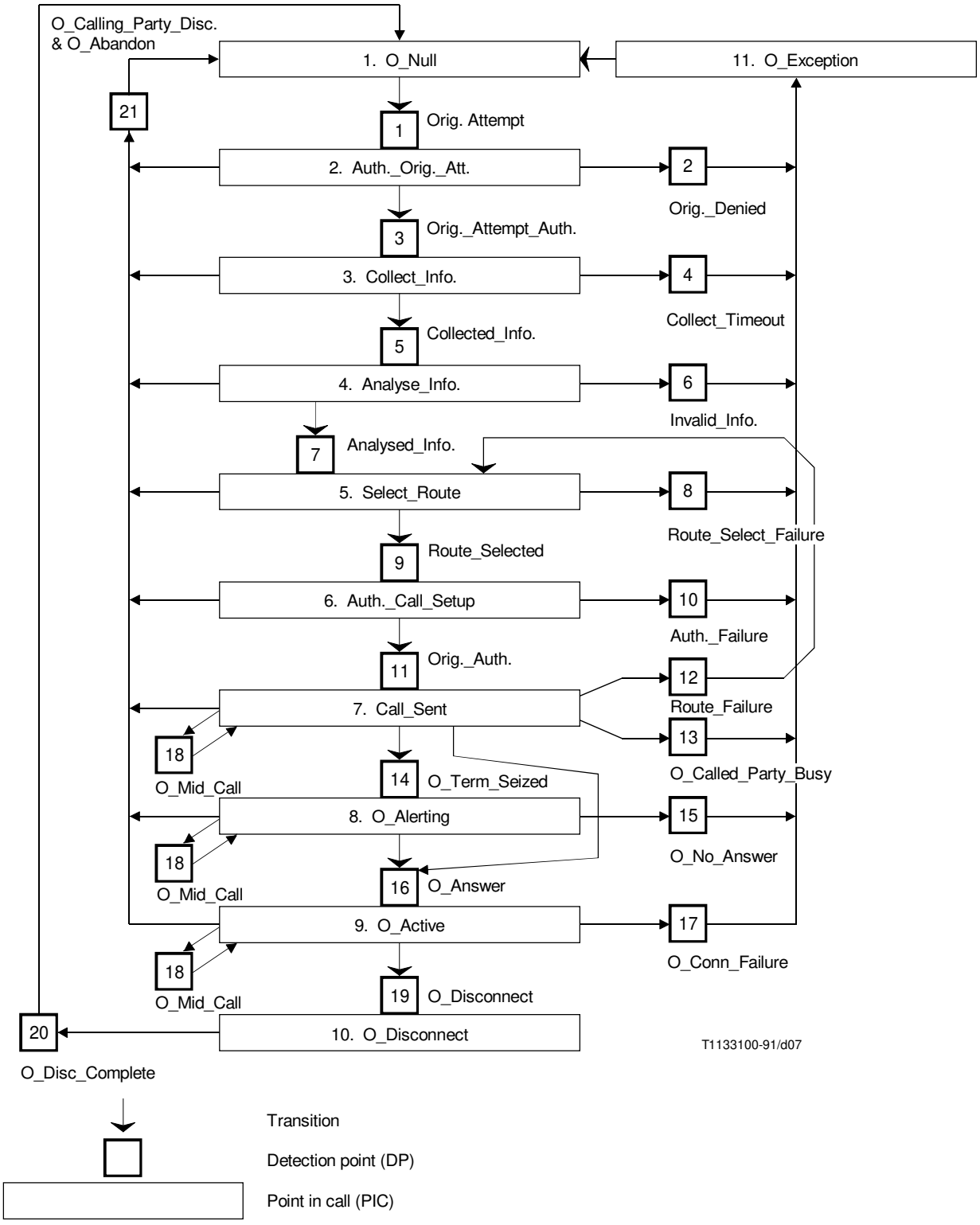


FIGURE A.2/Q.1204

Example originating BCSM

Exit events:

– Authority/ability to place outgoing call denied. (DP 2 – Origination_Denied)

– Authority/ability to place outgoing call verified. (DP 3 – Origination_Attempt_Authorized)

– Originating party abandons call. (DP 21 – O_Abandon & O_Calling_Party_Disconnect)

NOTE – Originating party abandon may not be detected until the end of processing for this PIC, since this PIC may be processed in an atomic manner (i.e. processing cannot be interrupted) for some implementations.

Corresponding Q.931 call state: Not Applicable.

3. Collect_Information

Entry event: Authority/ability to place outgoing call verified.
(DP 3 – Origination_Attempt_Authorized)

Function: Initial information package/dialling string (e.g. service codes, prefixes, dialled address digits) being collected from originating party. Information being examined according to dialling plan to determine end of collection. No further action may be required if an en bloc signalling method is in use (e.g. an ISDN user using en bloc signalling, an incoming SS No. 7 trunk).

Exit events:

– Information collection error has occurred (e.g. invalid dial string format, digit collection timeout). (DP 4 – Collect_Timeout)

– Availability of complete initial information package/dialling string from originating party. (This event may have already occurred in the case of en bloc signalling, in which case the waiting duration in this PIC is zero.) (DP 5 – Collected_Info)

– Originating party abandons calls. (DP 21 – O_Abandon & O_Calling_Party_Disconnect)

NOTE – Some digit analysis is required to determine the end of dialing. However, it is assumed that this analysis may be modelled as separable from the rest of digit analysis, which occurs in PIC 4, Analyse_Information. There is no intention to specify an implementation. However, a switch should externally present the separable view described for closed numbering plans.[1)]

Corresponding Q.931 call state: 1. call initiated and (optionally) 2. Overlap sending.

4. Analyse_Information

Entry event: Availability of complete initial information package/dialling string from originating party. (DP 5 – Collected_Info)

Function: Information being analysed and/or translated according to dialling plan to determine routing address and call type (e.g. local exchange call, transit exchange call, international exchange call).

Exit events:

– Unable to analyse and translate dial string in the dialling plan (e.g. invalid dial string). (DP 6 – Invalid_Info)

– Availability of routing address and call type. (DP 7 – Analysed_Info)

– Originating party abandons call. (DP 21 – O_Abandon & O_Calling_Party_Disconnect)

NOTE – The routing address does not necessarily mean that the final physical route has been determined (e.g. route list has not been searched, hunt groups have not yet been searched, directory number has not yet been translated to physical port address), though this may be the case (e.g. when routing to a specific private facility).

Corresponding Q.931 call state: Not applicable.

---

1) This separable view is provided by supporting distinct DPs for DP 5 (Collected_Info) and DP 7 (Analysed_Info), and by populating information flows accordingly for corresponding TDP and EDP information flows to the SCF.

5. Select_Route

   Entry events:

   – Availability of routing address and call type. (DP 7 – Analysed_Info)

   – Unable to complete call using specified route (e.g. congestion). (DP 12 – Route_Failure)

   Function: Routing address and call type being interpreted. The next route is being selected. This may involve sequentially searching a route list, translating a directory number into physical port address, etc. The individual destination resource out of a resource group (e.g. a multi-line hunt group, a trunk group) is not selected. In some cases (e.g. an analogue line interface), a single resource (not a group) is selected.

   Exit events:

   – Unable to select a route (e.g. unable to determine a correct route, no more routes on route list). (DP 8 – Route_Select_Failure)

   – Terminating resource (group) to which call should be routed has been identified. (DP 9 – Route_Selected)

   – Originating party abandons call. (DP 21 – O_Abandon & O_Calling_Party_Disconnect)

   Corresponding Q.931 sall state: Not applicable.

6. Authorize_Call_Setup (optional)

   Entry event: Terminating resource (group) to which call should be routed has been identified. (DP 9 – Route_Selected)

   Function: Authority of originating party to place this particular call being verified (e.g. checking business group restrictions, toll restrictions, route restrictions). The types of authorization checks to be performed may depend upon the type of originating resource (e.g. line vs. trunk).

   Exit events:

   – Authority of originating party to place this call is denied (e.g. business group restriction mismatch, toll restricted calling line). (DP 10 – Authorization_Failure)

   – Authority of originating party to place this call verified. (DP 11 – Origination_Authorized)

   – Originating party abandons call. (DP 21 – O_Abandon & O_Calling_Party_Disconnect)

   Corresponding Q.931 call state: Not applicable.

7. Call_Sent

   Entry event: Authority of originating party to place call verified. (DP 11 – Origination_Authorized)

   Function: Call is being processed by the terminating half BCSM. The originating half BCSM is awaiting some indication that the call has been presented to the called party.

   Exit events:

   – Indication from terminating half BCSM that the call cannot be presented to the terminating party (e.g. network congestion). (DP 12 – Route_Failure)

   – Indication from terminating half BCSM that the terminating party is busy. (DP 13 – O_Called_Party_Busy)

   – Indication from terminating half BCSM that the terminating party is being alerted. (DP 14 – O_Term_Seized)

– Indication from terminating half BCSM that the call is accepted and answered by terminating party (e.g. terminating party goes offhook, Q.931 connect message received, ISDN-UP answer message received). (DP 16 – O_Answer)

– A service/service feature request is received from the originating party (e.g. hook flash, ISDN feature activator, Q.931 HOLD or RETrieve message). (DP 18 – O_Mid_Call)

– Originating party abandons call. (DP 21 – O_Abandon & O_Calling_Party_Disconnect)

Corresponding Q.931 call state: Not applicable.

8. O_Alerting

Entry event: Indication from terminating half BCSM that the terminating party is being alerted of incoming call. (DP 14 – O_Term_Seized)

Function: Continued processing of call setup (e.g. ringing, audible ring indication) is taking place. Waiting for indication from terminating half BCSM that the call has been answered by terminating party.

Exit events:

– Indication from terminating half BCSM that the terminating party does not answer within a specified time period. (DP 15 – O_No_Answer)

– Indication from terminating half BCSM that the call is accepted and answered by terminating party (e.g. terminating party goes offhook, Q.931 connect message received, ISDN-UP answer message received). (DP 16 – O_Answer)

– A service/service feature request is received from the originating party (e.g. hook flash, ISDN feature activator, Q.931 HOLD or RETrieve message). (DP 18 – O_Mid_Call)

– Originating party abandons call. (DP 21 – O_Abandon & O_Calling_Party_Disconnect)

NOTE – For terminations to SS No. 7 trunk groups, this PIC is entered upon the receipt of an address complete (ACM) message.

Corresponding Q.931 call state: 4. call delivered.

9. O_Active

Entry event: Indication from terminating half BCSM that the call is accepted and answered by terminating party. (DP 16 – O_Answer)

Function: Connection established between originating and terminating party. Message accounting/charging data may be being collected. Call supervision is being provided.

Exit events:

– A connection failure occurs. (DP 17 – O_Connection_Failure)

– A service/service feature request is received from the originating party (e.g. DTMF, hook flash, ISDN feature activator, Q.931 HOLD or RETrieve message). (DP 18 – O_Mid_Call)

– A disconnect indication (e.g. onhook, Q.931 disconnect message, SS No. 7 release message) is received from the originating party. (DP 21 – O_Abandon & O_Calling_Party_Disconnect)

– A disconnect indication (e.g. onhook, Q.931 disconnect message, SS No. 7 release message) is received from the terminating party via the terminating half BCSM. (DP 19 – O_Disconnect)

NOTE – A terminating party may disconnect then reconnect before the expiration of disconnect timing. In this case, the call is considered to remain in the O_Active PIC.

Corresponding Q.931 sall state: 10. active.

10. O_Disconnect

    Entry event: A disconnect indication is received from the terminating party via the terminating half BCSM. (DP 19 – O_Disconnect)

    Function: disconnect treatment is being applied.[2)]

    Exit Event: Completion of disconnection of call (e.g. expiration of disconnect timing, resources idled). (DP 20 – O_Disconnect_Complete)

    NOTE – Disconnect indications and treatment are asymmetrical in the way disconnect timing is applied. Disconnect treatment and timing is different for call attempts originating from ISDN and analogue line interfaces.

    Corresponding Q.931 call states: 11. Disconnect request, 12. Disconnect indication and 19. Release request.

11. O_Exception

    Entry event: An exception condition is encountered (DPs 2, 4, 6, 8, 10, 13, 15, and 17 as described above).

    Function: Default handling of the exception condition is being provided. This includes general actions necessary to ensure no resources remain inappropriately allocated, such as:

    – If any relationships exist between the SSF and SCF(s), send an error indication to the SCF(s) closing the relationships and indicating that any outstanding call handling instructions will not run to completion.
    – If an SCF previously requested that call parameters be provided at the end of the call (e.g. for logging purposes), these should be included in the error information flow.
    – The SSF/CCF should make use of vendor-specific procedures to ensure release of resources within the SSF/CCF so that line, trunk, and other resources are made available for new calls.

    Exit event: Default handling of the exception condition by SSF/CCF completed (Transition to O_Null).

b) *Example terminating BCSM*

The terminating half of the BCSM corresponds to that portion of the BCSM associated with the terminating party. It is shown in Figure A.3. The description for each of the PICs in the terminating half of the BCSM are described below:

12. T_Null

    Entry event: Disconnect and clearing of a previous call.
    (DPs 34 – T_Disconnect_Complete or 35 – T_Abandon & T_Calling_Party_Disconnect)

    Function: Interface (line/trunk) is idled (no call exists, no call reference exists, etc.) Supervision is being provided.

    Exit event: Indication of incoming call received from originating half BCSM.
    (DP 22 – Termination_Attempt)

    Corresponding Q.931 call state: 0. Null.

13. Authorize_Termination_Attempt (optional)

    Entry event: Indication of incoming call received from originating half BCSM.
    (DP 22 – Termination_Attempt)

    Function: Authority to route this call to terminating party is being verified (e.g. business group restrictions, restricted incoming access to line, bearer capability compatibility). (This PIC may not be applicable for terminations to trunks.)

---

2) If the terminating party disconnected (i.e. an indication of terminating party disconnect is received from the terminating half BCSM), then disconnect timing may be applied by the terminating half BCSM (if the terminating party is not an ISDN station).

Exit events:

– Authority to route call to specified terminating resource (or group) denied.
(DP 23 – Termination_Denied)

– Authority to route call to a specified terminating resource (or group) verified.
(DP 24 – Termination_Authorized)

– Indication of originating party abandon received from originating half BCSM.
(DP 35 – T_Abandon & T_Calling_Party_Disconnect)

NOTE – Originating party abandon may not be detected until the end of processing for this PIC, since this PIC may be processed in an atomic manner (i.e. processing cannot be interrupted) for some implementations.

Corresponding Q.931 call state: Not applicable.

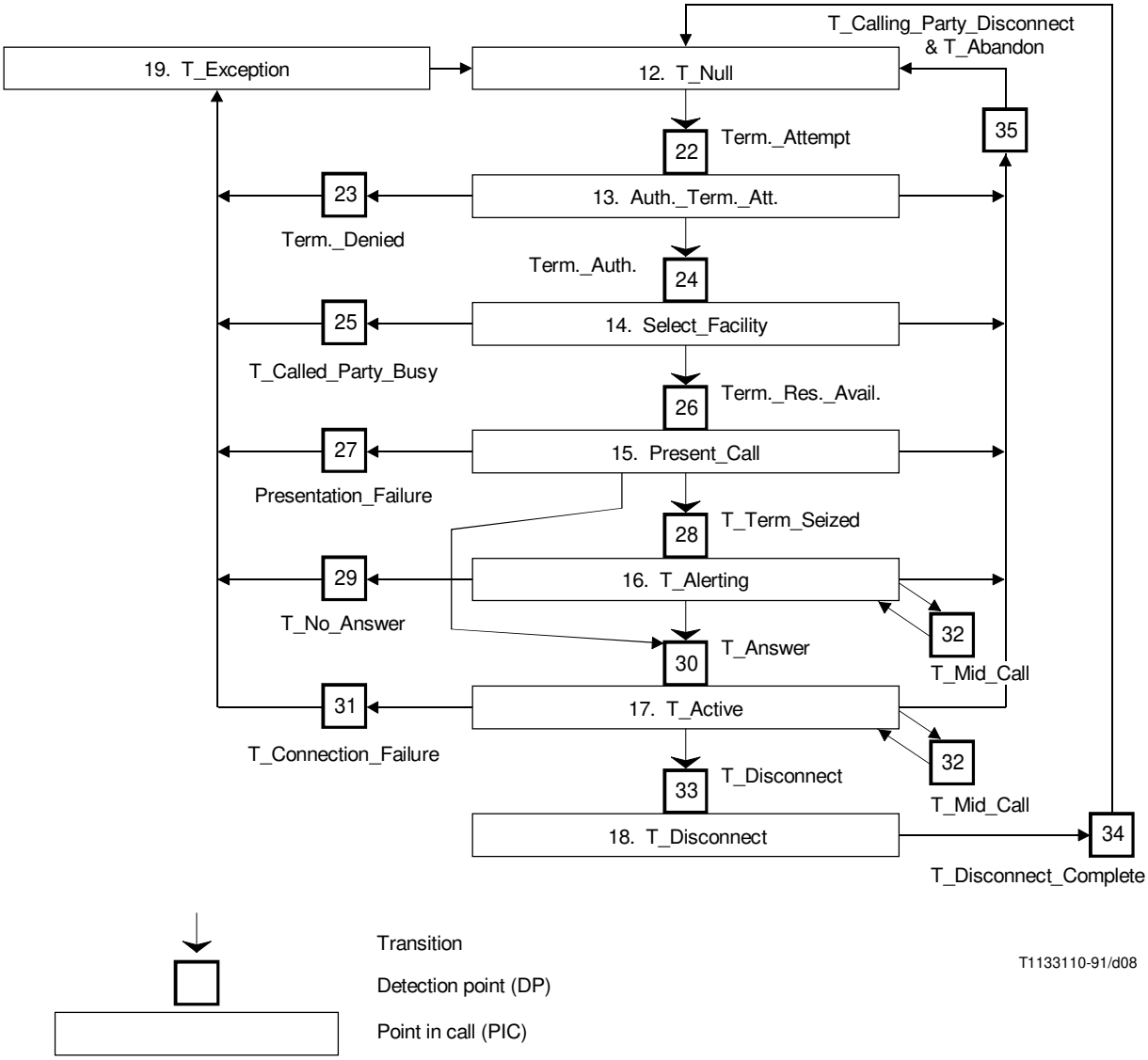


FIGURE A.3/Q.1204

Example terminating BCSM

14. Select_Facility

Entry event: Authority to route call to specified terminating resource group verified. (DP 24 – Termination_Authorized)

Function: A particular available resource in the specified resource group is being selected. It is possible that all resources in the group could be busy. A single resource is treated as a group of size 1.

Exit events:

– All resources in group busy or called party busy. (DP 25 – T_Called_Party_Busy)

– Available terminating resource in resource group identified. (DP 26 – Terminating_Resource_Available)

– Indication of originating party abandon received from originating half BCSM. (DP 35 – T_Abandon & T_Calling_Party_Disconnect)

Corresponding Q.931 call state: Not applicable.

15. Present_Call

Entry event: Available terminating resource identified. (DP 26 – Terminating_Resource_Available)

Function: Terminating resource informed of incoming call (e.g. line seizure, Q.931 Setup message, ISDN-UP IAM message). In the case of an analogue line, ringing is being applied.

Exit events:

– Cannot present call (e.g. ISDN user determined busy, ISDN-UP release message with busy cause) (DP 27 – Presentation_Failure)

– Terminating party is being alerted (e.g. ringing being applied, Q.931 Alerting message, ISDN-UP ACM message). In the case of an analogue line, this event should occur almost instantly after entering this PIC. (DP 28 – T_Termination_Seized)

– Call is accepted and answered by terminating party (e.g. terminating party goes offhook, Q.931 connect message received, ISDN-UP answer message received). (DP 30 – T_Answer)

– Indication of originating party abandon. (DP 35 – T_Abandon & T_Calling_Party_Disconnect)

Corresponding Q.931 call state: 6. Call present.

16. T_Alerting

Entry event: Terminating party is being alerted of incoming call. (DP 28 – T_Termination_Seized)

Function: An indication is sent to the originating half BCSM that the terminating party is being alerted. Continued processing of call setup (e.g. ringing, audible ring indication) is taking place. Supervision is waiting for the call to be answered by terminating party.

Exit events:

– Terminating party does not answer within a specified duration. (DP 29 – T_No_Answer)

– Call is accepted and answered by terminating party (e.g. terminating party goes offhook, Q.931 connect message received, ISDN-UP answer message received). (DP 30 – T_Answer)

– A service/service feature request is received from the terminating party (e.g. hook flash, ISDN feature activator, Q.931 HOLD or RETrieve message). (DP 32 – T_Mid_Call)

– Indication of originating party abandon received from originating half BCSM. (DP 35 – T_Abandon & T_Calling_Party_Disconnect)

NOTE – This PIC is not applicable when terminating to a non-SS No. 7 trunk group. For terminations to SS No. 7 trunk groups, this PIC is entered upon the receipt of an address complete (ACM) message.

Corresponding Q.931 call states: 7. Call received and 8. Connect request.

17. T_Active

Entry events: An indication is sent to the originating half BCSM that the terminating party has accepted and answered the call (e.g. terminating party goes offhook, Q.931 connect message received, ISDN-UP answer message received). (DP 30 – T_Answer)

Function: Connection established between originating and terminating party. Call supervision is being provided.

Exit events:

– A connection failure occurs. (DP 31 – T_Connection_Failure)

– A service/service feature request is received from the terminating party (e.g. DTMF, hook flash, ISDN feature activator, Q.931 HOLD or RETrieve message). (DP 32 – T_Mid_Call)

– A disconnect indication (e.g. onhook, Q.931 disconnect message, SS No. 7 release message) is received from the terminating party. (DP 33 – T_Disconnect)

– A disconnect indication (e.g. onhook, Q.931 disconnect message, SS No. 7 release message) is received from the originating party via the originating half BCSM. (DP 35 – T_Abandon & T_Calling_Party_Disconnect)

NOTE – A terminating party may disconnect then reconnect before the expiration of disconnect timing. In this case, the call is considered to remain in the T_Active PIC.

Corresponding Q.931 call state: 10. Active.

18. T_Disconnect

Entry event: A disconnect indication is received from the terminating party.
(DP 33 – T_Disconnect)

Function: Disconnect treatment being applied. This includes disconnect timing for non-ISDN calls.

Exit events:

– Completion of disconnection of call. (DP 34 – T_Disconnect_Complete)

NOTE – Disconnect indications and treatment are asymmetrical in the way disconnect timing is applied.

Corresponding Q.931 call states: 11. Disconnect request, 12. Disconnect indication, and 19. Release Request.

19. T_Exception

Entry event: An exception condition is encountered (DPs 23, 25, 27, 29, and 31 as described above).

Function: An indication of the exception condition is sent to the originating half BCSM. Default handling of the exception condition is being provided. This includes general actions necessary to ensure no resources remain inappropriately allocated, such as:

– If any relationships exist between the SSF and SCF(s), send an error information flow to the SCF(s) closing the relationships and indicating that any outstanding call handling instructions will not run to completion.

– If an SCF previously requested that call parameters be provided at the end of the call (e.g. for logging purposes), these should be included in the error information flow.

– The SSF/CCF should make use of vendor-specific procedures to ensure release of resources within the SSF/CCF so that line, trunk, and other resources are made available for new calls.

Exit event: Default handling of the exception condition by SSF/CCF completed. (Transition to T_Null).

Annex B

Object-oriented finite state machine modelling

(This annex forms an integral part of this Recommendation)

B.1 A finite state machine (FSM) model is an operational (dynamic) model of a system that is described by the finite set of states the system can be in and the finite set of transitions possible from one state to another state. Specific operations or activities being performed by the system at a given point in time are associated with specific states. Specific inputs to or outputs from a given state (referred to as events) are associated with each transition from one state to another state. For a given event, the transition from one state to another will always be the same (i.e. the FSM model is deterministic).

To describe a system in terms of an FSM model, it is first necessary to characterize the state of the system. Object-oriented techniques provide a means to do so by first characterizing the system as a set of one or more objects that represent the system properties of interest. These abstract objects are each described in terms of the unique characteristics they represent (referred to as attributes) and the actions that can manipulate those objects (referred to as functions). As a result, the objects are modular, autonomous entities that can be freely combined and reused. In addition, their description can be at an appropriate level of abstraction to hide the technical complexity, physical details, and evolution of the underlying technology of the system.

Given the set of objects that characterize the system (e.g. legs and connection points), the state of the system and its operation can be described. For a given instance of an object, its attributes have specific values which can be constant (i.e. static) or variable (i.e. dynamic). The state of an object instance is defined by the values of its attributes at a given point in time. The state of a system is then defined by the set of states of its objects. The operation of the system can then be described in terms of an FSM model, given that transitions are defined as changes in the values of object attributes, which changes the state of the system. Transitions occur when events cause the system to perform functions that change the values of object attributes.

The benefits of the object-oriented FSM modelling approach are as follows:

a) it provides a means of completely characterizing a system in terms of a set of modular objects, and its operation in terms of a finite set of well-defined states and transitions;

b) it allows the system to be described at an appropriate level of abstraction to model the objects, attributes, functions, and events of interest;

c) it provides an external (observable) view of a system in terms of the functions it performs in response to events, a view which hides the implementation details of how the system performs these functions;

d) it can be formally specified.

An object-oriented FSM modelling approach is in general appropriate whenever an external view of a system is desired (i.e. the view of an SSF from an SCF). In particular, it is useful in describing a relationship or an information flow between systems, and is often used to describe protocol machines at a system interface (where protocol messages serve as events). The benefits of this FSM modelling approach serve to meet the general modelling objectives/criteria described in 3.2. In particular, it helps to:

e) provide a high-level, vendor/implementation independent abstraction of call/service processing functions;

f) present an observable view of an SSF to an SCF;

g) provide a framework for defining the information flows between the SSF and SCF;

h) provides a framework for ensuring the correct sequencing of functions within an SSF.

The following methodology can be applied to define IN object types in keeping with an object-oriented FSM modelling approach.

B.1.1 Step 0 – Identification of IN object type

IN object types are identified based on the following rules:

a) IN object types should be identified to represent the physical resources of interest (i.e. physical resources accessible via an interface);

b) separate IN object types should be identified for physical resources whose behaviour is represented by different sets of IN object states and/or different IN object state transitions;

B.1.2 Step 1 – Definition of IN object types

IN object types are defined in terms of functionality and physical resource mapping. The functionality and physical resource mapping should be expressed in terms of both the attributes that characterize the resource and the functions that manipulate the resource.

B.1.3 Step 2 – State description of IN object types

The state of an IN object type is defined in terms of the values of its attributes. The values of the attributes at a given point in time define the state of an IN object. The allowed range and combination of attribute values should be described to define the set of possible states for an IN object type.

B.1.4 Step 3 – IN object type functional message definition

An IN object type functional message invokes a single IN object function or a set of IN object functions. IN object functions can cause transitions from one IN object state to another by changing the values of IN object attributes. Functional messages should be defined for an IN object type to invoke each IN object function or set of functions of interest.

B.1.5 Step 4 – IN object type state transitions

IN object type state transitions are caused by IN object functions in response to IN object functional messages. SDL diagrams should be developed to describe the state transitions of IN object types in response to functional messages.

Annex C

Call segment model

(This annex forms an integral part of this Recommendation)

C.1 Call segment model components

An overall representation of a call is useful to understand how the SSF/CCF views and manages a call. A call segment model (CSM) provides such a representation. The components of the CSM that have been identified include access segments, basic call segments, feature segments and links. Figure C.1 illustrates these components. Access segments represent external access points into or out of an entity containing SSF/CCF functionality (e.g. line or trunk access arrangements). Basic call segments represent the relationship between access arrangements (as supported by switching and transmission resources and described by the BCSM). As such, there are basic call segments between access segments. Since functional separation is maintained between originating and terminating basic call segments, these segments provide a means to isolate one end user's call/service processing from another (to maintain single-ended control), and to manage signals propagating from one access segment to another. A feature segment corresponds to an instance of service logic invoked on behalf of a particular end user. It is inserted between the access segment and basic call segment associated with the end user. Links represent the signalling and transmission paths between segments.

In the process of establishing and maintaining a call and invoking instances of service logic relative to the call, segments are chained together, inserted, and deleted, as appropriate.

C.2 Local/global SCF view of call/connection processing

It is recognized that the SCF can have a local view of call/connection processing via an interaction with a single SSF, but can also have a global or network view of call/connection processing via interactions with multiple SSFs. The CSM can be used to illustrate these views, as shown in Figure C.2. In the local view, an SLP instance in an SCF is shown interacting with a single feature segment on a call. In the global view, an SLP instance in an SCF (or pair of communicating SLP instances in one or more SCFs) is shown interacting with multiple feature segments on a call.

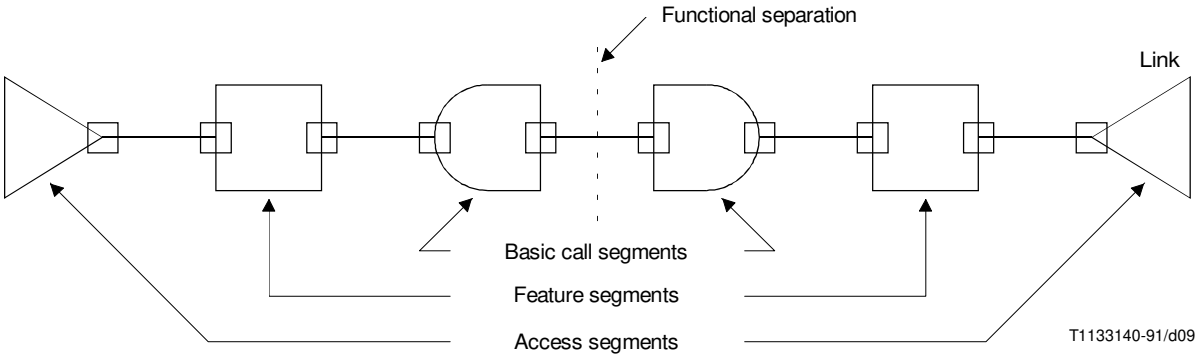


FIGURE C.1/Q.1204

CSM components

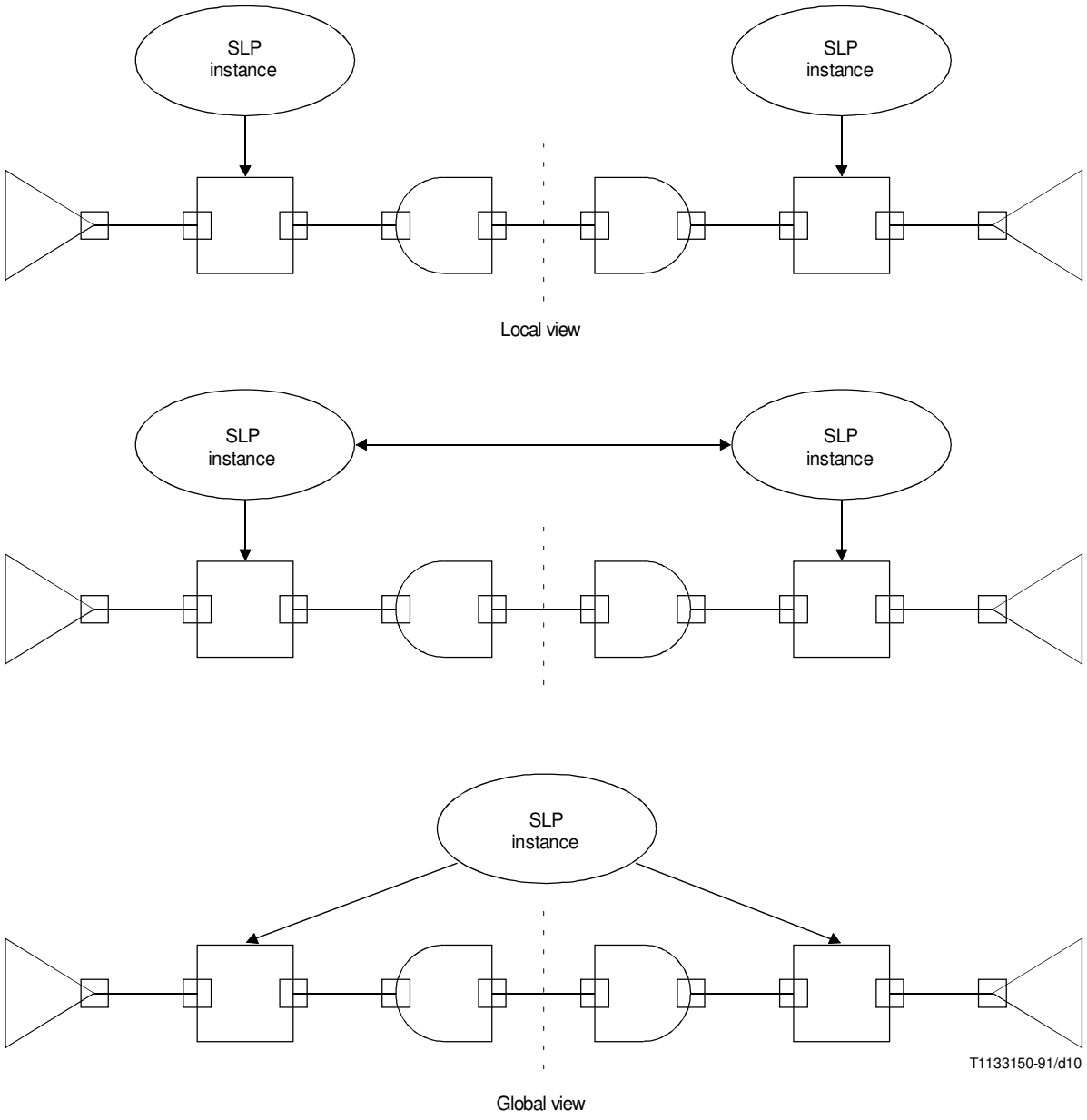


FIGURE C.2/Q.1204

Local/global SCF view of call/connection processing