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Intelligent Network - ISDN Interworking Call Model

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Titel : Intelligent Network - ISDN Interworking Call Model

Excerpt : Het Intelligent Network (IN) en het Integrated Services Digital Network (ISDN) zijn beiden grotendeels gestandaardiseerd. Naar de toepassing van het IN-concept op ISDN is echter nog onvoldoende onderzoek verricht. De interactie tussen IN-diensten en ISDN supplementaire diensten is een belangrijk onderdeel van de integratie van de IN- en ISDN-architecturen.
In dit rapport wordt de toevoeging van IN-functionaliteit aan de ISDN basic call behandeld op basis van een nieuw IN-ISDN functioneel model. De uitbreiding van dit model wordt besproken aan de hand van de ISDN-dienst "Closed User Group" en de IN-dienst "Universal Personal Telecommunication". Ook worden onderwerpen voor verdere studie geïdentificeerd.

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Trefwoorden : Intelligent Networks (IN), ISDN, call model, SDL, interworking, supplementary services, standaardisatie

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Management Summary

The Intelligent Network (IN) and the Integrated Services Digital Network (ISDN) are two architectures that have been progressing quickly the last years. Unfortunately, the co-ordination between the developments of these architectures has been poor. The result is that at the moment there is no clear specification of the interaction between IN and ISDN. One of the activities of the project "Integratie van Architecturen" is to make the interaction between IN and ISDN work. This holds for the interaction on transit exchange level as well as for the interaction on local exchange level. Furthermore, the interaction between ISDN supplementary services and IN services is studied. The studies on this type of interaction were directed at avoiding negative interaction between those services. Especially the interactions on a transit level have been taken into account.

The study described in this report concerns the interaction in a local exchange. Within standardization bodies the studies on this interaction are in the starting phase. During the studies done for this graduation project, it is decided to gear together the Recommendations on the ISDN basic call and supplementary services (Q.71), and the Recommendations on the "triggering" of IN services (Q.1214), within the scope of IN Capability Set 1. This is important for PTT Telecom when the IN concept should be applied to an underlying ISDN.

This report provides useful information for the discussion on the integration of IN and ISDN in the relevant standardization groups of ITU-T and ETSI. The results of this study should be used as a starting point for a better gearing of the IN and ISDN Recommendations.

Technical Summary

This report describes the integration of the Intelligent Network (IN) concept and the Integrated Services Digital Network (ISDN). The purpose is to support the search for a solution to the problem described by constructing a model with which solutions to the interworking problem can be examined. The final target is to come to recommendations that add to the solution of the IN-ISDN interworking problem.

The basic principles of ISDN, as far as they are needed for this report, are explained with emphasis on the ISDN supplementary services and functional models. The IN is described generally, focussing on the Distributed Functional Plane description with the Originating and Terminating Basic Call State Models.

The IN-ISDN interworking is considered first from the point of view of services. After that, the problem is exemplified with the Closed User Group (CUG) and Universal Personal Telecommunication Service (UPT). A detailed consideration of the functional descriptions of the two network architectures is presented. The resulting combined IN-ISDN functional differs from the IN DFP model because the ISDN supplementary services control entities are included in the model. The model is described in the Specification and Description Language (SDL).

An examination of the "IN-simulator" and the "AXE-model" leads to the conclusion that they are not simply suitable for the study of the interaction of IN services and ISDN supplementary services. It is decided to concentrate on the originating local exchange of the combined IN-ISDN model and depart from the ISDN procedures for basic call set-up and release, described in ITU Recommendation Q.71. By inserting IN detection points in the ISDN basic call process, a Basic IN-ISDN Model is constructed. This model is suitable for the analysis of the interworking of IN and the ISDN basic call. A detailed description of the IN points in call (PICs) and detection points (DPs) in relation to ISDN basic call set-up and release procedures is obtained.

In the Extended IN-ISDN model a part of the UPT functionality is added, and the "hooks" for the CUG service are included in the basic call procedures. The consideration of IN and ISDN services "triggering" leads to ideas about general service trigger management. These ideas are presented in this report and seem to be a step in the right way to the solution of the IN-ISDN service interaction problems.

Preface

This is the report on my final project done as part of the electrical engineering studies at the Eindhoven University of Technology. During nine months in 1994, I worked at the Dr. Neher Laboratories of PTT Research in Leidschendam. For me this was a great opportunity to get familiar with the way of working in a big company and doing research on the relatively new area of Intelligent Networks.

I thank prof. ir. De Stigter for taking the responsibility for my graduation project and adjusting my planning when necessary. I really enjoyed working in his department. Richard Sturrus was in control of my supervision and helped me very well in solving the difficulties I came accross. He was a nice person speaking to during the many discussions we had. Thank you very much Richard!

Thanks to all the colleagues who were always ready to help, the working atmosphere very was pleasant. Next to them, the other students doing their graduation project or practical traineeship added greatly to the nice time I had at PTT Research.

I cannot refrain from thanking some persons that hold important positions in my private life. I am most grateful to my parents who encouraged me to study and made it possible for me to join study tours and practical traineeships abroad. I promise to make life even more enjoyable for my girlfriend, after spending many hours behind the computer screen at home to finish this report in time. Thanks for your support Rachel!

November 1994
Edwin Nieuwenhuyse

Contents

1 Introduction

A 'plain telephone call' used to be the only service the telecommunication operators offered. With the increase in telephone traffic however, the demand for extra services also increased. Nowadays, telecommunication operators are confronted with competition from other suppliers. They have to be fast in offering new services to be able to keep a good position at the telecommunication market. When the number of supplementary services increases, the chance of interaction between services increases as well.

The kinds of services we talk about are for example *Call Forwarding*, *Premium Rate*, *Virtual Private Network*, *Calling Line Identification*, etc. At first sight these *supplementary services* do not interact with each other. However, a closer look will show the opposite. Let us therefore take two services as an example. The first is *Universal Personal Telecommunication* (UPT) and the second *Call Forwarding Unconditional* (CFU).

UPT is a service that offers, among other things, the possibility to the subscriber to register at any ISDN terminal. When registered, all incoming calls to the UPT user will be presented to the registered terminal until deregistration.

The CFU supplementary service permits a served user to have the network send all incoming calls addressed to the served user's ISDN number to another number.

What happens if the CFU is activated at the terminal at which the UPT user is registered? When somebody calls the UPT user, the call is routed to the other terminal specified by the CFU service and the UPT user might not be reached.

The cause of this service interaction problem lies in the structure of the network. UPT and CFU are not of the same kind of services. UPT is an Intelligen Network (IN) service and CFU is an Integrated Service Digital Network (ISDN) supplementary service. To understand the difference between the two, one has to know more about IN and ISDN.

The ISDN will be a worldwide digital public telecommunications network that can handle telephone, data, and other services. It provides teleservices like telephony, teletex, telefax, videotex, and telex.

The IN always uses an underlying network. This can be the Public Switched Telephone Network (PSTN) but also the ISDN. The IN provides a set of additions to the underlying network that makes it possible to develop new services at a centralized computer platform and provide them from this platform. New services can be offered much faster with this structure than with the use of the conventional networks.

In the example the UPT service is offered by the IN. What happens is in fact that the IN modifies ISDN messages. In case a person calls a UPT user, ISDN sends a call set-up message with the UPT number. The IN recognizes the number as being a UPT number and translates this number to the terminal address at which the UPT user is registered. After that the address is passed to ISDN, which subsequently routes the call to the specific terminal, or forwards the call to another terminal in the case of CFU. At this time, ISDN handles call control and IN is not informed about the signalling anymore. Because of this, IN does not have influence on the call forwarding that might occur at the destination terminal.

This example illustrates the problems that could occur when IN services as well as ISDN supplementary services are activated in the same call. Another possibility is that IN services could take advantage of existing ISDN supplementary services. In this case the co-operation of services has positive effects and is called synergy. UPT service profile modification could for example be simplified by using the User-to-User Signalling (UUS) supplementary service. In that case, in stead of in-band audible information, a menu could be presented to the UPT user on the ISDN terminal.

Most of the properties of IN and ISDN are recorded in standards, but the relation between the two is not yet fully investigated. There has been an investigation of the integration of IN with ISDN, with regard to the ISDN basic call, because IN is based on the ISDN. The co-operation of the supplementary services however has not been worked out. A study of the control of supplementary services is thus necessary.

A way to show inadequacies is to build a model that simulates the cooperation of the two protocols. An important issue is that one can use the model to test possible solutions. The complexity of interworking requires the use of a formal specification method.

1.1 Problem definition and purpose

The ISDN and the IN both offer supplementary services. The relation between the two has not been fully investigated. Interworking could lead to positive as well as negative effects. The interworking problem is very complex and cannot be solved at once. All the more so because new services increase the complexity: Each time a new service is added, the interworking problem is extended. Parts of specific solutions that are found do not necessarily lead to solutions in practice and one should look as early as possible whether an end solution is feasable. Therefore, there is a need for a test environment.

It looks like a model is necessary with which the interworking problems can be studied. A requirement on the model is that it allows additions of new services to simplify the treatment of future problems.

The purpose of the project is to

1) Support the search for a solution to the problem described by constructing a model with which solutions can be examined. This model can be based on an existing model. In this case, the original model has to be studied to determine its suitability. The model can also be completely new.

2) Demonstrate the working of the model by a 'case'. This case constists of a modelled IN-service (to be chosen) and some ISDN supplementary services. The working and interactions of these services have to be made clear by the model.

3) Find solutions to the detected interworking problems.

4) Demonstrate the results, by using for example message sequence charts.

5) Come to recommendations for the adjustment of the IN and ISDN with which confronted problems will be solved.

6) Come to recommendations that add to the solution of the IN - ISDN interworking problem in general.

1.2 Report outline

This report describes the search for the solution of the problem described previously in this introductory chapter. It is outlined as follows:

To introduce the reader in the main aspects of ISDN and IN we devote two chapters to them. In these chapters we will concentrate on the aspects that are important for the understanding of the rest of the report. Readers that are already familiar with ISDN and IN might skip these two chapters and go directly to chapter 4. In that chapter, we will identify the problems that occur when we like to apply the intelligent network concept to ISDN. We will discuss existing models and decide which model to use to search for a solution to a part of the interworking problem.

In chapter 5 we will describe the results of the modellation of the Basic IN-ISDN Model. In chapter 6 we will discuss the extension this model with ISDN hooks and IN service functionality. We will put into words our thoughts about the control of service triggers.

In chapter 7 we will evaluate the study that has been done and draw conlusions. We will come to the resulting recommendations and items for further study in that last chapter as well.

The annexes include a detailed description of the interworking model we have constructed.

2 ISDN

This chapter introduces in ISDN. The aim is to provide enough information for the reader to understand the basic principles that are used in this report. Next to a description of services in general, the Closed User Group supplementary service is discussed in more detail.

2.1 Introduction

The computer and telecommunication technologies are increasingly merging. For that there is a need for a network that is able to transport all kinds of information efficiently. The Integrated Services Digital Network (ISDN) [Clarke93], [Stall91], is such a telecommunication network: Via one connection the user has the possibility to communicate using speech, text, data and images. This means that the ISDN integrates the functionalities of the telephone network (speech and facsimile), the teletext network (text) and data networks (data).

All connections from user to user are digital. Otherwise it would not be possible to send all kinds of data and speech over the same network. For the user this means that he does not need different connections for a telephone or computer terminal anymore. The user has access to the ISDN by means of a local interface to a digital "pipe" of a certain bit rate. Pipes of various sizes will be available to satisfy different needs.

Benifits for the customer are cost savings, flexibility, and better connections. Due to integration the customer does not have to buy multiple services to meet multiple needs. The efficiencies and economies of scale of an integrated network allow these services to be offered at lower cost than if they were provided separately. Thanks to standardization, the users enjoy the advantage of competition among equipment vendors.

The basic user access constists of two B-channels that may be used independently. One could have a telephone conversation via one channel while data or a fax is being sent via the other channel. A third channel is the signalling channel and is called the D-channel. ISDN uses the D-channel mainly for signalling between the user and the network. Besides, it can also be used to transport small amounts of data.

Another access to ISDN constists of more channels. It offers 30 B-channels of 64 kbit/s and a D-channel of 64 kbit/s. It is called the primary rate access. With the use of this access one could connect company switches to ISDN.

2.2 Services

Three types of ISDN services are defined by ITU[1]: bearer services, teleservices and supplementary services. In the following paragraphs we will explain what is meant by them.

Bearer services provide the means to convey information between users in real time and without alteration of the content of the message. These services correspond to the lower three layers of the OSI model. A number of bearer services has been defined for ISDN. An example of a bearer service is 64-kbps unrestricted, 8 KHz structured. It is the most general-purpose services at that data rate. The term unrestricted means that the information is transferred without alteration; this is also known as a transparent bearer service. Users may employ this service for any application that requires a data rate of 64 kbps.

Teleservices combine the transportation function with the information processing function. They employ bearer services to transport data and, in addition, provide a set of higher-layer functions. These higher-layer functions correspond to OSI layers 4 trough 7. Whereas bearer services define requirements for, and are provided by, network functions, teleservices include terminal as well as network capabilities. Teleservices are intended to cover a wide variety of user applications over ISDN. Examples of teleservices are telephony, teletex, videotex, and message handling.

Both bearer services and teleservices may be enhanced by *supplementary services* [Q.730]. A supplementary service is one that may be used in conjunction with one or more of the bearer or teleservices. It cannot be used alone. This kind of services is very important in this report, because they have to do with the control of the call. This means that they have to do, amongst other matters, with the routing of the call. This is important in relation with Intelligent Networks (see chapter 3).

An example of a supplementary service is Call Forwarding Unconditional (CFU). An ISDN user can instruct his terminal to forward all incoming calls to another terminal. This service is enabled until unsubscription. Of the same kind of service is Call Forwarding Busy Subscriber. In this case the incoming call is only forwarded when the destination terminal is busy. One other example of a supplementary service is Closed User Group (CUG). We will consider this service at lenght because we will use it in our model. In annex 1 the whole list of standardized supplementary services can be found.

The Closed User Group (CUG) supplementary service enables users to form groups, to and from which access is restricted. A specific user may be a member of one or more CUGs. Members of a specific CUG can communicate among themselves but not, in general, with users outside the group. A CUG may be defined independently of any basic service, or in relation with one, or a number of basic services. The general structure and service capabilities of CUG are

1) CCITT has become ITU (International Telecommunication Union) in 1993.

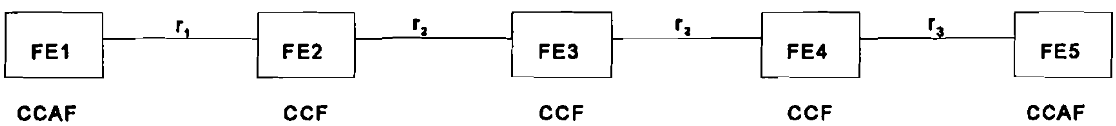
described in the stage 1 definition of CUG service [I.255.1]. The Stage 2 description includes network functions [Q.85.1], and the stage 3 description of CUG, can be found in [Q.735]. How the CUG functionality can be included in the ISDN basic call process functional entities is described in [Q.71].

The realisation of the CUG facilities is done by the provision of interlock codes and is based on various validation checks as defined in Recommendation [Q.85] at call set-up, determining whether or not a requested call to or from a user having a CUG facility is allowed. In particular, a validation check is performed by verifying that both the calling and called parties belong to the CUG indicated by the interlock code.

Information about the access arrangements, access restrictions, and subsciption options of the CUG service can be found in the annexes.

2.3 Functional models

In Figure 1, the Functional Entities (FEs) in the ISDN functional model are shown. The CCAFs are functional entities that serve the users and are responsible for initiating functional requests and interacting with CCFs. CCFs are functional entities that cooperate with each other to provide the services requested by the CCAFs. r_1, r_2 and r_3 are relationships between functional entities wherein information flows occur in order to process call attempts or service requests.



FE Functional Entity
CCAF Call Control Agent Function
CCF Call Control Function
r Relationship between entities

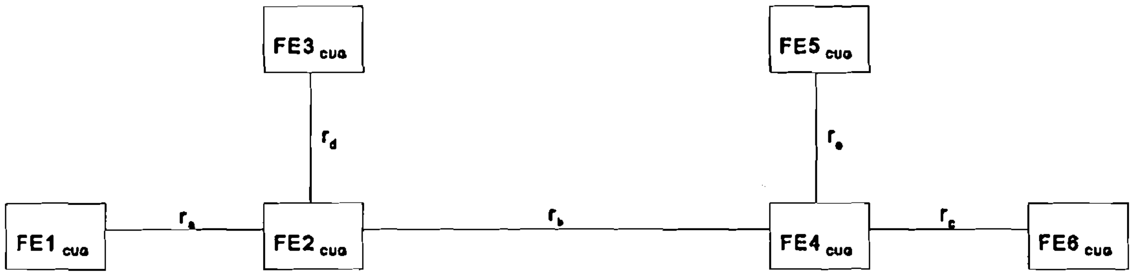
Figure 1 - ISDN Functional model conform Q.71.

For each FE an SDL diagram of the behaviour is given in [Q.71]. We will concentrate on FE2 because that entity will play an important role in our model. FE2 represents an originating CCF serving the calling party's CCA which will

a) establish, manipulate and release a single call (upon request of the CCA entity);
b) associate and relate the CCA entities that are involved in a particular call and/or service;
c) manage the relationship between the CCA entities involved in a call (i.e. reconcile and maintain the overall perspective of the call and/or service).

r_2 is a relationship between two CCFs. It can be of different types, depending on the functionality the related CCFs represent in a specific network scenario, e.g. a CCF may be a gateway exchange or a local exchange.

For the supplementary services different functional models are defined. We will illustrate this for the CUG supplementary service. This might be confusing, because the names used for the functional entities (e.g. FE1, FE2, etc.) in the CUG model are the same as the names for the FEs in the ISDN functional model. We will not change these names to stay in line with the recommendations. To avoid confusion we will add "$_{CUG}$" to the CUG FEs when we talk about them in this report (e.g. $FE1_{CUG}$).

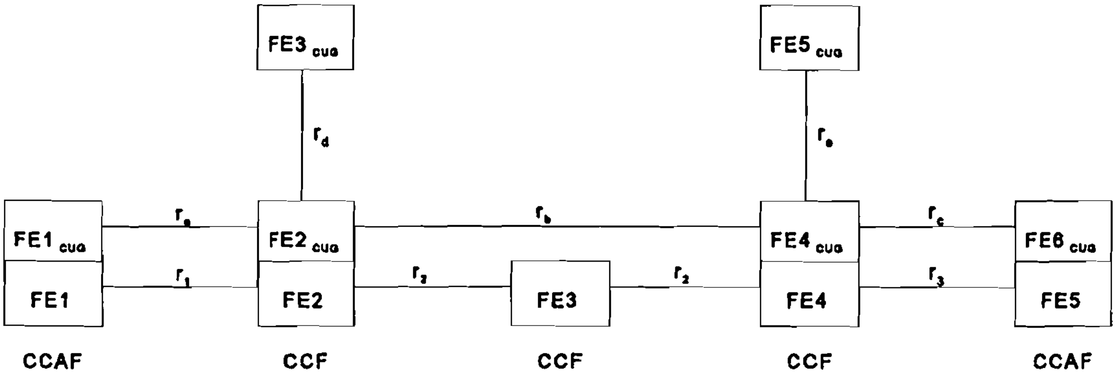


FE_{CUG} Closed User Group Functional Entity
r Relationship

Figure 2 - Functional model for the CUG supplementary service conform Q.85.

In Figure 2, $FE1_{CUG}$ is the originating CUG agent, $FE2_{CUG}$ is outgoing CUG agent, $FE3_{CUG}$ provides outgoing CUG control, $FE4_{CUG}$ performs the incoming CUG determination, $FE5_{CUG}$ provides incoming CUG control and $FE6_{CUG}$ is the destination CUG agent.

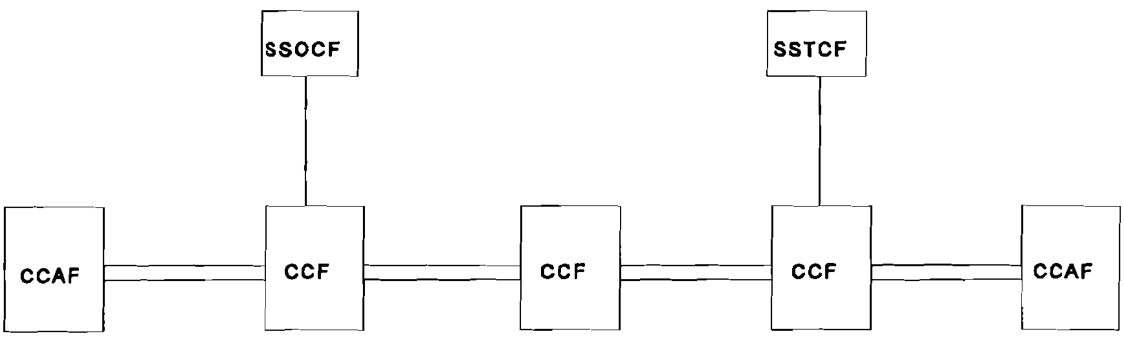
The relationship of the CUG functional model with a basic call may be as shown in Figure 3. The functionality needed for the CUG service is added to the functional entities (CCAF, CCF) of the basic call. Thus the functionalities FEx_{CUG} and FEx are combined to new FEs. As a result, the ISDN CCAFs and CCFs are 'upgraded' with CUG skills.



FE_{CUG} Closed User Group Functional Entity
FE ISDN Functional Entity
CCAF Call Control Agent Function
CCF Call control Function
r Relationship

Figure 3 - Relationship of the CUG model to a basic call conform Q.85.

In figure 4, the model of figure 3 is simplified. In this simplified model, the CCAFs and CCFs are the 'upgraded' functional entities with CUG skills. The incoming and outgoing CUG control entities are renamed in Supplementary Service Originating (and Terminating) Control Functions. We have drawn the model in this way to show that there is a controlling entity 'above' the network basic call entities. We will use this representation in chapter 4.



CCAF	Call Control Agent Function
CCF	Call control Function
SSOCF	Supplementary Service Originating Control Function
SSTCF	Supplementary Service Terminating Control Function

Figure 4 - ISDN Functional Model with Supplementary Service Control entities

2.4 Information flows

We are interested in how the different functional entities communicate with each other. This communication is described in information flow diagrams. Figures 5 and 6 show two of these diagrams for circuit mode switched bearer service call set-up and call release. These procedures play an important role in our model.

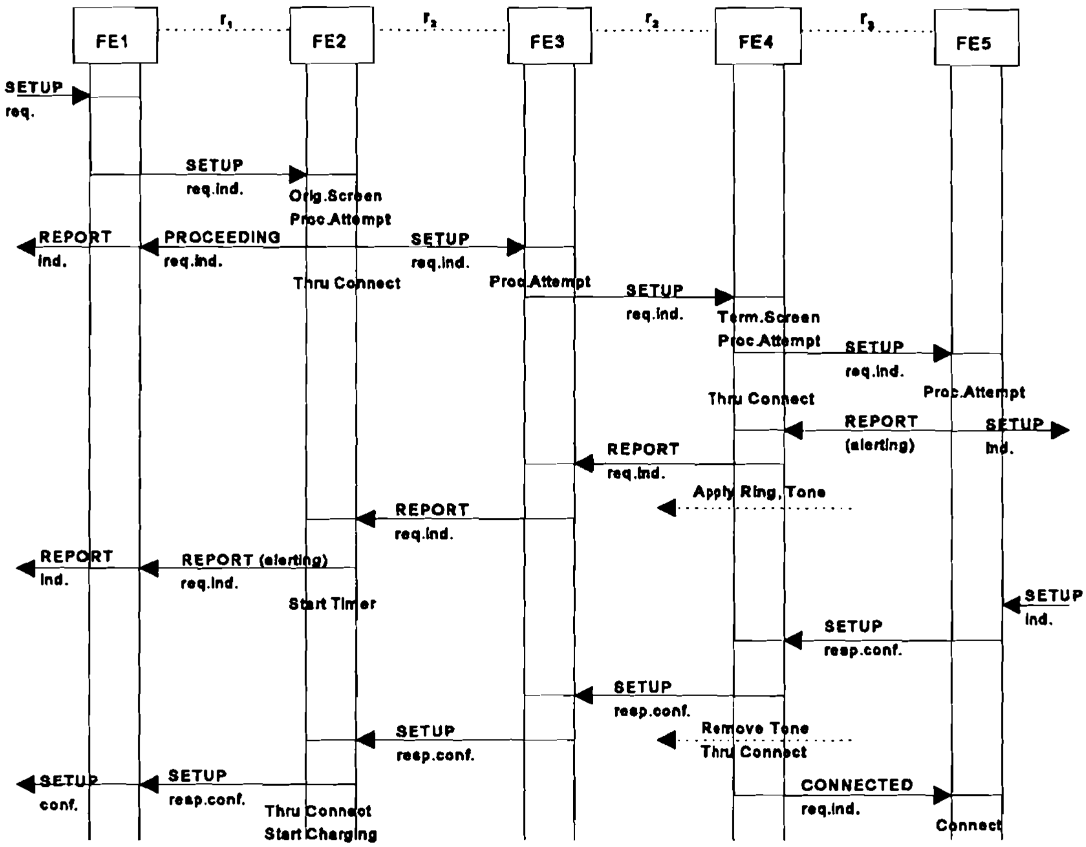


Figure 5 - Successful ISDN call set-up, en-bloc sending

The messages in the diagrams are used as follows:

- CONNECTED req.ind.
  is used to acknowledge that a previously sent SETUP resp.conf. has been received and accepted.
- DISCONNECT req.ind.
  is used to notify that the end user has disconnected from the connection or cannot be connected (e.g. the called user is busy).
- PROCEEDING req.ind.
  is used to indicate that sufficient address digits have been received to process a call attempt.

- RELEASE req.ind. & resp.conf.
  are used to free the resources associated with the call/connection such as call references and channels.
- REPORT req.ind.
  is used to report status and/or other types of information across the nework. The type of information may be indicated (e.g. alerting, suspended, hold, resume, etc.)
- SETUP req.ind.
  is used to request establishment of a connection.
- SETUP resp.conf.
  is used to confirm that the connection has been established.
- SETUP REJECT req.ind.
  is used to indicate that the SETUP req.ind. has been rejected.
- PROGRESS req.ind.
  is used to indicate that the call may leave an ISDN environment; e.g. because of interworking with another network.

A summary of the individual semantics of the information flows and the relationship between them is given in table 1 on the next page.

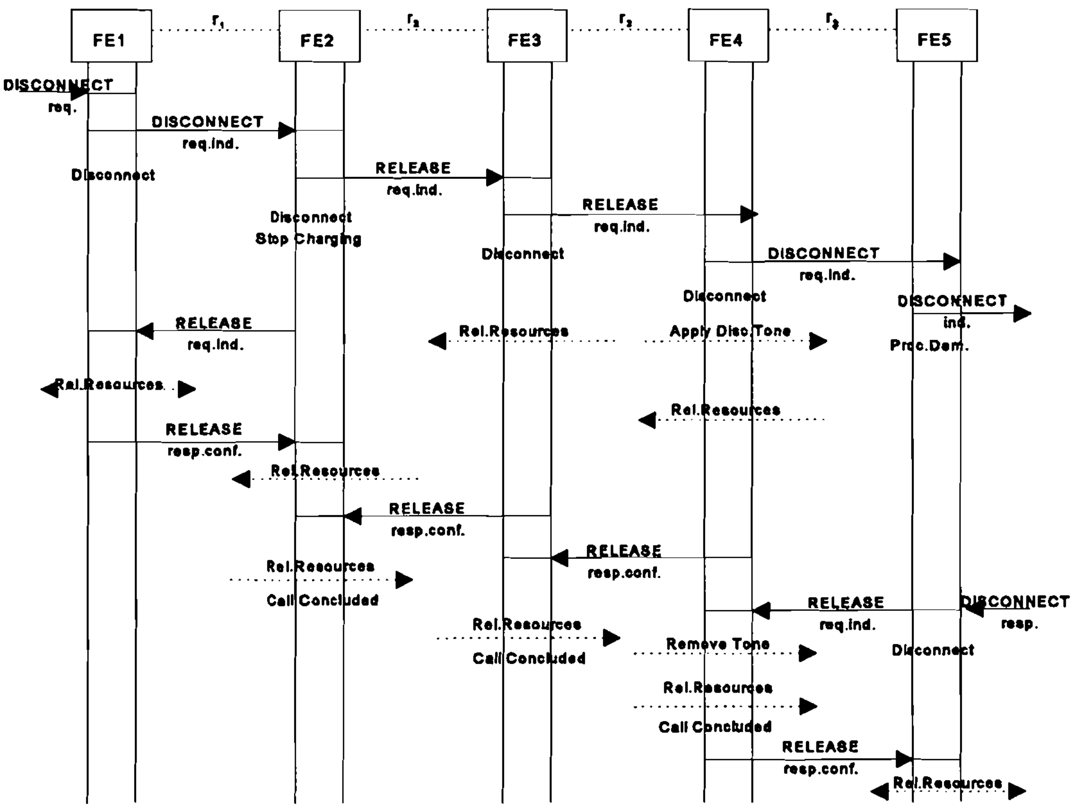


Figure 6 - Normal clearing, calling party disconnect

Table 1 - Information Flow meanings

Semantics	SETUP req.ind.	SETUP resp. conf.	SETUP REJECT req.ind.	PROCEE-DING req.ind	REPORT (Alerting) req.ind.	DISCON-NECT req.ind.	RELEASE req.ind.	RELEASE resp.conf.	CONNEC-TED req.ind.
Request for connection	X								
Connection accepted by user		X							
Call info complete		X		X	X				
Connection request accepted		X		X	X				
Connection request rejected			X						
Called user being alerted					X				
Connection unavailable						X	X		
Demand to disconnect bearer resources						X			
Demand to release bearer resources - With acknowledgement							X		
Disconnected - Ready to be released						X	X		
Bearer resources released - Reallocatable								X	
Request to terminate call						X	X		
Setup response accepted									X

The information flows that are shown in the figures on the previous pages are used in the ISDN Recommendations. For the physical implementation of the functional entities other messages are used. For this case, all the functions, procedures and interchange signalling information flows are defined in the ISDN User Part of Signalling System No. 7 (ISUP SS7) [Q.761], [ISUP2]. The agreements on SS7 are required to provide bearer services and associated user facilities for calls over ISDN. In particular, the ISUP meets the requirements defined by ITU for worldwide international telephone and circuit switched data traffic.

2.5 Dynamical description of the entities

To lay down the behaviour of the functional entities of ISDN, a description of the information flows alone is not enough. Agreements have to be made on the dynamical behaviour of the network elements. This dynamical behaviour can be descripted properly using the Specification and Description Language (SDL) [Z.100], [Z.100A], [Belina91]. Within ITU this description langauge is well accepted and is preferred above other types of description.

The SDLs in Recommendation [Q.71] cover the allowable (expected) sequences for succesful call set-up and release for each of the ISDN basic call functional entities. It is assumed that errors detected by the incoming and outgoing signalling system protocols are handled within those protocol state machines. This means that error detection methods are omitted in [Q.71].

Let us consider the following example. In Figure 7, a part of the simplified description of FE2, the CCF at the originating side of the network, is drawn. It covers the reception of the SETUP req.ind. message from FE1 (CCAF), the originating screening and process attempt, the output of the PROCEEDING req.ind. message, the output of the SETUP req.ind. to FE3 (the next CCF), the through connection and the transition to the CALL SENT state. The input and output of the messages can be seen in the diagram in Figure 5. In the SDL diagram more information about the functional entity is included.

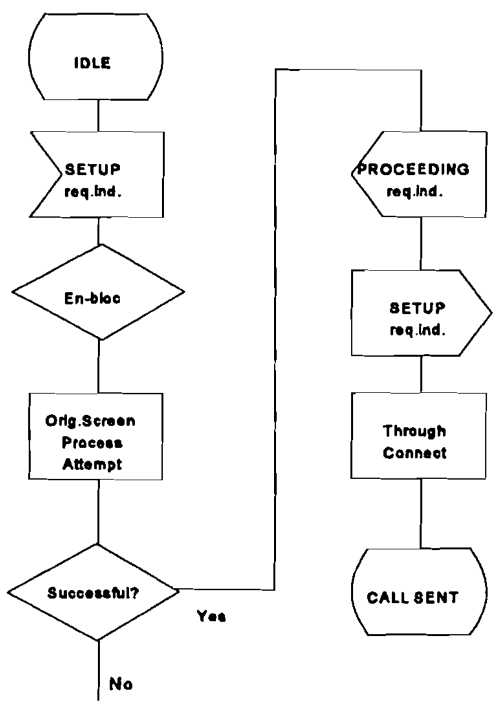


Figure 7 - Part of the SDL description of FE2

Next to the description of the basic call procedures, in [Q.71] the interworking with ISDN supplementary services is described. The locations of the hooks in the set-up and cleardown procedures are given and the SDLs of the functionality needed for the supplementary services are drawn as well. In Figure 8 this is illustrated for a pair of CUG hooks (CUG7 and CUG8).

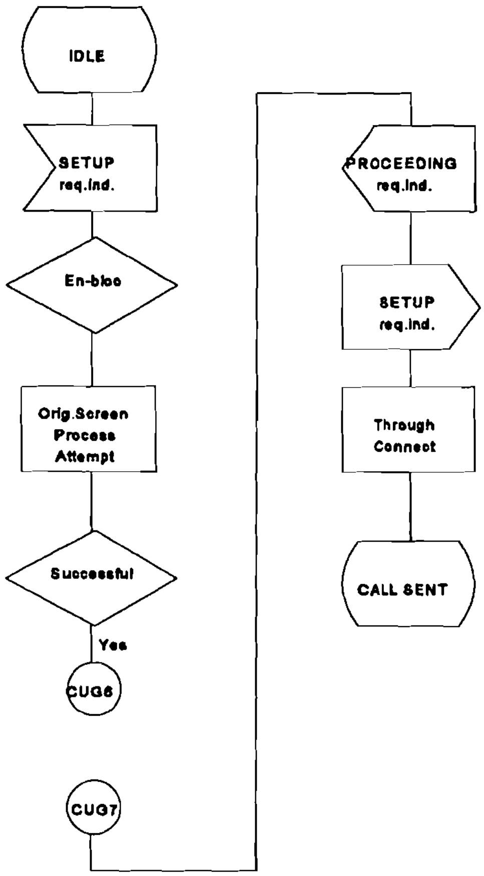


Figure 8 - SDL of a part of FE2 with CUG hooks

Hooks are indicated with connector symbols (circles). They interrupt the call processing. In between these hooks the necessary functionality for the CUG service is inserted. An example SDL of this functionality is shown in figure 9.

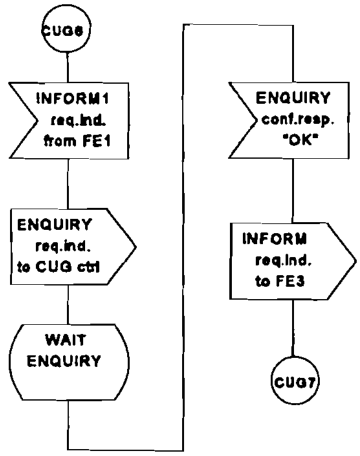


Figure 9 - SDL of CUG request processing.

The complete SDLs can be found in [Q.85]. The input of the INFORM1 message symbolyses the input of information concerning the CUG service, received together with the SETUP req.ind. IF. This information indicates that the CUG service is requested. The request has to be processed in the outgoing CUG control entity and therefore an ENQUIRY message is sent to this entity. In our example the outcome of the request is positive ("OK"). The output of the INFORM2 messages denotes that CUG information has to be sent together with the SETUP req.ind. message to the FE3 (the next CCF). Call processing is resumed at the point where it was suspended (connector/hook CUG8).

3 Intelligent Networks

The purpose of this chapter is to give the reader enough relevant knowledge of Intelligent Networks (INs) to understand the rest of the report. Therefore, general aspects of INs will be discussed, an IN service example will be given and some models of the IN will be presented.

3.1 Introduction

An Intelligent Network (IN) is an architectural concept on top of an existing network ([Brouwer92], [Carl90], [Deak92], [Eske91]). It enables the creation and the provision of services to be performed at a central position in the network. The goal of the IN is to be able to answer quickly to new demands of the telecommunication market. When services can be provided by central general purpose computers, it is not necessary to change the software in many local switches. This used to be the problem in the plain old telephone system (POTS). In the present infrastructure the installation of new services is very difficult. Furthermore, the telecommunication operators are dependent on the switch manufacturers for the development of new services. By moving the intelligence necessary for the support of supplementary services out of the switches to general purpose computers, the dependency on switch manufacturers can be reduced significantly. The telecommunication operators can then develop and update the software for new services themselves.

3.2 Services

Before we go into more detail about the IN, we will focus on the most important aspect of IN: Services. What is meant by *service* when we talk about IN? It is a stand-alone commercial offering, characterized by one or more core service features and optionally enhanced by other services features. A *service feature* is a specific aspect of a service which is noticed by the user. A *core service feature* is a service feature that is characteristic for a certain service; without that service feature the service could not exist.

ITU has selected a set of services that at least has to be supported by the IN. Services and service features are defined in [Q.1211]. The services themselves and the IN-functionality needed to support these services are described in Capability Set 1 (CS-1). IN CS-1 is the first standardized stage of the IN as an architectural concept for the creation and provision of telecommunications services. It defines an intial subset of IN capabilities that meet the following criteria:

- CS-1 is a subset of the target IN architecture;
- CS-1 is a set of definitions of capabilities that is of direct use to both manufacturers and network operators;
- CS-1 provides network capabilities to support services either defined or in the process of being defined by ITU. CS-1 also provides capabilities to support the introduction of services which may neither be standardized by ITU, nor be part of the proposed set of targeted services;
- CS-1 is the first standardized stage of evolution based upon the existing technology base and on evolvability requirements.

The CS-1 architecture may be supported over PSTN, ISDN, and mobile networks.

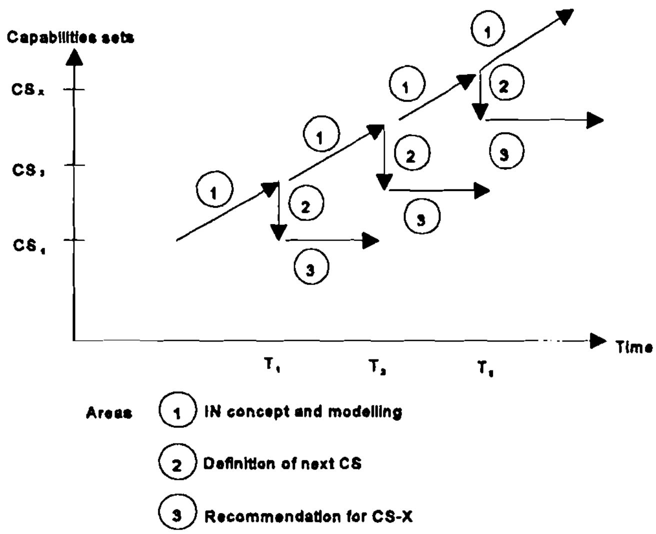


Figure 10 - Sequencing of capability sets

When it comes to CS-1, some restrictions apply to services:
- A service applies to one and only one party in a call and is independent at both topology and service level to any other parties that might participate in the call. So, different features might apply to different parties in a call as long as the service features do not have interaction problems with eachother.
- A service (feature) is only controlled by one and only one Service Control Function at any point in time.

In future capability sets other kinds of services will be allowed as well. For now, the restrictions are valid to limit the complexity of the network. For the same reason the creation and management functionalities are not included in the recommendations of CS-1.

In the previous chapter we have seen ISDN supplementary services. Let us now take a look at an example of an IN service: Universal Personal Telecommunication. In [UPTNA], a general description is given of the UPT service for the UPT implementation phase 1 (the restricted UPT service scenario). In this phase the UPT service is restricted to a set of UPT features that can be implemented without major changes to current technology, and is basically restricted to provision in PSTN and ISDN with voice and telephony type services.

UPT enables the user to subscribe to a certain terminal. This is called in-call registration. All UPT calls for this subscriber are then routed to this terminal. This works as follows. When somebody dials a UPT number, the first switch with intelligent network capabilities recognizes the UPT number as being a special number. It executes some control and database actions to get the correct address. After that, routing through other switches continues with this address and the right connection is made.

The restricted UPT service scenario includes, amongst others, the following essential UPT features:

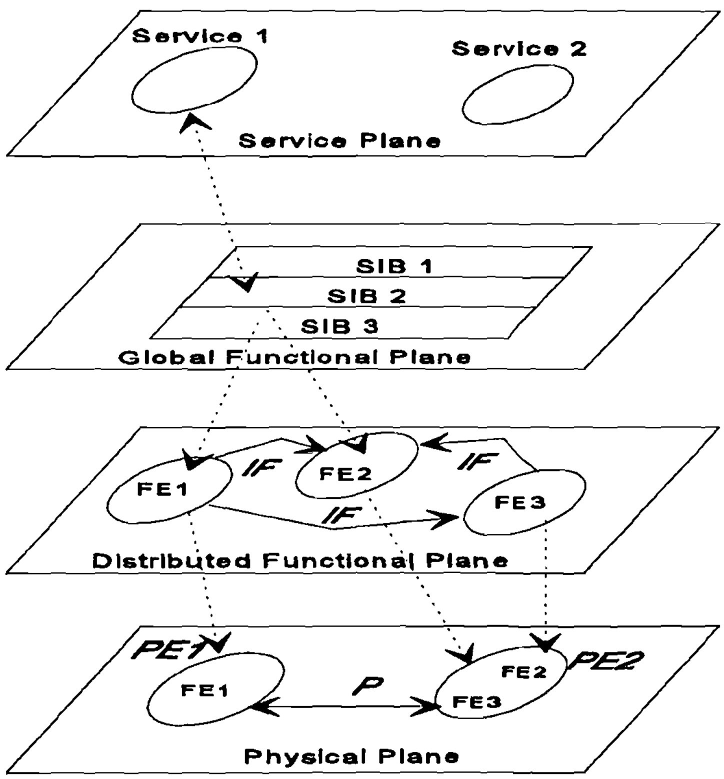
- In-call registration (IR)
  A UPT user registers from the current terminal access for incoming UPT calls to be presented to that terminal access;
- UPT user identity authentication (UUIA)
  The UPT service provider verifies that the identity of the UPT user is the one claimed;
- Direct outgoing UPT call (DOUC)
  A UPT user can initiate, from any terminal access, a single outgoing UPT call which is charged to the UPT subscriber;
- UPT service profile modification (UPM)
  The UPT user modifies his/her own service profile;
- Global follow-on (GFO)
  When terminating an UPT procedure, the UPT user indicates a global follow-on activity before disconnecting completely. Another UPT procedure is allowed without further authentication;

We have listed these features to give the reader an idea of the possibilities of IN services. For us it is important now to know how the IN is able to provide these services. Therefore, we will take a look at the functional architecture of IN in the next paragraph.

3.3 Functional Model

The IN architectural framework consists of a related set of four planes, each specifying a different approach to the network. These planes are

- the Service Plane (SP) describing the services and service features;
- the Global Functional Plane (GFP) describing the IN from a global, network wide point of view. Services and Service Features are redefined in terms of network-wide functions, called Service Independent Building Blocks (SIBs). A SIB is a set of functional entity actions and information flows, used to provide a service feature or a part of a service feature in an IN. In other words, a SIB can be used to create service features. A special kind of SIB is the Basic Call Process (BCP) which contains the functionality of handling normal (non-IN) calls;
- the Distributed Functional Plane (DFP) describing distributed functionality aspects. The elements of the GFP are specified in terms of elements of the DFP. In this way the distribution aspects of the elements of the GFP become clear;
- and the Physical Plane (PhP) describing the physical entities. The PhP presents different mappings of Functional Entities to Physical Entities and defines the interfaces between the Physical Entities.



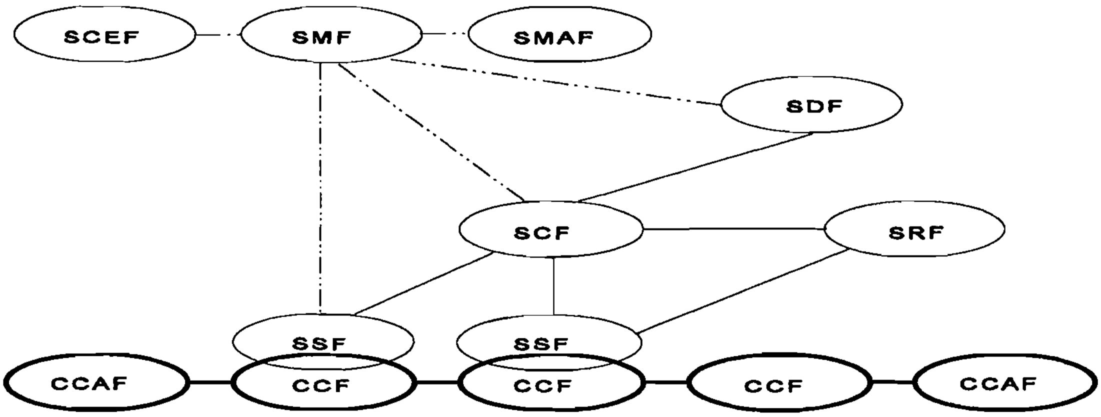
SIB	Service Independent Building Block	FE	Functional Entity
PE	Physical Entity	IF	Information Flow
P	Protocol		

Figure 11 - Intelligent Network conceptual model

It is intended that the IN conceptual model, see figure 11, remains consistent troughout the evolution of the IN. Evolutionary changes must fit within the contraints proposed by this model.

In this report we use the DFP description. The principles of the DFP are described in [Q.1204] and the filling-in of the DFP for CS-1 is given in [Q.1214].

Most important subject of the DFP is the IN Functional Model which shows the grouping of functions, their relations and actions, of an IN-structured network, see figure 12 which is drawn according to [Q.1204].



CCAF	Call Control Agent Function	SDF	Service Data Function
CCF	Call Control Function	SRF	Service Resource Function
SSF	Service Switching Function	SMF	Service Management Function
SCF	Service Control Function	SMEF	Service Creation Environment Function
SMAF	Service Management Access Function		

Figure 12 - Intelligent Network Distributed Functional Plane model

The Functional Entities (FEs) together (or alone) provide the higher level service. The FEs have been given special names corresponding to the kind of functions they perform. The lines between the FEs show the allowed relationships between the FEs. FEs which have a relationship can exchange information by Information Flows (IFs).

The CCAF and the CCF are related to normal call processing (i.e. non-IN processing); no other FEs are involved in a basic call. In our case these FEs correspond to the ISDN FEs we have seen in the previous chapter.

The SSF is the service switching 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.

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 data) required to process a call/service logic instance. It

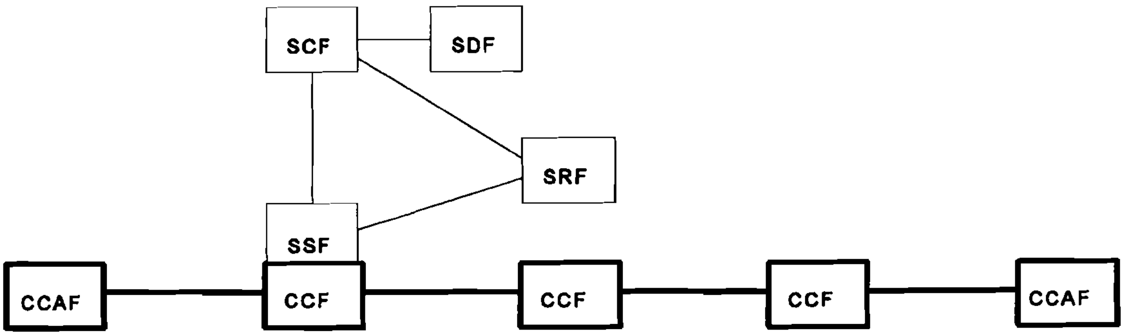
a) interfaces and interacts with service switching functional/call control function, spezialized resource function (SRF) and service data function (SDF) functional entities;
b) contains the logic and processing capability required to handle IN provided service attempts.

The SDF contains customer and network data for real time access by the SCF in the execution of an IN provided service. It interfaces and interacts with SCFs as required.

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

- interfaces and interacts with SCF and SSF (and with the CCF);
- may contain the logic and processing capability to receive/send and convert information received from users;
- may contain functionality similar to the CCF to manage bearer connections to the specialised resources.

The SCEF, the SMAF, and the SMF are not related to call processing, but to the creation and management of IN services. We will not discuss these entities because we are only interested in the relationships related to IN service execution. In the IN functional model for CS-1 these entities are left out as well.



CCAF	Call Control Agent Function	SDF	Service Data Function
CCF	Call Control Function	SRF	Service Resource Function
SSF	Service Switching Function	SCF	Service Control Function

Figure 13 - IN DFP model for CS-1 with the SSF at local exchange level

Let us take a look at figure 13, the Intelligent Network Distributed Functional Plane Model according to [Q.1214], with the SSF at local exchange level. It is a restricted model compared to the model in figure 12.

In case of an IN-call, the SSF 'recognizes' that IN call processing is required. This recognition may, for example, be derived from the particular number dialled (e.g. a UPT number). However, the SSF may also trigger on other events, like 'called user busy'. When the SSF determines that IN call processing is required, normal call processing is suspended and call control is given to the SCF. In the SCF the 'intelligence' resides; it executes a service logic program. After the SCF has completed the service logic program, call control is returned to the SSF. In between, the SCF may have translated the dialled number into another one. In this way the call is routed to another destination.

When a service is executed, the SCF may want to sort something out. It is able for example to question the SDF to lookup some numbers and to order the SRF to play an announcement to the user.

Briefly described, IN service processing amounts to the following:

- In case special service processing is needed, suspend normal call processing;
- Let the SCF sort something out (with the help of the SDF and the SRF);
- Continue normal call processing (if needed with changed call related data).

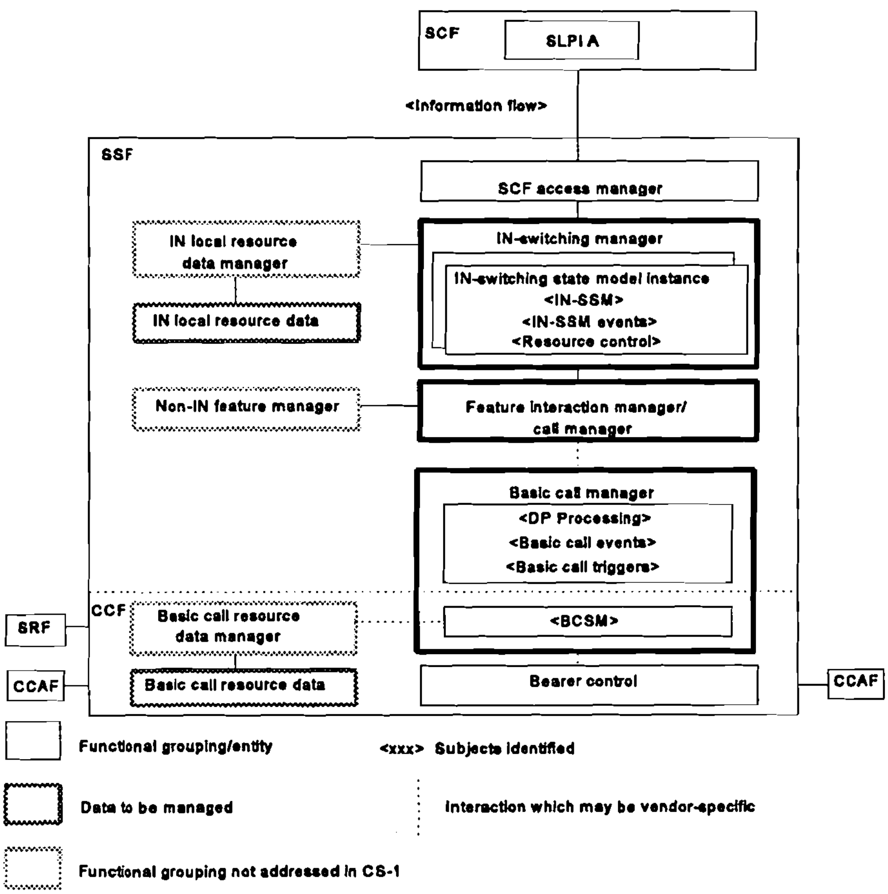


Figure 14 - SSF/CCF model - single ended SLIP related to calling or called party

A model for the SSF/CCF is shown in figure 14. It shows the SSF/CCF model for a single-ended service logic instance (SLI) related to the calling or called party. The figure includes the agreements made in June 1994 [Q.1214]. Some parts of the Basic Call Manager are part of the SSF. The BCSM can be seen as a component of the CCF. We will handle the case of a SLI related to the calling party and we will not handle the case of of seperate SLIs related to the calling and called parties to restrict the compexity of our model. The purpose of the model in figure 14 is to provide a framework, within the IN Recommendations, for call modelling subjects with respect to the SSF/CCF.

We will give a short description of some aspects of the SSF/CCF model below.

1) **Basic Call Manager (BCM)** - The BCM is not a functional entity. It provides an abstraction of a part of a switch that
   - implements basic call and connection control to establish communication paths for users;
   - interconnects such communication paths;
   - detects basic call and connection control events (of ISDN) that can lead to the invocation of IN service logic instances or should be reported to active IN service logic instances;
   - manages CCF/SSF resources required to support basic call and connection control;
   - implements the BCSM and the DP processing.

   The DP processing is the entity of the BCM that interacts with the Feature Interactions Manager/Call Manager (FIM/CM).

   Thus, the BCM is the ISDN entity enhanced with IN functional aspects, a kind of upgrade of the ISDN call control functionality. (In our model this is an important entity.)

2) **IN-Switching Manager (IN-SM)** - The entity in the SSF that
   - interacts with the SCF in the course of providing IN service features to users;
   - provides the SCF with an observable view of SSF/CCF call/connection processing activities;
   - provides the SCF with access to SSF/CCF capabilities and resources;
   - detects IN call/connection prosessing events that should be reported to active IN service logic instances;
   - manages SSF resources required to support IN service logic instances.

   In other words, this entity passes information to and from the BCM.

3) **Feature Interactions Manager (FIM) / Call Manager (CM)** - The entity in the SSF that provides mechanisms to support multiple concurrent instances of IN service logic instances and non-IN service logic instances on a single call. The ability of the FIM/CM to arbitrate between multiple instances of IN and non-IN service logic instances was for further study in the March 1993 version of [Q.1214]. The FIM/CM intergrates the interactions mechanisms with the BCM and IN-SM to provide the SSF with a unified view of call/service processing internal to the SSF for a single call.

This is an important issue for the study of ISDN-IN service interactions. Non-IN service logic instances are for example ISDN supplementary services. When the FIM has enough knowledge of the ISDN supplementary service mechanisms, interactions between IN service instances and ISDN supplementary service instances can be managed. We will discuss this ability later in this report when we evaluate our modellation results.

4) **BCM relationship to IN-SM** - The relationship that encompasses the interaction between the BCM and the IN-SM, through the FIM/CM. The information flow related to this interaction is not externally visible and is not standardized in CS-1. However, an understanding of this subject is required to identify how basic call and connection processing and IN call/connection processing may interact.
This is particularly the case in our study and we will come back to this in chapter 5.

At this stage, we will concentrate on the BCM, because it is directly related to the ISDN. IN service management will be discussed during the evaluation of the model we made. As can be seen in figure 14, one of the subjects of the BCM is the BCSM. We will provide a description of this subject in the next section.

3.3.1 Basic Call State Model

The BCM is centred around the Basic Call State Model (BCSM). This BCSM provides a high-level model of CCF activities required to establish and maintain the communication paths for users. It consists of:

- Points In Call (PICs), identifying CCF activities associated with one or more basic call/connection states of interest to IN service logic instances;
- Detection Points (DPs), points in the basic call where transfer of control can occur (from CCF to service logic or backwards);
- Transistions, indicating the normal flow of basic call/connection processing from one PIC to antoher;
- Events, causing transitions into and out of PICs.

The BCSM reflects the functional separation between the originating and terminating portions of calls as illustrated in figures 15 and 16. These figures show an originating and terminating half BCSM, each of which is managed by a functionally separate BCM in the SSF/CCF. The description is a starting point to identify the aspects of the BCSM that are visible to IN service logic instances, and the nature of the information flows between SSF/CCF and SCF.

For each PIC, an initial list of BCSM information that must be maintained is given in the September 1994 version of [Q.1214]. The information that is sent to the SCF at a given trigger detection point is a subset of the information listed in this Recommendation. Other information may be available at a given PIC that is not used used by processing at the PIC or is only used by underlying call processing.

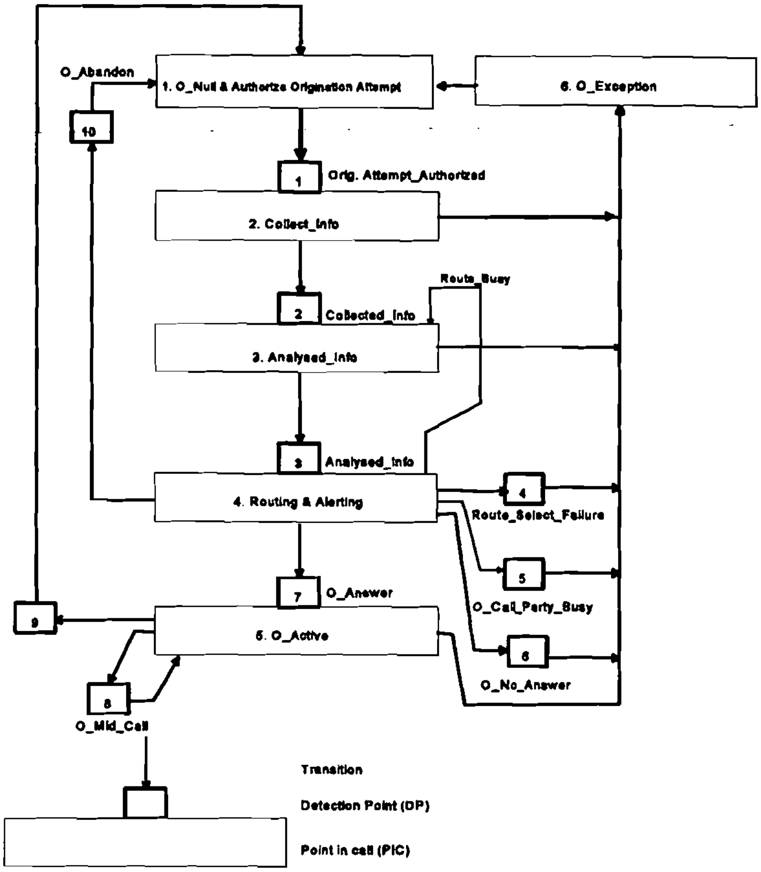


Figure 15 - Originating BCSM for CS-1

We will not describe the BCSM at lenght at this point in our report. Reason for this is that it will be discussed extensively when we describe our call model.

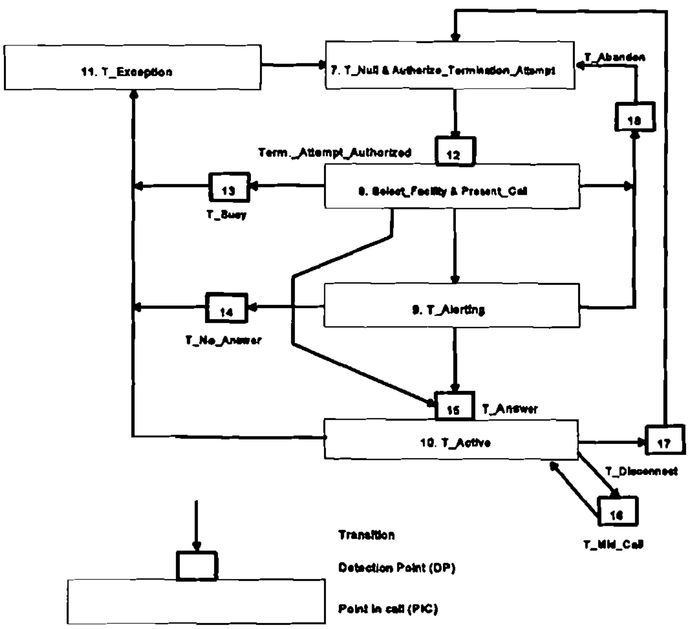


Figure 16 - Terminating BCSM for CS-1

BCSM Detection points

Certain basic all and connection events may be visible to IN service logic instances. DPs are the points in call processing at which these events are detected. They are charcterized by the following attributes:

a) Arming mechanism: Only if an DP is armed it is notified to the IN service logic. This arming may be done statically or dynamically. A static armed DP is armed through SMF service features provisioning and stays armed until explicitly disarmed by the SMF. Staticallty arming of DPs by the SCF is for further study. Dynamic arming is performed by the SCF within the contect of a call-associated IN service dontrol relationship. This arming remains in effect until the DP is detected ot until the end of the relationship between SSF and SCF.
b) Criteria: In addition to the condition that a DP is armed, conditions that must be met in order to notify the SCF that the DP was encountered. Three types of criteria are distinguished:
   1) Individula line/trunk based vcriteria. this type applies to single subscriber line or trunk line.
   2) Group based criteria apply to a certain group of lines or users.
   3) Office based criteria apply to the whole switch. Any calls generated in the switching system will be subject to these criteria.
c) Relationship: SSF may, using Information Flows, inform other entities (i.e. SCF) about encountering Detection Points via two types of relationships:
   1) An IN service relationship with the SCF. This is a **control** relationship if the SCF is able to influence call processing and a **monitor** relationship if that is not the case.
   2) If this relationship is between the SSF/SMF for management purposes, a service management control relationship, this relationship is for further study.
d) Call processing suspension: If an armed DP was encountered and DP criteria are met for an IN service control relationship, the SSF may suspend the call processing. If the call is suspended, the SSF sends an IF to the SCF requesting instructions, if not the SSF sends an IF notifying that a DP was encountered and continues call processing.

Based on these four attributes, 4 types of DPs are distinguished:

1) Trigger Detection Point-Request (TDP-R)
2) Trigger Detection Point-Notification (TDP-N)
3) Event Detection Point-Request (EDP-R)
4) Event Detection Point-Notification (EDP-N)

Points in Call

The points in call (PICs) as defined in [Q.1214], are extensively described in annex 2.

3.3.2 Functional model for UPT Service set 1

Many of the functionalities required to support UPT will be provided within the IN architectural framework. UPT intelligence can be situated in the SCF and SDF functional entities and UPT service access can be priveded by the CCF/SSF, SRF and CCAF functional entities of the IN Distributed Functional Plane (DFP) model. Detailed functional mappings for the support of UPT within the IN framework still have to made. For the moment, the functional model of UPT is the DFP model of [Q.1214], see figure 12. The CCAF is identical with the CCA of [Q.71]. The CCF is based on the corresponding [Q.71] ISDN definition, but has to be modified a little for use in IN. This is subject of our model and will come back to this later in this report.

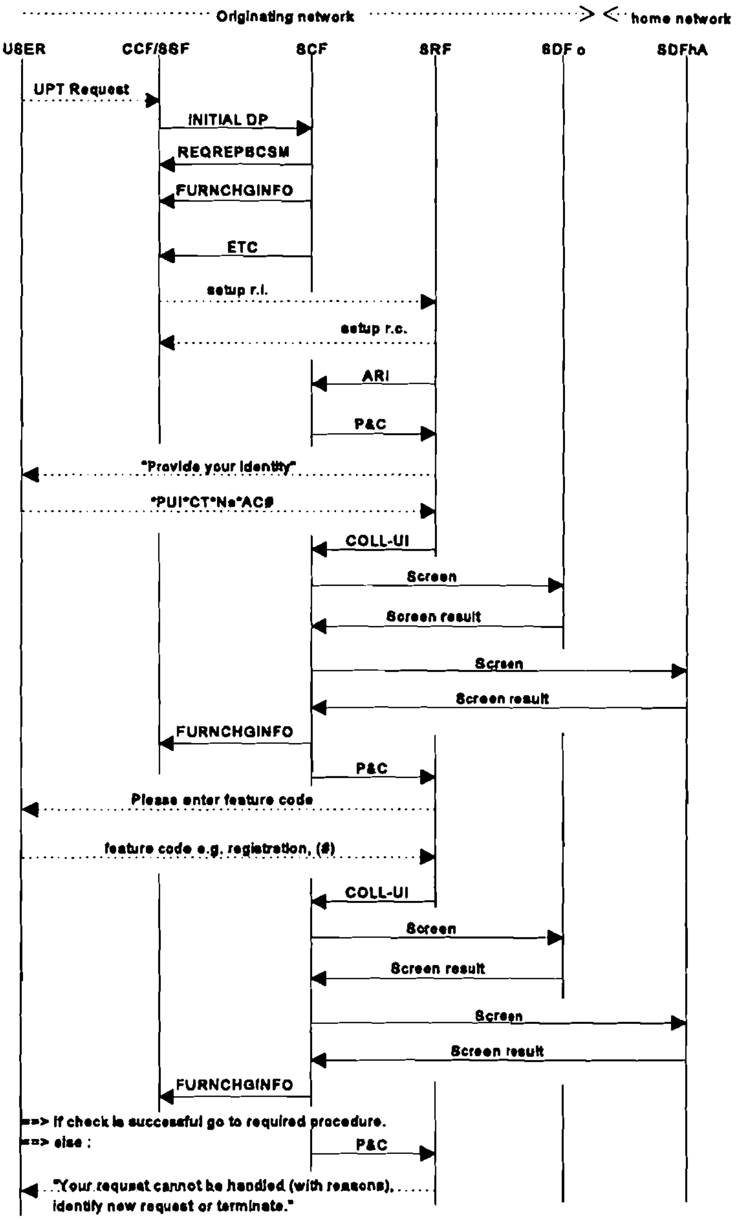


Figure 17 - Information flows for UPT Access, identification and authentication.

3.3.3 Information flows

In the previous chapter we saw the ISDN information flows for the succesful basic call set-up and release in the case of an en-bloc call. Let us now take a look at the information flows necessary for an IN service. We will take UPT as an example once again. In figure 17, the information flows for a part of the UPT service are shown. It concerns, among other features, the access to the UPT service. The figure is derived from the descriptions in [UPT].
The UPT Request contains information that enables CCF/SSF to trigger "Initial Detection Point" (INITIAL DP). This is DP3, Analysed_Info, as we will see as we discuss the addition of services to our model in chapter 6. "Request Report BCSM Event" (REQREPBCSM) contains the list of events and their monitoring mode. The "FurnishChargingInformation" (FURNCHGINFO) operation is sent to instruct SSF to create a call record for the following user request. The SSF is then ordered to connect an SRF using the ETC operation. (The ARI operation is used.) "Prompt and Collect User Info" (P&C) enables the SRF to prompt the user. In this figure we assume an automatic subscription procedure. This means that all the authentication information is send in one string, with the star (*) used as a seperator. At the head of the sequence, the (*) enables the SCF and the SDhA to recognise an automatic authentication sequence. When the complete string is received in the SCF, a format check is applied. The SDFo query is meant to locally check e.g. if there exist particular agreements between the local service provider and the user's home provider. The SDFh address and service specific data may also be retrieved with this query. The received information is sent to the SDFh in one string for screening. As a result, the SDFh sends the result of authentication back to the SCF. The FURNCHGINFO operation is sent to instruct the SSF to update the record. The SRF is now ordered to inform the user that authentication is successful and that feature identification may that place. We assume the user then indicated the requested code. The SRF sends this code to the SCF. Again a local check and a check at the user's home provider is performed. The SDFh query is intended to check e.g. if the user has subscribed to the requested feature and if the request is consistent with the user state. The FURNCHGINFO operation is sent to the SSF to update the record and the outcome of the request is prompted to the user. When the request is denied this is promted to the user as well.

The example above illustrates how the IFs are sent for UPT. The IFs are included in IN Application Protocol (INAP) messages and operations. We will discuss INAP shortly in the next section.

3.4 The Physical Plane and INAP

In the previous paragraphs we have discussed the Distributed Functional Plane (DFP). In the IN conceptual model (figure 11) we saw that the FEs of the DFP can be mapped to Physical Entities (PEs) in the Physical Plane (PhP) (in different ways). A one-on-one mapping is possible, but combinations of FEs mapped to one PE is more obvious. In stead of information flows the interfaces between the entities are identified at the PhP. There can be more than one information flow in one message between two physical entities.

In [Q.1215], the PhP is described and different scenarios of FE to PE mapping are suggested. Within the PhP, the protocols that are used to transfer the messages between the PEs are specified. The IN Application Protocol (INAP) is defined assuming maximum distribution (i.e. one FE per PE). [Q.1218] describes INAP for Capability Set 1. Within ETSI, INAP for CS-1 [ETSINAP93] is modified and standardized in ETSI core INAP. It supports interactions between the SSF, SCF, SRF, and SDF.

INAP is different from the ISUP (that we shortly discussed in the previous chapter) in many ways. In INAP for example, there are service logic programs next to the fixed rules. The control message flows are partly dependent on the service executed. ISUP uses fixed rules for the behaviour of the different physical entities.

3.5 Dynamical description of the entities

Just like we have seen in the previous chapter for the ISDN FEs, there are dynamical descriptions of the IN FEs as well. The Basic Call State Model is the most important of them. There are in the form of SDL diagrams as well. In annex B of the latest draft version of [Q.1214] (September 1994), the SDLs of the BCSM are given. There are seperate SDLs of the originating and terminating BCSM.

For the SCF, SRF, SCF, and SDF there are service specific dynamical descriptions available. We have found SDLs for UPT in recommendation [Q.76].

In annex 3, where the results of our modellation are listed, the service specific SCF can be found (process UPT_SCF1).

4 IN-ISDN Interworking

In this chapter we will investigate the IN-ISDN interworking from different points of view. First we we will discuss service interaction. We will then take a look at the functional models of ISDN and IN again. The functional models will give a good understanding of the cooperation of IN services and ISDN supplementary services. We will see that the CCF/SSF is the interesting entity for the investigation of service interaction. In this chapter we will make clear how we will tackle the interworking problem. Therefore, we will take a look at two existing models and will give a sound basis for the choice of the model we made.

4.1 Service interaction

There are several points of view to look at the interworking of IN and ISDN [Carl90], [Chow90]. The purpose of the IN concept is to be able to provide new services in an easy way. Therefore, a look at the point of view of services seems to be an interesting one.

When we want to provide new services in ISDN using the IN concept, we have to take the existing supplementary services into account. The behaviour of these services can influence the desired behaviour of the new IN-services to be provided. This kind of influencing of services is called service interaction.

An example of service interaction is drawn in figure 18. The service Universal Personal Telecommunication (UPT, see chapter 3) enables the user to subscribe to a terminal for the reception of incoming calls. The call forwarding service causes calls for a certain terminal to be received at another terminal. Suppose, subscriber A likes to call UPT user John who has registered himself at terminal B. But another user of terminal B has enabled call forwarding to subscriber C. As a result the call for John will be forwarded to C and John will not receive the call.

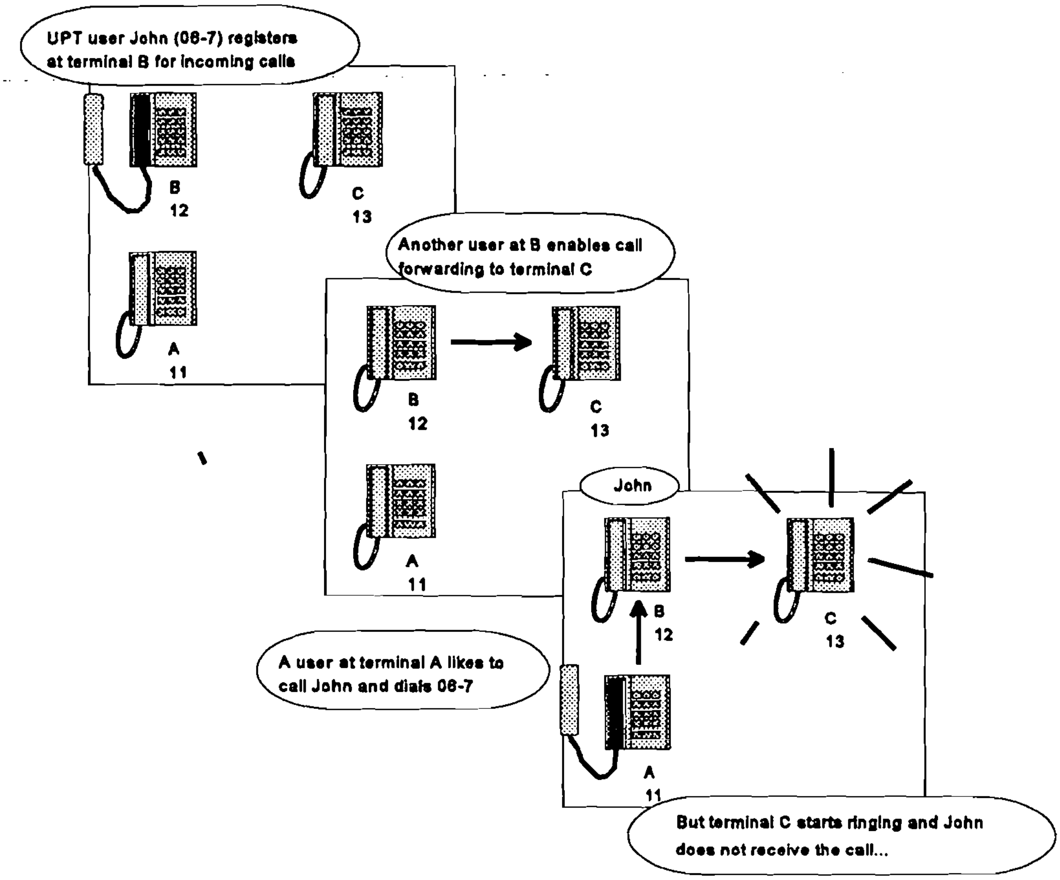


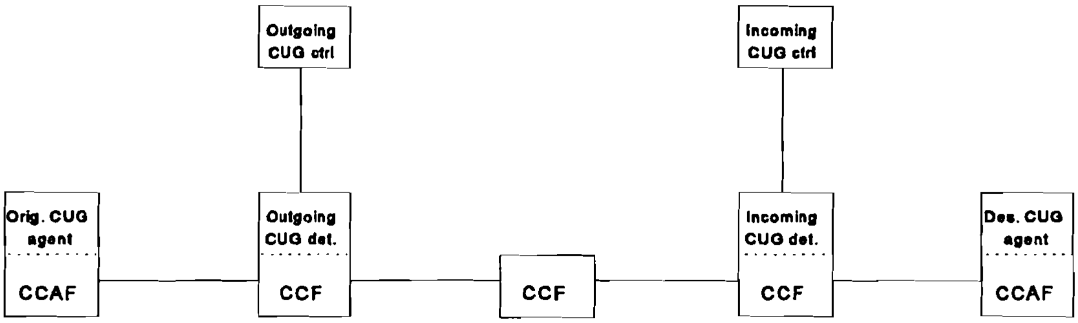
Figure 18 - Service interaction between the UPT and call forwarding services

The two services interacting in the example above are controlled by different entities. UPT is an IN service, and the call forwarding service could be an ISDN supplementary service. When observing the interworking of IN and ISDN one could find solutions to this service interaction example. A suggested solution is for example: When the call is a UPT call, call forwarding should be disabled by including a suitable parameter in the call set-up message. On service level, this is a suitable solution. When the interaction is to be solved in practice however, one has to know whether it is possible to include such a parameter. In other words, one has to know more about the protocols used in the signalling of the IN and ISDN.

One other way to study the interworking of IN and ISDN is to examine the control of supplementary services in the two networks. For that point of view we will take a look at the functional models in the next section.

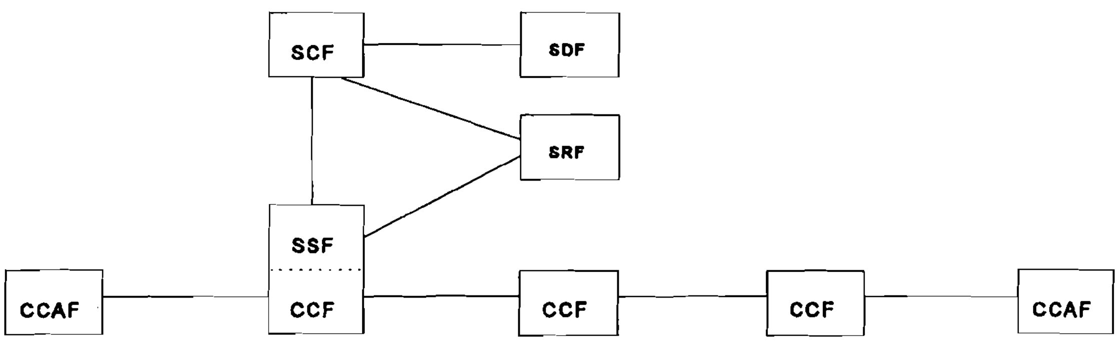
4.2 Interworking in functional description

The functional models can give us a good insight in the working of the control of services. In figure 19 the functional model of ISDN with the functional entities of the closed user group service is drawn again. When we compare this figure with the DFP model of IN with the SSF at local exchange level (figure 20), we see that both the ISDN and the IN 'hook' in the CCF at the originating local exchange. The dotted lines in the figures indicate that the functionalities that are seperated by them are in fact partly integrated (i.e. they cannot be implemented in different physical entities).



CUG Closed User Group
CCAF Call Control Agent Function
CCF Call Control Function

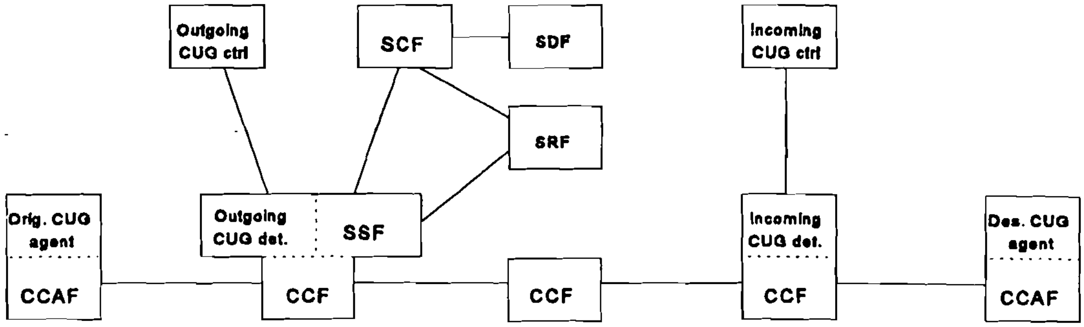
Figure 19 - Functional model for the CUG supplementary service conform Q.85.



SCF	Service Control Function	SRF	Specialized Resource Function
SDF	Service Data Function	CCAF	Call Control Agent Function
SSF	Service Switching Function	CCF	Call Control Function

Figure 20 - IN DFP model for CS-1 with SSF at local exchange level

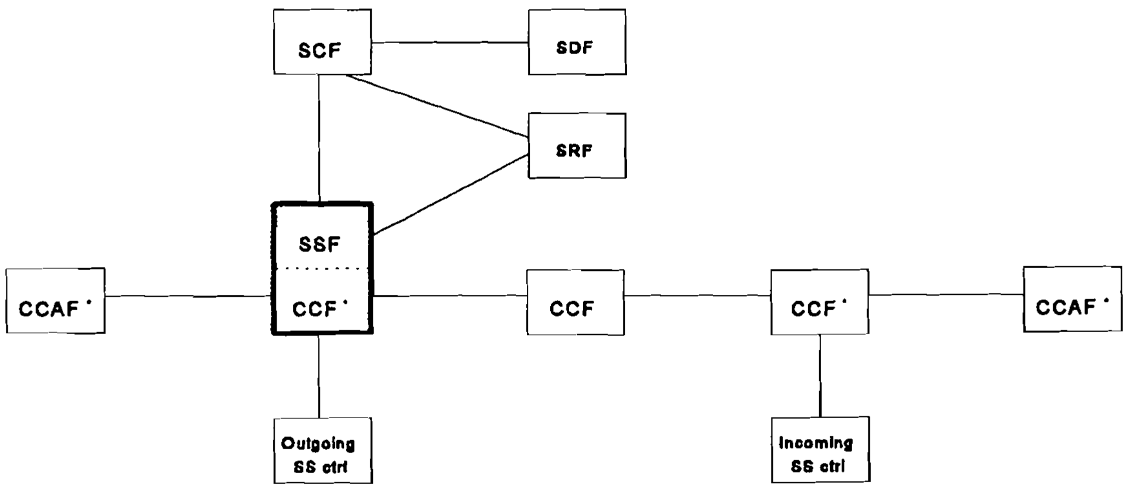
It is interesting to know what exactly happens when both an ISDN supplementary service and an IN service interfere in the call processing at the same time. This situation is illustrateed in figure 21. We obtain a combined functional model that nearly matches the IN DFP model. The difference is that the functional entities of the CUG functional model are added.



SCF	Service Control Function	SRF	Specialized Resource Function
SDF	Service Data Function	CCAF	Call Control Agent Function
SSF	Service Switching Function	CCF	Call Control Function
CUG	Closed User Group	Orig.	Originating
		Des.	Destination

Figure 21 - Combined IN-ISDN (CUG) functional model

Note that the originating and terminating CUG agents are enhancements of the CCAFs of ISDN. They can be seen as an integrated part of the CCAFs of ISDN. The same goes for the outgoing and incoming CUG determination functionalities. In the implementation of the ISDN Call Control entities they cannot be seen seperate from the CCs. Let us assume that the call control entities do have the required capabilities for the supplementary services and indicate that by adding an asterisk to their names. Since the control structure of the other ISDN supplementary services equals that of the CUG service, we can draw an IN-ISDN model with supplementary service control as done in figure 22. This model is very important and we will consider it again later in this report.



SCF	Service Control Function	SRF	Specialized Resource Function
SDF	Service Data Function	CCAF	Call Control Agent Function
SSF	Service Switching Function	CCF	Call Control Function
SS ctrl	Supplementary Service control		

Figure 22 - Combined IN-ISDN functional model

Remember that we assumed the SSF at local exchange level. This is not exactly in accordance with the situation in the existing networks at this time, but interesting because the control of ISDN supplementary services as well as IN services will interfere in this case in the same basic call process. A universal IN-ISDN model with supplementary service control could thus look a bit differently because an SSF at transit exchange level should be considered as well.

The model makes it obvious that the SSF/CCF* entity the most interesting. In this entity the contact between ISDN and IN takes place. It is therefore a good idea to focus our study on this entity. The next step is to determine what the contents of the different entities are and how we are going to model these. To choose a modellation method we examined two existing models. We report on our findings in the next section.

4.3 Existing models

The IN-simulator and the AXE-model are models in which IN functionality is included. We will discuss these models shortly and evaluate the suitability of them for our study.

4.3.1 IN-simulator

For the study of feature interaction, within the RACE project SCORE existing tools and methods were adapted that can aid with the analysis of the network and existing services and service features [Bouma94]. The approach to service (feature) interaction detection requires a specification of the involved services and service features. Since features use and extend functionality of the underlying telecommunications platform, it was necessary to create a full specification of the behaviour of services.

When the Global Functional Plane is modelled in SDL, the problem is faced that the [Q.1213] description for the GFP only describes the data flows between the Basic Call and the Service Independent Service Blocks (SIBs). Because no control flow is given in [Q.1213], it is impossible to describe the behaviour of services composed of SIBs and thus create an executable specification. Due to this observation, it was decided in SCORE to make an executable specification of a more detailed level of the IN standard: the Distributed Functional Plane (DFP).

The structure of the specification resembles the IN functional model quite strongly. The functional entities of the IN model also appear in this SDL specification. This model was created for feature-interaction analysis using the SDT Validator: A state place exploration tool. Such a tool generates all possible states of the SDL specification by executing it in all possible ways. To limit the state space, it was decided to make a closed specification, i.e. a specification without communication with entities outside the specification. Thus, the specification also includes, next to the model of the IN DFP model itself, the immediate environment of the IN DFP model consisting of telephones and users.

An overview of the specification is given in Figure 23. The main system consists of three blocks, i.e. Environment, CCF_and_SSF, and SCF_SDF. The environment block contains the environment of the telephony network, i.e. telephones and users. The CCF_and_SSF block contains the functionality of a service Switching and Control Point (SSCP), i.e. the CCAF, the CCF, and the SSF. The SCF_SDF block contains functionality from the Service Control Point, i.e. the service logic and the service data. The distribution of the functionalities over the three blocks coincides with a possible mapping of functional entities onto physical locations and constitutes one of the possible implementations for an IN.

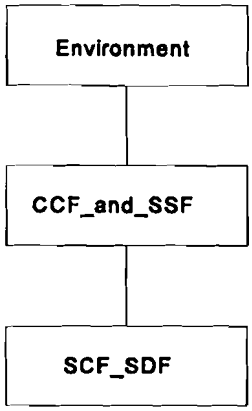


Figure 23 - Blocks in the IN DFP model.

In the report on this SDL specification [Bouma94], some comments are given on the Q.1200 series. Some of them are also interesting for us and will therefore be given here:

- The [Q.1214] recommendation contains SDL descriptions of the Service Logic Building blocks. The SDL diagrams do not have real semantics, however, because they are not part of a complete specification and they are used very informally. The descriptions are included in the diagram which gave them semantics in a formal context. In doing so, a number of ambiguities, that arose when informally defined mechanisms had to be formally specified, needed to be resolved.

- In the view of the devellopers of the SDL specification of the IN DFP, splitting the call process in an originating and a terminating part results in a service model that is still more switch oriented than call oriented. Services that modify the call process would be easier to describe in a call-oriented service model, because then an overall view of the call in one single model is provided. According to the current IN CS-1 definition, an overall view of a call can only be achieved by defining relations between the originating and terminating call models implicitly. Managing feature interactions would become simpler using a call oriented service model since services could then be analysed within the scope of the entire call.

- The division of the basic call process in an originating and terminating part creates other problems as well. The Q.1200 series assume that the call process is a single, sequential process. This may be the case for one call segment, but a call always involves two, or more, call segments. These call segments are autonomous, concurrent communnicating processes: The complete call process is thus not a sequential, but a concurrent one. A feature, acting on one call segment, can therefore influence the behaviour of a related call segment.

In this model only the IN is considered. The IN recommendations are taken as a starting point and the research of feature interactions is at the centre. This means that the the call set-up and release procedures of ISDN are not included, neither the hooks for ISDN supplementary services. This means that this model cannot be used right away for our study. The structure has to be changed to make it suitable for ISDN call processing and the detection of interactions with ISDN supplementary services. For us this model is useful for the understanding of the IN but not directly usable as a base for the model we need.

Another model we examined is the model based on a network with Ericsson AXE switches. Let us take a closer look at that model now.

4.3.2 AXE-model

At Telia Research AB in Sweden, a model for detecting network dependent service interactions is being developed [Deval94]. The model will especially serve for the detection of interactions between switched-based services and IN services. In this model a whole network is described on implementation level. This means the behaviour of the AXE exchanges used is included in this model.

Because the ISDN signalling procedures are not obviously included in this model, major adjustments have to be made to the model before we can use it for the investigations of IN-ISDN interactions.

At the moment we were doing our study, the model was not finished yet. Some functionalities of the AXE switches still had to be inlcuded. The structure however was clear and consisted of two local exchanges (localX) and one transit exchange (transitX) as shown in figure 24. The transit exchange is connected to one IN Service Control Point (SCP).

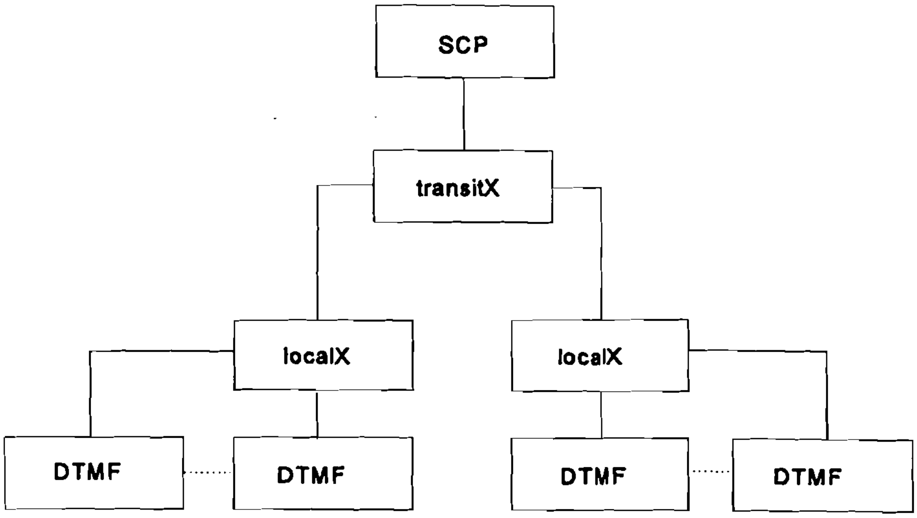


Figure 24 - Network topology of the AXE model.

The only service that is modelled is HOLD. When the model is completed the full set of services will be included. Then the model will contain the full IN functionality as well.

The following assumptions about the network have been made in order to simplify the model:
- Only the fixed network is modelled;
- There are only identical AXE exchanges in the network;
- Every AXE exchange has its own (unique) area number to make routing easier;
- Management aspects (network management, subscriber management) are not modelled;
- Only DTMF telephones are connected to the network to make the terminal interface easier;
- All area codes consist of two digits to make number analysis easier.

With these simplifications, negative interactions can still be found. For operational use, some of these simplifications may have to be reconsidered.

Since many services are caused by contention for limited resources, a resource oriented style has been adopted for the specification of the AXE network model. The various resources that are known to lead to interactions take a central place and can be easily found in the model. These are for example line interfaces, key code reception circuits multi junctor cicuits: in the model these can be found directly as processes. The logic that controls these processes is concentrated in the CallHandler process. This is not directly in accordance with the AXE exchange but makes it easier to understand the model (according to the makers of the model).

We can see that the AXE model is quite different from the IN DFP model we discussed in the previous section. At the moment the IN functionality included in the AXE model is far from complete. People are still working on the completion of the model. In order to be able to work with the model of the network with AXE exchanges, some knowledge of the working of AXE switches is necessary. Since the model is very complex, we doubt that it is possible to extend this model in a half year period and make it suitable for the study of IN and ISDN interworking.

4.3.3 Q-model

In the models we discussed above, the signalling procedures of ISDN are not obviously included. In the model which we will call the *Q-model*, the ISDN procedures are included explicitly.

In the chapters two and three we discussed the Recommendations [Q.71] and [Q.1214] respectively. As we have seen, the BCSM of IN consists of detection points (DPs). They "trigger" the IN. The ISDN basic call process consists of so called *hooks*, which trigger the ISDN supplementary services. Thus, the IN detection points are analogous to hooks for ISDN supplementary services. When the two concepts are joined together, the interaction between IN services and ISDN supplementary services could be studied easiely.

Up till now, not much effort is put in the combination of the [Q.71] and [Q.1214] descriptions to one ISDN-IN basic call model. Only a start was made at PTT Research with this *Q-model*, but this was not more than a first attempt. With this attempt, [Q.1214] has been taken as a starting point. From there, some ISDN procedures are inserted at the correct points in call processing. In the model, just like in the IN DFP model, the originating and terminating portions of the call are seperated processes.

Like the IN-simulator, this model is designed at a logical level, i.e. the physical structure of the switched is not included. However, due to the insertion of ISDN procedures, the model could be more useful for the study of service interactions between IN services and switch-based services. Nevertheless, we think this is not the ideal way of approaching the interworking problems. The structure of the model is analogous to the IN descriptions.

The BCSM as described in [Q.1214], describes the the total call process, divided in an orignating and a terminating part. For the control of both IN services and ISDN supplementary services, a description of the originating local exchange is enough for a start. When we depart from the BCSM, all the functionalities of the ISDN functional entities have to be included in the model to make it complete. Otherwise the control of ISDN supplementary services cannot be included correctly. This would the model very complex and diffucult to understand for other people. Since we are just interested in the supplementary services, some other solution has to be found. This solution will be handled in the next paragraph.

4.4 Selection of the IN-ISDN model

The existing models we examined are not suitable for our study for the following reasons:

- The IN-simulator is purely based on the IN definitions; adaption to ISDN requires major adjustments. The model is thus not simply usable for the interaction of IN services and ISDN supplementary services;
- The AXE model is far too complex. For the investigation of the IN-ISDN interworking problem it contains too many details about the AXE switches themselves. Adaption to ISDN call processing demands knowledge of AXE switches and the structure of the existing network. The addition of IN functions is complex as well, and will involve a lot of work;
- The Q-model departs from the IN definitions in [Q.1214] and insertion of ISDN call procedures is possible but not easy. Including the necessary ISDN procedures will lead to a poorly organized model.

Why not depart from the ISDN Recommendations and find out what functionality has to be added to be able to process IN services? As we have seen in chapter two, in [Q.71] the ISDN functionality and hooks for the supplementary services are described clearly. The interference of IN in the basic call using detection points goes analogously to the intererence of ISDN supplementary services using hooks. This means that if we insert the detection points at the right positions in the descriptions of the ISDN basic call, we would obtain a well organized ISDN-IN call model. Well-organized because the structure of the ISDN description can be preserved and with that the location of the ISDN hooks. For this reason the resulting model will be comparatively speaking easy to understand for people with knowledge of ISDN, but by whom the knowledge of IN is not sufficient to understand a model like the IN simulator right away. The other way around, people with an IN background will be able to understand the model when the descriptions of the contruction will be clear. We therefore decide to construct a new model that departs from [Q.71] and we will add IN functionality as descibed in [Q.1214].

In the March 1993 version of [Q.71] the addition of IN detection points is kept for further study. When we execute the addtion of IN detection points properly, a contribution to [Q.71] is one of the possibilities.

Previously in this chapter we focussed on the functional models of ISDN and IN and we saw that the call processing in the CCF/SSF entity is most interesting. With the [Q.71] descriptions as a starting point we are able to restrict ourselves to the call processing in that entity. After all, the ISDN FEs are described seperately in [Q.71] and a limitation to the originating local exchange is easy. In this functional entity, some parts of the call processing concern the originating portion of the call and others concern the terminating portion of the call. It is thus possible to identify the originating and terminating points in call in as described in the [Q.1214] and with them the locations of the originating and terminating detection points. As a result, we would obtain a dynamical description of an originating local exchange with IN service switching functionality.

5 The Basic IN-ISDN Model

In this chapter we will discuss the model that we have made. First we will focus our attention on the architecture and the general aspects of the model. After that we will go into detail about several problems we encoutered during the modellation. To conclude we will go into the usefulness of the call model.

5.1 Architecture

In the previous chapter we have decided to construct a new model which is derived from the ITU Recommendations [Q.71] and [Q.1214]. In [Q.71] the procedures for call setup and release are given in the form of dynamic descriptions. A seperate description for each functional entity of the ISDN functional model. Since our primary attention goes out to the originating local call control entity (CCF/SSF) we will focus on the processes in that entity. To make the place of this entity in the total model clear, in figure 25 the complete structure of the IN-ISDN model is shown. The architecture is derived from the combined IN and ISDN model that we saw in the previous chapter (figure 22). As we have seen in the previous chapter, the CCF/SSF entity is the most important. In this entity the interference of IN in ISDN is visible and in our model it is called FE2_CC_SSF.

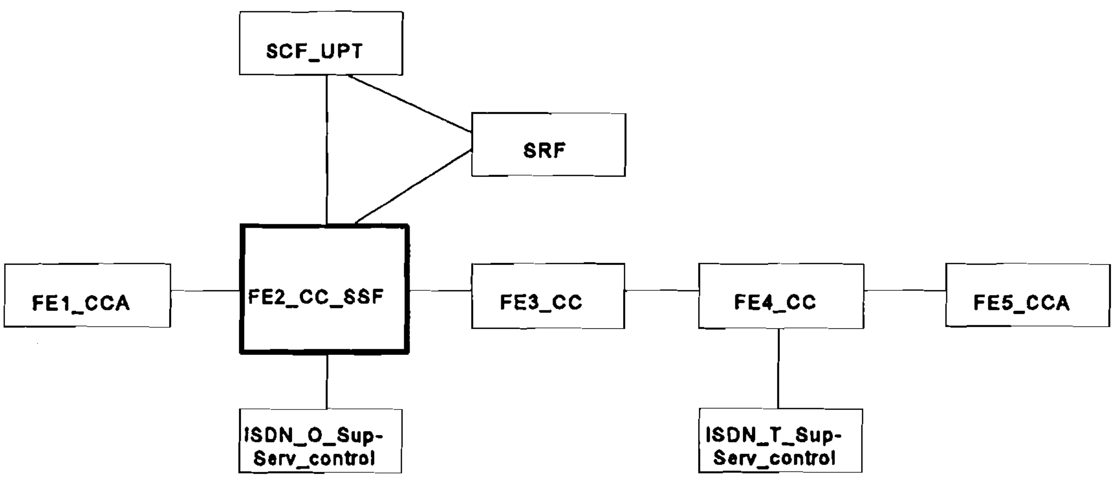


Figure 25 - Architecture of the IN-ISDN model

In figure 25, the rectangles are the blocks of the system. The architecture looks nearly the same as the architecture of the IN-ISDN model we saw in the previous chapter (figure 22 on page 34). The names are changed. The FEx prefixes correspond to the FEs of the ISDN functional model. The CCF/SSF entity is renamed in FE2_CC_SSF. Within the blocks of the system, processes lay down the behaviour. The FE2_CC_SSF block contains two processes, Call_Model and SSF, see figure 26. The arrows indicate the information flows between the two processes and the processes and the environment. In fact, this is a simplified version of the drawing in figure 14, page 23 (SSF/CCF model from IN recommendations). In our case, the SSF/CCF model is for a single service logic instance related to the calling party. The different entities within the SSF/CCF model are not recognisable in our model.

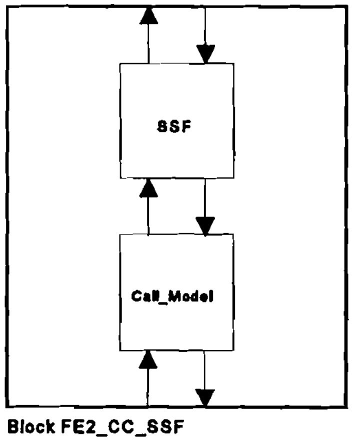


Figure 26 - Process structure in FE2_CC_SSF

The SCF and SDF are both represented by the same entity in our model, the SCF_UPT. The reason for this is that we are interested in what happens in the CCF/SSF entity rather than the details of the SCF/SDF entity.

The actions and information flows that concern the originating and terminating parts of call processing are listed in the same SDL diagram in [Q.71]. When we take [Q.71] as a starting point for our description of the call processing in the local exchange, it is better to place the call model in one process in the model as well.

Note that the fact that an integrated call model is considered not means that the originating and terminating parts of the call are not recognisable. The process Call_model consists of actions that belong to the part of the call process that is described in the originating basic call state model but it also consitsts of actions that relate to the terminating basic call state model. This means that both the originating and terminating PICs, as described in [Q.1214] can be recognised in the description of the call process in FE2 and with them the location of the detection points.

Before we discuss our results we will give precise references, the sources from which the model is derived. For the basic call model figure 2-14 of the March 1993 version of [Q.71] is used. To keep the model simple, we have restricted ourselves to the en-bloc case. This means that the digit-by-digit procedures are ommitted and thus only five of the seven sheets of figure 2-14/[Q.71] are used.

The names of the states, inputs, outputs, decision points and actions are kept the same as in [Q.71]. This means that the procedures in our model can easily by compared with the procedures in [Q.71]. As a consequence, not all the names are in line with the SDL'88 conventions since this is neither the case in [Q.71].

Functional entities are assumed to have the basic capabilities required to properly perform their functions in the ISDN (e.g. synchronism, signalling capabilities, etc.). In addition, the actions that occur at the functional entities during call processing at stages for providing services described in [Q.71] have been given reference numbers and brief descriptions. The reference numbers are shown on the [Q.71] information flow diagrams and on SDL diagrams. The detailed list of descriptions of actions, together with references to the information flow diagrams is given in paragraph 2.5/[Q.71]. Some actions are represented by one symbol in the SDL diagrams. This is for example the case with the Originating Screening and Process Attempt action (see figure 2-14/[Q.71], sheet 1). Some of the events included in this action belong to different points in call defined in [Q.1214]. Therefore, the sub-actions of the Originating Screening and Process Attempt action are extracted from the corresponding block and represented seperately by their own symbols. In this way it is possible to place the detection points at the right positions within the originating screen process. More about this in the next section.

5.2 Addition of detection points

Now we have come to one of the most important sections of this report, because we will discuss the results of our modellation. To increase the readability of this report, we have listed the details of the modellation choices in annex 2. There we compare the [Q.71] descriptions with the BCSM of [Q.1214]. The entry events, functions and exit events as identified in [Q.1214] are mapped to the events in [Q.71]. By doing this, the desired location of the detection points can be found.

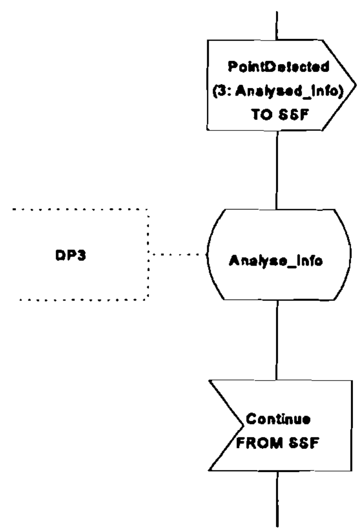


Figure 27 - SDL representation of a detection point

We have chosen to include detection points in the way that is illustrated in figure 27. As soon as the detection point is ecnountered, as message is sent to the SSF process. A transition is made to the call suspension state named after the detection point. Call processing is resumed after the continue message is received. When certain call parameters are changed, this is included in the continue message.

To keep the model as simply as possible, we decided to limit ourselves to the en-bloc signalling case. As a consequence, the detection points for the digit-by-digit case are ommitted.

For a detailed description of the designing results, the reader is referred to annex 3. As an example, we will discuss the mapping of one point in call (PIC) in our model.

Consider PIC 4: Routing and Alerting. According to [Q.1214], this PIC is entered when the routing address and call type information is available. In the model, DP 3-Analysed_Info should have been encountered. Note that the routing address could have been changed by UPT service logic in the case of a UPT call.

In PIC 4 the routing and call type are being being interpreted and 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. In the [Q.71] model, this interpretation is not seen. It looks like this is already done in the originating screening and process attempt procedure (Orig_screen on sheet Setup in annex 3). As a consequence, the placement of this PIC in the ISDN model is difficult. When we add extra decision points in the model, the relationship with this PIC becomes clear. Annex 3, sheet Setup2, includes the connectors PIC_4A and PIC_4B. Between these connectors the extra decision points can be found. After DP 3 has been detected a continue message from the SSF is received. Depending on the contents of this message, 'normal' call processing is continued, or a transition to the Exception PIC is made.

The transition to the Exception state is not listed in [Q.71]. Reason for this is that [Q.71] describes the normal call setup and call release procedures and some exception conditions are omitted on purpose. In an update of [Q.71] some extra transitions to the exception states have to be added, to enable correct IN PIC processing.

One other function of PIC 4 is the verification of the authority of the originating party to place this particular call. (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 versus trunk). In our model, this is already done in the originating screening process, as part of PIC 1. It is not made clear which parts of authority/ability determination are performed in PIC 1 or PIC 4. A solution for making the difference clear could be the following: In PIC 1 the authority is verified for the original address in the SETUP message. During DP 3 processing this address might be changed (e.g. number translation for UPT call). A second authorization/ability check has to be performed, for the new address information. This part of the verification is done in PIC 4. As a consequence, the ISDN setup procedure has to be modified to include this decision procedure.

In PIC 4 the call is being processed by the terminating half BCSM. There, continued processing of call setup (e.g. audible ring indication) is taking place. According to [Q.1214], the originating BCSM is waiting for an indication from the terminating half BCSM that the call has been answered by the terminating party. Since we incorperate both the orginating and terminating parts of the call process in our model, the communication between the two parts is not visible in our model.

Within this originating PIC a terminating detection point is encountered. The terminating BCSM PIC 7 (T_Null) processing starts. After the authority/ability determination (as described above) has taken place the T_DP 12 is encoutered and a transition is made to T_PIC 8 (Select_Route & Present Call).

Now we have described all the functions in PIC 4. Let us take a look at the exit events that apply to this PIC. The first exit event identified for this PIC is the reception of an indication from the terminating half BCSM that the call has been accepted and answered by the terminating party (e.g. terminating party goes offhook, ISUP ANM). This equals DP7-O_Answer. Since the internal communication between the originating and terminating half BCSMs is omitted, the terminating and originating detection points are encountered right after each other in the same sequence in our model. The solution is the following: After the SETUP resp.conf. message is received by FE2_CC_SSF, the answer timer is stopped and T_DP 15 is encountered (see T_BSCM description). In the model, first a transition to the T_Answer DP state is made, before DP 7 is detected.

In the latest draft of [Q.1214] the description of exception exit events is improved in comparison with previous versions. The new descriptions helped us solving some unclearities that we faced when using the older version of [Q.1214]. The following exception exit events are applicable to PIC 4: Route_Select_Failure, O_Called_Party_Busy, O_No_Answer and O_Abandon. We have added some of these exceptions to our model.

The Route_Select_Failure event occurs when the SSF/CCF receives an indication that all the routes are busy. This event (e.g. unable to determine a correct route, no more routes on the route list) should lead to the Route_Select_Failure DP. This DP is not inlcuded in our model because the route select failure case is not included in [Q.71].
The O_Called_Party_Busy event occurs when an indication of a T_Busy event specifying user busy (i.e. network determined user busy) is received from the terminating portion of the call. This event also occurs when an indication of CallRejected event specifying user busy (i.e. network determined user busy) is received from the terminating portion of the call. This event leads to the O_Called_Party_Busy DP 5. In [Q.71] this is modelled by the reception of the RELEASE req.ind. from FE 3 with busy cause. After the input of this message DP 5 is deteced. After the continue message is received from the SSF, a transition to exception PIC_6B is made. The O_No_Answer event occurs when the calling party receives no indication of an answer from the terminating side within a specified period of time. It can only occur when an O_No_Answer trigger is assigned and detected or when requested by a RequestReportBCSMEvent operation.

In this case TIMER 4 (time out no answer) goes off. In SDL, this is modelled as the reception of a TIMER 4 message. First, DP 14 (T_No_Answer) is detected. Then DP 6 is encountered. In [Q.1214] this is modelled by a message to be sent from the terminating part to the originating part of the BCSM. In our model, we placed the detection points right after each other, because the communication between the originating and terminating parts of the BCSM is not included. (For reasons of clearity, some of these BCSM internal communication events are given in the model as comments.)
The O_Abandon event is an IN event, as described in PIC 1 (see annex 2). In this case, the event is visible because there is a corresponding DP (O_Abandon). When the DISCONNECT req.ind. event is received, DP 10 is detected. After the continue message from the SSF is received T_DP 18 is detected. When the continue message for that DP is received, a normal call clearing procedure is executed.

The last exit event that could occur is the denial of the authority of the calling party to place a call (e.g. business group restriction mismatch, toll restricted dialling line). We have already discussed this exception state in the comments by the PIC 4 function description above.

By describing the design decisions for PIC 4 we have given the reader an idea of how we have made our model. The complete description of the placement of detection points in our model and the determination of the places of the IN PICs can be found in annex 3.

5.3 Value of this model

A Basic IN-ISDN Model is made. Now it is time for an evaluation of the results. In other words: what can be done with this model?

The model is suitable for analysis of the interworking of IN and the ISDN basic call and can be helpful with the implementation of IN services in ISDN. The detailed description of the IN PICs and DPs in relation to ISDN basic call set-up and release procedures (see annex 2) can be used as a starting point for the gearing of the Recommendations [Q.1214] and [Q.71].

To be able to see what happens when an IN service is invoked, some extra IN functionality has to be included. This will be discussed for the UPT service in the next chapter.

Because there are very many hooks defined in [Q.71], and all of these hooks require a seperate examination, the hooks are omitted in the Basic IN-ISDN. Since we are interested in the interworking of IN services with ISDN supplementary services, a begin is made with the insertion of ISDN hooks. We will treat this in the next chapter as well.

6 The Extended IN-ISDN Model

In this chapter we will discuss the addition of ISDN hooks to the call model described in the previous chapter. We will do this on the basis of the Closed User Group supplementary service. We will also describe the use of the inserted detection points on the basis of the IN service Universal Personal Telecommunication. To conclude this chapter we will suggest a general approach for ISDN and IN service triggering management.

6.1 Addition of UPT functionality

The advantage of the Basic IN-ISDN Model is that for the addition of IN services, no addition to the basic call model with detection points is necessary. We have got the trigger points, we only need to control these. The control of the detection points and the change of the call process is different for each IN service. We did not define the exact parameters necessary for the execution of services, and this is of course an important item. When one would like to make the model executable, one has to know exactly which parameters are needed for certain services, and which parameters could be modified by certain services.

We have added the dynamical descriptions of the SRF and SCF/SDF to clarify the working of these functional entities in general terms. The details concerning call related information/parameters have not been inlcuded. To be more precise: In the call model a message PointDetected(...) to SSF is included at several points in the dynamical description. This message should not only include the announcement "point detected" but should include extensive information about the call as well. Think of calling party address, called number, call type, etc. (The information that should be available at certain points in the call process is described in detail in the September 1994 draft of [Q.1214].) Of course, the IN services do something with this information. For example, they change the called party number in the case of a number translation service. The new information should be returned to the basic call process in the Continue from SSF message. We have limited ourselves to the inclusion of the messages PointDetected and Continue and did not define the contents of these messages. When the precise working of the services has to be known, more attention to the contents of the information flows has to be given.

The most important aspect of the IN functional entities in our model is the relation with the CCF/SSF. Exact knowledge of the service logic executed in the SCF or the way of retrieving data in the SDF is less interesting at this point. We assume that the data necessary for the execution of services is available in the SCP itself. This means that an SDF is directly connected to an SCF in the same physical entity. In our model, a procedure SDF_Request is included. The SDF process is not omitted and is supposed to return the query result or update confirmation as required.

We like to know which information flows can be expected at the SSF after the SSF has sent an information flow to the SCF or SRF. Let us therefore consider the example in figure 28. The SRF is in IDLE state until a SETUP req.ind. message is received from the SSF. The connection is established and a confirmation is sent to the SSF. We now know that the SSF has to be able to receive this confirmation message after it has sent the connection request.

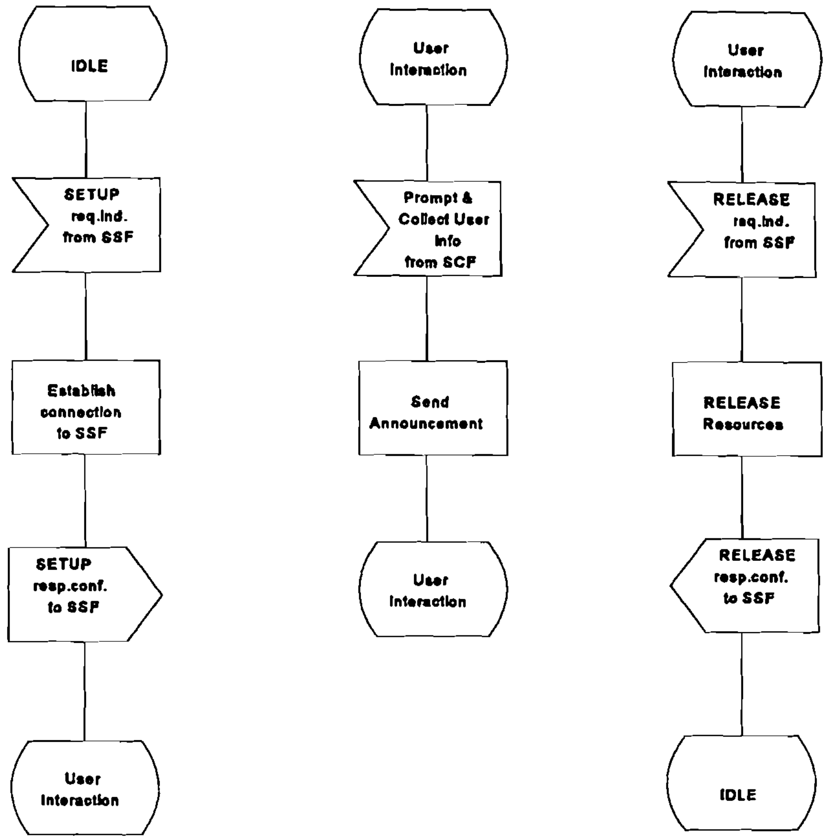


Figure 28 - Example: part of a dynamical description of the SRF

The SRF may interact with the user, controlled by the SCF. Collected information is sent to the SCF (not seen in the figure) and from the SCF to the SSF. When the SSF has collected the necessary information, a release message is sent and the SRF returns in the idle state.

For the addition of UPT functionality we have to know which detection points need to be armed. In the contribution for ETSI (DE/SPS-2004:1994), the operational requirements for UPT can be found. We have not included an arming mechanism. The addition of this mechanism is necessary when the model should be executable.

In [Q.76] the service procedures for UPT are given. Next to the UPT functional models and information flows the SDLs for the IN functional entities are described. Using this Recommendation we have obtained descriptions of the SCF, SRF and SDF.

We have included the descriptions of [Q.76] in our model and modified them a little to make them suitable for our model.

In summary, the addition of UPT functionality discussed in this paragraph amounts to the following:
- The basic call process (of the Basic IN-ISDN Model) remained the same. When the model should be executable, a detailed study of the necessary parameters in the PointDetected and Continue information flows remains to be done;
- The dynamic descriptions of the SRF, SCF and SDF are derived from the Recommendations on UPT and inlcuded in our model to see the relationship with the CCF/SSF. To derive the precise behaviour of the UPT service in relation with the ISDN basic call, the model has to be extended. Among others, a DP arming mechanism should be included.

6.2 Addition of CUG hooks

In [Q.71] the interworking of the ISDN basic call and all the ISDN supplementary services is described. The description is limited to the definition of the places of the hooks in the basic call process. The dynamic descriptions of the procedures of the different supplementary services can be found in other Recommendations (e.g. [Q.85]). When we would like to have a complete IN-ISDN model for the examination of the interaction of ISDN supplementary services and IN services, all the hooks have to be taken in consideration. Since we have changed the basic call procedures by inserting IN detection points, the places of the ISDN hooks could be changed slightly as well. It the worst case, ISDN hooks and IN detection points coincide at the same point in call and a preference determination has to be included.

Since it is impossible for us to examine the placement of all the hooks in the IN-ISDN basic call model in the time available for the project, we have chosen to add the hooks of the Closed User Group Supplementary (CUG) service only.

A detailed description of the CUG supplementary service can be found in [Q.85]. We assume a single CUG domain. This means that we do not have to worry about interworking between CUG domains.

The ISDN_O_SupServ_Control block contains the CUG_outgoing_control entity, see annex 4. The process description is relatively simple: The validation checks to be performed are done in the action block Perform Outgoing CUG control (see sheet Process CUG_outgoing_control in annex 4), and the results of these checks are returned to the basic call process. What we have said in the previous section is applicable to the addition of the CUG functionality as well: We are not interested in the exact actions of the service control block, but in the relation of this block with the basic call process (i.e. inputs and outputs).

The first CUG hook is placed between the decision point after the Orig. Screen & Process Attempt procedures and the PROCEEDING message, see annex 4, sheet Setup_with_hooks2. The placement of the first hook in relation to DP3 is important. In the description of O_PIC4 (see chapter 4) the checking of business group restrictions is mentioned. Thus, CUG-control should be performed in PIC4, i.e. after DP3 (Analysed_Info) and before DP12 (Term._Attempt_Authorised).

On sheet Setup2 (annex 3) the action Verify Authority of A party to place a call is included. This is the right place for the CUG-hook. Compare sheet Setup2 (annex 3) with sheet Setup_with_hooks2 (annex 4) to see the addtions for CUG hooks 5 and 6. The comments in the SDL diagrams make the functions of the components clear.

CUG9/10: A hook and a DP at the same point in call, see annex 4, sheet Call_sent_enbloc2. Since the CUG functionality does not influence the call processing at this stage (it only modifies the CUG-related contents of the information flow), the best option is to put the DP after the CUG hook.

We assume a local database for the CUG service. As a consequence, it is not necessary to include the CUG TIMER.

For the complete SDLs of the CUG hooks in the IN-ISDN call model the reader is referred to annex 4. The information flows in the model contain the following parameters:

Information Flow	Contents	Information Flow	Contents
INFORM1	CUG index Outgoing Access (OA) index	INFORM1 REJECT	CUG specific reason
INFORM2	CUG interlock code OA indication	INFORM2 REJECT	CUG specific reason
ENQUIRY1	Calling party number Basic service parameter CUG index OA indication	RESULT1	Non-CUG CUG interlock code or OA indication Reject reason
ENQUIRY2	Called party number Basic service parameter CUG interlock code Non-CUG OA indication	RESULT2	Non-CUG CUG index OA indicator Reject reason

We have learned from the inclusion of the CUG hooks that it is difficult to add the necessary functionality in the model when one is not well up in the matter of control of services. In other words, it is more difficult to obtain the correct dynamical description for the supplementary services in our model than it was for the call model without detection points. Reason for this is that the detection points "break" the call process at points at which ISDN hooks could have to be inserted. The locations of hooks could then become less obvious.

[Q.71] provides a description of the interworking with supplementary services. This part of the Recommendation has to be revised when the IN detection points are included in the description of the basic call. This means that for all the hooks the relation with the detection points has to be examined to obtain a complete IN-ISDN interworking description.

6.3 Dynamic detection of interactions

Service interactions could be made visible with the Extended IN-ISDN Model, but to achieve this, the model should be made executable. The model is already described in a formal language, but a complete formal declaration of the messages and parameters is necessary for an executable model. We have not done this for the following reasons:

- We wanted our model to be clearly in line with the [Q.71] recommendation. In this recommendation the information flows and procedures are described in general words. In other words, [Q.71] is not declared formally. To keep the same contruction and direct correspondence with [Q.71] a more general way of describing the procedures in our model is needed;

- The amount of time saved by omitting a pure formal description of the procedures is substantial. This time is used to make a general Basic IN-ISDN Model in stead of a specific model for the investigation of one ISDN supplementary service and one IN service.

6.4 Service trigger management

As discussed in the IN chapter, the service trigger management is an important matter. A problem is how to the determine the top priority of services. When there is more than one service involved in the processing of a single call, and more than one service has to influence the call processing, it has to be decided which service is given priority over the others. This is a typical problem with service interactions that is being studied for the case of IN services (among others in the RACE project SCORE).

In this section we present a general approach for service trigger management. It is an outline of the ideas that arose when making the Extended IN-ISDN Model. These ideas are useful for further studies on this subject. We cannot claim the suggestions are feasible, but we are convinced that a detailed study in this direction will bring us closer to a solution of the interworking problem.

In the ISDN, several ISDN supplementary services can be activated for the same call. The determination of top priority is modelled in [Q.71] as illustrated in figure 29. When an ISDN hook is encoutered (e.g. S2/1), first is determined whether a supplementary service is active. When this is not the case, call processing is resumed at the same point in call (e.g. hook S2/2). When there is one, or more than one service active, the functionality of the top priority service is executed. It could also be that the service processing is dependent on certain call parameters. In figure 29 for example, the CUG service logic can start at hook CUG5 or CUG6, depending on the availability of certain information. Service procedures are assumed to be declared between CUG5 and CUG7, and CUG6 and CUG8.

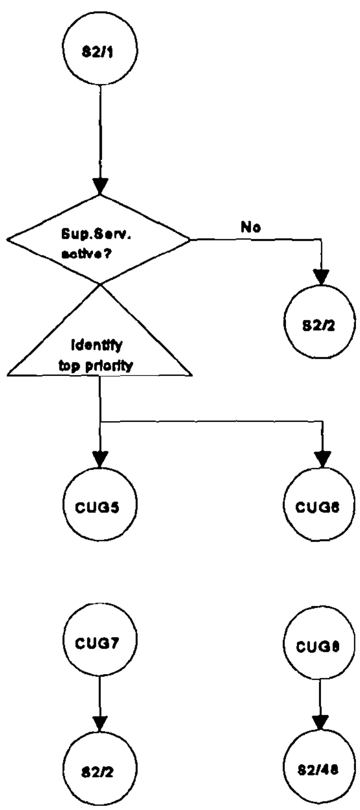


Figure 29 - Identification of priority of supplementary services

In our case, the service interactions concern the interactions of IN services with ISDN supplementary services. This requires a different approach because the control of the ISDN and IN services is performed in different entities. In [Q.1214] is already mentioned that the service trigger management requires further study. In the SSF/CCF model (figure 14 on page 23) the feature interaction manager/call manager (FIM/CM) should deal with service (feature) interaction.

It should be able to arbitrate between multiple instances of IN and non-IN service logic. In figure 30 a simplified version of the SSF/CCF model is drawn. The ISDN service control function is added and the non-IN feature manager is renamed in the ISDN feature manager.

In the SSF/CCF model in figure 30, two functional groupings are very interesting for the service interaction problem. Next to the FIM/CM, in which the arbitration between different features should take place, the basic call manager is interesting because it should provide triggers.

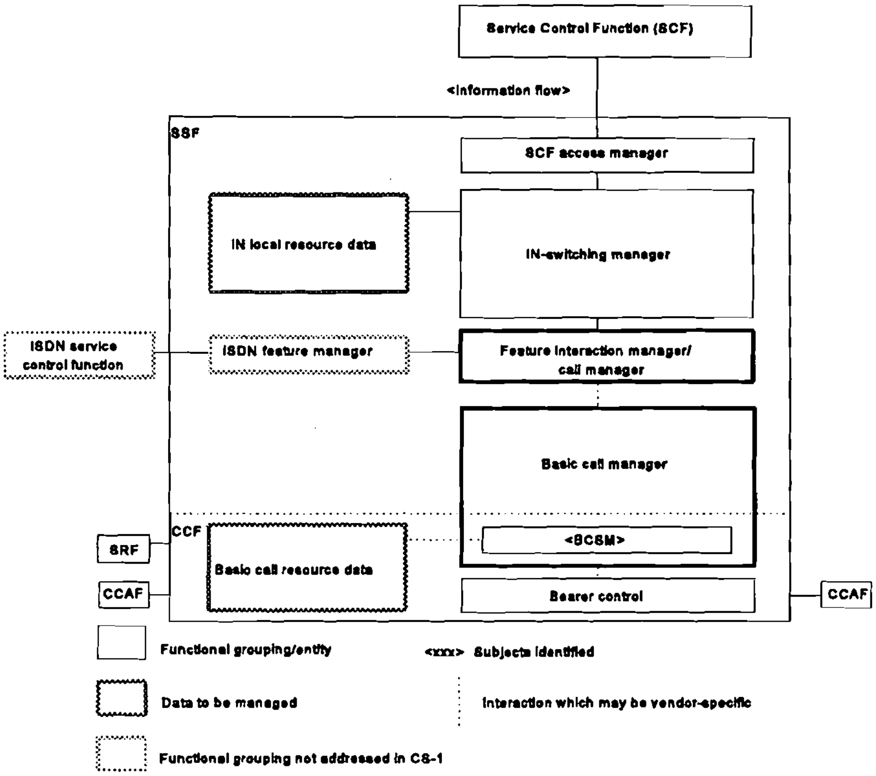


Figure 30 - Modified SSF/CCF model with ISDN service control

The basic call manager sends indications to the FIM/CM at certain points in call. These indications correspond to the ISDN hooks and the IN detection points. The first step in the management of service triggers should be the equalization of these indications in the basic call process. We have not given the right example in our model, because we handled hooks and DPs in different manners. The hook was indicated by a connector symbol, and the DP was represented by the ouput of a PointDetected message to the SSF. Let us now assume that a detection point is modelled by a pair of connector symbols in the basic call model as well. In this case the hooks and the detection points are modelled in the same way. When a hook is encountered, the accompanying ISDN supplementary service is invoked. When there are more supplementary services active at the same hook, the top priority service is identified like in figure 29.

Suppose that some ISDN hooks as well as an IN DP belong to the same pair of connectors in the basic call. The DP can then be included in a priority determinator as in figure 29. In figure 31 we have illustrated such a determinator in which ISDN supplementary services as well as IN services are considered to be active during the same call. The identification of network (nw) priority should take place in the FIM/CM. When preference has been given to the ISDN supplementary service(s), service priority identification takes place as described in [Q.71] for ISDN. The same can be done for the IN service (features): When preference has been given to the IN service(s), the priority identification for IN services should take place in the IN switching manager.

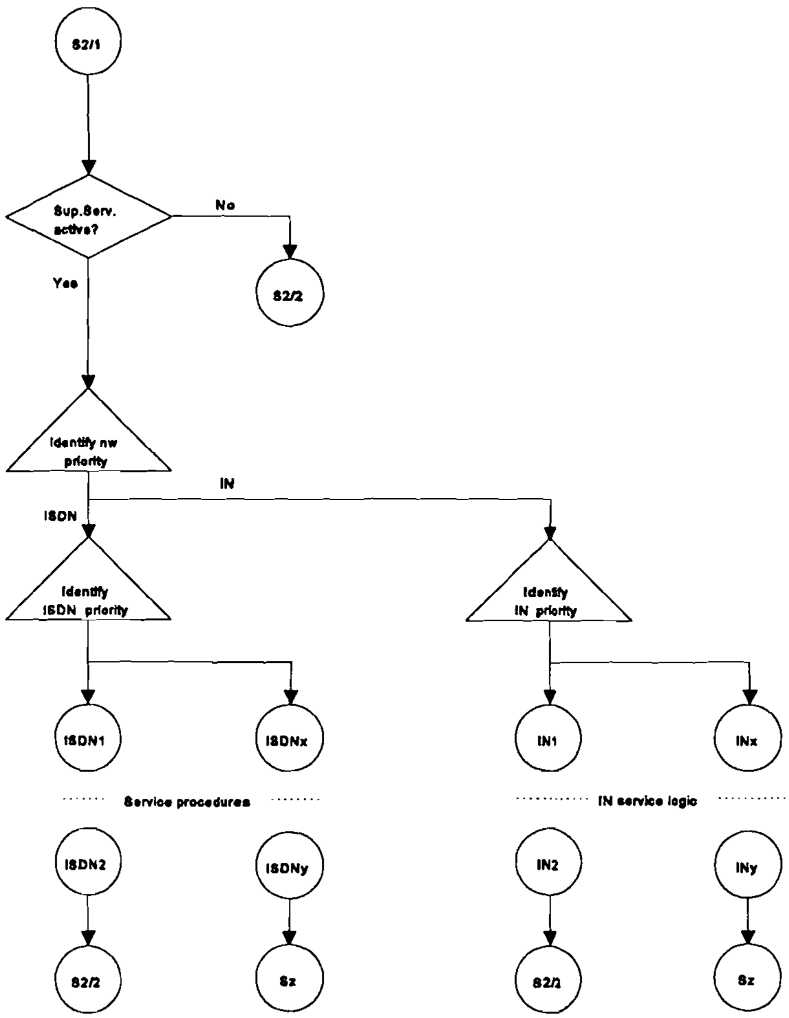


Figure 31 - Determination of priority of ISDN supplementary services and IN services

How exactly these priorities are determined is beyond the scope of this report. We assume the priorities are determined by high level service interaction considerations. E.g. the UPT service may overrule the call forwarding service.

In [Q.1214] the communication between the basic call manager and the FIM/CM occurs via BCM event indications and control requests. These indications and requests are assumed to be sent between the connectors in the basic call model and the connectors in the FIM/CM. In our modellation these messages cannot be seen, i.e. it looks like the connectors are directly connected to each other.

Let us summarize our thoughts and illustrate them in a simple model. In figure 32 the basic idea is shown. We have the Basic call process in the basic call manager (in IN represented by the BCSM) in which trigger points are placed. These trigger points are modelled in SDL as connectors, just like ISDN hooks. In the Trigger manager the network priority is determined and service control is given to the right network service control entities. This Trigger manager corresponds to the feature interaction manager/call manager in the [Q.1214] Recommendation.

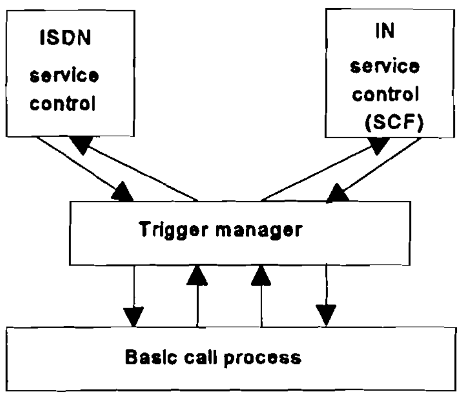


Figure 32 - General service trigger management model

The ideas illustrated in this section arose during the modellation of the IN-ISDN model and we emphasize that they are not based on an detailed study on the subject of feature interaction in the SSF/CCF model. Because of this reason we cannot conclude that this approach is a solution for the IN-ISDN interworking problem in general terms, but it seems to be a step on the right way to consider IN and ISDN services.

7 Discussion

7.1 Evaluation

In the following, the purposes of the project as defined in chapter 1 will be summarized. In view of the results we conclude whether the purposes of the project are met satisfactory.

1) Support the search for a solution to the IN-ISDN interworking problem by constructing a model with which solutions can be examined.

The search for a solution to the IN-ISDN interworking problem is supported indeed by constructing a Basic IN-ISDN Model in stead of a making a model that is only suitable for examination of specific service interaction problems. SDL diagrams (annexes 4 and 5) are made and a detailed description of the difficulties (annex 2) that were faced when gearing IN and ISDN Recommendations is presented. These results are usable for the solution of IN-ISDN interworking problems.

2) Demonstrate the working of the model by a 'case'.

A Basic IN-ISDN Model is made and the suitability of the model is demonstrated by adding the ISDN supplementary service Closed User Group and the IN service Universal Personal Telecommunication.

Since it was decided to approach the interworking problem in a general way by modifying the ISDN basic call procedures, the interpretation of purpose 2 had to be changed in comparison with the start of the project. We started from the idea of an executable model which could be tested with an example service. The model that was made in the end, was too complex to be made executable in the time available for the project. Therefore, the 'case' consisted of some additions to the Basic IN-ISDN Model.

3) Find solutions to the detected interworking problems.

The problems that were detected during the making of the IN-ISDN, i.e. unclearities about the location of the detection points in the ISDN basic call procedures, have been solved (see annex 2 and 3). Concrete interaction problems between IN and ISDN services could not be solved because we focussed on general interworking aspects.

4) Demonstrate the results by using for example message sequence charts.

The results are presented in the form of SDLs (see annexes 3 and 4). Message sequence charts could not be shown because the model is not executable. However, the working of the call model could have been demonstrated by showing the precise working of the CUG and UPT services within the Extended IN-ISDN Model. Unfortunately, the time available for the project was too short to do so.

5) Come to recommendations for the adjustment of the IN and ISDN with which confronted problems will be solved.

By studying the existing ITU and ETSI Recommendations, unclearities are detected and it is shown that additions to the existing Recommendations are necessary. These additions are described in annex 2.

6) Come to recommendations that add to the solution of the IN-ISDN interworking problem in general.

Although this purpose seemed to be some ideal case in the beginning of the project, the experience, obtained by studying specific service interactions, has lead to insights that add to the solution of the interworking of the IN and ISDN in general. By studying the Recommendations of IN and ISDN, and examination of some existing network models, we saw that a general IN-ISDN interworking call model would be more valuable than a model with which only specific service interactions could be solved. Our proposals for the management of service triggers (section 6.4) contribute to the solution of the IN-ISDN interworking problem in general.

7.2 Conclusions

The exact location of IN detection points in the call model of the underlying network is important to know for the implementation of IN services in ISDN and to get insight in the interaction problems between IN services and the supplementary services of the underlying network. The latest draft version of [Q.1214] (September 1994) describes the placement of detection points in the form of SDLs, which is more precise than before. This draft however, was not available when we started working on our description.

For the application of the IN concept on ISDN, there is a need for a model that concerns the ISDN specifically. The basic call procedures for set-up and release of a call are described in [Q.71]. It was decided to use that Recommendation as a starting point for a modellation of the Basic IN-ISDN Model. A new version of the [Q.71] Recommendations can be expected any moment. Probably, the problems that were faced during this study will be addressed in the new version of [Q.71] as well.

In view of the results of this project the following conlusions are drawn:

- In the existing standards, the relationship between IN services and ISDN services has not been described sufficiently. There is enough information in the ITU and ETSI Recommendations about the services itself, but the control of both IN and ISDN supplementary services at the same time, has not been studied in detail;

- For the interference of IN in ISDN one has mainly studied the case of an SSP at transit level. For the optimum control of services however, an SSP at local exchange level is more interesting, because the control of ISDN supplementary services takes largely place at local exchange level;

- A clear understanding of the interworking of IN and ISDN services is obtained by studying the relationship between IN services, ISDN supplementary services, and the ISDN basic call procedures. This insight is shown in the detailed desciption of the basic call model with detection points in annex 2. Besides, it is illustrated by the description of the proposals for the approach of service management in chapter 6;

- A Basic IN-ISDN model is constructed in line with the Recommendations [Q.1214] and [Q.71]. This model should be used for the gearing of these Recommendations;

- By including ISDN hooks and IN detection points in the same way in the basic call procedures, a clear view of the interference of services in the basic call is obtained. A proposal is presented for a standard way of handling services. This proposal is useful for further studies on the subject of IN-ISDN interworking.

7.3 Items for further study

- A clear treatise of the additions to be made to the Recommendations [Q.1214] and [Q.71].

- An exact implementation of the CUG and UPT services;

- A solution to service interaction problems between CUG and UPT;

- More effort should be put in the investigation of the ideas that are illustrated about service trigger management;

- The efforts that are put in feature interaction handling for IN services can be used for the study of ISDN supplementary services as well. For the evolution of the existing ISDNs to Intelligent ISDNs, one should examine whether the control of supplementary services could be extracted from the basic ISDN to implement it in the intelligent control structure 'above' the ISDN.

- The general ideas and detailed descriptions in this report should be compared with the ideas within study groups of ITU. Since we have used the [Q.71] version of December 1993, a part of this study could be not as up to date as we like to think. A new version of [Q.71] could be published any moment now and a comparison of our results and the progress of the study groups in this area is recommended. We were able to include aspects of the final draft version of [Q.1214]. The purpose of that Recommendation is to give a technology independent description of the IN, but the signalling as described in [Q71] is included at different places in [Q.1214]. This is very helpful for the understanding of specific aspects of the call procedures for IN. An extension of the ISDN specific procedures in [Q.1214] is handled in this report and is useful for the improvement of the IN Recommendations.

Abbreviations

Agent	Entity acting on behalf of another
BCP	Basic Call Process
BCSM	Basic Call State Model
CCAF	Call Control Agent Function
CCBS	Completion of Calls to Busy Subscribers
CCF	Call Control Function
CFB	Call Forwarding Busy
CFU	Call Forwarding Unconditional
CID	Call Instance Data
CLIP	Calling Line Identification
CLIR	Calling Line Identification Restriction
CM	Call Model
COLP	Connected Line Identification Presentation
COLR	Connected Line Identification Restriction
CS	Capability Set
CUG	Closed User Group
DFP	Distributed Functional Plane
DSS1	Distributed Subscriber Signalling No1. Protocol
DP	Detection Point
DTMF	Dual Tone Multi Frequency
EDP	Event Detection Point
ETS	European Telecommunication Standard
ETSI	European Telecommunication Standards Institute
FEA	Functional Entity Action
FEAM	Functional Entity Access Manager
FSM	Finite State Machine
GFP	Global Functional Plane
GSL	Global Service Logic
GSM	Global System for Mobile Communications
IN	Intelligent Network
INAP	Intelligent Network Application Protocol
INCM	Intelligent Network Conceptual Model

IP	Intelligent Peripheral
ISDN	Integrated Services Digital Network
ISUP	Integrated Services Digital Network User Part
ITU-T	International Telecomunication Union - Telecommunication Standardization Sector
LE	Local Exchange
PIC	Point In Call
POC	Point Of Control
POI	Point of Initiation
POR	Point Of Return
POTS	Plain Old Telephone System
PSTN	Public Switched Telephony Network
RACE	Research for Advanced Communications in Europe
SCE	Service Creation Environment
SCAF	Service Control Access Function
SCEF	Service Creation Environment Function
SCF	Service Control Function
SCME	Service Control Management Entity
SCP	Service Control Point
SDF	Service Data Function
SDL	Specification and Description Language
SDT	SDL Definition Tool
SF	Service Feature
SIB	Service Independent Building Block
SL	Service Logic
SLI	Single-ended Service Logic Instance
SLPI	Service Logic Program Instance
SM	Service Manager
SMAF	Service Management Access (or Agent) Function
SMF	Service Management Function
SN	Service Node
SRF	Specialised Resource Function
SS	Service Subscriber
SSF	Service Switching Function
SSP	Service Switching Point
TDP	Trigger Detection Point
TE	Terminal Exchange
UPT	Universal Personal Telecommunication
UUS	User-to-User Signalling

References

[Beckers93] Beckers, H.J.H. en L. Dijkstra, C. van Maastricht, R.A. Sturrus
INTERWORKING VAN ARCHITECTUREN: IN-ISDN INTERWORKING.
Leidschendam: PTT Research, 1993.
Internal report NT-RA-93-1765.

[Belina91] Belina, F. et al.
SDL WITH APPLICATIONS FROM PROTOCOL SPECIFICATION.
Hertfordshire: Prentice Hall, 1991.

[Bouma94] Bouma, L.G. en W.G. Levelt, H. Velthuijsen, J. Zuidweg
DETECTION OF FEATURE INTERACTIONS USING FORMAL METHODS
Leidschendam: PTT Research, 1994
Internal report RA-94-75.

[Brouwer92] Brouwer, W. en B. Kastelein, R.A. Sturrus.
Q.1200 EXPLAINED - INS AND OUTS.
Leidschendam: PTT Research, 1992.
Report NT-RA-92-1532.

[Carl90] Carl, D and K. Schreier
INTRODUCTION IN EXISTING NETWORKS.
ICCT '92, Proc. of 1992 International Conference on Communication Technology, Beijing, China, 16-18 Sept. 1992.
Beijing: Int. Acad. Publishers, 1992, Vol. 2, p. 30.01/1-4

[Chow90] Chow, C.-H.
PROTOCOL ISSUES IN INTERCONNECTING ISDN, IN, AND LAN.
IEEE TENCON'90: 1990 IEEE Region 10 Conference on Computer and Communication Systems
Hong Kong, 24-27 Sept. 1990.
New York: IEEE, 1990, Vol. 2, p. 610-616.

[Clarke93] Clarke, P.G.
ISDN STANDARDS: AN OVERVIEW.
British Telecommunications Engineering, Vol. 12, 1993, Part 1, p. 47-55.

[Deak92] Deak, T.
INTRODUCING INTELLIGENT NETWORKS INTO THE PSTN.
The Path to global Networking. Proc. of the Int. Council for Computer Communication Intelligent Networks Conf., p. 300-315.
Tampa, FL, USA, 4-6 May 1992.
Amsterdam: IOS Press, 1992.

[Deval94] Devallius, L.
A MODEL FOR DETECTING NETWORK DEPENDENT SERVICE INTERACTIONS
Stockholm: Telia Research AB, 1994.
Report: TU 5102/94.

[Eske91] Eske-Christensen, B. et al.
INTELLIGENTE NETZE: BASIS FÜR FLEXIBLERE TELECOM-DIENSTE.
Funkschau, 1991, No. 12, p. 54-59.
Germany: May 1991.

[ETSI_CCBS] ETSI Draft Standard: COMPLETION OF CALLS TO BUSY SUBSCRIBER (CCBS) SUPPLEMENTARY SERVICE FOR SIGNALLING SYSTEM NO. 7 ISUP PROTOCOL.
Valbonne: ETSI, 20 November 1992.
ETS 6001.27.

[ETSINAP93] ETSI Draft European Standard, version 8: SIGNALLING PROTOCOLS AND SWITCHING, CS-1, INAP.
SPS Technical Committee of ETSI
Valbonne: ETSI, May 1993.
ETSI DE/SPS-3015.

[I.255] ITU Recommendation I255.1: ISDN GENERAL STRUCTURE AND SERVICE CAPABILITIES - CLOSED USER GROUP (CUG)
Geneva: ITU, August 1992.

[ISUP2] ETSI European Telecommunication Standard
ISDN USER PART VERSION 2 FOR THE INTERNATIONAL INTERFACE, PART 1: BASIC SERVICES
Valbonne: ETSI, February 1994.
ETS 300 356-1

[Q.1200] ITU Q-SERIES INTELLIGENT NETWORK RECOMMENDATION STRUCTURE
Geneva: ITU, December 1993.
Published in document COM XI-R 207-E.

[Q.1204] ITU Recommendation Q.1214: INTELLIGENT NETWORK DISTRIBUTED FUNCTIONAL PLANE ARCHITECTURE.
Geneva: ITU, December 1993.
Published in document COM XI-R 208-E.

[Q.1211] ITU New Recommendation Q.1211: INTRODUCTION TO INTELLIGENT NETWORK CAPABILITY SET 1.
Geneva: ITU, December 1993.
Published in document COM XI-R 210-E.

[Q.1214] ITU New Recommendation Q.1214: DISTRIBUTED FUNCTIONAL PLANE FOR INTELLIGENT NETWORK CAPABILITY SET 1.
Geneva: ITU, December 1993.
Published in document COM XI-R 212-E.

[Q.1214] ITU Draft Recommendation Q.1214: DISTRIBUTED FUNCTIONAL PLANE FOR INTELLIGENT NETWORK CAPABILITY SET 1.
September 1994 (not published yet)

[Q.1215] ITU New Recommendation Q.1215: PHYSICAL PLANE FOR IN CS-1.
Geneva: ITU, December 1993.
Published in document COM XI-R 216-E.

[Q.1218] ITU New Recommendation Q.1218: INTERFACE RECOMMENDATION FOR IN CS-1.
Geneva: ITU, December 1993.
Published in document COM XI-R 217-E.

[Q.1290] ITU New Recommendation Q.1290: VOCUBULARY OF TERMS USED IN THE DEFINITION OF INTELLIGENT NETWORKS.
Geneva: ITU, December 1993.
Published in document COM XI-R 218-E.

[Q.71] ITU Recommendation Q.71: GENERAL RECOMMENDATIONS ON TELEPHONE SWITCHING AND SIGNALLING; FUNCTIONS AND INFORMATION FLOWS FOR SERVICES IN THE ISDN: ISDN CIRCUIT MODE SWITCHED BEARER SERVICES
Geneva: ITU, March 1993.

[Q.730] CCITT Recommendation Q.730: ISDN SUPPLEMENTARY SERVICES
REPORT OF THE FINAL MEETING HELD IN GENEVA FROM 9 TO 20 MARCH 1992, PART II.41 - REVISED RECOMMENDATION Q.730
Published in document COM XI-R 226-E
Geneva: CCITT, April 1992

[Q.735] ITU Recommendation Q.735: STAGE 3 DESCRIPTION FOR COMMUNITY OF INTEREST SUPPLEMENTARY SERVICES USING SS NO. 7: CLAUSE 1 -CLOSED USER GROUP (CUG)
Geneva: ITU, March 1993.

[Q.76] ITU Recommendation Q.76: SERVICE PROCEDURES FOR UNIVERSAL PERSONAL TELECOMMUNICATION - FUNCTIONAL MODELLING AND INFORMATION FLOWS - VERSION 3
Published in document COM 11-R 43-E.
Geneva: ITU, February 1994

[Q.761] CCITT Recommendation Q.761: FUNCTIONAL DESCRIPTION OF THE ISDN USER PART OF SIGNALLING SYSTEM NO. 7
Geneva: CCITT, April 1992
Published in document COM XI-R 233-E.

[Q.764] ITU Recommendation Q.764: SS7 ISDN USER PART SIGNALLING PROCEDURES.
Geneva: ITU, 1993.
Published in document COM XI-R 235-E.

[Q.85] ITU Recommendation Q.85: FUNCTIONS AND INFORMATION FLOWS FOR SERVICES IN THE ISDN: STAGE 2 DESCRIPTION FOR COMMUNITY OF INTEREST SUPPLEMENTARY SERVICES, SECTION1 - CLOSED USER GROUP (CUG)
Geneva: ITU, 1992.

[Q.850] ITU Recommendation Q.850: USAGE OF CAUSE AND LOCATION IN THE DIGITAL SUBSCRIBER SIGNALLING SYSTEM NO. 1 AND THE SIGNALLING SYTEM NO. 7 ISDN USER PART.
Geneva: ITU, 1993.
Published in document COM XI-R 236-E.

[Stall91] Stallings, W.
ISDN AND BROADBAND ISDN.
New York: Macmillan Publishing Company, 1992.

[UPT] ETSI Technical Committee Technical Report: UNIVERSAL PERSONAL TELECOMMUNICATION (UPT) REQUIREMENTS ON INFORMATION FLOWS AND PROTOCOLS PHASE 1.
Valbonne: ETSI, 25 February 1994.
ETSI Draft TC-TR NA-71301, Version 0.3.2.

[UPTNA] ETSI Technical Committee Technical Report: UNIVERSAL PERSONAL TELECOMMUNICATION (UPT) PHASE 1 (RESTRICTED UPT SERVICE SCENARIO).
Valbonne: ETSI, July 1992.
ETSI Draft TC-TR NA-71101, Version 0.6.0.

[Z.100] ITU Recomendation Z.100: SPECIFICATION AND DESCRIPTION LANGUAGE SDL
Geneva: ITU, 1988.
Blue Book, Vol. X.1 - X.5.

[Z.100A] ITU Appendix I to Recommendation Z.100: SDL METHODOLOGY GUIDELINES
Geneva: ITU, July 1992
Published in document COM X-R 32-E.

Annex 1: ISDN Supplementary Services

Number Identification

Direct Dialling In (DDI)
Enables a user to call directly to another user on an ISDN-compatible PBX or Centrex, without attendant intervention, or to call a terminal on a passive bus selectively.

Multiple Subscriber Number (MSN)
Allows multiple ISDN numbers to be assigned to a single public or private access. This enables the selection of one or more multiple distinct terminals attached to the same access.

Calling line identification presentation (CLIP)
Service offered to the called party that provides the ISDN number of the calling party.

Calling line identification restriction (CLIR)
Service offered to the calling user to restrict presentation of the calling party's ISDN number to the called party.

Connected line identification presentation (COLP)
Service offered to the calling party that provides the ISDN number of the party to whom the caller is connected.

Connected line identification restriction (COLR)
Service offered to the connected party to restrict presentation of the connected party's ISDN number to the calling party.

Malicious call identification (MCID)
Gives the possibility to obtain, by an appropriate request, the storage and registration of the following information:

- called party number;
- calling party number;
- time and date of the request.

As an option the calling party subaddress can be provided.

Subaddress (SUB)
The subaddress information is access significant information which is transported transparent through the network in the Access Transport parameter in the Initial Address Message (IAM).

Call Offering

Call transfer (CT)
Enables a user to transfer an established call to a third party. This services is different from the call forwarding services since, in this case, the call to be transferred must have an established end-to-end connection prior to the transfer.

Call forwarding busy (CFB)
Permits a served user to have the network send incoming calls (or just those associated with a specific basic service) addressed to the served user's ISDN number to another number when this user's line is busy. The served user's originating service is unaffected.

Call forwarding no reply (CFNR)

Permits a served user to have the network send incoming calls (or just those associated with a specific basic service) addressed to the served user's ISDN number to another number when there is no answer on this user's line. The served user's originatingservice is unaffected.

Call forwarding unconditional (CFU)

Permits a served user to have the network send incoming calls (or just those associated with a specific basic service) addressed to the served user's ISDN number to another number. The served user's originating service is unaffected.

Call deflection (CD)

Allows a served user to respond to an incoming call offered by the network by requesting redirection of that call to another number specified in the response. This redirection is only allowed before the called user has answered the call.

Line hunting (LN)

Enables incoming calls to a specific ISDN number (or numbers) to be distributed over a group of interfaces or terminals.

Call completion

Call waiting (CW)

Permits a subscriber to be notified of an incoming call with an indication that no interface information channel is available. The user then has the choice of accepting, rejecting, or ignoring the waiting call.

Call hold (HOLD)

Allows a user to interrupt communications on an existing call and then subsequently reestablish the connection.

Completion of calls to busy subscribers (CCBS)

When user A encounters a busy destination B, user A can request the CCBS supplementary service. The network will then monitor the wanted destination B for becoming not busy. When the wanted destination B becomes not busy, the network will automaticly recall user A. When the user A accepts the recall, then the network will automaticly generate a CCBS call to destination B.

Terminal Portability (TP)

Allows the user to move a terminal from one socket top another within one given basic acccess during the active state of a call. It also allows a user to move a call from one terminal to another terminal within one given basic access during the active phase of the call.

Multiparty

Conference calling (CONF)

Allows a user to communicate simultaniously with multiple parties, which may also communicate among themselves.

Three-party service (3PTY)

Allows a subscriber to hold an existing call and make a call to a third party. The following arrangements may then be possible: the ability to switch between the two calls, the introduction of a common speech path between the three parties, and the connection of the other two parties.

Charging

Credit card calling

International telecommunication charge card.

Advice of charge (AOC)

Provides the user paying for a call with usage-based charging information. This service may be provided at call setup time, during the call, and/or at the completion of the call.

Reserve charging (REV)

Provides the possibility that the called user pays for the call.

Freephone

Offers a free call to a calling party. The costs will be charged to the subscriber of the freephone number.

Additional information transfer

User-to-user signalling (UUS)

Allows an ISDN user to send/receive a limited amount of information to/from another ISDN user over the signalling channel in association with a call to the other ISDN user.

Community of interest

Multi-level precedence and preemption (MLPP)

Provides prioritized call handling service. This service has two parts - precedence and preemption. Precedence involves assigning priority level to a call. Preemption involves the seizing of resources, which are in use by a call of a lower precedence, by a higher level precedence call in the absence of idle resources.

Closed user group (CUG)

Allows a group of users to intercommunicate only among themselves or, as required, one or more users may be provided with incoming/outgoing access to users outside the group.

Additional information on CUG

A user may be a member of several CUGs. Each service provider may define the maximum number of CUGs which can be allocated to an individual subscriber. When subscribed to at least one CUG, a user may subscribe to one of the following access arrangements:

- *Closed User Group (c)*: The user may make calls to, and receive calls from members of those CUGs of which the user is a member;
- *Closed User Group with outgoing access (c+o):* The user may make and receive calls in the same way with the same exceptions as with CUG(c). In addition, this user can make calls to other non-CUG users, and to those other users who allow incoming access. Incoming calls are only allowed from members of the user's CUG(s);
- *Closed User Group with incoming access (c+i):* The user may make and receive calls in the same way with the same exceptions as with CUG(c). In addition, this user may receive calls from any non-CUG user and also from other CUG users who have outgoing access. Outgoing calls are only allowed to members of the user's CUG(s);
- *Closed User Group with incoming and outgoing access (c+i+o)*: The outgoing and incoming access can be offered simultaneously to the user by the provider.

A user may subscribe to one of the two additional access restrictions within each particular CUG:

- *incoming calls barred within a CUG (ICB)*: This access restriction means that a CUG- user is prohibited from receiving calls from users subscribed to the same CUG. This access restriction is given per CUG-user and CUG;
- *outgoing calls barred within a CUG (OCB)*: This access restriction means that a CUG- user is prohibited from making calls to users subscribed to the same CUG. This access restriction is given per CUG-user and CUG;

All of these cases are illustrated in Figure 1/[I.255].

The CUG service is provided on a subscription basis. As a network provider option, CUG can be offered with several subscription options. The subscriber options may apply to each ISDN number and basic service, or apply to a particular ISDN number for a set of basic services (see table 1).

Table: CUG subscription options

General subscription options	
Subscription option	Value
Closed User Groups	List of one or more CUGS
Intra-CUG restrictions (for each CUG)	None Incoming (terminating) calls barred Outgoing (originating) calls barred
Applicability to basic services	List of one or more basic services All basic services
Per service subscription options	
Subscription option	Value
Preferential CUG	None designated CUG value
Type of inter-CUG access (in/out of CUG)	None Outgoing access Incoming Access Outgoing and incoming access

Annex 2: Model compared to BCSM

In this section the [Q.1214] quotes are written in standard text. Personal remarks are written in *italics*. These remarks include the [Q.71] procedures themselves and additions to them.

<u>**Originating Basic Call State Model**</u>

1. O_Nul & Authorize_Origination_Attempt

<u>Entry event:</u>

Disconnect and clearing of a previous call (DPs 9-O_Disconnect and 10-O_Abandon), or default handling of exceptions by SSF/CCF completed.

<u>Functions:</u>

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

  This equals the IDLE state in the [Q.71] description. It is the start of O_Null (PIC 1) processing and part of T_Null (PIC 7).

- Given an indication from an originating party of a desire to place an outgoing call (e.g. offhook, Q.931 setup message, ISDN UP IAM, *SETUP req.ind.*), the authority/ability of the party to place the call with given properties (e.g. bearer capability, line restrictions) is verified. The types of authorization to be performed may vary for different types of originating resources (e.g. for lines vs. trunks).

Here we encounter the first decision to be made. There are several stages in the call process in which the authority and ability to place a call is verified. These different stages are inlcluded in the Originating screen procedure and process attempt that is described in text form in [Q.71]. There is no SDL diagram given of this procedure, so it is derived from the textual description.
The first three actions in the procedure are:

- *Analyse Service Request;*
- *Identify calling terminal and User priority level;*
- *Verify the user's authorization capabilities and the availability of appropriate resources.*

Then the process attempt starts by establishing the callID and reserving the <u>incoming</u> resources. This point equals the detection point Orig.Attempt_Authorized. In the SDL an output message PointDetected Orig.Attempt_Authorized is sent to the SSF. A new state is included, called Orig.Screen_Authorized. Call processing is suspended until a Continue message from the SSF is received.

This is the standard way we have chosen to include a detection point in the SDL. In the september version of The Continue message include several parameters which might influence call processing. These parameters are depended of the detection point and the service logic that is invoked. I have not identified the exact contents of the Continue message yet.

<u>Exit events:</u>

- Indication of the desire to place an outgoing call (e.g. offhook, Q.931 Setup message, ISDN UP IAM) and authority/ability of the party to place the outgoing call verified (DP 1-Origination_Attempt_Authorized);

This event occurs after the originating screen part of the originating screen and process attempt procedure, when the authority/ability to place a call is verified. DP1 is detected.

- (agreed march 1994) The following exception exit events are applicable to PIC 1. For this PIC, if the call encounters one of these exceptions during PIC 1processing, the exception event is not visible in IN because there is no corresponding DP.

  The O_Abandon occurs when the calling party disconnects. This event can result from one of the following:
  - The SSF/CCF receives an on-hook indication from a non-ISDN line, following switchhook flash timing;

    This is not applicable to the Q-model.
  - The SSF/CCF receives an on-hook indication from a caller served by an DSS-1 interface;

    This event is not include in the [Q.71] description in this stage of call processing.
  - The SSF/CCF receives a disconnect indication from a conventional trunk or private facility trunk;

    This does not apply to the Q-model, because we suppose a public SS7 trunk.
  - The SSF/CCF receives a disconnect message from an SS7 trunk;

    This event is not include in the [Q.71] description in this stage of call processing.
- Authority/ability to place outgoing call denied (Exception).

  This event occurs after the originating screen part of the originating screen and process attempt procedure, when the authority/ability to place a call is denied. A transition to the exception PIC occurs. Not visible to IN because no DP is encountered.

2. Collect_Information

Entry event:

- Indication of the desire to place an outgoing call (e.g. offhook, Q.931 Setup message, ISDN UP IAM) and authority/ability of the party to place the outgoing call verified (DP 1-Origination_Attempt_Authorized)

  This PIC processing starts after the originating screen part of the originating screen and process attempt procedure, when the authority/ability to place a call is verified. DP1 has been detected.

Functions:

- *We consider the ISDN en-bloc case so this function restricts to the examination of the IAM. Note however, that this event has already taken place. As a consequence, no information flows or activities take place in between the Orig.Attempt_Authorized and Collected_Info detection points. The start and end of PIC 2 are located at the same spot in the SDL diagram.*
- (Agreed June 1994) The SSF shall be able to support subsequent digit collection according to trigger criteria assigned before sending the query. For example, if an feature code (e.g. *64) is entered, the SSF/CCF may:
  - *collect digits to the normal dialling plan,* or
  - collect a variable number of digits.

  This ability of the CCF/SSF has not been in identified in [Q.71] yet. The addition of functionality in the the ISDN CCF is for further study.

Exit events:

- In the case of ISDN en bloc sending, the receipt of a SETUP message detected at the Origination_Attempt_Authorized Detection Point (DP 1) causes the BCSM to pass through to the Collected_Information DP (DP 2), without further processing in PIC 2.

  This is the case in our model and for this we placed the DPs 1 and 2 directly after each other.

3. Analyse_Information

Entry event:

- Availability of complete initial information package/dialling string from originating party (DP 2-Collected_Info).
  This PIC processing starts in the process attempt part of the originating screen procedure, right after DP 2.

Function:

- Information being analysed and/or translated according to dialling plan to determine routing address and call type (e.g. local exchnage call, international exchange call).
  The corresponding sub-procedures in Originating screen are:
  - Analyse information
  - Determine elements
  - Check resource availability, as required
  - Select path(s) through entity
  - Reserve outgoing resource ans any other required resources
  One of the results of processing in this PIC is determination of routing address.

Exit events:

- Availability of routing address and nature address. (DP 3-Analysed_Info)
  In this case the outcome of procedure Originating screen is successful and DP 3 is encountered. This detection point is triggers the UPT service logic program. This means that in the SFF process, the DP message is received and the SCF is notified.
- The following exception exit events are applicable to PIC 3: O_Abandon and InvalidInformation.
  - The O_Abandon event, as described in PIC 1. In this case, the event is visible because there is a corresponding DP. (O_Abandon DP)
    This possibility is not included in [Q.71] in this stage of the call process. This means that in the Q-model this event is not visible to IN.
  - The InvalidInformation event (e.g. wrong number). (Exception).
    Here, a transition to the Exception PIC is made.

Comments:

In the case of a UPT call, the address could have been translated. The new address information is received by the Call_Model process in the Continue message.

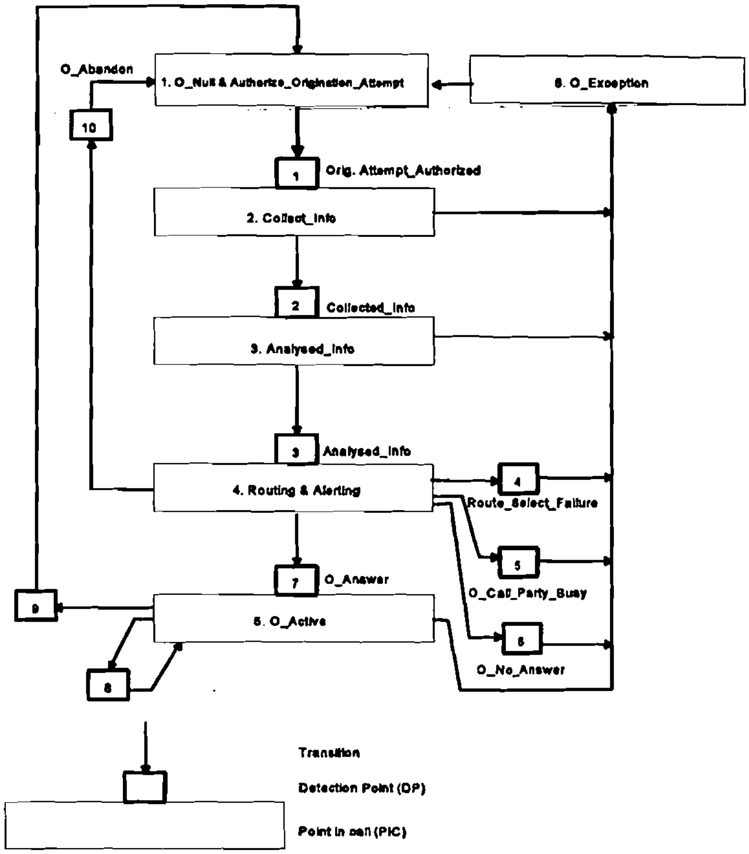


Figure 1 - Originating BCSM for CS-1

4. Routing and Alerting

Entry event:

- Availability of routing address and call type. (DP 3-Analysed_Info)
  The routing address could have been changed by UPT service logic.

Functions:

- Routing and call type being interpreted. The next route is being selected. This may involve sequentially searching a route list, translating a directory number into physiaval 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.
  In the model, this interpretation is not seen. It looks like this is already done in the originating screening and process attempt procedure. As a consequence, the placement of this PIC is difficult. When we add an extra decision point in the model, the relationship with this PIC becomes clear. After DP 3 has been detected a continue message from the SSF is received. Depending on the contents of this message, 'normal' call processing is continued, or a transition to the Exception PIC is made.
  The transition to the Exception state is not listed in [Q.71]. Reason for this is that [Q.71] the normal call setup and call release procedures describes and some exception conditions are ommitted on purpose. In an update of [Q.71] some extra transitions to the excption states have to be added, to enable correct IN PIC processing.
- 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 versus trunk).

This is already done in the originating screening process, as part of PIC 1! It is not made clear which parts of authority/ability determination are performed in PIC 1 or PIC 4. A solution for making the difference clear could be the following:
In PIC 1 the authority is verified for the original address in the SETUP message. During DP 3 processing, this address might be changed (e.g. number translation for UPT call). A second authorization/ability check has to be performed, for the new address information. This part of the verification is done in PIC 4. As a consequence, the ISDN setup procedure has to be modified to include this decision procedure.

- Call is being processed by the terminating half BCSM. 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.
  Within this originating PIC a terminating detection point is encountered. The terminating BCSM PIC 7 (T_Null) processing starts. After the authority/ability determination (as described above) has taken place the T_DP 12 is encoutered and a transition is made to T_PIC 8 (Select_Route & Present Call).

Exit events:

- Indication from the terminating half BCSM that the call is accepted and answered by terminating party (e.g. terminating party goed offhook, ISDN UP ANM) (DP7-O_Answer)
  After the SETUP req.resp. message is received by FE2, the answer timer is stopped and T_DP 15 is encounterd. (see T_BSCM description). In the model, first a transition to the T_Answer DP state is made, before DP 7 is detected.

The following exception exit events are applicable to PIC 4: Route_Select_Failure, O_Called_Praty_Busy, O_No_Answer and O_Abandon.

- The RouteSelectFailure event occurs when the SSF/CCF receives an indication that all the routes are busy. This event (e.g. unable to determine a correct route, no more routes on the route list) leads to the Route_Select_Failure DP.
  This DP is not inlcuded in our model because it is not included in [Q.71].

- The O_Called_Busy event occurs when an indication of a T_Busy event specifying useer busy (i.e. network determined user busy) is received from the terminating potion of the call.
  This event also occurs when an indication of CallRejected event specifying user busy (i.e. network determined user busy) is received from the terminating portion of the call. This event leads to the O_Called_Party_Busy DP 5.
  In [Q.71] this is modelled by the reception of the RELEASE req.ind. from FE 3 with busy cause. After the input of this message DP 5 is deteced. After the continue message is received from the SSF a transition to exception PIC 6B is made.

- The O_No_Answer event occurs when the calling party receives no indication of an answer from the terminating side within a specified period of time
  > The O_No_Answer event is an IN event. That is, it can only occur when an O_No_Answer trigger is assigned and detected or when requested by a RequestReportBCSMEvent operation.

  In this case TIMER 4 (time out no answer) goes off. In SDL, this is modelled as the reception of a TIMER 4 message. First, DP 14 ((T_No_Answer) is detected. Then DP 6 is encountered. In [Q.1214] this is modelled by a message to be sent from the terminating part to the originating part of the BCSM. In our model, we place the detection point right after each other, because the communication between the originating anr teminating parts of the BCSM is not inlcluded. (For reasons of clearity, some of these BCSM internal communication events are given in the model as comments.)

- The O_Abandon event is an IN event, as described in PIC 1. In this case, the event is visible because there is a corresponding DP (O_Abandon).

When the DISCONNECT req.ind. event is received, DP 10 is detected. After the continue message from the SSF is received T_DP 18 is detected. After the continue message for that DP is received, a normal call clearing procedure takes place.

- Authority of calling party to place call is denied (e.g. business group restriction mismatch, toll restricted dialling line) (Exception)
  See comments by function description.

Corresponding [Q.931] call state: 4.Call delivered.

5. O_Active

Entry event:

- Indication from the terminating half BCSM that the call is accepted and answered by terminating party. (DP7-O_Answer)
  When the SETUP resp.conf. message is received, first DP 15 (T_Answer) is detected. Right after the reception of the continue message from the SSF (terminating BCSM) DP 7 is detected. After DP 7 processing PIC 5 starts.

Function:

- Connection established between originating and terminating party. Message accounting/charging data may be being collected. Call supervision is being provided.
  First, the SETUP resp.conf. message is sent to the CCAF. Then trough connection takes place and charging starts. After that a transition to the r1-r2 ACTIVE state takes place.

Exit events:

- A service (feature) request is received from the originating party (e.g. hook flash, ISDN feature activator, [Q.931] HOLD or RETRIEVE message). (DP 8 - O_Mid_Call).
  After service request processing the call returns in the r1-r2 ACTIVE state. A service request from the terminating party is possible as well, see T_BCSM description.

- A disconnect indication (e.g.onhook, Q.931 disconnect message, SS7 release message) is receivved from the originating party, or received from the terminating party via the terminating half BCSM. (DP 9-O_Disconnect)
  The procedures for the two cases are different. They are described in the following:
  - *When a DISCONNECT req.ind. is received from the CCAF, DP 9A is detected. After the reception of the continue message from the SSF, T_DP 17A is detected. After that, A-party initiated call clearing takes place.*
  - *When a RELEASE req.ind. from FE 3 is received, DP 17B is detected first. After the continue message from the SSF, DP 9B is detected. After that, B-party initiated call clearing takes place.*

  In [Q.1214], internal communicaion between the O_BCSM and the T_BCSM is included. Since we inlcude the originating and terminating portions of the call in one model, these information flows are ommitted in our model.
  In the case of B-part initiated call clearing, a possibility of receiving a DISCONNECT req.ind. from the CCAF is inlcuded in [Q.1214]. This case however, is not included in [Q.71] and is ommitted in our model.

- A connection failure occurs. (Exception)
  This case is not modelled by a seperate information flow in our model. We suppose that the notification of, or the information about a connection failure is included in the RELEASE req.ind. from FE 3. This leads to a normal B-party initiated call clearing procedure. (The connection failure condition is thus invislible in this model.)

Comments:

- A terminating party may disconnenct and then reconnect before the expiration of disconnect timing. In this case, the call is considered to remain in the O_Active PIC.
  This event is modelled by the service (feature) req. ind. message, received from the CCAF. After the processing of this request a transition to the r1-r2 ACTIVE state takes place.

- Disconnect indications and treatment are asymmetrical in the way disconnect timing is applied. Disconnect treatment and timing is different for call attempts originating from DSS-1 and analogue line interfaces.

Corresponding Q.931 call state: 10. Active

Q.931 call states corresponding to disconnect: 11. Disconnect request, 12. Disconnect indication and 19. Release request.

6. O_Exception

Entry event:

- An exception condition is encountered (as described aboce for each PIC)
  The exception conditions are not the same for each part of the call process. Therefore, different excpeption pics are included in our model. The corresponding release procedures are given in [Q.71] and included in our model.

Function:

- Default handling of the exception condition is being provided. This includes general actions necessary to ensure no resources remain inappropiately allocated such as:
  - If any relationships exist between the SSF and SCF, send an error information flow to the SCF closing the relationships and indicating that any outstanding call handling instructions will not run to completion (e.g. see annex B/[Q1214]).[1]
    The release of connection with SSF and SCF is performed by sending an ABORT req.ind. (unconfirmed) to the SSF. This information flow has to be inlcuded in the ISDN basic call processing, when necessary. This functionalitty has to be added in [Q.71].
  - If an SCF previously requested that all call parameters should be provided at the end of the call (see the call information request information flow in 6/[Q.1214]), these should be included in the error information flow.
    This comment has to be included in [Q.71].
  - 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 & Authorize_Origination_Attempt PIC)
  In our model: When the exception procedure are completed, a transition to the IDLE state takes place. This corresponds to the transition to PIC 1.

Terminating BCSM for CS-1

The terminating half of the BCSM corresponds to that portion of the BCSM associated with the terminating party (see Figure 8, 14). The description for each of the PICs in the terminating half of the BCSM are described below:

1) This should be handled in the physical plane via an ABORT protocol pocedure to close the relationship (i.e. close the TCAP transaction) and indicate that any outstanding operations will not be run to completion.

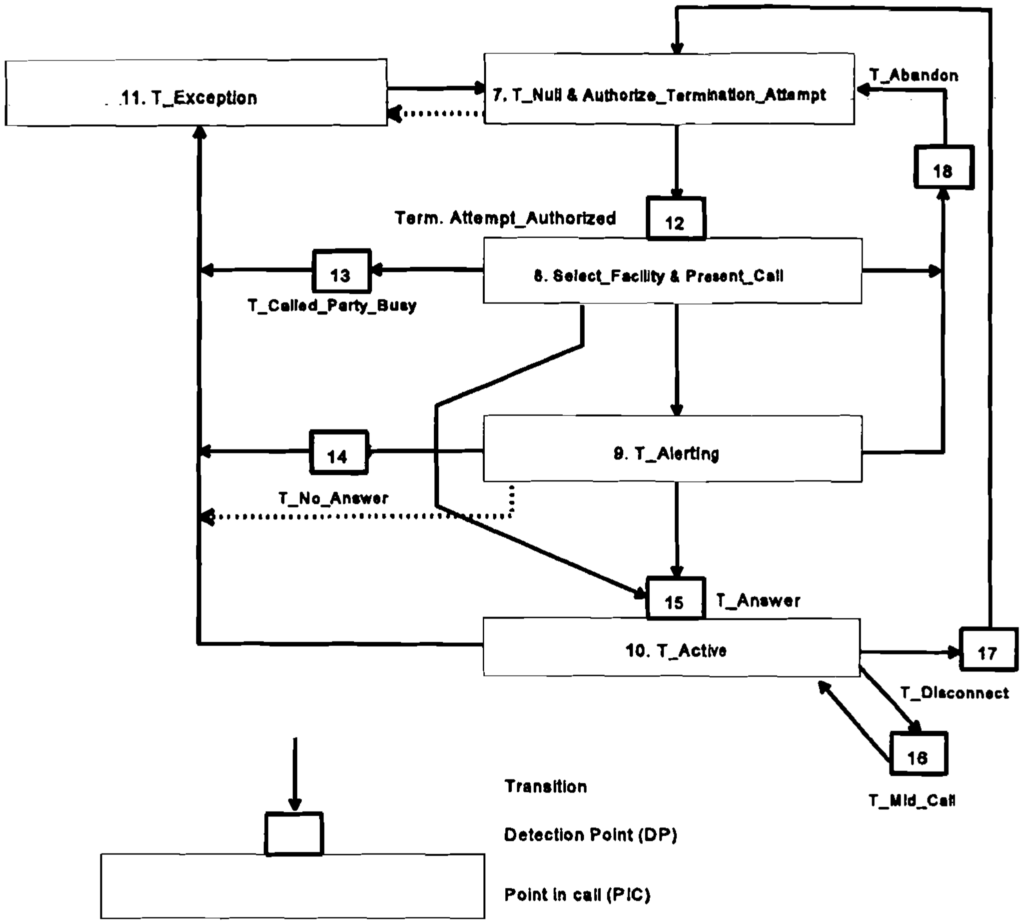


Figure 2 - Terminating BCSM for CS-1

7. T_Null & Authorize_Termination_Attempt

Entry event:

- Disconnect and clearing of a previous call (DPs 17-T_Disconnect or 18-T_Abandon), or default handling of exceptions by SSF/CCF completed.
  The IDLE state is part of PIC 7.

Functions:

- Interface (line/trunk) is idled (no call exists, no call reference exists, etc.). Supervision is being provided.
- Given an indication of an incoming call received from the originating half BCSM, authority to route this call to the terminating party is being verified (e.g. business group resttrictions, restricted incoming access to line, bearer capability compatibility.) This function may not be applicable for terminations to trunks.
  In our model the information flows between the originating and terminating portions of the call process are only shown in some comments.

Exit events:

- Indication of incoming call received from originating half BCSM and authority to route call to a specified terminating resource (or group) verified (DP 12 - Term_Attempt_Authorized)

As said in the discussion of the O_BCSM, the verification takes place in two steps. The basic verification is done in the ISDN part. After DP 3 is processed, the call might continue with new a new address (e.g. after number translation). Verification has to be performed again.
This could lead to a problem in the case of a UPT call. When the calling part is authorized to call a UPT number, number translation can take place. But when the call is continued with the physial address of the UPT user, call continuation could be denied by ISDN. This interaction can take place when the calling or called user is member of a closed user group. A possible siolution could be to disable ISDN call verification after DP 3 has been processed. Thus, the decision to be made in the decision point in our model after DP 3, is not taken by ISDN call control instances, but by IN.

- The following exception exit events are applicable to PIC 7: TerminationDenied and T_Abandon. For this PIC, if the call encouters one of these exceptions during PIC processing, the exception event is not visible because there is no corresponding DP.
    - The TerminationDenied event occurs when an indication of an incoming call from the originating half of the BCSM is received and the authority to route the call to a specified terminating resource is denied. (Exception)
      This information flow is not included in our model. The exception point is included.
    - The T_Abandon occurs when an indication of call disconnection is received from the originating part of the call.
      The information flow between the originating and terminating half of the BCSM is not included. DP 18 (T_Abandon) is detected after DP 10 (O_Abandon) has been processed when a DISCONNECT req.ind. from the CCAF is received.
      In case there is a RELEASE req.ind. from FE 3 is received, it is assumed that the cause is busy. In our model, the case that the B-party abandons the call is not explicitly included in this PIC.

8. Select_Facility & Present_Call

Entry event:

- Indication of incoming call received from originating half BCSM and authority to route call to a specified terminating resource (or group) verified (DP 12 - Term_Attempt_Authorized)
  DP 12 is detected right after the decision point in PIC 4 (O_Routing & Alerting). PIC 12 processing starts with the sending of the PROCEEDING req.ind. message to CCAF.

Functions:

- A particular available resource in the specified resource group is being selected. It is possible that all reesources in the group could be busy. A single resource is treated as a group of size 1.
  This function is included in the process attmpt procedure in ou rmodel. The same dificulty as with the placement of O_PIC 4 is encoutered here.
- Terminating resource informed of incoming call (e.g. line seizure, Q.931 Alerting message, ISDN UP IAM). In the case of an analogue line, ringing is applied.
  The SETUP req.ind message is sent to FE 3.

Exit events:

- Terminating party is being alerted (e.g. ringing being applied, Q.931 Alerting message, ISDN UP ACM). (Transition to T_Alerting PIC)
  The REPORT(alerting) req.ind. is received from FE 3.
- Call is accepted and answered by terminating party (e.g. terminating party goed offhook, Q.931 Connect message received, ISDN UP ANM received). (DP 15-T_Answer)
  The SETUP resp.conf. message is received from FE 3. Timer 5 is stopped en DP 15 is detected. (After that O_DP 7 O_Answer is detected.)
- The following exception exit events are applicable to PIC 8: T_Busy and T_Abandon.

- The T_Busy event occurs when the terminating access is busy meaning:
  - Interface busy (e.g. a B-channel is unavailable for the call);
  - Call-reference busy: there are no idle call reference values available on the terminating Directory Number and Call Type with which the call will be offered.
  - All appearances of a closed user group are busy.
- The T_Busy event may also be detected as a result of an analog line being out of order, being marked as busy by a customer make-busy key or as a result of certain maintenance action. This event leads to the T_Busy DP. An indication of T_Busy event is passed to the originating half of the BCSM.

  In our model the T_Busy DP is detected after the reception of the RELEASE req.ind. message with busy cause from FE 3 (or the network).

  (In the March 1993 version of [Q.1214] a transition to the exception state should have taken place when this message is the ISDN-UP message with busy cause. In March 1994 a correction is made.)
- The T_Abandon as described in PIC 7.

  In [Q.71] only the case when the calling party abandons the call is included. When the called party terminates the call, normal call clearing takes place. Thus, the T_Abondon is detected after the O_Abondon PIC has been detected and after that the normal a-party initiated call clearing takes place.

Corresponding Q.931 state: 6. Call present

9. T_Alerting

Entry event:

- Terminating party is being alerted of incoming call.

  After the reception of the REPORT (alerting) req.ind. from FE 3.

Functions:

- An indication is sent ot the originating half BCSM that the terminating party is being alerted.

  Since internal BCSM information flows are not included in this model, only the message REPORT req.ind to CCAF is seen in our model.
- Continued processing of call setup (e.g. ringing, audible ring indication) is taking place.
- Waiting for the call to be answered by terminating party.

Exit events:

- Call is accepted and answered by terminating part (e.g. terminating party goes offhook, Q.931 Connect message received, ISDN UP ANM received). (DP 15-T_Answer)

  SETUP resp.conf. message is received. Timer 4 is stopped and DP 15 is detected.
- The following exception exit events are applicable to PIC 9: T_No_Answer and T_Abandon.

  - The T_No_Answer event occurs when the terminating party does not answer before the switch-based ringing timer expires. An indication of the T_No_Answer event is passed to the originating half of the BCSM. This event leads to the T_No_Answer DP.

  In [Q.71] this is modelled by the reception of the TIMER 4 message. After this input T_No_Answer and O_No_Answer are detected, respectively.

  After DP T_No_Answer has been processed two things can happen.

  - The service logic forces a transition to PIC 8. In this case the GOTO PIC 8 message is received and the transition is made.

  - A Continue message from the SSF is received and call processing continues at the same point in call as where the call processing was suspended for DP processing (and DP O_No_Answer is detected).
- The T_Abandon as described in PIC 7. (T_Abandon DP)

  At this point in call DP T_Abandon is detected conform [Q.1214] (unlike the situation in PIC 8, see comment in the corresponding section), after the reception of the RELEASE req.ind. message from FE 3.

  After PIC 7 processing DP O_Abandon is detected, without an information flow in our model.

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

10. T_Active

Entry events:

- Call is accepted and answered by terminating party (e.g. terminating party goes offhook, Q.931 Connect message received, ISDN UP ANM received). (DP 15-T_Answer)

Functions:

- An indication is sent to the originating half BCSM that the terminating party has accepted and answered the call;
  After DP 15 has been detected nd the continue message from the SSF has been received, PIC T_Active processing starts. First DP 7 O_Answer is processed and then the SETUP resp.conf message is sent to the CCAF.
- Connection established between originating and terminating party;
  Through connection takes place and charching starts. A transition to the r1-r2 ACTIVE state takes place.
- Call supervision is being provided.
  (IN call supervision)

Exit events:

- A service (feature) request is received from the terminating party (e.g. DTMF, hook flash, ISDN feature activator, Q.931 HOLD or RETRIEVE message). (DP 16-T_Mid_Call)
  After service request processing the call returns in the r1-r2 ACTIVE state. A service request from the originating party is possible as well, see O_BCSM description.
- A disconnect indication (e.g.onhook, Q.931 disconnect message, SS7 release message) is received from the terminating party, or received from the originating party via the originating half BCSM. (DP 17-T_Disconnect)
  The procedures for the two cases are different. We have already discussed these possibilities in the comments with the PIC O_Active.
- A connection failure occurs. (Exception)
  This event is not modelled seperately in [Q.71]. See the comments with the PIC O_Active.

Comments:

- A terminating party may disconnect and then reconnect before the expiration of disconnect timing. In this case, the call is considered to remain in the T_Active PIC.
  No message is sent and the event is invisible in our model. In case of a hook flash the event is modelled by the service (feature) request processing described above.
- Disconnect indications and treatment are asymmetrical in the way disconnect timing is applied.

Corresponding Q.931 call state: 10. Active

Q.931 call states corresponding to T_Disconnect: 11. Disconnect request, 12. Disconnect indication, and 19. release request.

11. T_Exception

Entry event:

- An exception condition is encountered (as described above for each PIC).
  The exception conditions are not the same for each part of the call process. Therefore, different excpeption pics are included in our model. The corresponding release procedures are given in [Q.71] and included in our model.

Functions:

- An indication of the exception condition is sent to the originating half BCSM.
  Internal information flow, thus invisible in our model.
- Default handling of the exception condition is being provided. This includes general actions necessary to ensure no resourcesremain inapprpriately 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 (e.g. see annex B/[Q1214]).[2]
    The release of connection with SSF and SCF is performed by sending an ABORT req.ind. (unconfirmed) to the SSF. This information flow has to be inlcuded in the ISDN basic call processing, when necessary. This functionalitty has to be added in [Q.71].
  - If an SCF previously requested that all call parameters be provided at the end of the call (see the call information request information flow in 6/[Q.1214]), 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.

Note that there are different exception procedures, because a transition to the exception state can take place at different points in call processing. In case a SETUP message has already been ssent to FE 3, a RELEASE message has to be sent in both directions. When a SETUP message has not been sent to the FE 3 yet, the sending of a RELEASE message is not necessary. For this reason, there are different PIC 6 versions in the model, In [Q.1214], only one PIC 6 is identified.

Exit event:

- Default handling of the exception condition by SSF/CCF completed (Transition to T_Null & Term.Attempt_Authorized PIC).
  A transition to the IDLE state occurs after call release has been completed.

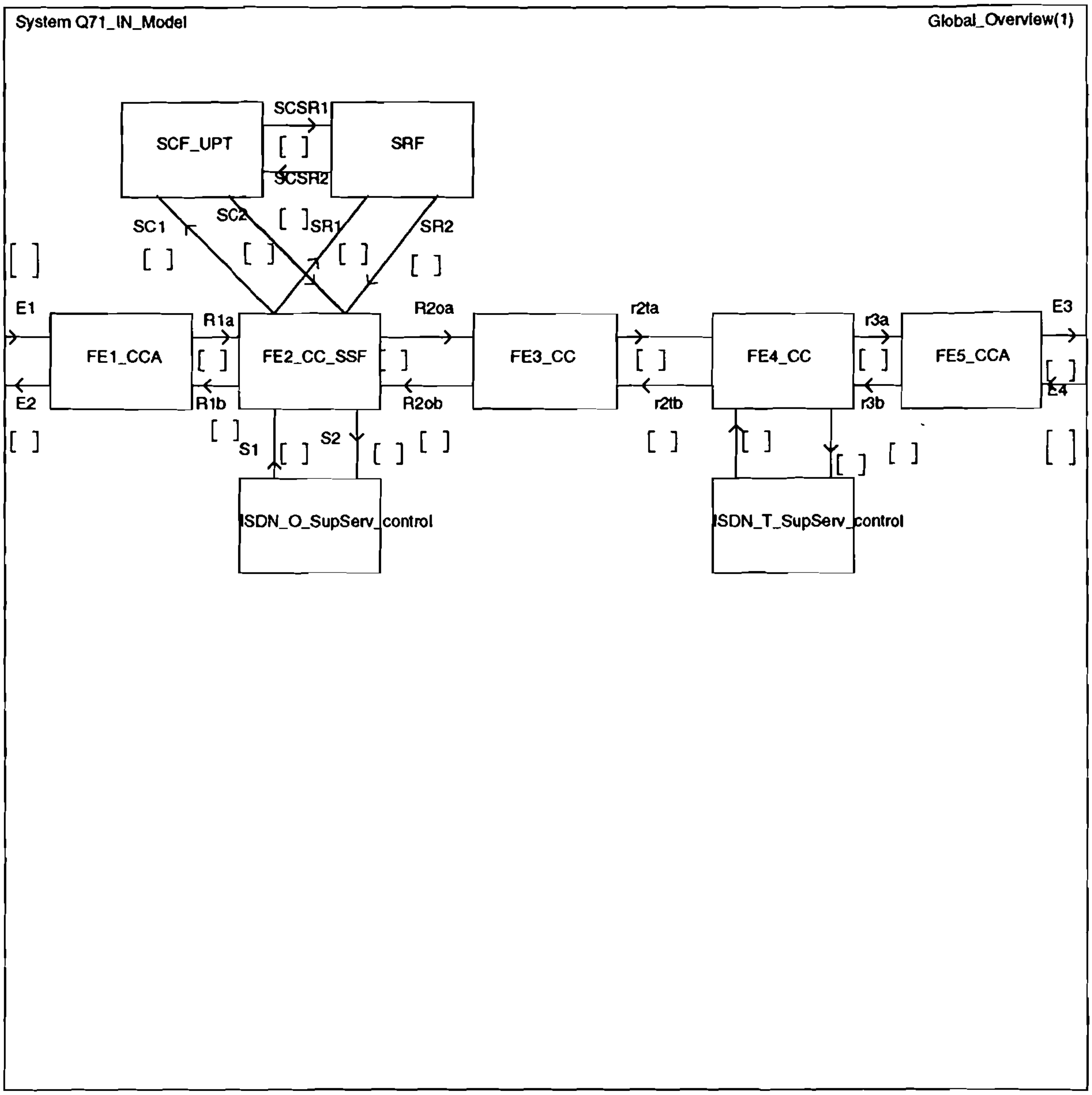
2) This should be handled in the physical plane via an ABORT protocol pocedure to close the relationship (i.e. close the TCAP transaction) and indicate that any outstanding operations will not be run to completion.

Annex 3: SDL diagrams of the Basic IN-ISDN model

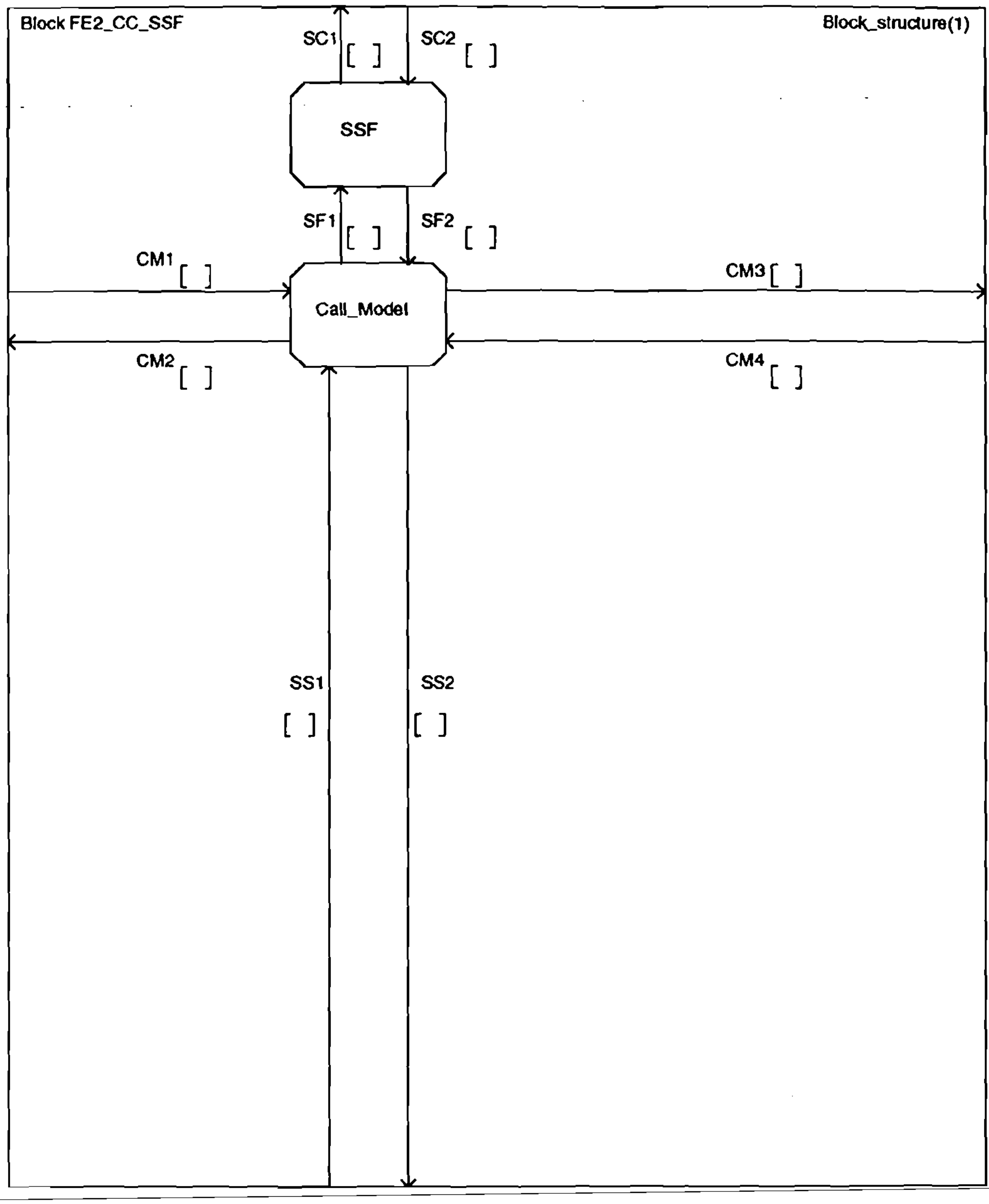
In this annex the SDL diagrams are given of the Basic IN-ISDN Model. The contents of this annex are listed on the next page.

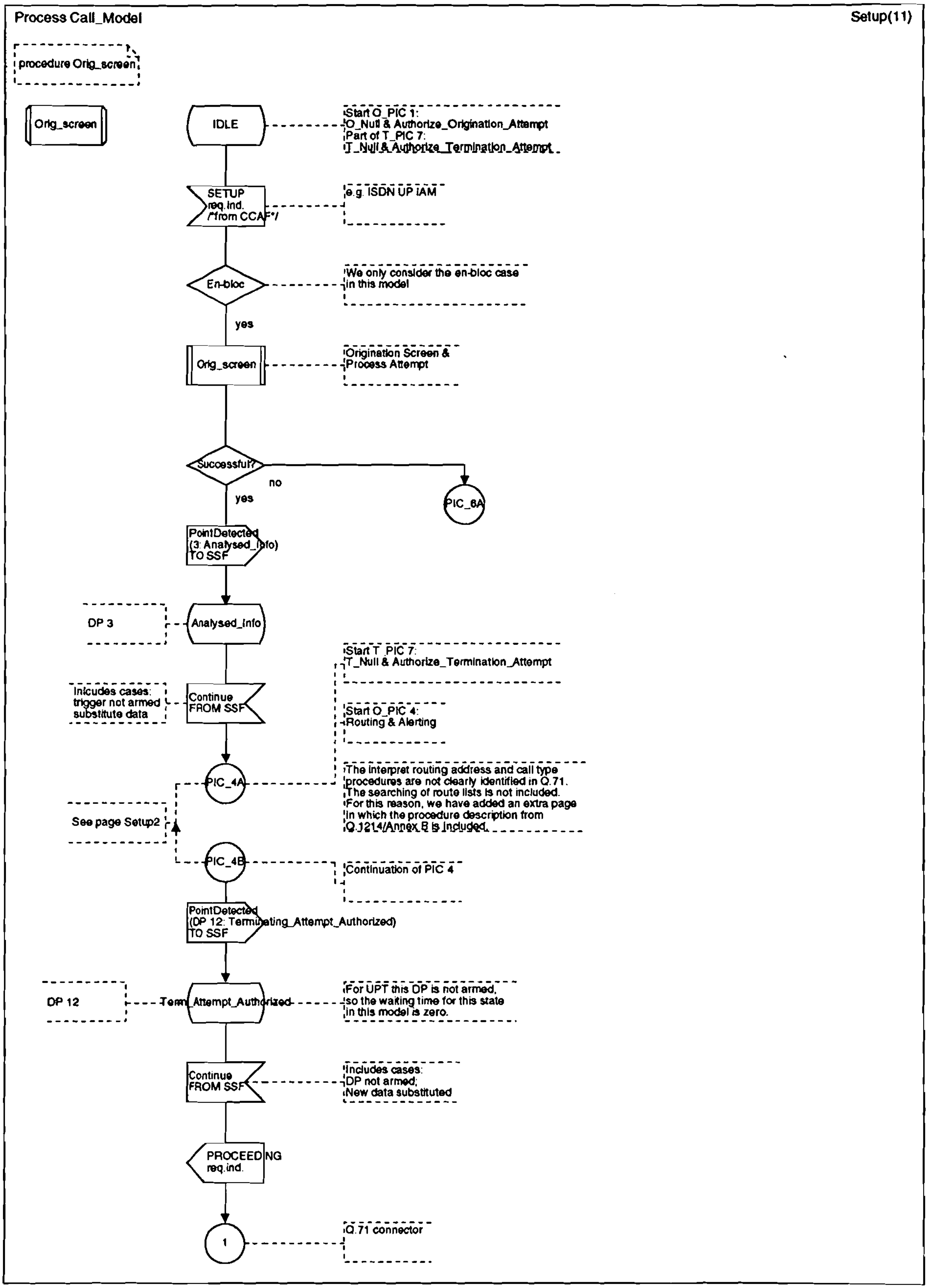
STRUCTURE INFORMATION

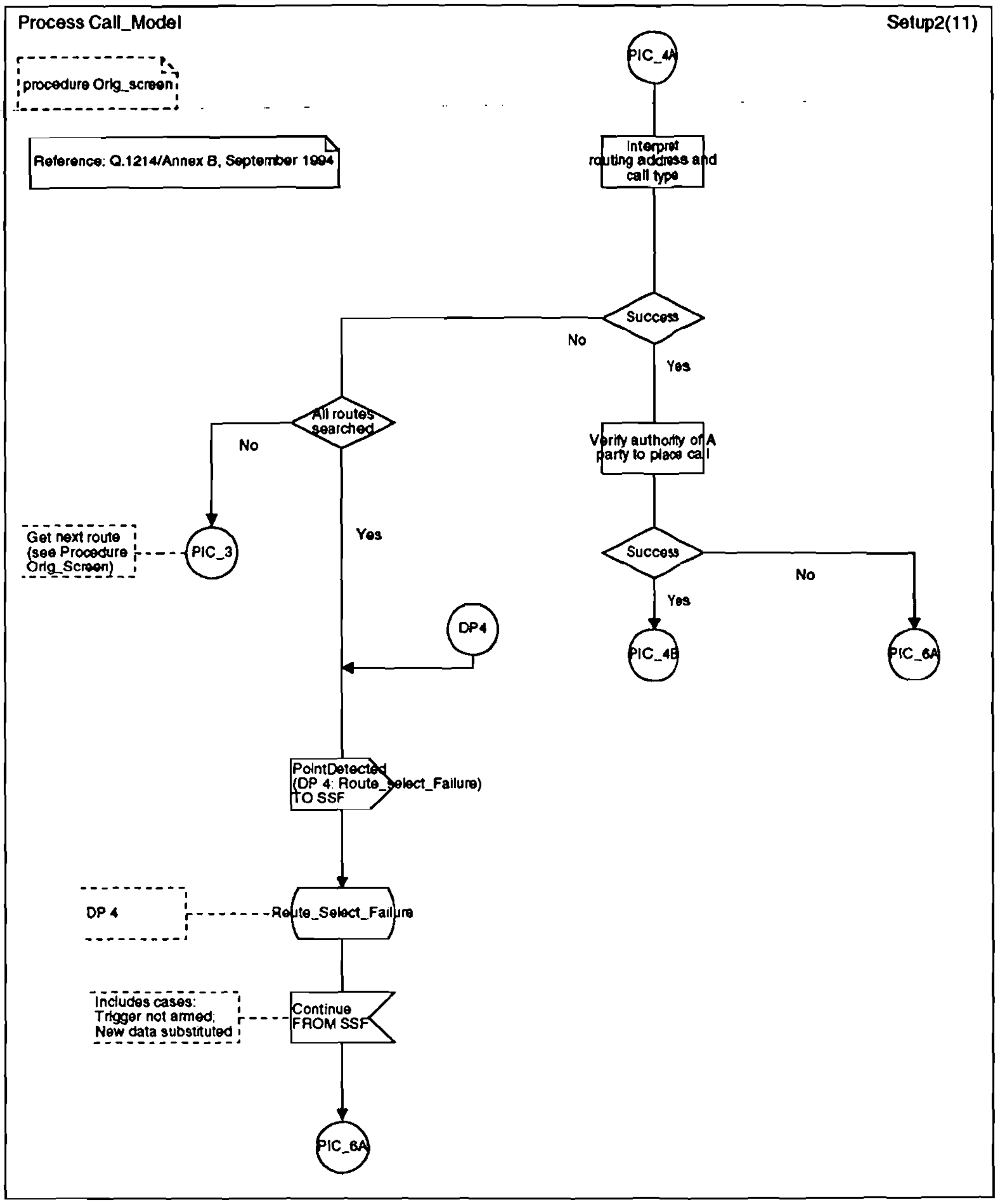
- System Q71_IN_Model
  - Page Global_Overview
    - Block FE1_CCA
    - Block FE2_CC_SSF
      - Page Block_structure
        - Process Call_Model
          - Page Setup
            - Procedure Orig_screen
              - Page 1
          - Page Setup2
          - Page Call_sent_enbloc
          - Page Call_sent_enbloc2
          - Page Call_sent_alerting
          - Page Call_sent_alerting2
          - Page Active1
          - Page Active2
          - Page Exception
          - Page Release
          - Page ExtraDPprocessing
        - Process SSF
    - Block FE3_CC
    - Block FE4_CC
    - Block FE5_CCA
    - Block ISDN_O_SupServ_control
    - Block ISDN_T_SupServ_control
    - Block SCF_UPT
    - Block SRF

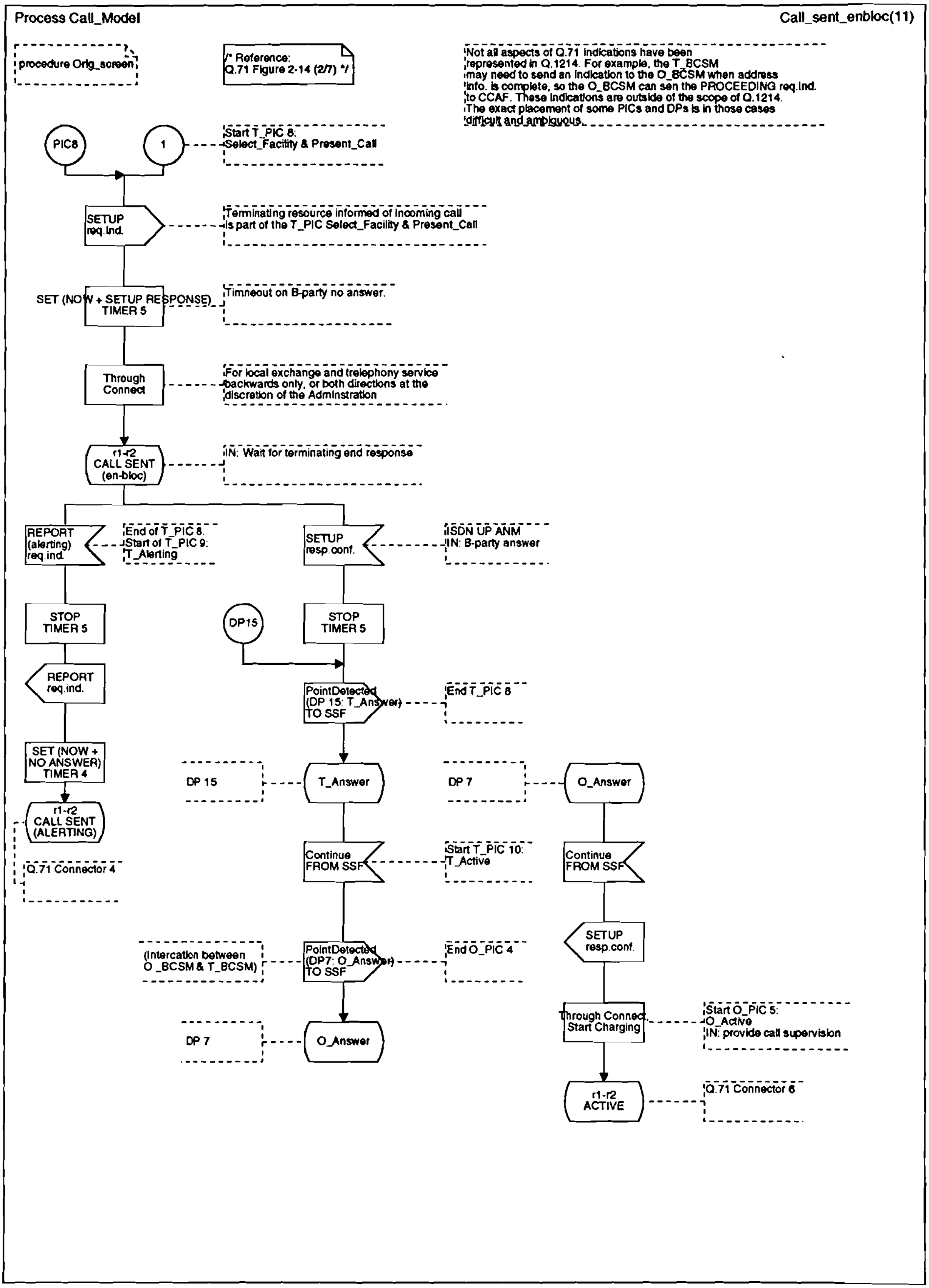


System Q71_IN_Model
Global_Overview(1)
SCF_UPT
SRF
SCSR1
SCSR2
SC1
SC2
SR1
SR2
E1
E2
FE1_CCA
R1a
R1b
FE2_CC_SSF
R2oa
R2ob
FE3_CC
r2ta
r2tb
FE4_CC
r3a
r3b
FE5_CCA
E3
E4
S1
S2
ISDN_O_SupServ_control
ISDN_T_SupServ_control

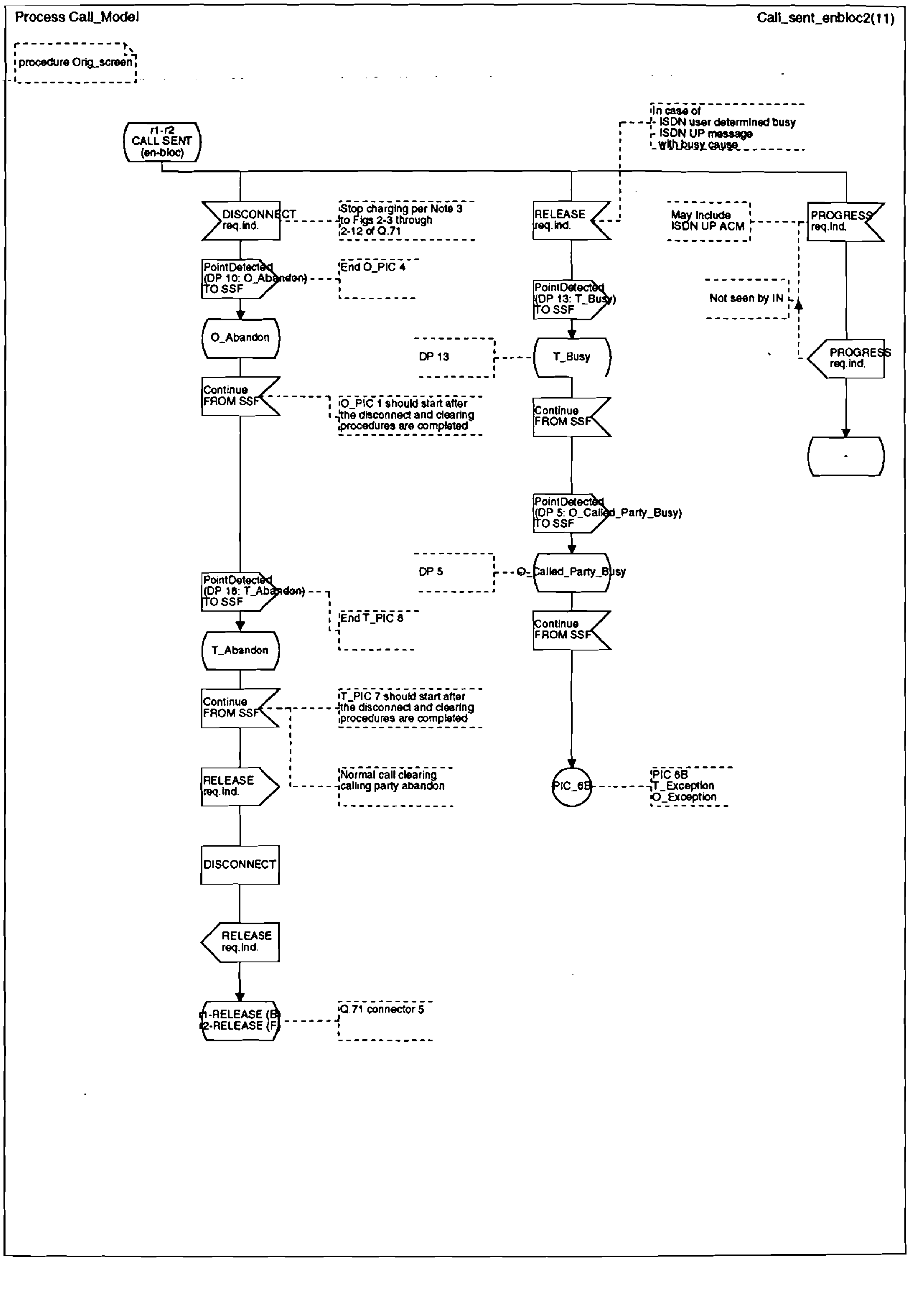

Block FE2_CC_SSF
Block_structure(1)
SC1 [ ]
SC2 [ ]
SSF
SF1 [ ]
SF2 [ ]
CM1 [ ]
CM3 [ ]
Call_Model
CM2 [ ]
CM4 [ ]
SS1 [ ]
SS2 [ ]

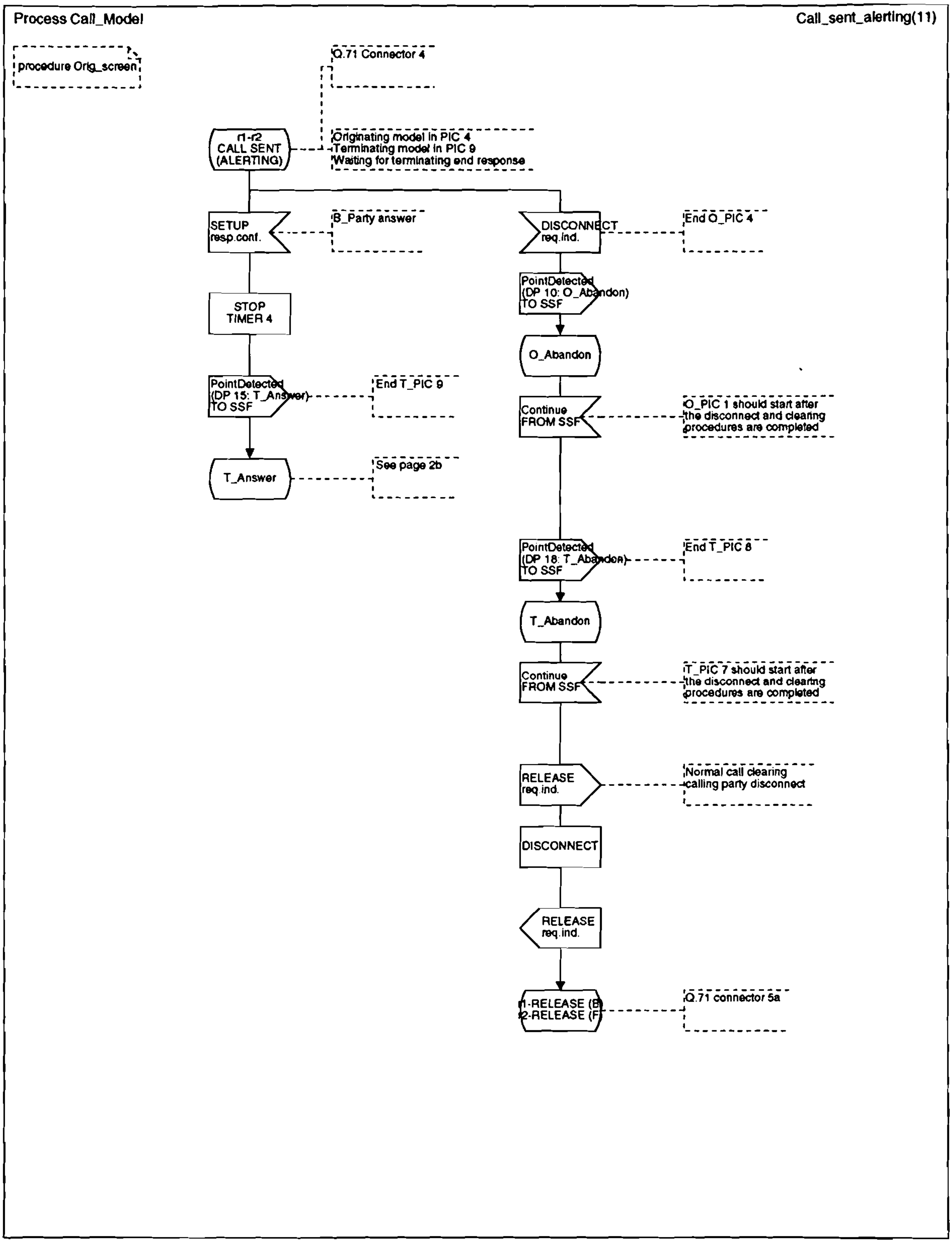

Process Call_Model
Setup(11)
procedure Orig_screen
Orig_screen
IDLE
Start O_PIC 1:
O_Null & Authorize_Origination_Attempt
Part of T_PIC 7:
T_Null & Authorize_Termination_Attempt
SETUP
req.ind.
/*from CCAF*/
e.g. ISDN UP IAM
En-bloc
We only consider the en-bloc case
in this model
yes
Orig_screen
Origination Screen &
Process Attempt
Successful?
no
yes
PIC_6A
PointDetected
(3: Analysed_Info)
TO SSF
DP 3
Analysed_Info
Start T_PIC 7:
T_Null & Authorize_Termination_Attempt
Inlcudes cases:
trigger not armed
substitute data
Continue
FROM SSF
Start O_PIC 4:
Routing & Alerting
PIC_4A
The interpret routing address and call type
procedures are not clearly identified in Q.71.
The searching of route lists is not included.
For this reason, we have added an extra page
in which the procedure description from
Q.1214/Annex B is included.
See page Setup2
PIC_4B
Continuation of PIC 4
PointDetected
(DP 12: Terminating_Attempt_Authorized)
TO SSF
DP 12
Term_Attempt_Authorized
For UPT this DP is not armed,
so the waiting time for this state
in this model is zero.
Continue
FROM SSF
Includes cases:
DP not armed;
New data substituted
PROCEEDING
req.ind.
1
Q.71 connector


Process Call_Model
Setup2(11)
procedure Orig_screen
Reference: Q.1214/Annex B, September 1994
PIC_4A
Interpret routing address and call type
Success
No
Yes
All routes searched
No
Yes
Verify authority of A party to place call
Success
Yes
No
Get next route (see Procedure Orig_Screen)
PIC_3
DP4
PIC_4B
PIC_6A
PointDetected (DP 4: Route_Select_Failure) TO SSF
DP 4
Route_Select_Failure
Includes cases: Trigger not armed; New data substituted
Continue FROM SSF
PIC_6A

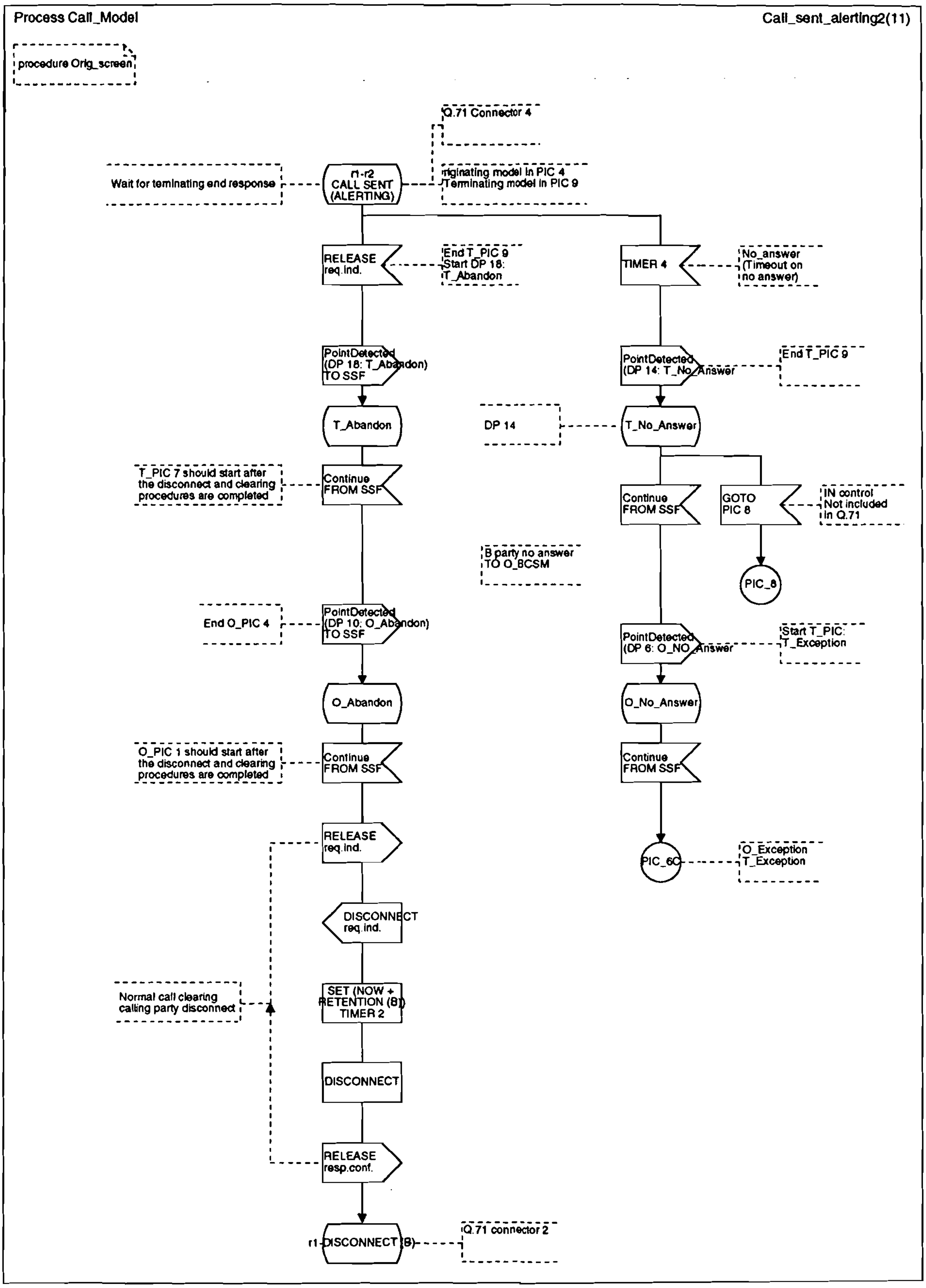


Process Call_Model
Call_sent_enbloc(11)
procedure Orig_screen
/* Reference:
Q.71 Figure 2-14 (2/7) */
Not all aspects of Q.71 indications have been represented in Q.1214. For example, the T_BCSM may need to send an indication to the O_BCSM when address info. is complete, so the O_BCSM can sen the PROCEEDING req.ind. to CCAF. These indications are outside of the scope of Q.1214. The exact placement of some PICs and DPs is in those cases difficult and ambiguous.
PIC8
1
Start T_PIC 8:
Select_Facility & Present_Call
SETUP
req.ind.
Terminating resource informed of incoming call
is part of the T_PIC Select_Facility & Present_Call
SET (NOW + SETUP RESPONSE)
TIMER 5
Timneout on B-party no answer.
Through
Connect
For local exchange and trelephony service backwards only, or both directions at the discretion of the Adminstration
r1-r2
CALL SENT
(en-bloc)
IN: Wait for terminating end response
REPORT
(alerting)
req.ind.
End of T_PIC 8.
Start of T_PIC 9:
T_Alerting
SETUP
resp.conf.
ISDN UP ANM
IN: B-party answer
STOP
TIMER 5
DP15
STOP
TIMER 5
REPORT
req.ind.
PointDetected
(DP 15: T_Answer)
TO SSF
End T_PIC 8
SET (NOW +
NO ANSWER)
TIMER 4
DP 15
T_Answer
DP 7
O_Answer
r1-r2
CALL SENT
(ALERTING)
Q.71 Connector 4
Continue
FROM SSF
Start T_PIC 10:
T_Active
Continue
FROM SSF
SETUP
resp.conf.
(Intercation between
O_BCSM & T_BCSM)
PointDetected
(DP7: O_Answer)
TO SSF
End O_PIC 4
Through Connect,
Start Charging
Start O_PIC 5:
O_Active
IN: provide call supervision
DP 7
O_Answer
r1-r2
ACTIVE
Q.71 Connector 6

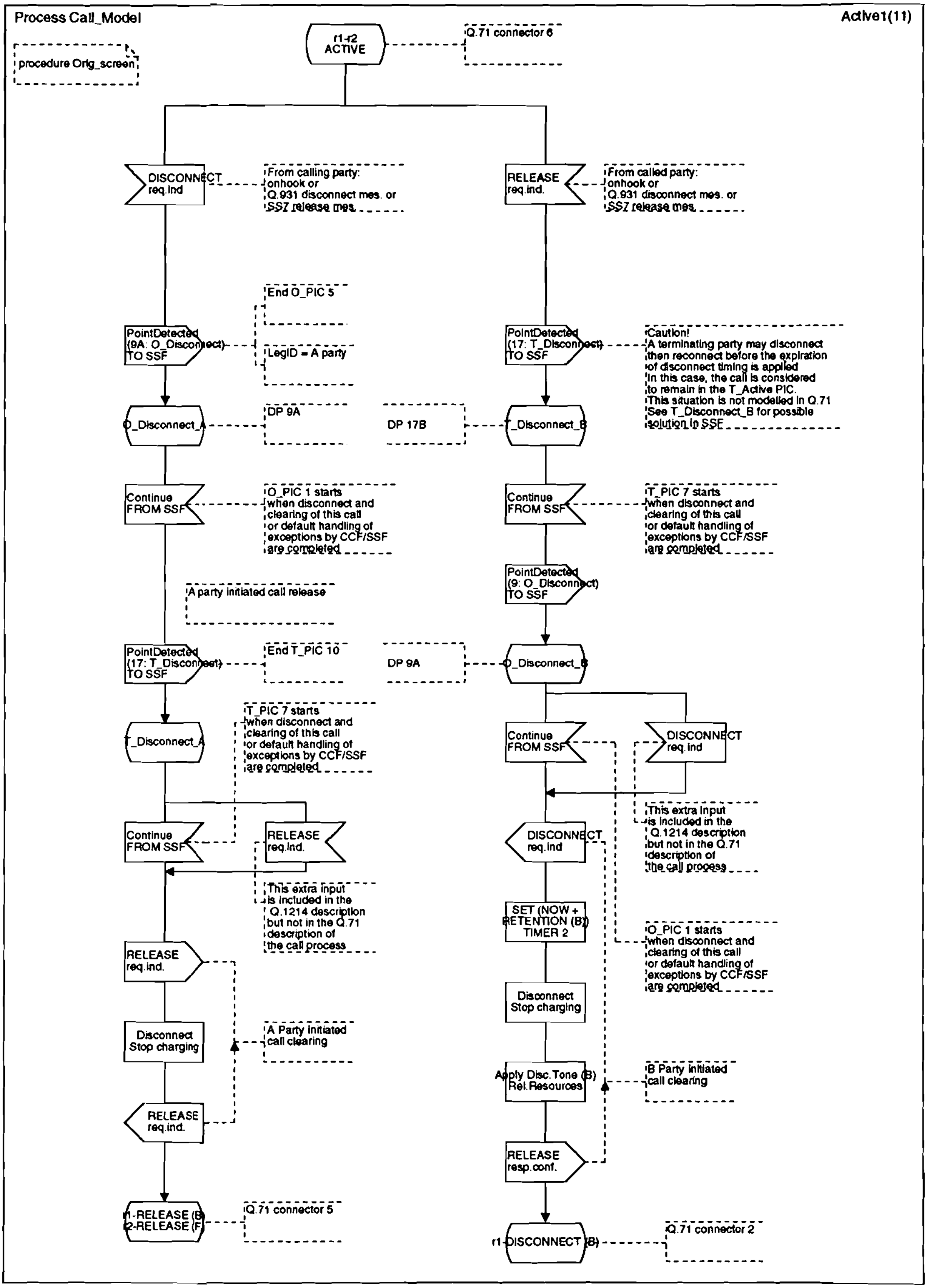

Process Call_Model
Call_sent_enbloc2(11)
procedure Orig_screen
r1-r2 CALL SENT (en-bloc)
DISCONNECT req.ind.
Stop charging per Note 3 to Figs 2-3 through 2-12 of Q.71
PointDetected (DP 10: O_Abandon) TO SSF
End O_PIC 4
O_Abandon
Continue FROM SSF
O_PIC 1 should start after the disconnect and clearing procedures are completed
PointDetected (DP 18: T_Abandon) TO SSF
End T_PIC 8
T_Abandon
Continue FROM SSF
T_PIC 7 should start after the disconnect and clearing procedures are completed
RELEASE req.ind.
Normal call clearing calling party abandon
DISCONNECT
RELEASE req.ind.
r1-RELEASE (B) r2-RELEASE (F)
Q.71 connector 5
In case of
- ISDN user determined busy
- ISDN UP message with busy cause
RELEASE req.ind.
PointDetected (DP 13: T_Busy) TO SSF
DP 13
T_Busy
Continue FROM SSF
PointDetected (DP 5: O_Called_Party_Busy) TO SSF
DP 5
O_Called_Party_Busy
Continue FROM SSF
PIC_6B
PIC 6B T_Exception O_Exception
May include ISDN UP ACM
PROGRESS req.ind.
Not seen by IN
PROGRESS req.ind.
-

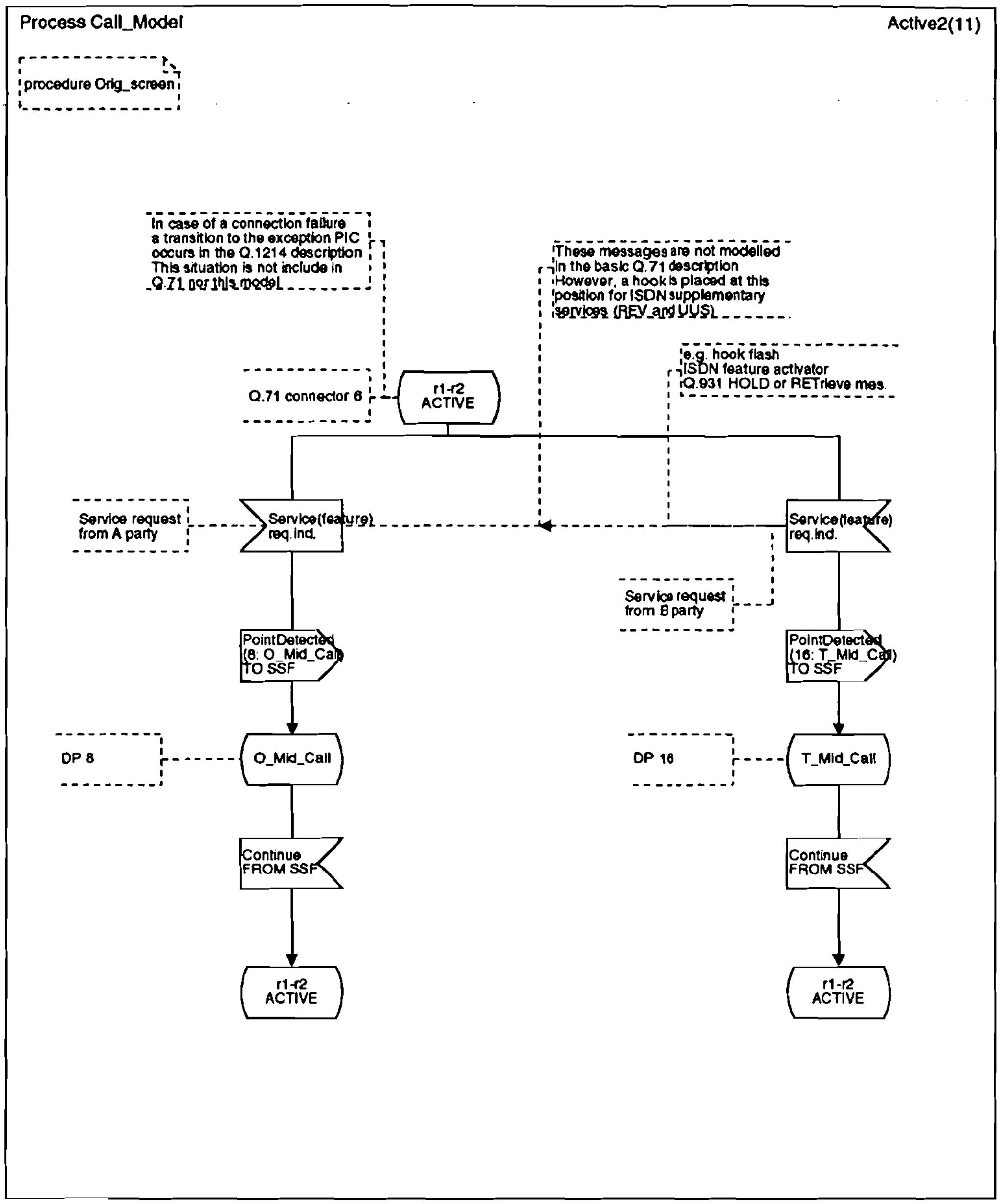


Process Call_Model
Call_sent_alerting(11)
procedure Orig_screen
Q.71 Connector 4
r1-r2
CALL SENT
(ALERTING)
Originating model in PIC 4
Terminating model in PIC 9
Waiting for terminating end response
SETUP
resp.conf.
B_Party answer
DISCONNECT
req.ind.
End O_PIC 4
STOP
TIMER 4
PointDetected
(DP 10: O_Abandon)
TO SSF
O_Abandon
PointDetected
(DP 15: T_Answer)
TO SSF
End T_PIC 9
Continue
FROM SSF
O_PIC 1 should start after
the disconnect and clearing
procedures are completed
T_Answer
See page 2b
PointDetected
(DP 18: T_Abandon)
TO SSF
End T_PIC 8
T_Abandon
Continue
FROM SSF
T_PIC 7 should start after
the disconnect and clearing
procedures are completed
RELEASE
req.ind.
Normal call clearing
calling party disconnect
DISCONNECT
RELEASE
req.ind.
r1-RELEASE (B)
r2-RELEASE (F)
Q.71 connector 5a

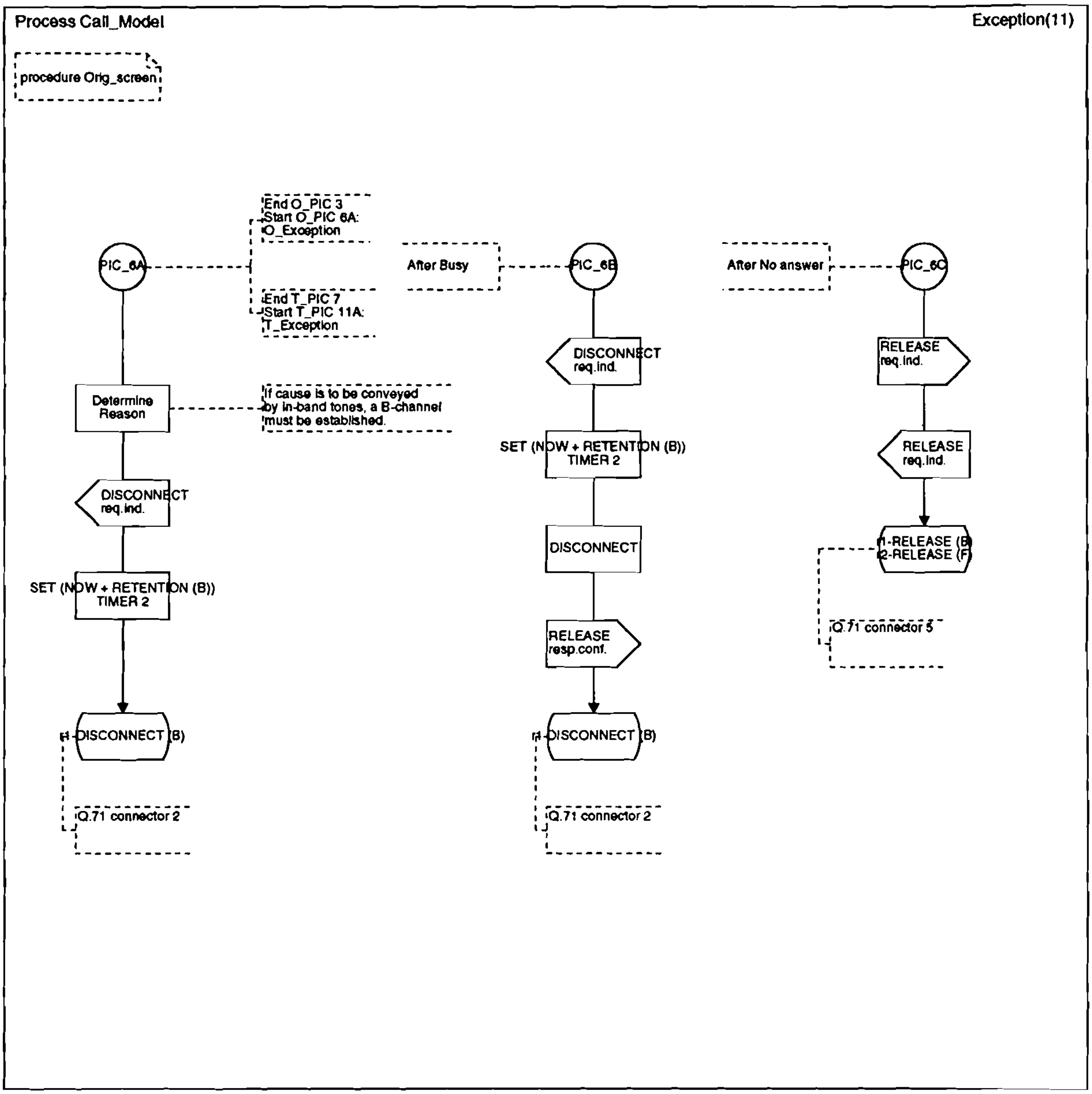


Process Call_Model
Call_sent_alerting2(11)
procedure Orig_screen
Q.71 Connector 4
Wait for teminating end response
r1-r2 CALL SENT (ALERTING)
riginating model in PIC 4
Terminating model in PIC 9
RELEASE req.ind.
End T_PIC 9
Start DP 18: T_Abandon
TIMER 4
No_answer (Timeout on no answer)
PointDetected (DP 18: T_Abandon) TO SSF
PointDetected (DP 14: T_No_Answer
End T_PIC 9
T_Abandon
DP 14
T_No_Answer
T_PIC 7 should start after the disconnect and clearing procedures are completed
Continue FROM SSF
Continue FROM SSF
GOTO PIC 8
IN control Not included in Q.71
B party no answer TO O_BCSM
PIC_8
End O_PIC 4
PointDetected (DP 10: O_Abandon) TO SSF
PointDetected (DP 6: O_NO_Answer
Start T_PIC: T_Exception
O_Abandon
O_No_Answer
O_PIC 1 should start after the disconnect and clearing procedures are completed
Continue FROM SSF
Continue FROM SSF
RELEASE req.ind.
PIC_6C
O_Exception
T_Exception
DISCONNECT req.ind.
Normal call clearing calling party disconnect
SET (NOW + RETENTION (8) TIMER 2
DISCONNECT
RELEASE resp.conf.
r1 DISCONNECT (B)
Q.71 connector 2

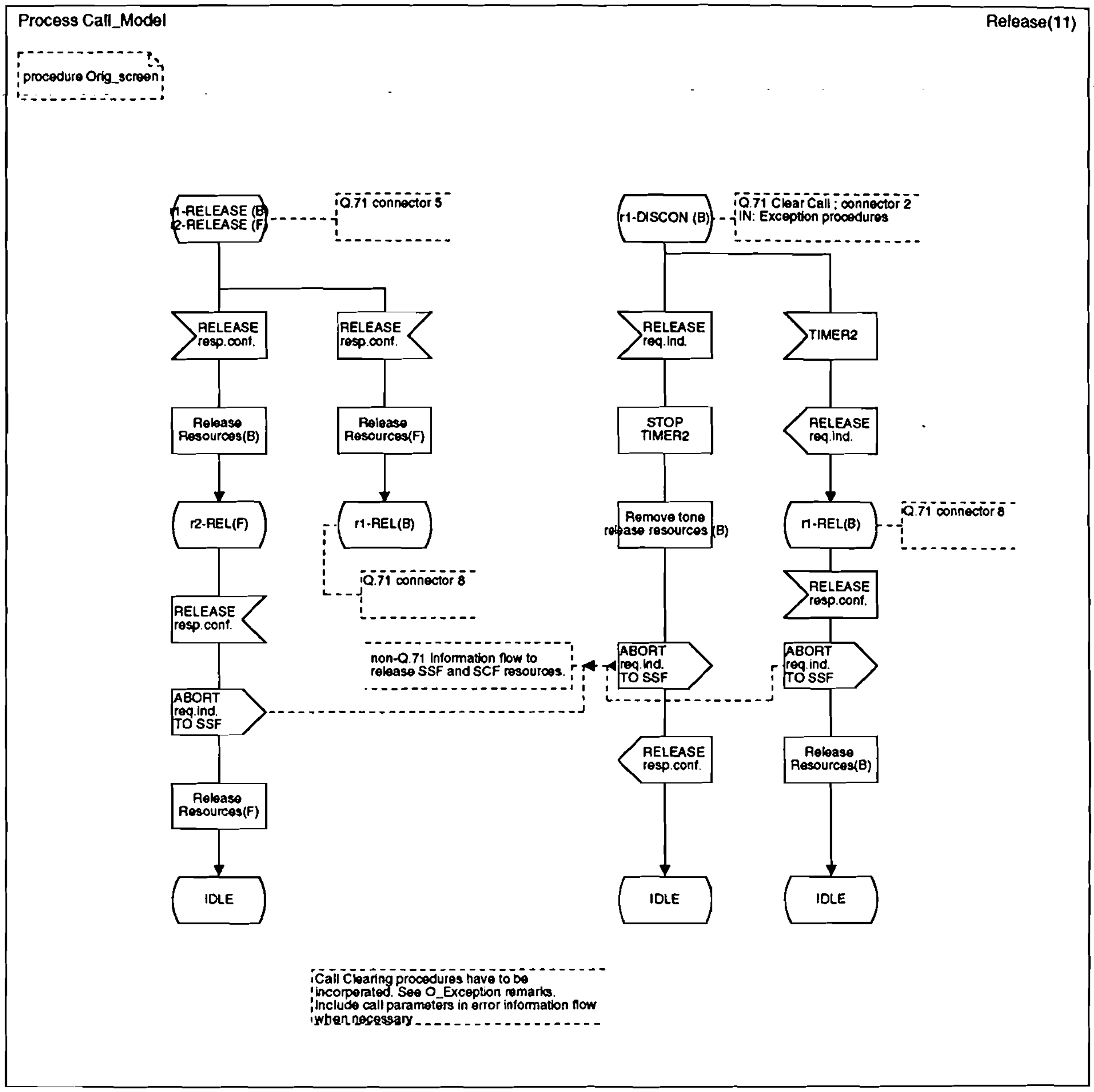

Process Call_Model
Active1(11)
procedure Orig_screen
r1-r2 ACTIVE
Q.71 connector 6
DISCONNECT req.ind
From calling party: onhook or Q.931 disconnect mes. or SS7 release mes.
RELEASE req.ind.
From called party: onhook or Q.931 disconnect mes. or SS7 release mes.
End O_PIC 5
PointDetected (9A: O_Disconnect) TO SSF
LegID = A party
PointDetected (17: T_Disconnect) TO SSF
Caution! A terminating party may disconnect then reconnect before the expiration of disconnect timing is applied In this case, the call is considered to remain in the T_Active PIC. This situation is not modelled in Q.71 See T_Disconnect_B for possible solution in SSF
O_Disconnect_A
DP 9A
DP 17B
T_Disconnect_B
Continue FROM SSF
O_PIC 1 starts when disconnect and clearing of this call or default handling of exceptions by CCF/SSF are completed
T_PIC 7 starts when disconnect and clearing of this call or default handling of exceptions by CCF/SSF are completed
PointDetected (9: O_Disconnect) TO SSF
A party initiated call release
PointDetected (17: T_Disconnect) TO SSF
End T_PIC 10
DP 9A
O_Disconnect_B
T_Disconnect_A
T_PIC 7 starts when disconnect and clearing of this call or default handling of exceptions by CCF/SSF are completed
Continue FROM SSF
DISCONNECT req.ind
Continue FROM SSF
RELEASE req.ind.
This extra input is included in the Q.1214 description but not in the Q.71 description of the call process
DISCONNECT req.ind
This extra input is included in the Q.1214 description but not in the Q.71 description of the call process
SET (NOW + RETENTION (B)) TIMER 2
O_PIC 1 starts when disconnect and clearing of this call or default handling of exceptions by CCF/SSF are completed
RELEASE req.ind.
Disconnect Stop charging
A Party initiated call clearing
Disconnect Stop charging
Apply Disc.Tone (B) Rel.Resources
B Party initiated call clearing
RELEASE req.ind.
RELEASE resp.conf.
r1-RELEASE (B) r2-RELEASE (F)
Q.71 connector 5
r1-DISCONNECT (B)
Q.71 connector 2

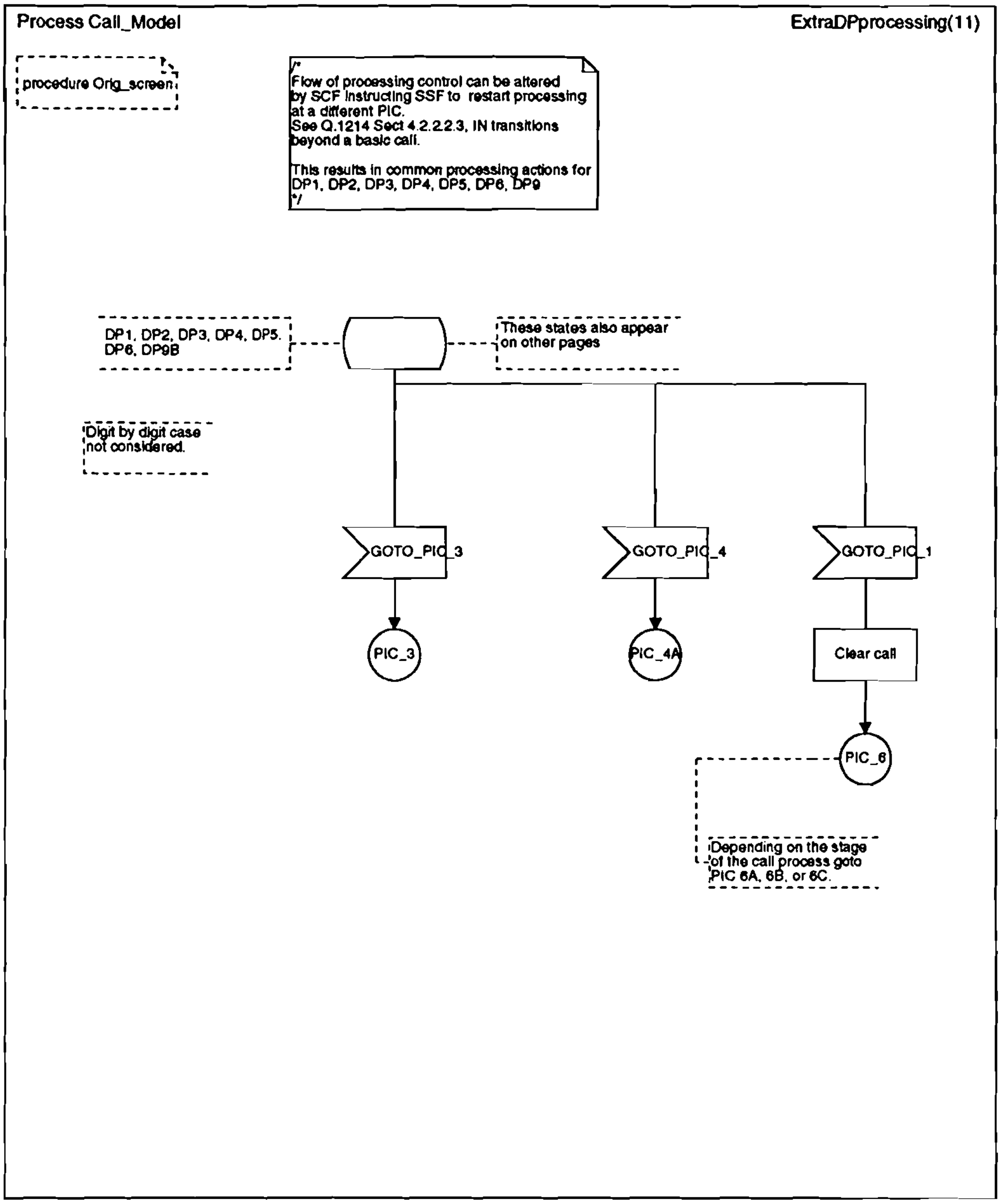


Process Call_Model
Active2(11)
procedure Orig_screen
In case of a connection failure a transition to the exception PIC occurs in the Q.1214 description This situation is not include in Q.71 nor this model
These messages are not modelled in the basic Q.71 description However, a hook is placed at this position for ISDN supplementary services (REV and UUS)
e.g. hook flash ISDN feature activator Q.931 HOLD or RETrieve mes.
Q.71 connector 6
r1-r2 ACTIVE
Service request from A party
Service(feature) req.ind.
Service(feature) req.ind.
Service request from B party
PointDetected (8: O_Mid_Call) TO SSF
PointDetected (16: T_Mid_Call) TO SSF
DP 8
O_Mid_Call
DP 16
T_Mid_Call
Continue FROM SSF
Continue FROM SSF
r1-r2 ACTIVE
r1-r2 ACTIVE



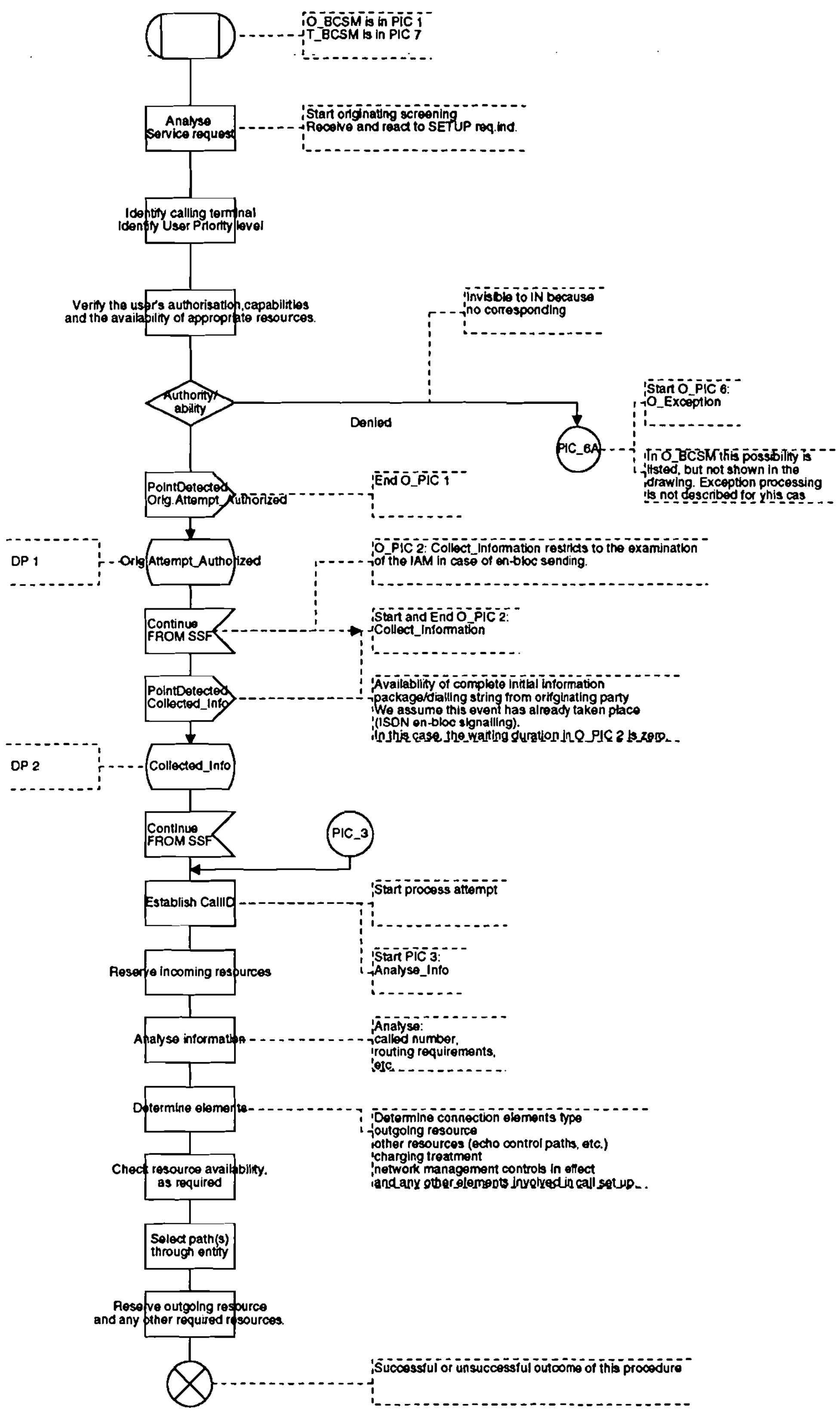
Process Call_Model
Exception(11)
procedure Orig_screen
End O_PIC 3
Start O_PIC 6A:
O_Exception
End T_PIC 7
Start T_PIC 11A:
T_Exception
PIC_6A
After Busy
PIC_6B
After No answer
PIC_6C
Determine Reason
If cause is to be conveyed by in-band tones, a B-channel must be established.
DISCONNECT req.ind.
SET (NOW + RETENTION (B)) TIMER 2
DISCONNECT (B)
Q.71 connector 2
DISCONNECT
RELEASE resp.conf.
RELEASE req.ind.
RELEASE (B)
RELEASE (F)
Q.71 connector 5


Process Call_Model
Release(11)
procedure Orig_screen
r1-RELEASE (B)
r2-RELEASE (F)
Q.71 connector 5
RELEASE resp.conf.
RELEASE resp.conf.
Release Resources(B)
Release Resources(F)
r2-REL(F)
r1-REL(B)
Q.71 connector 8
RELEASE resp.conf.
ABORT req.ind. TO SSF
Release Resources(F)
IDLE
non-Q.71 Information flow to release SSF and SCF resources.
r1-DISCON (B)
Q.71 Clear Call ; connector 2
IN: Exception procedures
RELEASE req.Ind.
TIMER2
STOP TIMER2
RELEASE req.Ind.
Remove tone release resources (B)
r1-REL(B)
Q.71 connector 8
RELEASE resp.conf.
ABORT req.ind. TO SSF
ABORT req.ind. TO SSF
RELEASE resp.conf.
Release Resources(B)
IDLE
IDLE
Call Clearing procedures have to be incorporated. See O_Exception remarks.
Include call parameters in error information flow when necessary



Process Call_Model
ExtraDPprocessing(11)
procedure Orig_screen
/*
Flow of processing control can be altered by SCF instructing SSF to restart processing at a different PIC.
See Q.1214 Sect 4.2.2.2.3, IN transitions beyond a basic call.
This results in common processing actions for DP1, DP2, DP3, DP4, DP5, DP6, DP9
*/
DP1, DP2, DP3, DP4, DP5, DP6, DP9B
These states also appear on other pages
Digit by digit case not considered.
GOTO_PIC_3
GOTO_PIC_4
GOTO_PIC_1
PIC_3
PIC_4A
Clear call
PIC_6
Depending on the stage of the call process goto PIC 6A, 6B, or 6C.

Procedure Orig_screen 1(1)

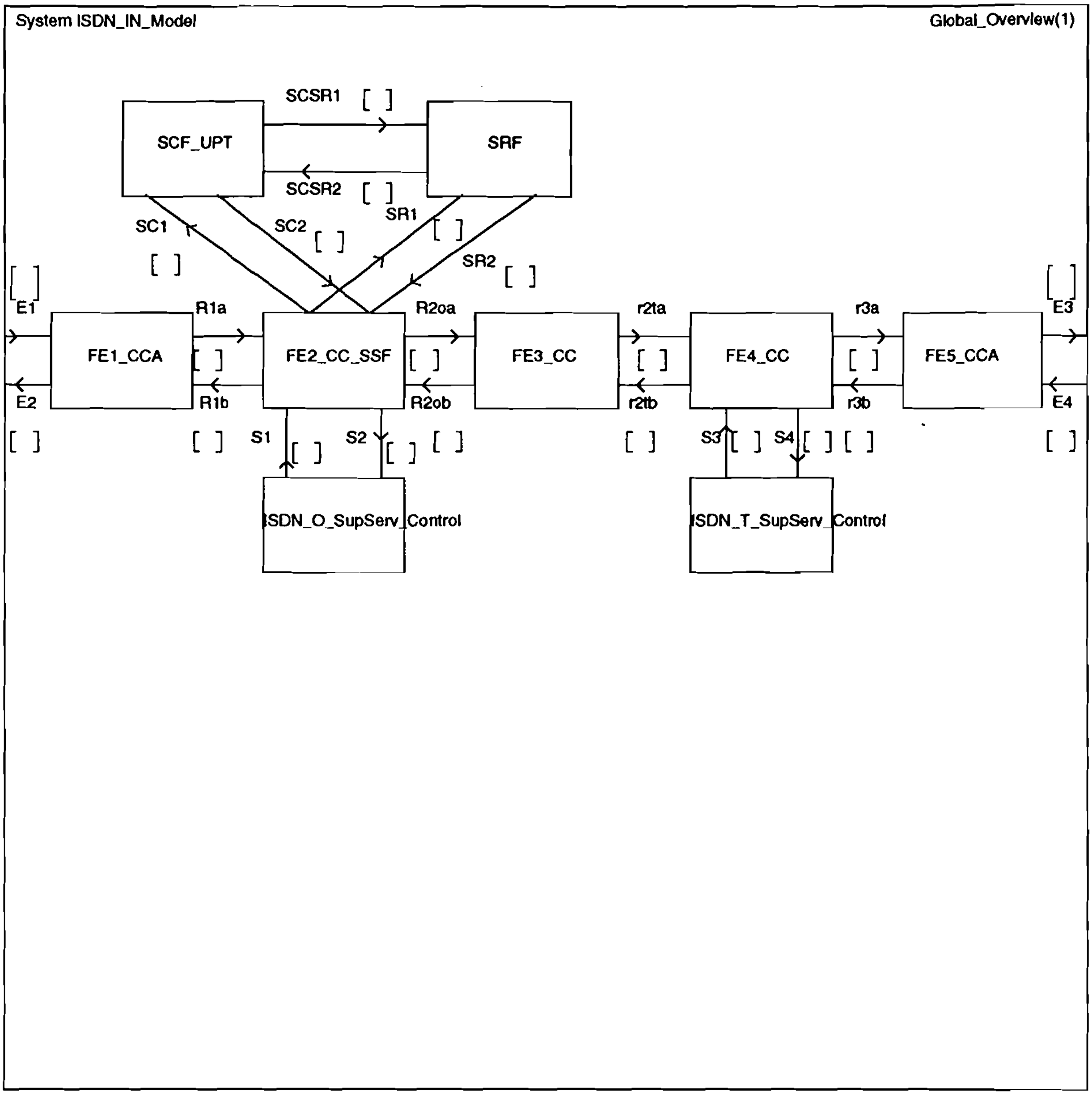


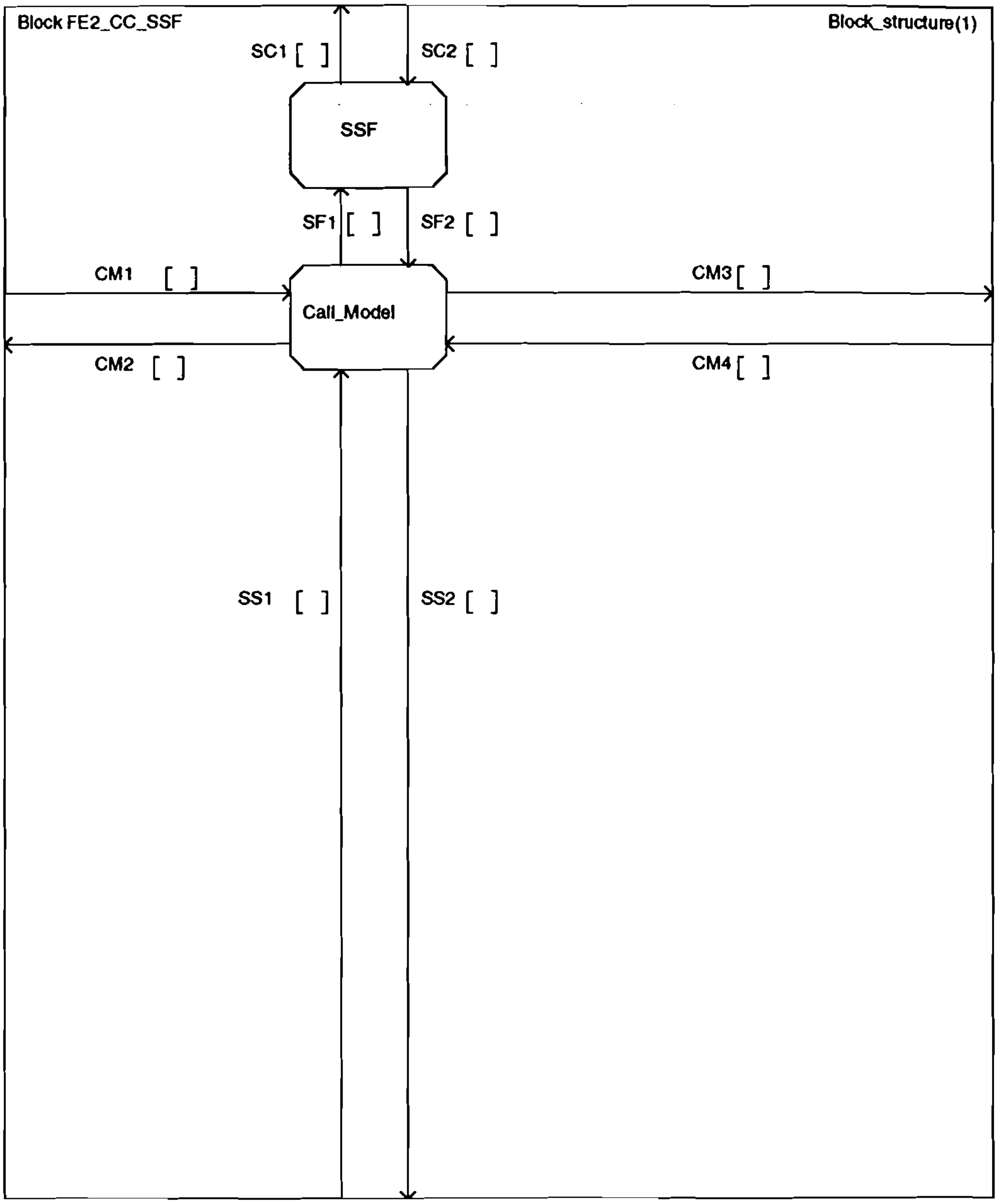
Annex 4: SDL diagrams of the Extended IN-ISDN model

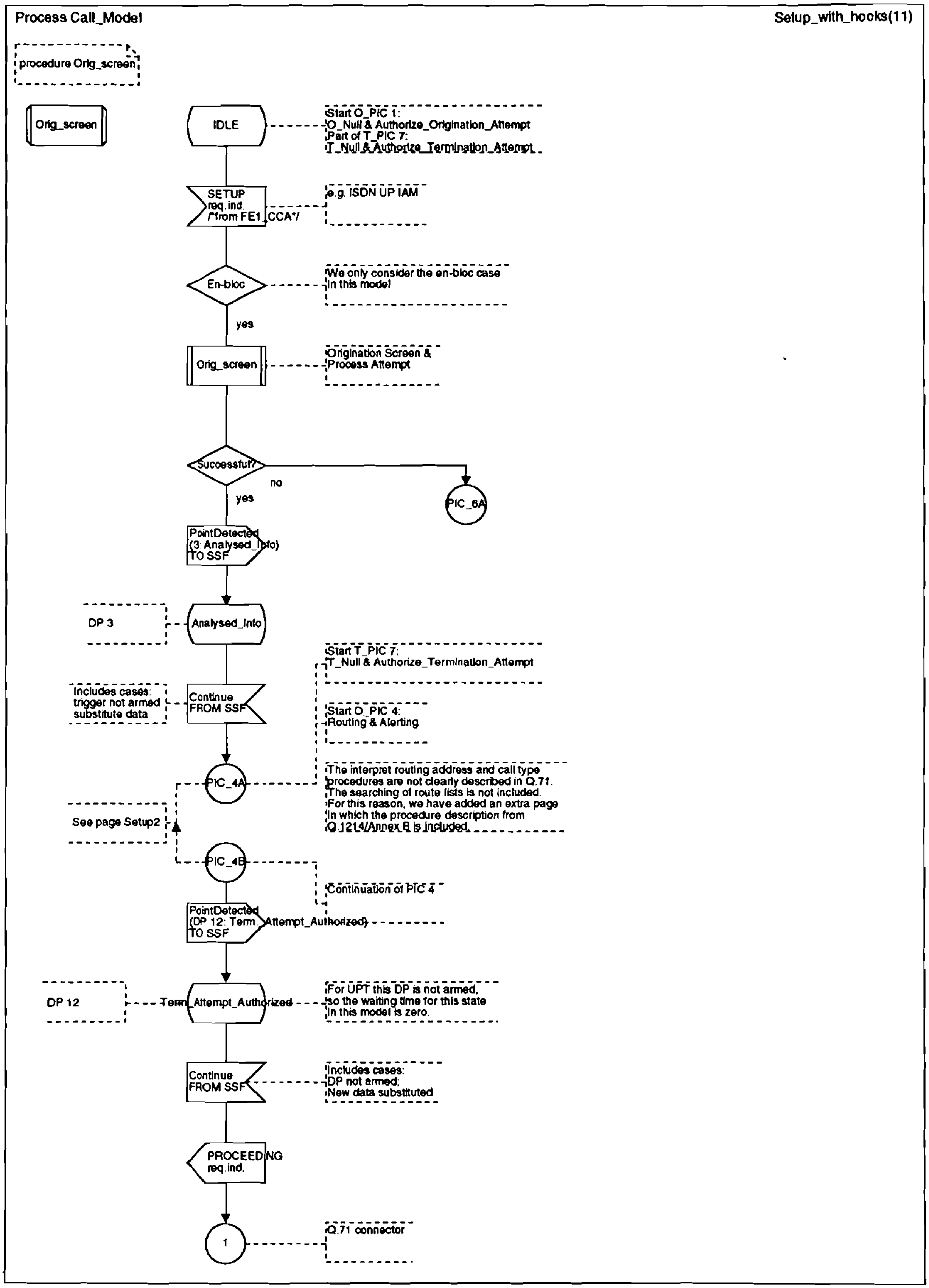
In this annex the SDL diagrams are extended in comparison with the basic call model of annex 3. The Process Call_Model is extended with CUG hooks. In the blocks SCF_UPT and SRF the dynamic descriptions of the corresponding IN functional entities are included. The outgoing Closed User Group control process is located in block ISDN_O_SupServ_Control.

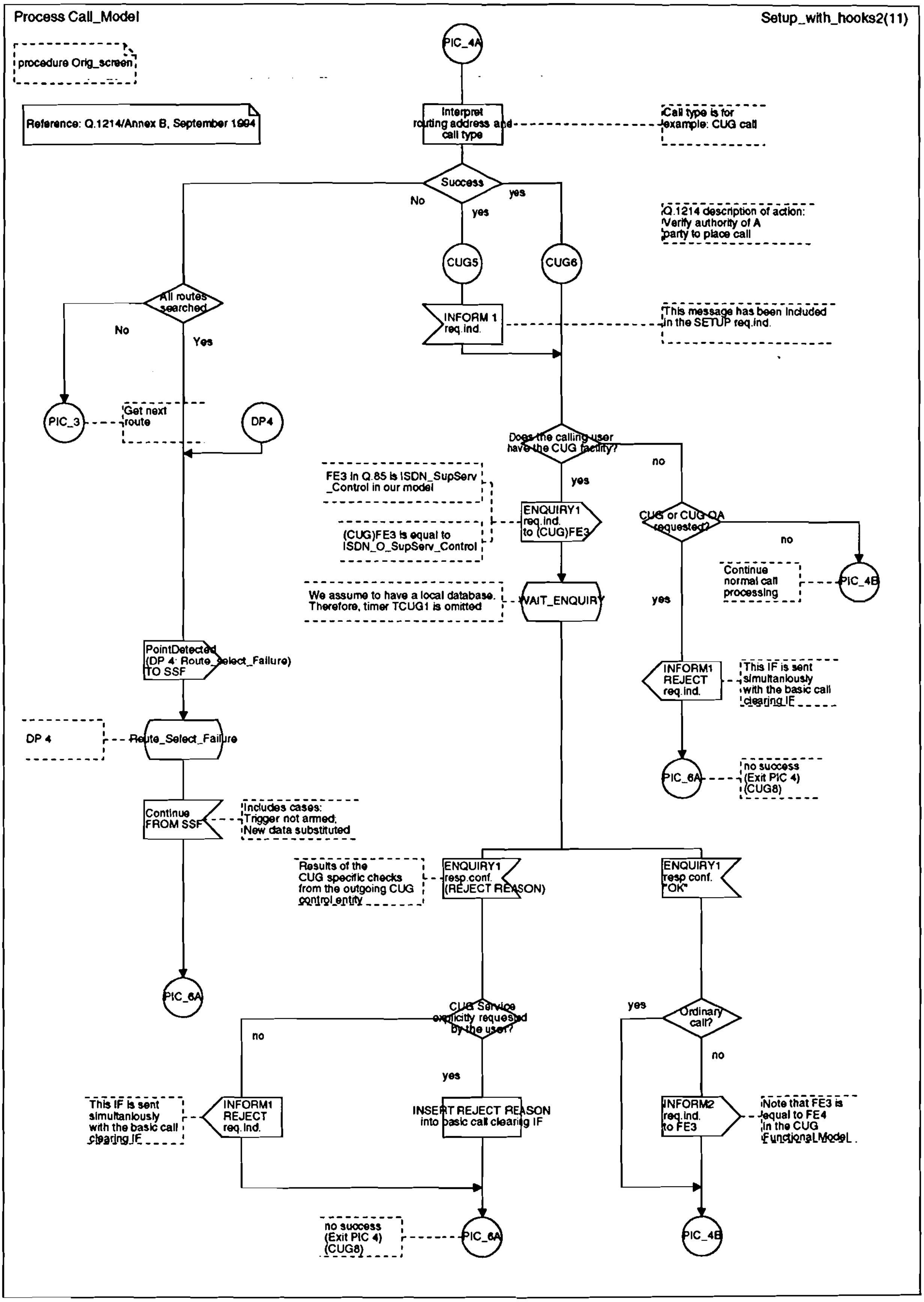
STRUCTURE INFORMATION

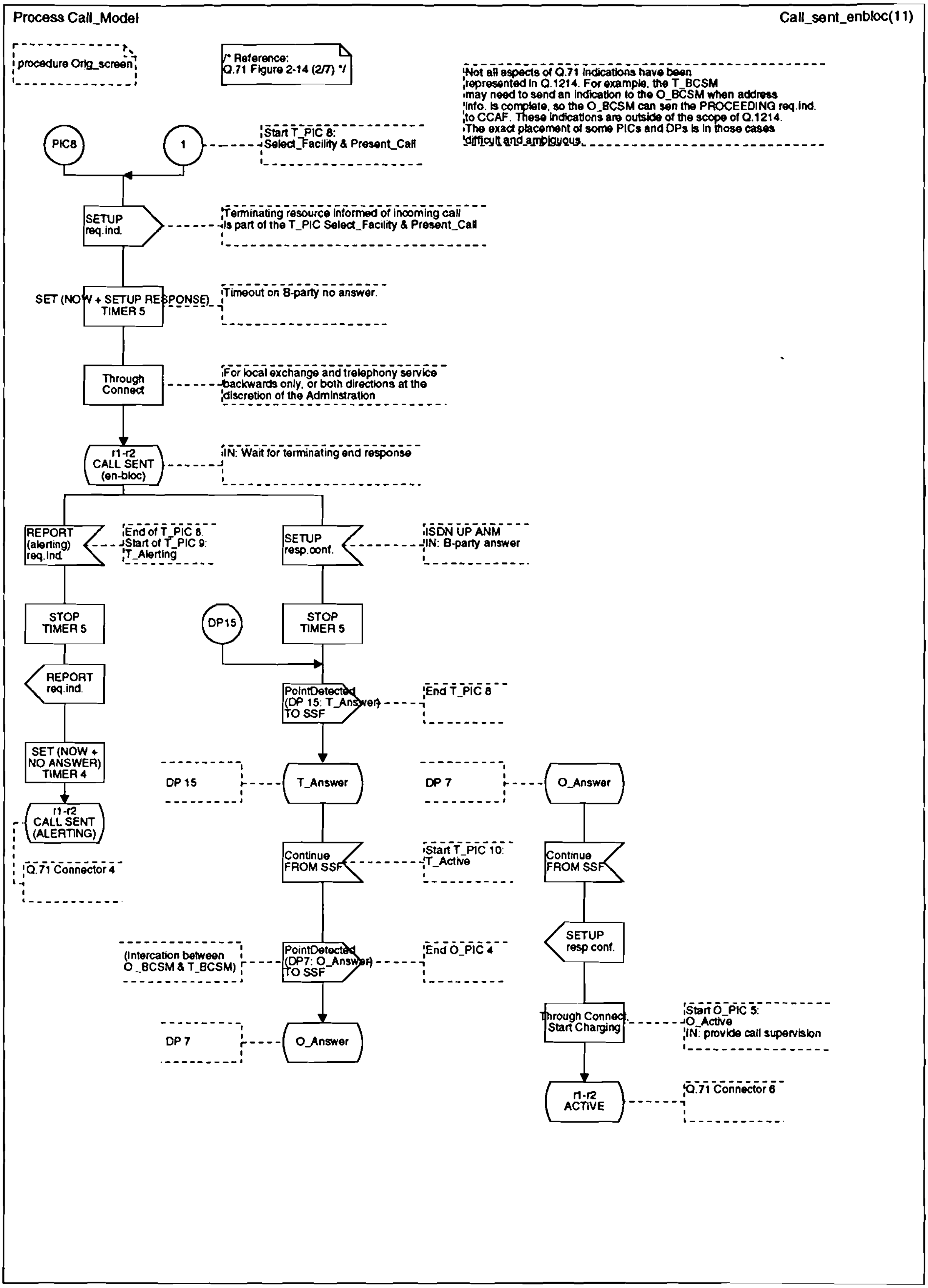
- System ISDN_IN_Model
  - Page Global_Overview
    - Block FE1_CCA
    - Block FE2_CC_SSF
      - Page Block_structure
        - Process Call_Model
          - Page Setup_with_hooks
            - Procedure Orig_screen
              - Page 1
          - Page Setup_with_hooks2
          - Page Call_sent_enbloc
          - Page Call_sent_enbloc2
          - Page Call_sent_alerting
          - Page Call_sent_alerting2
          - Page Active1
          - Page Active2
          - Page Exception
          - Page Release
          - Page ExtraDPprocessing
        - Process SSF
          - Page UPT_SSF1
          - Page UPT_SSF2
          - Page UPT_SSF3
          - Page UPT_SSF4
          - Page UPT_SSF5
          - Page UPT_SSF6
          - Page UPT_SSF7
          - Page T_Disconnect_B
    - Block FE3_CC
    - Block FE4_CC
    - Block FE5_CCA
    - Block ISDN_O_SupServ_Control
      - Page 1
        - Process CUG_outgoing_control
          - Page 1
    - Block ISDN_T_SupServ_Control
    - Block SCF_UPT
      - Page SCF_Overview
        - Process SCF
          - Page UPT_SCF1
            - Procedure SDF_Request
              - Page 1
          - Page UPT_SCF2
          - Page UPT_SCF3
          - Page UPT_SCF4
          - Page UPT_SCF5
          - Page UPT_SCF6
          - Page UPT_SCF7
          - Page UPT_SCF8
            - Procedure SDF_Request
    - Block SRF
      - Page SRF1
      - Page 1
        - Process UPT_SRF
          - Page UPT_SRF1
          - Page UPT_SRF2
          - Page UPT_SRF3

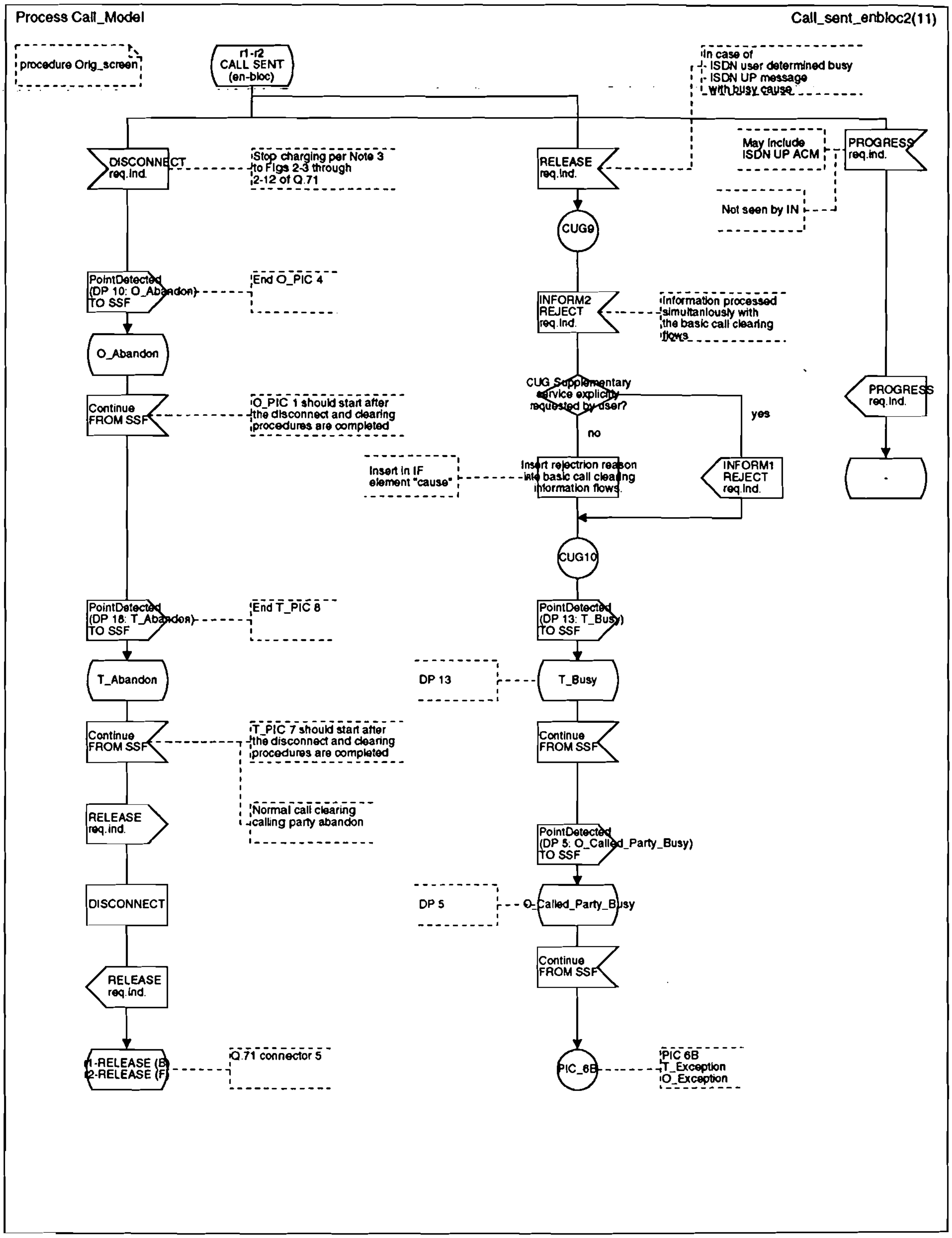

System ISDN_IN_Model
Global_Overview(1)
SCF_UPT
SRF
SCSR1 [ ]
SCSR2 [ ]
SC1 [ ]
SC2 [ ]
SR1 [ ]
SR2 [ ]
E1 [ ]
E2 [ ]
E3 [ ]
E4 [ ]
FE1_CCA
FE2_CC_SSF
FE3_CC
FE4_CC
FE5_CCA
R1a [ ]
R1b [ ]
R2oa [ ]
R2ob [ ]
r2ta [ ]
r2tb [ ]
r3a [ ]
r3b [ ]
S1 [ ]
S2 [ ]
S3 [ ]
S4 [ ]
ISDN_O_SupServ_Control
ISDN_T_SupServ_Control

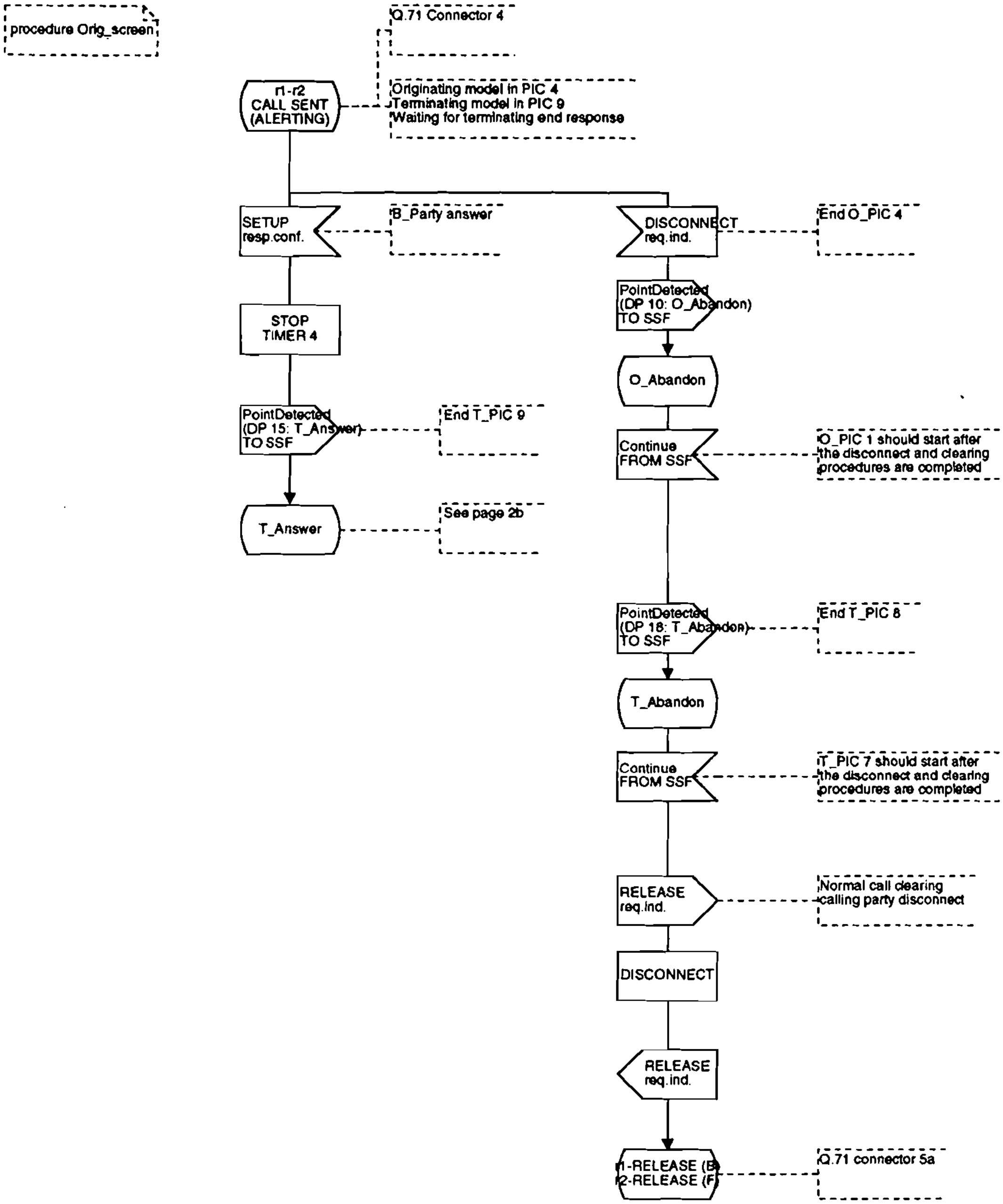

Block FE2_CC_SSF
Block_structure(1)
SC1 [ ]
SC2 [ ]
SSF
SF1 [ ]
SF2 [ ]
CM1 [ ]
CM3 [ ]
Call_Model
CM2 [ ]
CM4 [ ]
SS1 [ ]
SS2 [ ]

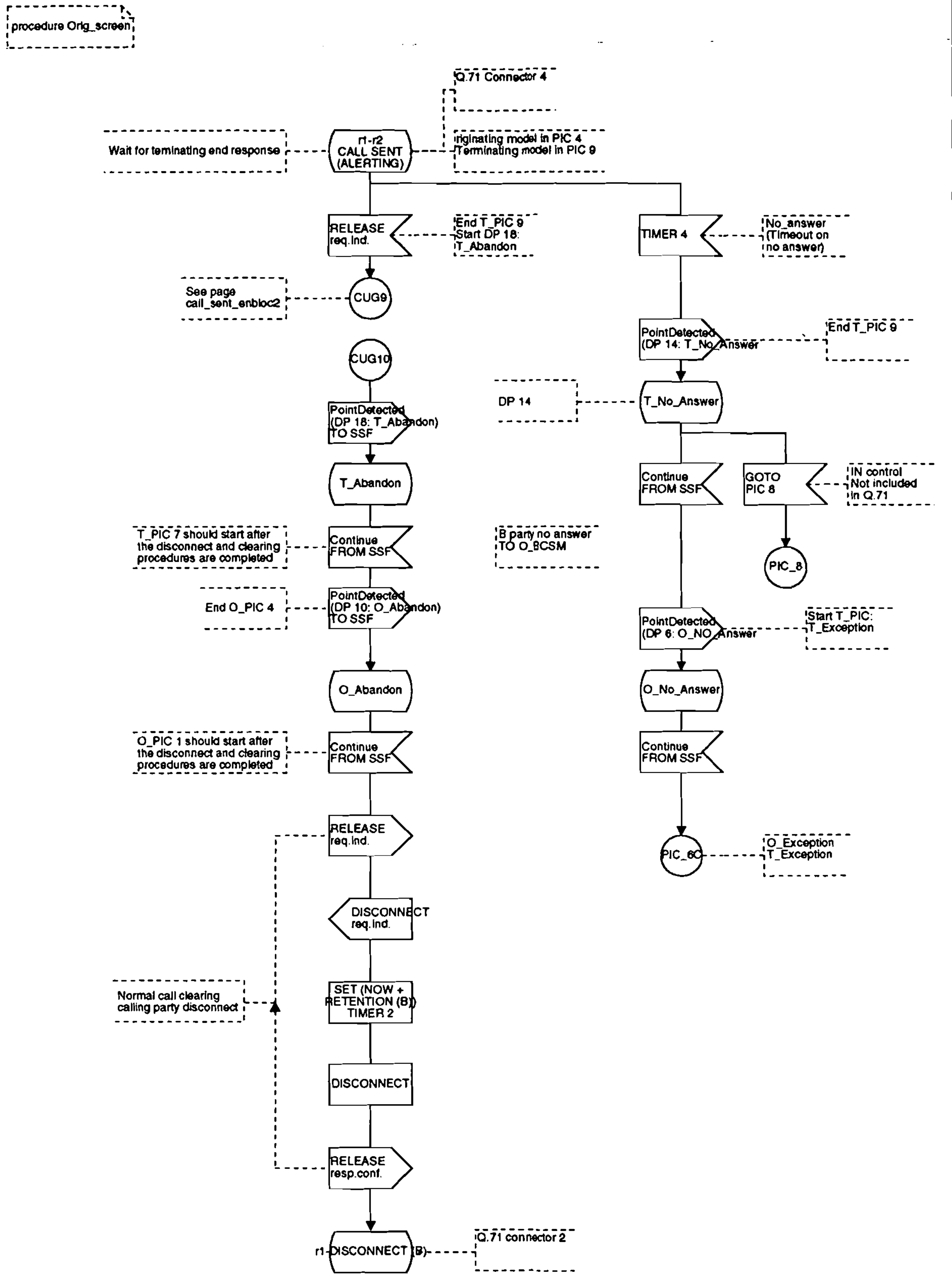

Process Call_Model
Setup_with_hooks(11)
procedure Orig_screen
Orig_screen
IDLE
Start O_PIC 1:
O_Null & Authorize_Origination_Attempt
Part of T_PIC 7:
T_Null & Authorize_Termination_Attempt
SETUP
req.ind.
/*from FE1_CCA*/
e.g. ISDN UP IAM
En-bloc
We only consider the en-bloc case
in this model
yes
Orig_screen
Origination Screen &
Process Attempt
Successful?
no
yes
PIC_6A
PointDetected
(3 Analysed_Info)
TO SSF
DP 3
Analysed_Info
Start T_PIC 7:
T_Null & Authorize_Termination_Attempt
Includes cases:
trigger not armed
substitute data
Continue
FROM SSF
Start O_PIC 4:
Routing & Alerting
PIC_4A
The interpret routing address and call type
procedures are not clearly described in Q.71.
The searching of route lists is not included.
For this reason, we have added an extra page
in which the procedure description from
Q.1214/Annex B is included.
See page Setup2
PIC_4B
Continuation of PIC 4
PointDetected
(DP 12: Term. Attempt_Authorized)
TO SSF
DP 12
Term_Attempt_Authorized
For UPT this DP is not armed,
so the waiting time for this state
in this model is zero.
Continue
FROM SSF
Includes cases:
DP not armed;
New data substituted
PROCEEDING
req.ind.
1
Q.71 connector

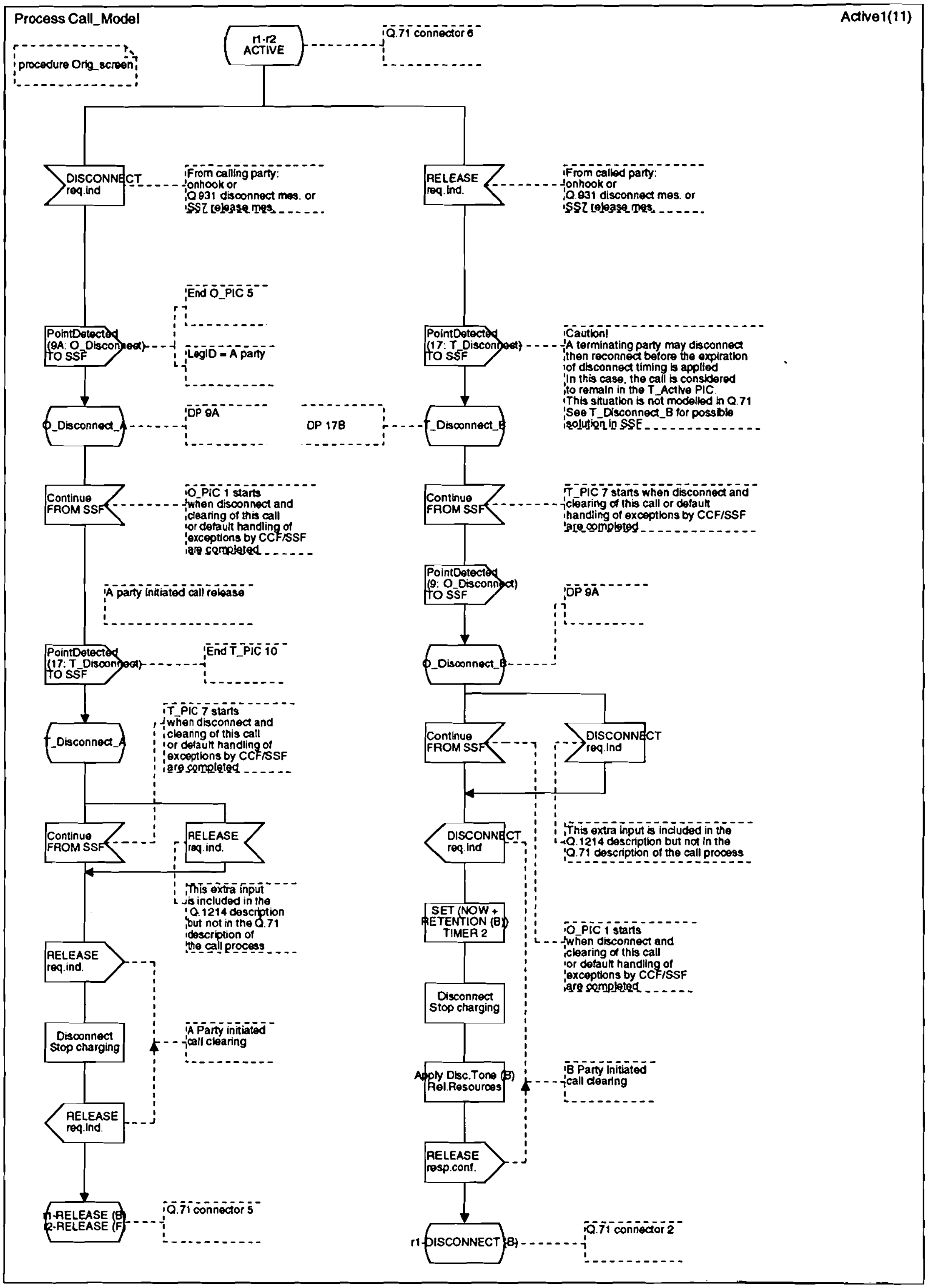

Process Call_Model
Setup_with_hooks2(11)
procedure Orig_screen
Reference: Q.1214/Annex B, September 1994
PIC_4A
Interpret routing address and call type
Call type is for example: CUG call
Success
No
yes
yes
Q.1214 description of action: Verify authority of A party to place call
CUG5
CUG6
All routes searched
No
Yes
INFORM 1 req.ind.
This message has been included in the SETUP req.ind.
PIC_3
Get next route
DP4
Does the calling user have the CUG facility?
no
yes
FE3 in Q.85 is ISDN_SupServ _Control in our model
ENQUIRY1 req.ind. to (CUG)FE3
(CUG)FE3 is equal to ISDN_O_SupServ_Control
CUG or CUG OA requested?
no
Continue normal call processing
PIC_4B
We assume to have a local database. Therefore, timer TCUG1 is omitted
WAIT_ENQUIRY
yes
PointDetected (DP 4: Route_Select_Failure) TO SSF
INFORM1 REJECT req.ind.
This IF is sent simultaniously with the basic call clearing IF
DP 4
Route_Select_Failure
PIC_6A
no success (Exit PIC 4) (CUG8)
Continue FROM SSF
Includes cases: Trigger not armed; New data substituted
Results of the CUG specific checks from the outgoing CUG control entity
ENQUIRY1 resp.conf. (REJECT REASON)
ENQUIRY1 resp.conf. "OK"
PIC_6A
CUG Service explicitly requested by the user?
yes
Ordinary call?
no
no
yes
This IF is sent simultaniously with the basic call clearing IF
INFORM1 REJECT req.ind.
INSERT REJECT REASON into basic call clearing IF
INFORM2 req.ind. to FE3
Note that FE3 is equal to FE4 in the CUG Functional Model
no success (Exit PIC 4) (CUG8)
PIC_6A
PIC_4B


Process Call_Model
Call_sent_enbloc(11)
procedure Orig_screen
/* Reference:
Q.71 Figure 2-14 (2/7) */
Not all aspects of Q.71 indications have been represented in Q.1214. For example, the T_BCSM may need to send an indication to the O_BCSM when address info. is complete, so the O_BCSM can sen the PROCEEDING req.ind. to CCAF. These indications are outside of the scope of Q.1214. The exact placement of some PICs and DPs is in those cases difficult and ambiguous.
PIC8
1
Start T_PIC 8:
Select_Facility & Present_Call
SETUP
req.ind.
Terminating resource informed of incoming call is part of the T_PIC Select_Facility & Present_Call
SET (NOW + SETUP RESPONSE)
TIMER 5
Timeout on B-party no answer.
Through
Connect
For local exchange and trelephony service backwards only, or both directions at the discretion of the Administration
r1-r2
CALL SENT
(en-bloc)
IN: Wait for terminating end response
REPORT
(alerting)
req.ind.
End of T_PIC 8.
Start of T_PIC 9:
T_Alerting
SETUP
resp.conf.
ISDN UP ANM
IN: B-party answer
STOP
TIMER 5
DP15
STOP
TIMER 5
REPORT
req.ind.
PointDetected
(DP 15: T_Answer)
TO SSF
End T_PIC 8
SET (NOW +
NO ANSWER)
TIMER 4
DP 15
T_Answer
DP 7
O_Answer
r1-r2
CALL SENT
(ALERTING)
Continue
FROM SSF
Start T_PIC 10:
T_Active
Continue
FROM SSF
Q.71 Connector 4
SETUP
resp conf.
(Intercation between
O_BCSM & T_BCSM)
PointDetected
(DP7: O_Answer)
TO SSF
End O_PIC 4
Through Connect
Start Charging
Start O_PIC 5:
O_Active
IN: provide call supervision
DP 7
O_Answer
r1-r2
ACTIVE
Q.71 Connector 6

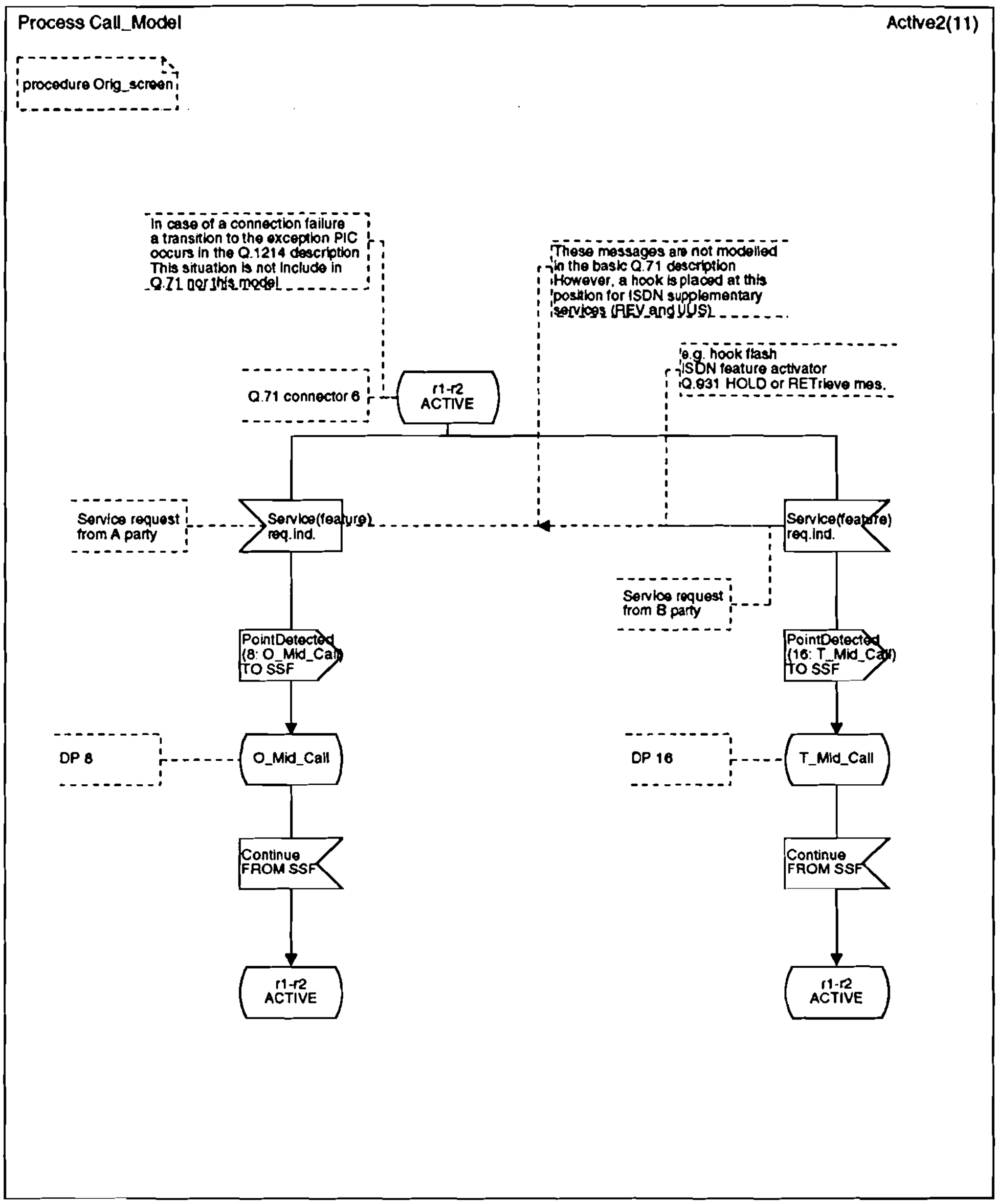

Process Call_Model
Call_sent_enbloc2(11)
procedure Orig_screen
r1-r2 CALL SENT (en-bloc)
In case of
- ISDN user determined busy
- ISDN UP message with busy cause
DISCONNECT req.ind.
Stop charging per Note 3 to Figs 2-3 through 2-12 of Q.71
RELEASE req.ind.
May include ISDN UP ACM
PROGRESS req.ind.
Not seen by IN
CUG9
PointDetected (DP 10: O_Abandon) TO SSF
End O_PIC 4
INFORM2 REJECT req.ind.
Information processed simultanlously with the basic call clearing flows
O_Abandon
CUG Supplementary service explicitly requested by user?
yes
no
PROGRESS req.ind.
Continue FROM SSF
O_PIC 1 should start after the disconnect and clearing procedures are completed
Insert in IF element "cause"
Insert rejectrion reason into basic call clearing information flows.
INFORM1 REJECT req.ind.
CUG10
PointDetected (DP 18: T_Abandon) TO SSF
End T_PIC 8
PointDetected (DP 13: T_Busy) TO SSF
T_Abandon
DP 13
T_Busy
Continue FROM SSF
T_PIC 7 should start after the disconnect and clearing procedures are completed
Continue FROM SSF
RELEASE req.ind.
Normal call clearing calling party abandon
PointDetected (DP 5: O_Called_Party_Busy) TO SSF
DISCONNECT
DP 5
O_Called_Party_Busy
Continue FROM SSF
RELEASE req.ind.
r1-RELEASE (B) r2-RELEASE (F)
Q.71 connector 5
PIC_6B
PIC 6B T_Exception O_Exception

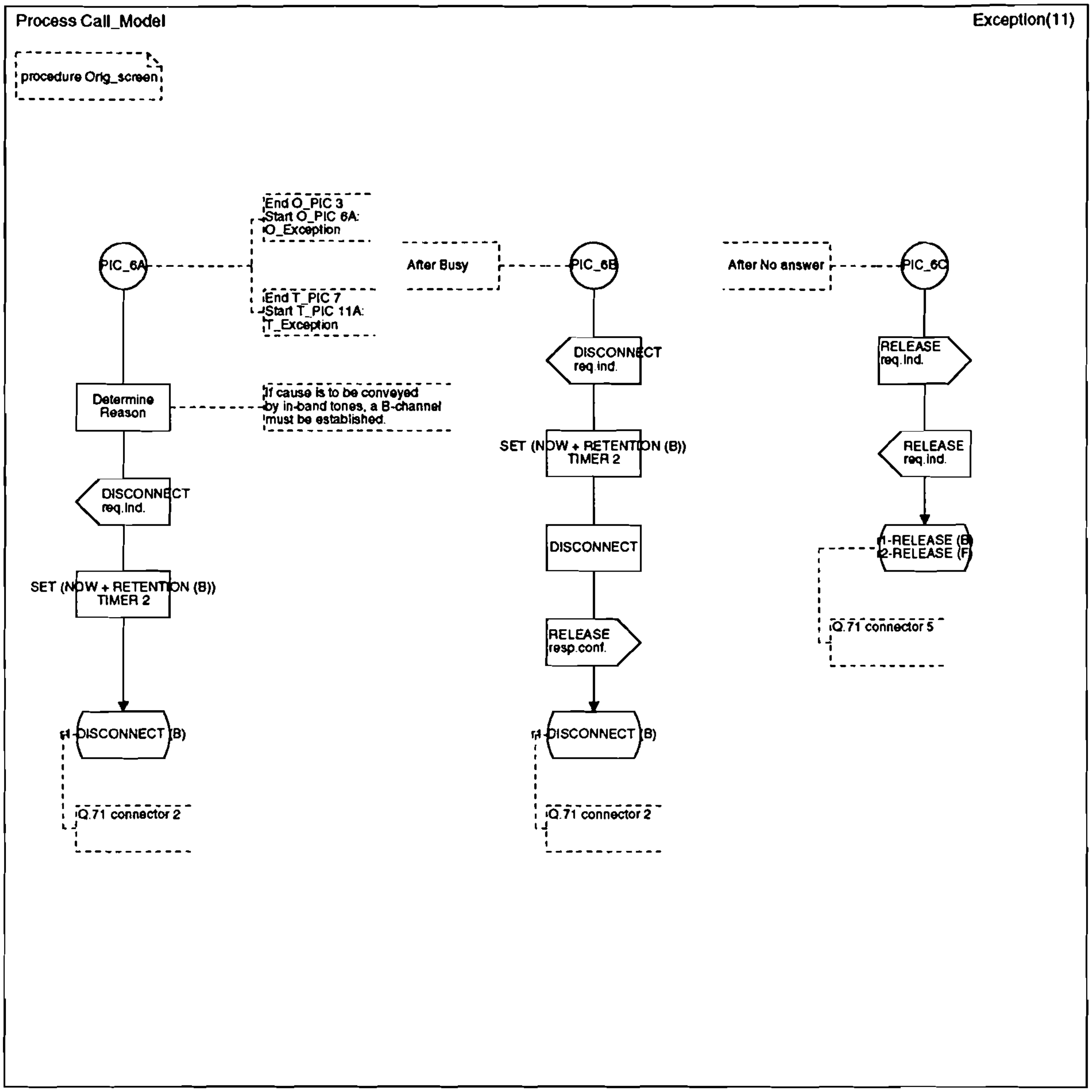

procedure Orig_screen
Q.71 Connector 4
r1-r2
CALL SENT
(ALERTING)
Originating model in PIC 4
Terminating model in PIC 9
Waiting for terminating end response
SETUP
resp.conf.
B_Party answer
DISCONNECT
req.ind.
End O_PIC 4
STOP
TIMER 4
PointDetected
(DP 10: O_Abandon)
TO SSF
O_Abandon
PointDetected
(DP 15: T_Answer)
TO SSF
End T_PIC 9
Continue
FROM SSF
O_PIC 1 should start after
the disconnect and clearing
procedures are completed
T_Answer
See page 2b
PointDetected
(DP 18: T_Abandon)
TO SSF
End T_PIC 8
T_Abandon
Continue
FROM SSF
T_PIC 7 should start after
the disconnect and clearing
procedures are completed
RELEASE
req.ind.
Normal call clearing
calling party disconnect
DISCONNECT
RELEASE
req.ind.
r1-RELEASE (B)
r2-RELEASE (F)
Q.71 connector 5a


procedure Orig_screen
Q.71 Connector 4
Wait for teminating end response
r1-r2 CALL SENT (ALERTING)
riginating model in PIC 4
Terminating model in PIC 9
RELEASE req.ind.
End T_PIC 9
Start DP 18:
T_Abandon
TIMER 4
No_answer
(Timeout on no answer)
See page call_sent_enbloc2
CUG9
CUG10
PointDetected (DP 14: T_No_Answer
End T_PIC 9
PointDetected (DP 18: T_Abandon) TO SSF
DP 14
T_No_Answer
T_Abandon
Continue FROM SSF
GOTO PIC 8
IN control
Not included
in Q.71
T_PIC 7 should start after the disconnect and clearing procedures are completed
Continue FROM SSF
B party no answer
TO O_BCSM
PIC_8
End O_PIC 4
PointDetected (DP 10: O_Abandon) TO SSF
PointDetected (DP 6: O_NO_Answer
Start T_PIC:
T_Exception
O_Abandon
O_No_Answer
O_PIC 1 should start after the disconnect and clearing procedures are completed
Continue FROM SSF
Continue FROM SSF
RELEASE req.ind.
PIC_6
O_Exception
T_Exception
DISCONNECT req.ind.
Normal call clearing calling party disconnect
SET (NOW + RETENTION (B)) TIMER 2
DISCONNECT
RELEASE resp.conf.
r1-DISCONNECT (B)
Q.71 connector 2

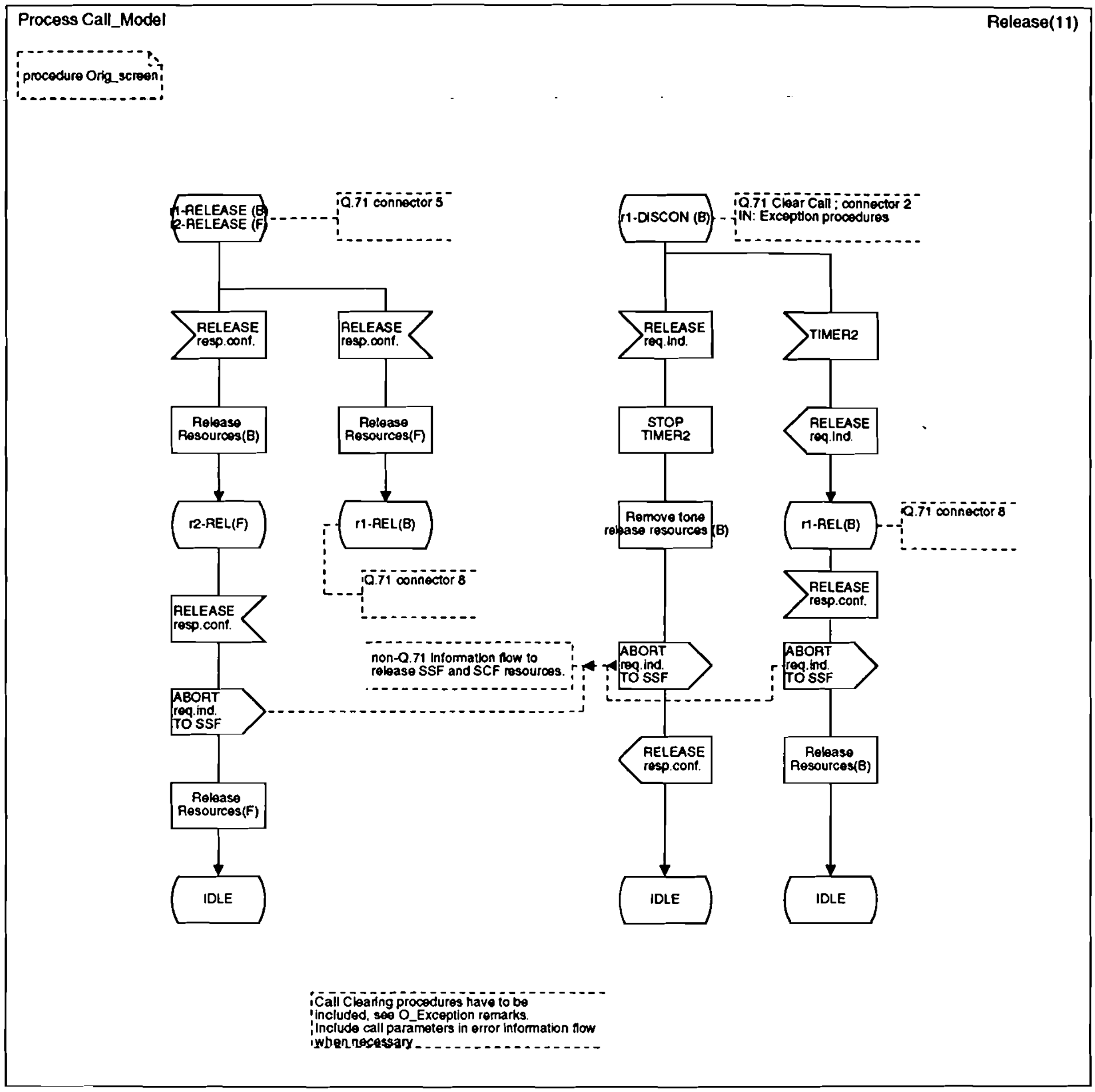


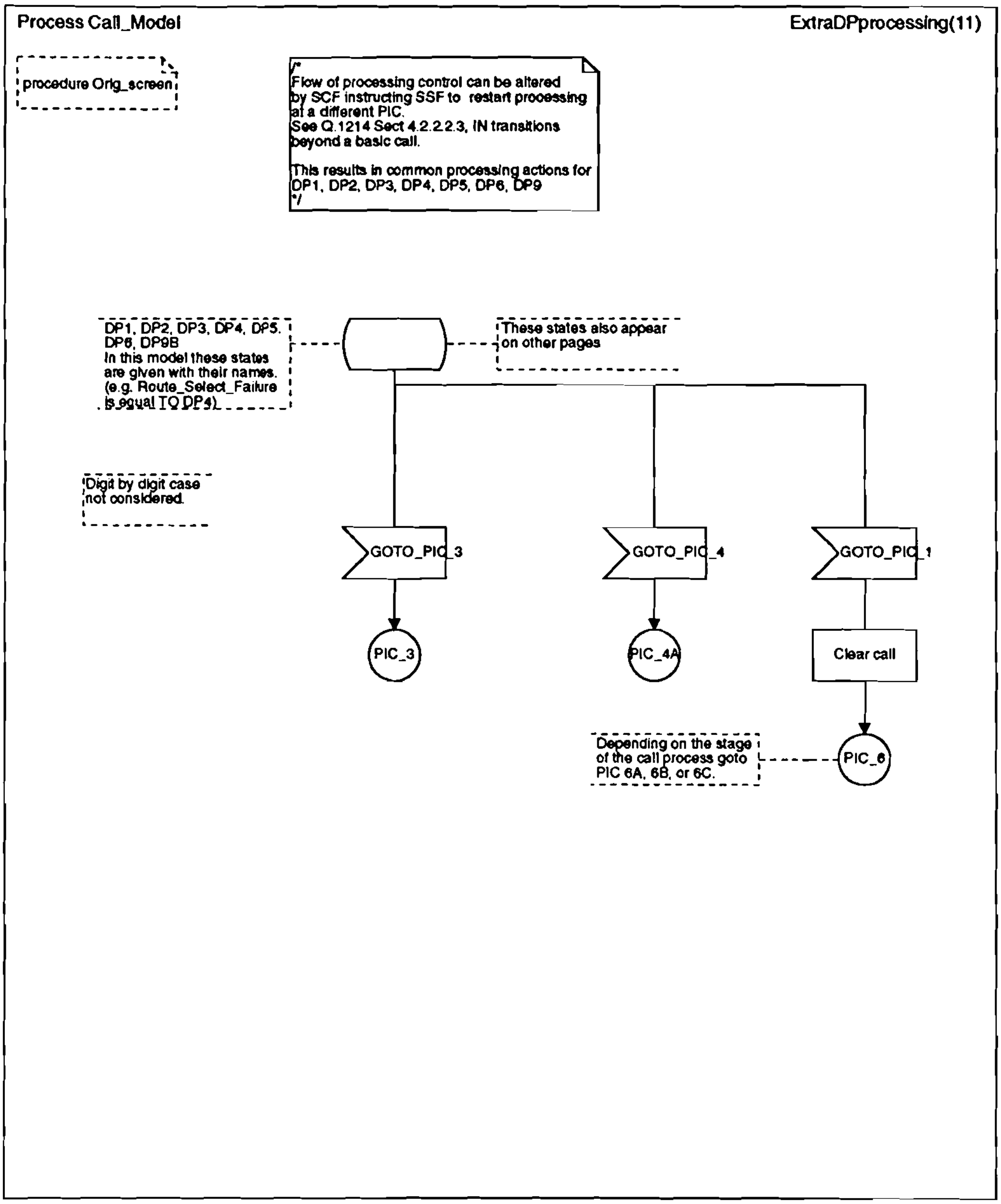
Process Call_Model
Active1(11)
procedure Orig_screen
r1-r2 ACTIVE
Q.71 connector 6
DISCONNECT req.ind
From calling party: onhook or Q.931 disconnect mes. or SS7 release mes.
RELEASE req.ind.
From called party: onhook or Q.931 disconnect mes. or SS7 release mes.
End O_PIC 5
PointDetected (9A: O_Disconnect) TO SSF
LegID = A party
PointDetected (17: T_Disconnect) TO SSF
Caution! A terminating party may disconnect then reconnect before the expiration of disconnect timing is applied In this case, the call is considered to remain in the T_Active PIC This situation is not modelled in Q.71 See T_Disconnect_B for possible solution in SSF
O_Disconnect_A
DP 9A
DP 17B
T_Disconnect_B
Continue FROM SSF
O_PIC 1 starts when disconnect and clearing of this call or default handling of exceptions by CCF/SSF are completed
Continue FROM SSF
T_PIC 7 starts when disconnect and clearing of this call or default handling of exceptions by CCF/SSF are completed
PointDetected (9: O_Disconnect) TO SSF
A party initiated call release
DP 9A
PointDetected (17: T_Disconnect) TO SSF
End T_PIC 10
O_Disconnect_B
T_Disconnect_A
T_PIC 7 starts when disconnect and clearing of this call or default handling of exceptions by CCF/SSF are completed
Continue FROM SSF
DISCONNECT req.ind
Continue FROM SSF
RELEASE req.ind.
This extra input is included in the Q.1214 description but not in the Q.71 description of the call process
DISCONNECT req.ind
This extra input is included in the Q.1214 description but not in the Q.71 description of the call process
SET (NOW + RETENTION (B)) TIMER 2
O_PIC 1 starts when disconnect and clearing of this call or default handling of exceptions by CCF/SSF are completed
RELEASE req.ind.
Disconnect Stop charging
Disconnect Stop charging
A Party initiated call clearing
Apply Disc.Tone (B) Rel.Resources
B Party initiated call clearing
RELEASE req.ind.
RELEASE resp.conf.
r1-RELEASE (B) r2-RELEASE (F)
Q.71 connector 5
r1-DISCONNECT (B)
Q.71 connector 2


Process Call_Model
Active2(11)
procedure Orig_screen
In case of a connection failure a transition to the exception PIC occurs in the Q.1214 description This situation is not include in Q.71 nor this model
These messages are not modelled in the basic Q.71 description However, a hook is placed at this position for ISDN supplementary services (REV and UUS)
e.g. hook flash ISDN feature activator Q.931 HOLD or RETrieve mes.
Q.71 connector 6
r1-r2 ACTIVE
Service request from A party
Service(feature) req.ind.
Service(feature) req.ind.
Service request from B party
PointDetected (8: O_Mid_Call) TO SSF
PointDetected (16: T_Mid_Call) TO SSF
DP 8
O_Mid_Call
DP 16
T_Mid_Call
Continue FROM SSF
Continue FROM SSF
r1-r2 ACTIVE
r1-r2 ACTIVE

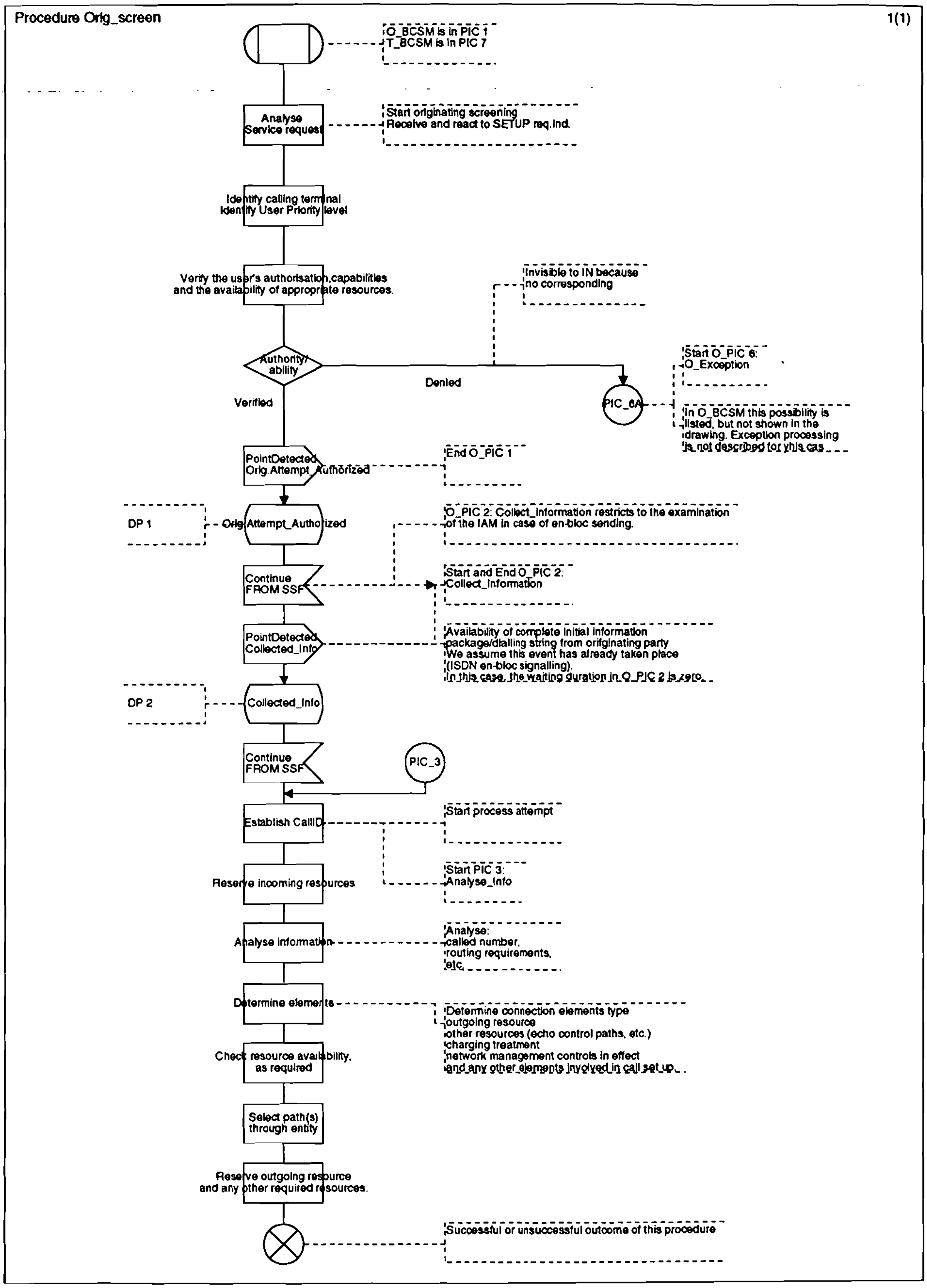


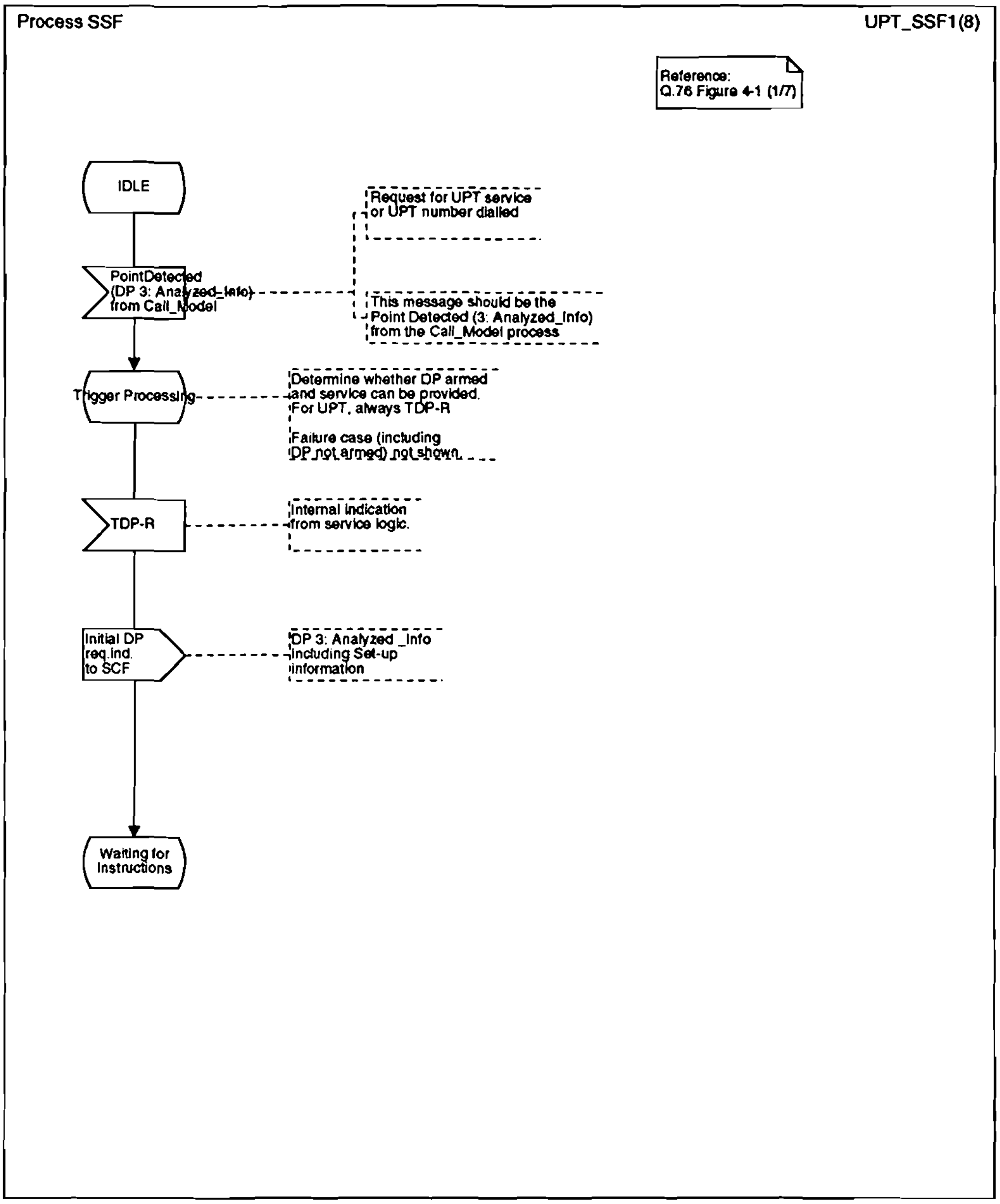
Process Call_Model
Exception(11)
procedure Orig_screen
End O_PIC 3
Start O_PIC 6A:
O_Exception
End T_PIC 7
Start T_PIC 11A:
T_Exception
PIC_6A
After Busy
PIC_6B
After No answer
PIC_6C
Determine Reason
If cause is to be conveyed by in-band tones, a B-channel must be established.
DISCONNECT req.ind.
SET (NOW + RETENTION (B)) TIMER 2
1-DISCONNECT (B)
Q.71 connector 2
DISCONNECT req.ind.
SET (NOW + RETENTION (B)) TIMER 2
DISCONNECT
RELEASE resp.conf.
1-DISCONNECT (B)
Q.71 connector 2
RELEASE req.ind.
RELEASE req.ind.
1-RELEASE (B)
2-RELEASE (F)
Q.71 connector 5

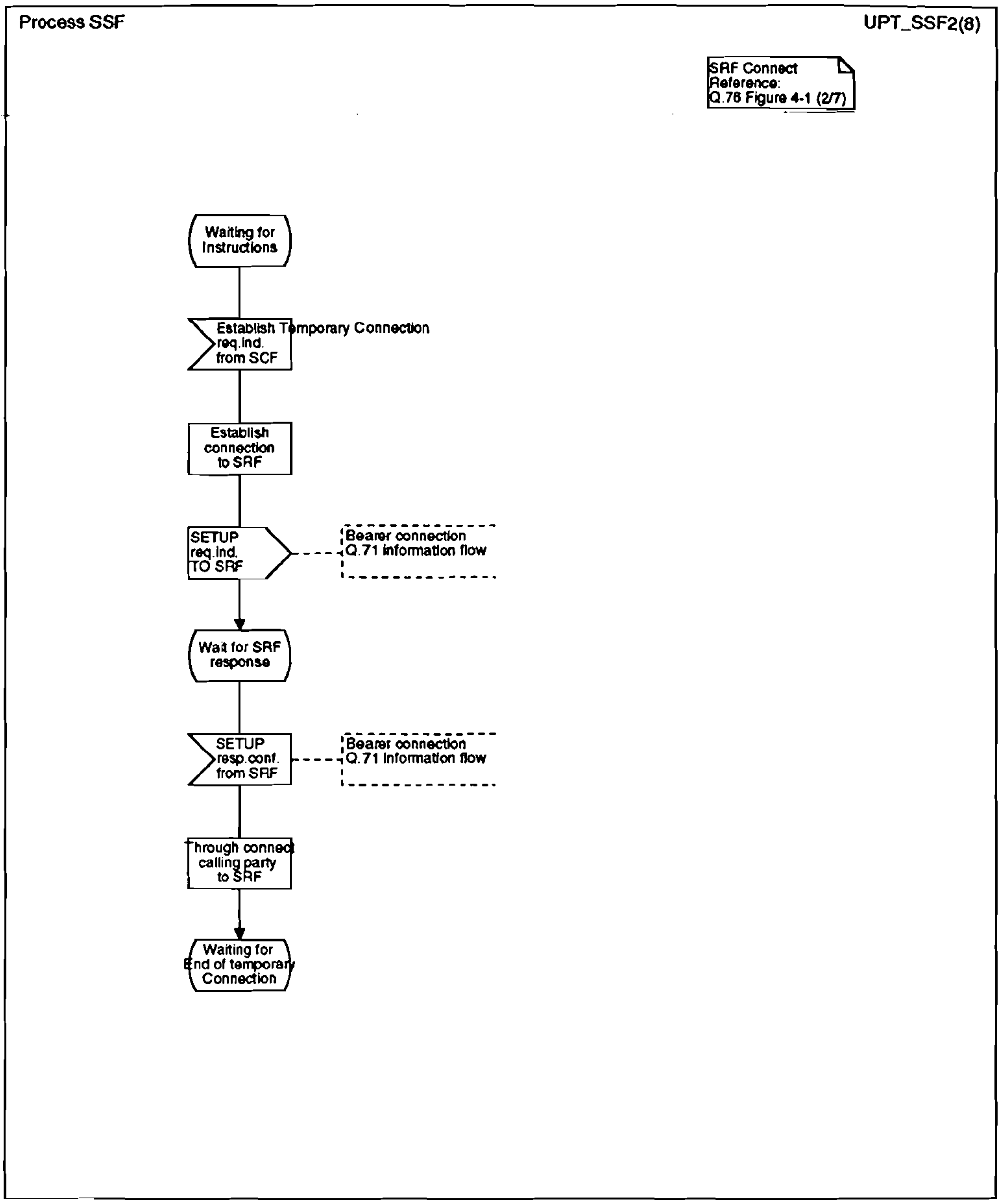

Process Call_Model
Release(11)
procedure Orig_screen
r1-RELEASE (B)
r2-RELEASE (F)
Q.71 connector 5
RELEASE resp.conf.
RELEASE resp.conf.
Release Resources(B)
Release Resources(F)
r2-REL(F)
r1-REL(B)
Q.71 connector 8
RELEASE resp.conf.
ABORT req.ind. TO SSF
Release Resources(F)
IDLE
r1-DISCON (B)
Q.71 Clear Call ; connector 2
IN: Exception procedures
RELEASE req.ind.
TIMER2
STOP TIMER2
RELEASE req.ind.
Remove tone release resources (B)
r1-REL(B)
Q.71 connector 8
RELEASE resp.conf.
non-Q.71 information flow to release SSF and SCF resources.
ABORT req.ind. TO SSF
ABORT req.ind. TO SSF
RELEASE resp.conf.
Release Resources(B)
IDLE
IDLE
Call Clearing procedures have to be included, see O_Exception remarks.
Include call parameters in error information flow when necessary



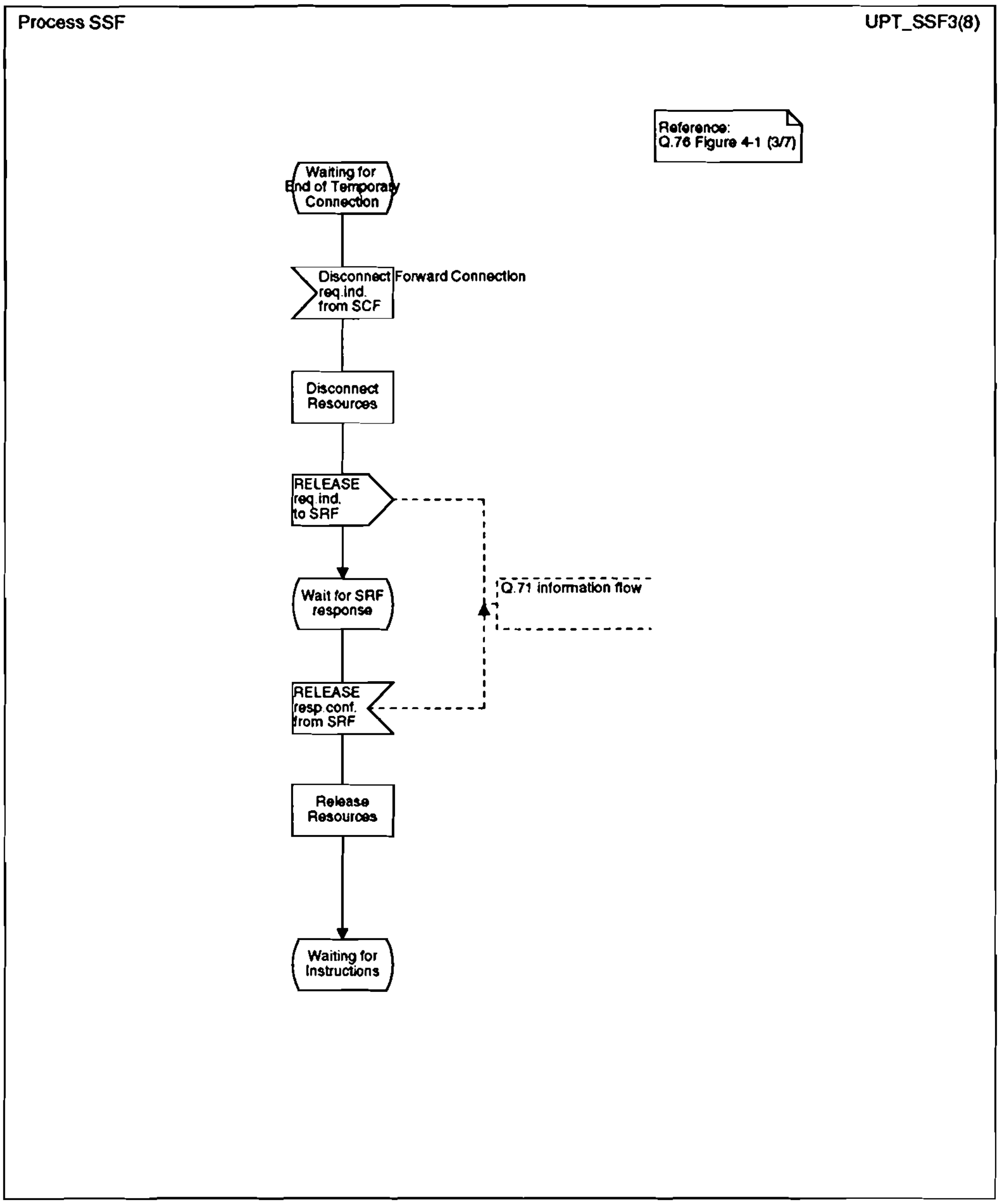
Process Call_Model
ExtraDPprocessing(11)
procedure Orig_screen
/*
Flow of processing control can be altered by SCF instructing SSF to restart processing at a different PIC.
See Q.1214 Sect 4.2.2.2.3, IN transitions beyond a basic call.
This results in common processing actions for DP1, DP2, DP3, DP4, DP5, DP6, DP9
*/
DP1, DP2, DP3, DP4, DP5, DP6, DP9B
In this model these states are given with their names. (e.g. Route_Select_Failure is equal TO DP4)
These states also appear on other pages
Digit by digit case not considered.
GOTO_PIC_3
GOTO_PIC_4
GOTO_PIC_1
PIC_3
PIC_4A
Clear call
Depending on the stage of the call process goto PIC 6A, 6B, or 6C.
PIC_6

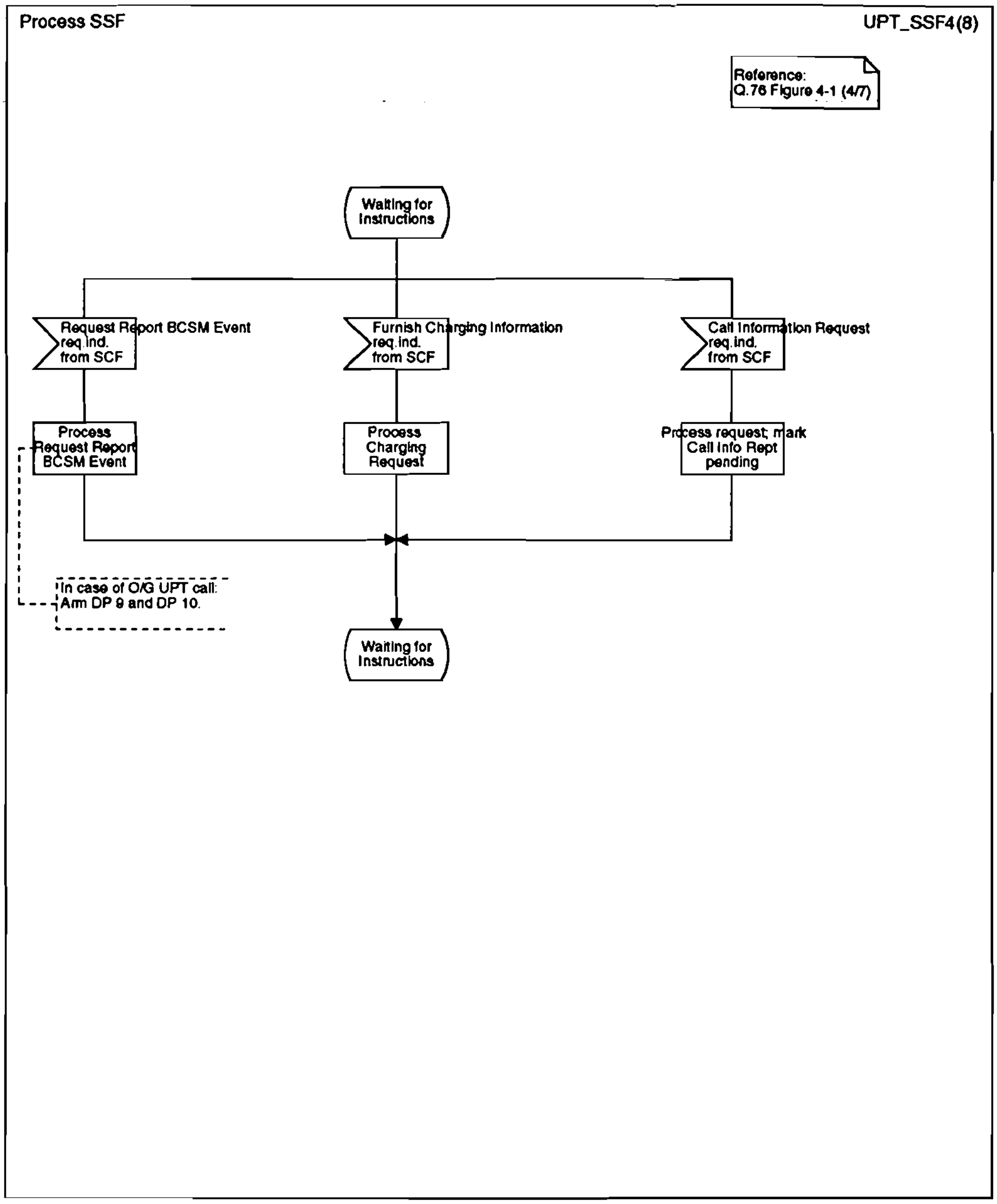

Procedure Orig_screen
1(1)
O_BCSM is in PIC 1
T_BCSM is in PIC 7
Analyse Service request
Start originating screening
Receive and react to SETUP req.ind.
Identify calling terminal
Identify User Priority level
Verify the user's authorisation,capabilities and the availability of appropriate resources.
Invisible to IN because no corresponding
Authority/ ability
Denied
Verified
PIC_6A
Start O_PIC 6: O_Exception
In O_BCSM this possibility is listed, but not shown in the drawing. Exception processing is not described for this cas
PointDetected Orig.Attempt_Authorized
End O_PIC 1
DP 1
Orig.Attempt_Authorized
O_PIC 2: Collect_Information restricts to the examination of the IAM in case of en-bloc sending.
Continue FROM SSF
Start and End O_PIC 2: Collect_Information
PointDetected Collected_Info
Availability of complete initial information package/dialling string from orifginating party
We assume this event has already taken place (ISDN en-bloc signalling).
In this case, the waiting duration in O_PIC 2 is zero.
DP 2
Collected_Info
Continue FROM SSF
PIC_3
Establish CallID
Start process attempt
Start PIC 3: Analyse_Info
Reserve incoming resources
Analyse information
Analyse: called number, routing requirements, etc.
Determine elements
Determine connection elements type
outgoing resource
other resources (echo control paths, etc.)
charging treatment
network management controls in effect
and any other elements involved in call set up.
Check resource availability, as required
Select path(s) through entity
Reserve outgoing resource and any other required resources.
Successful or unsuccessful outcome of this procedure

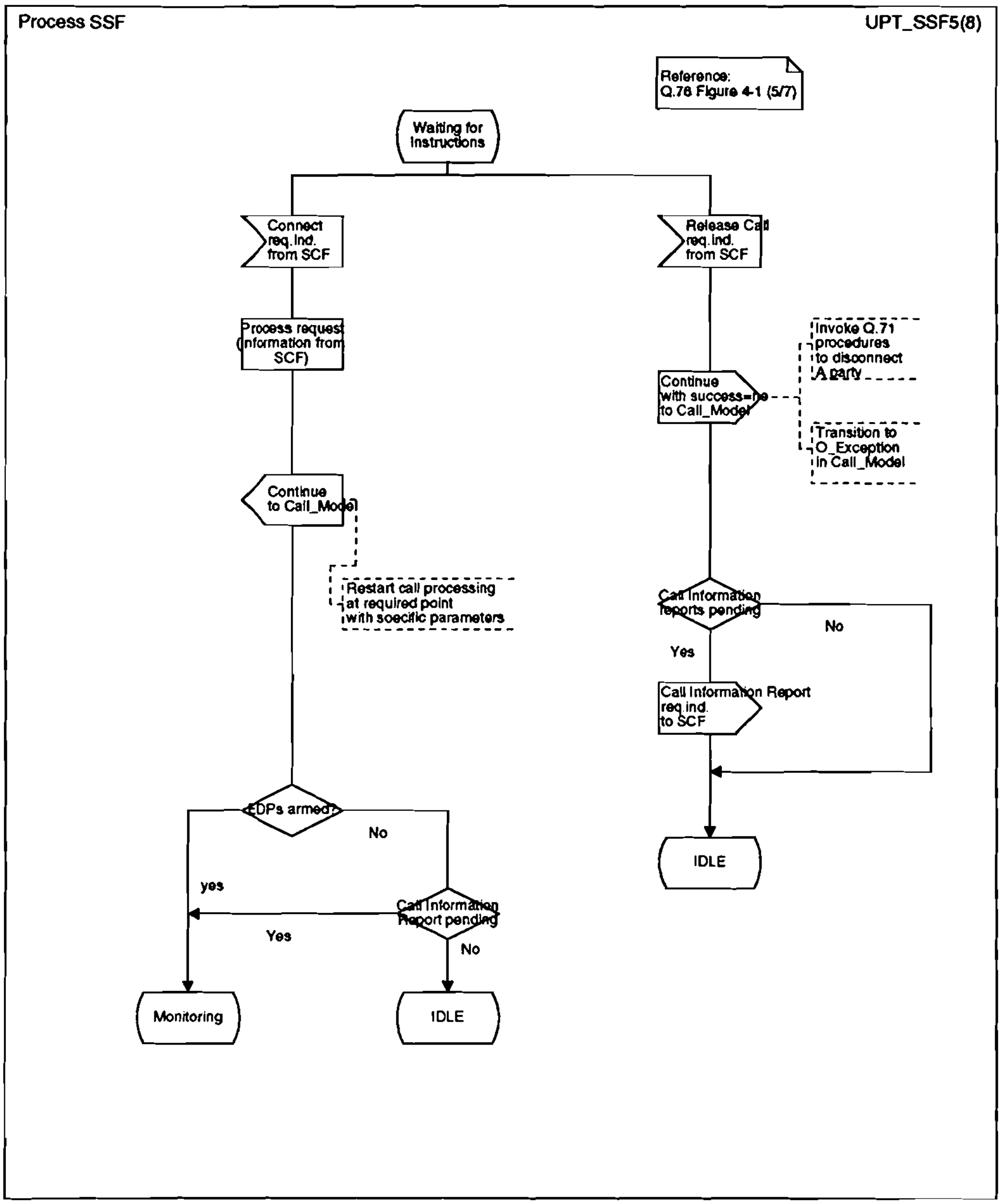

Process SSF
UPT_SSF1(8)
Reference:
Q.76 Figure 4-1 (1/7)
IDLE
Request for UPT service
or UPT number dialled
PointDetected
(DP 3: Analyzed_Info)
from Call_Model
This message should be the
Point Detected (3: Analyzed_Info)
from the Call_Model process
Trigger Processing
Determine whether DP armed
and service can be provided.
For UPT, always TDP-R
Failure case (including
DP not armed) not shown.
TDP-R
Internal indication
from service logic.
Initial DP
req.ind.
to SCF
DP 3: Analyzed _Info
including Set-up
information
Waiting for
Instructions



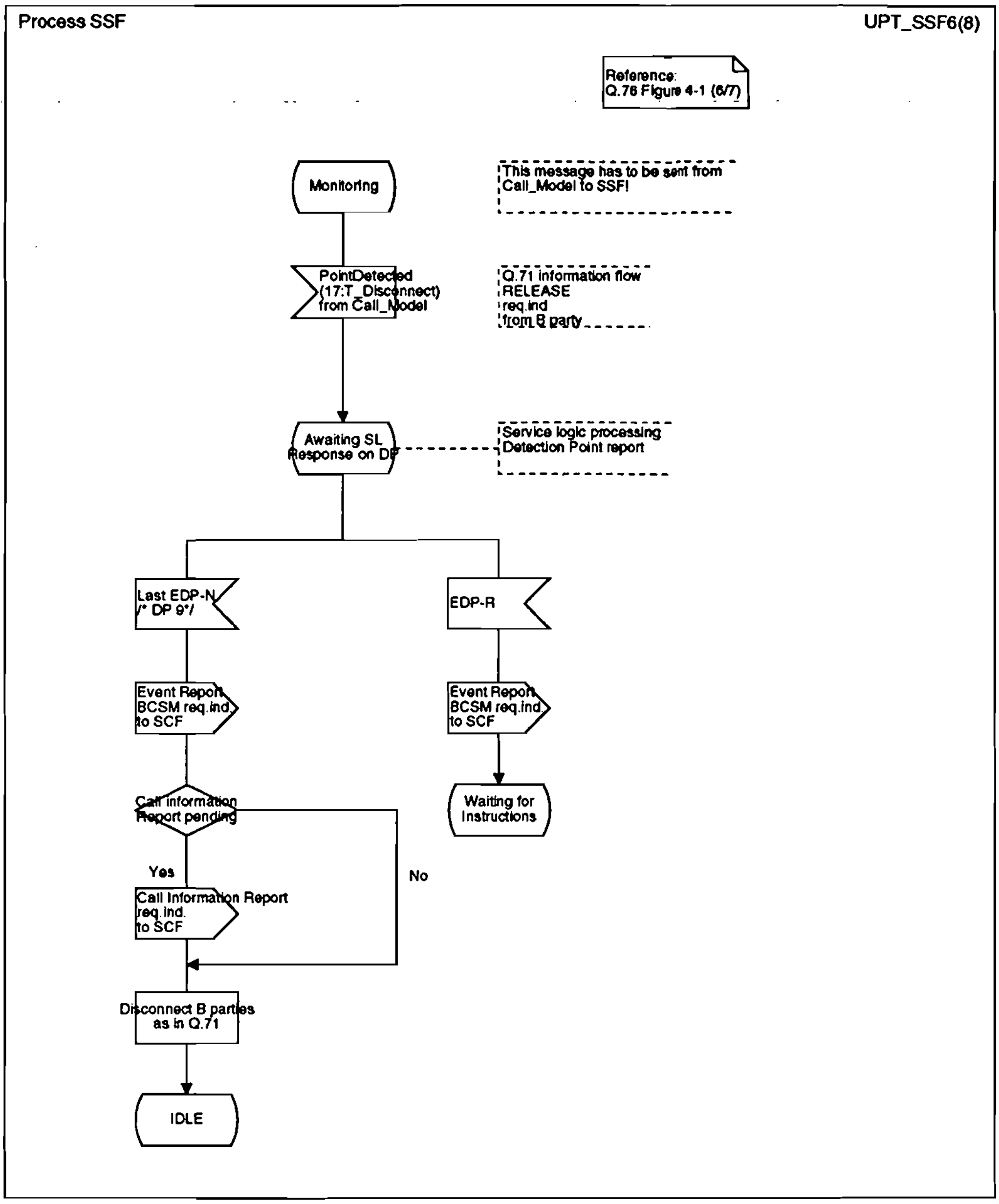
Process SSF
UPT_SSF2(8)
SRF Connect
Reference:
Q.76 Figure 4-1 (2/7)
Waiting for Instructions
Establish Temporary Connection
req.ind.
from SCF
Establish connection to SRF
SETUP
req.ind.
TO SRF
Bearer connection
Q.71 information flow
Wait for SRF response
SETUP
resp.conf.
from SRF
Bearer connection
Q.71 information flow
Through connect calling party to SRF
Waiting for End of temporary Connection

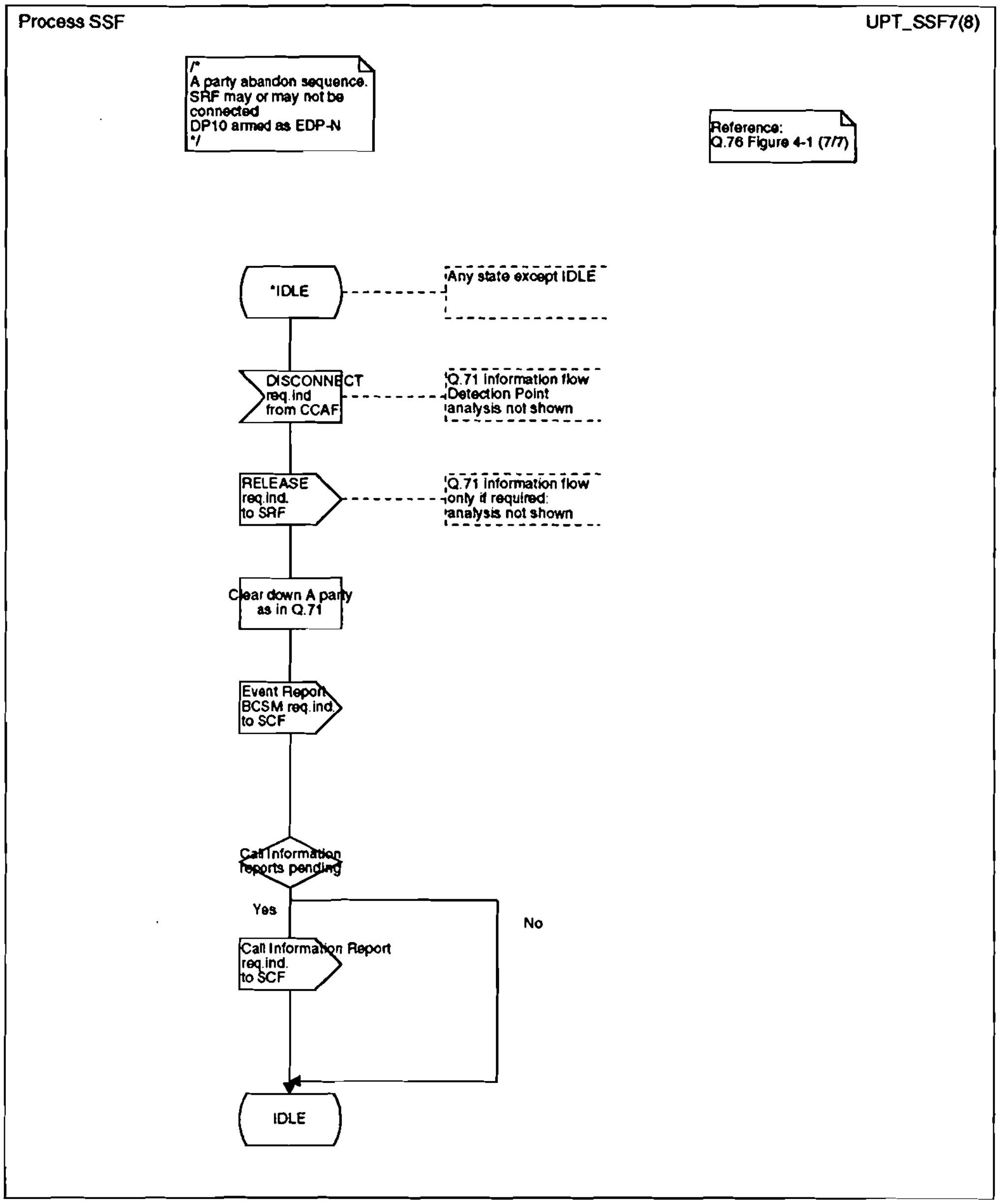

Process SSF
UPT_SSF3(8)
Reference:
Q.76 Figure 4-1 (3/7)
Waiting for End of Temporary Connection
Disconnect req.ind. from SCF
Forward Connection
Disconnect Resources
RELEASE req.ind. to SRF
Wait for SRF response
Q.71 information flow
RELEASE resp.conf. from SRF
Release Resources
Waiting for Instructions

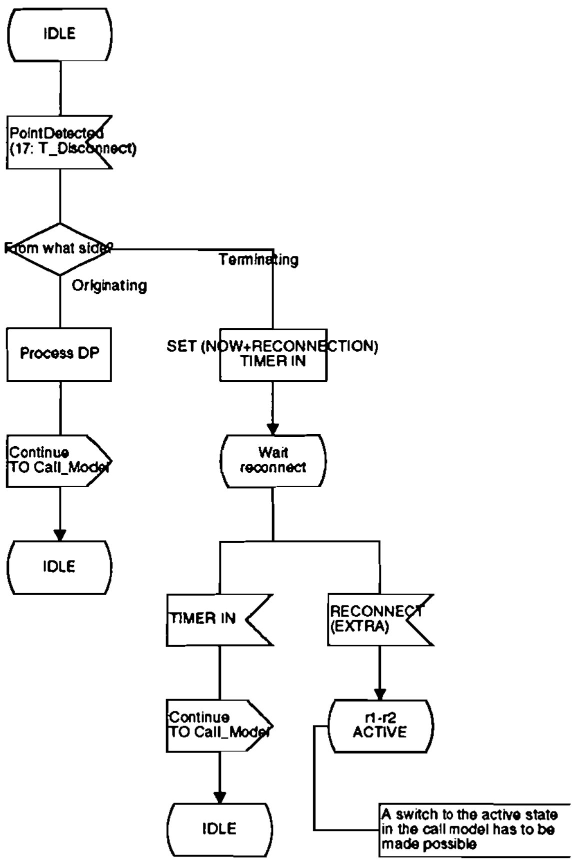

Process SSF
UPT_SSF4(8)
Reference:
Q.76 Figure 4-1 (4/7)
Waiting for Instructions
Request Report BCSM Event
req.ind.
from SCF
Furnish Charging Information
req.ind.
from SCF
Call Information Request
req.ind.
from SCF
Process Request Report BCSM Event
Process Charging Request
Process request; mark Call Info Rept pending
In case of O/G UPT call:
Arm DP 9 and DP 10.
Waiting for Instructions

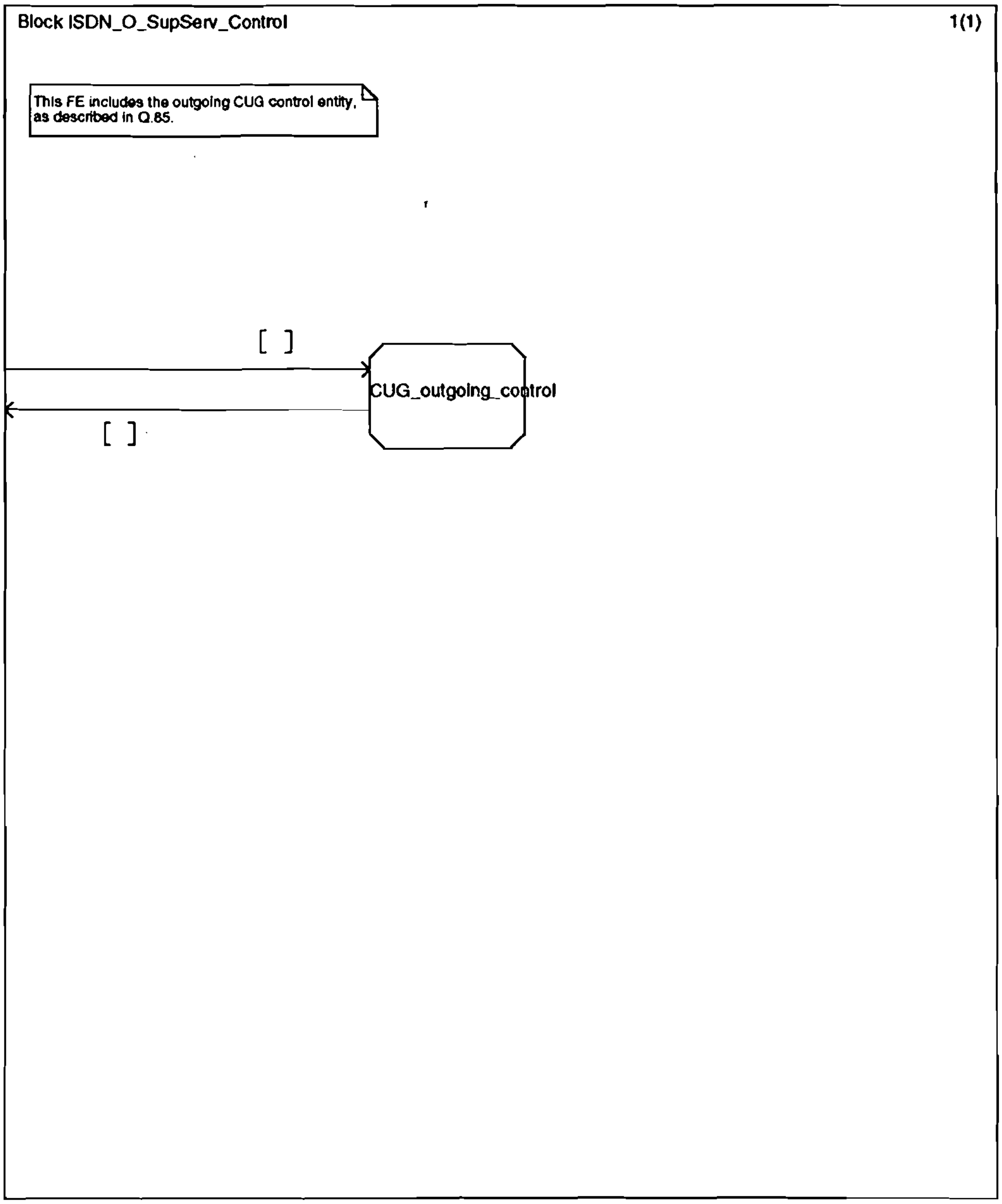


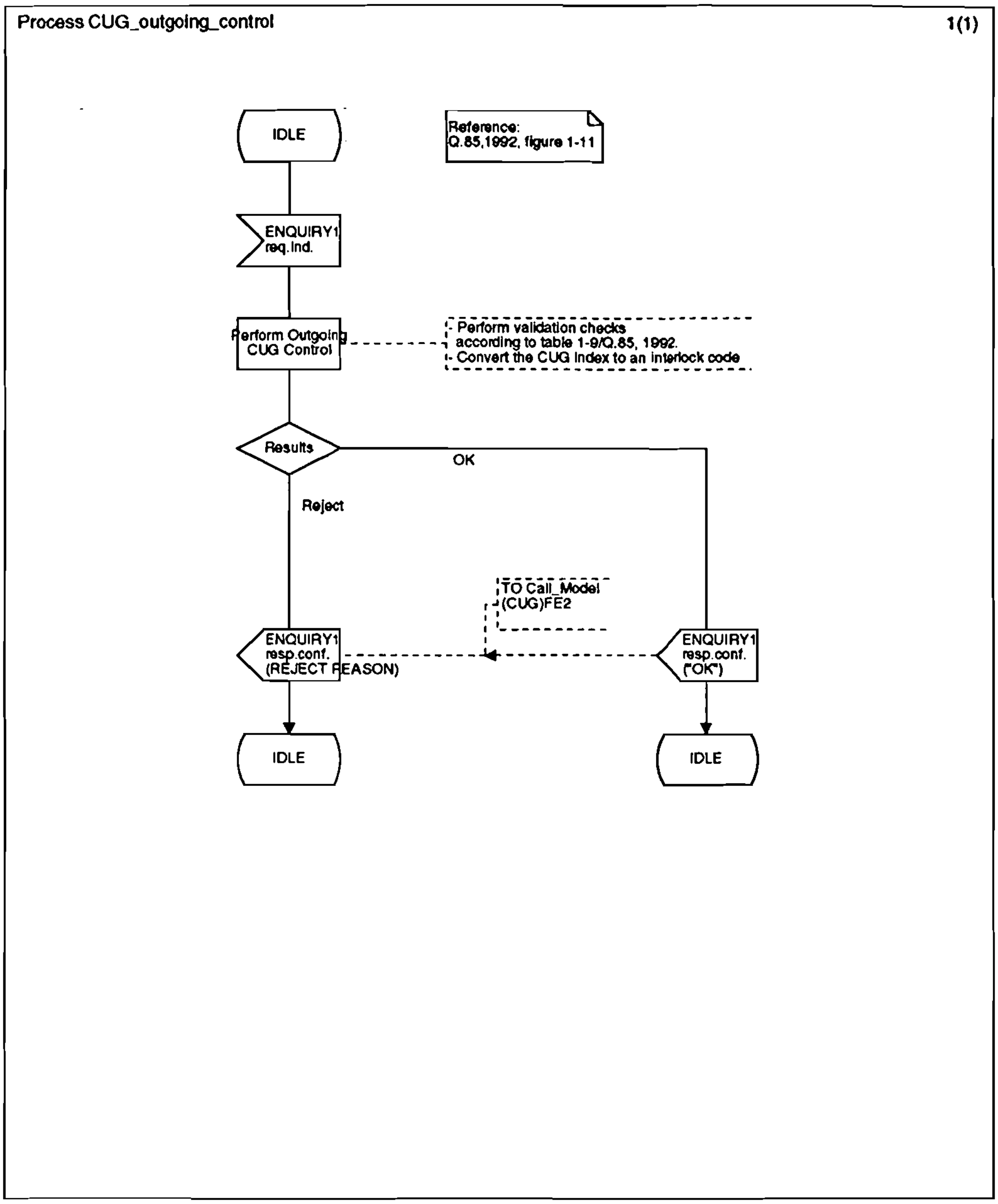
Process SSF
UPT_SSF5(8)
Reference:
Q.78 Figure 4-1 (5/7)
Waiting for Instructions
Connect req.ind. from SCF
Process request (information from SCF)
Continue to Call_Model
Restart call processing at required point with specific parameters
EDPs armed?
yes
No
Call Information Report pending
Yes
No
Monitoring
IDLE
Release Call req.ind. from SCF
Invoke Q.71 procedures to disconnect A party
Continue with success=no to Call_Model
Transition to O_Exception in Call_Model
Call Information reports pending
No
Yes
Call Information Report req.ind. to SCF
IDLE

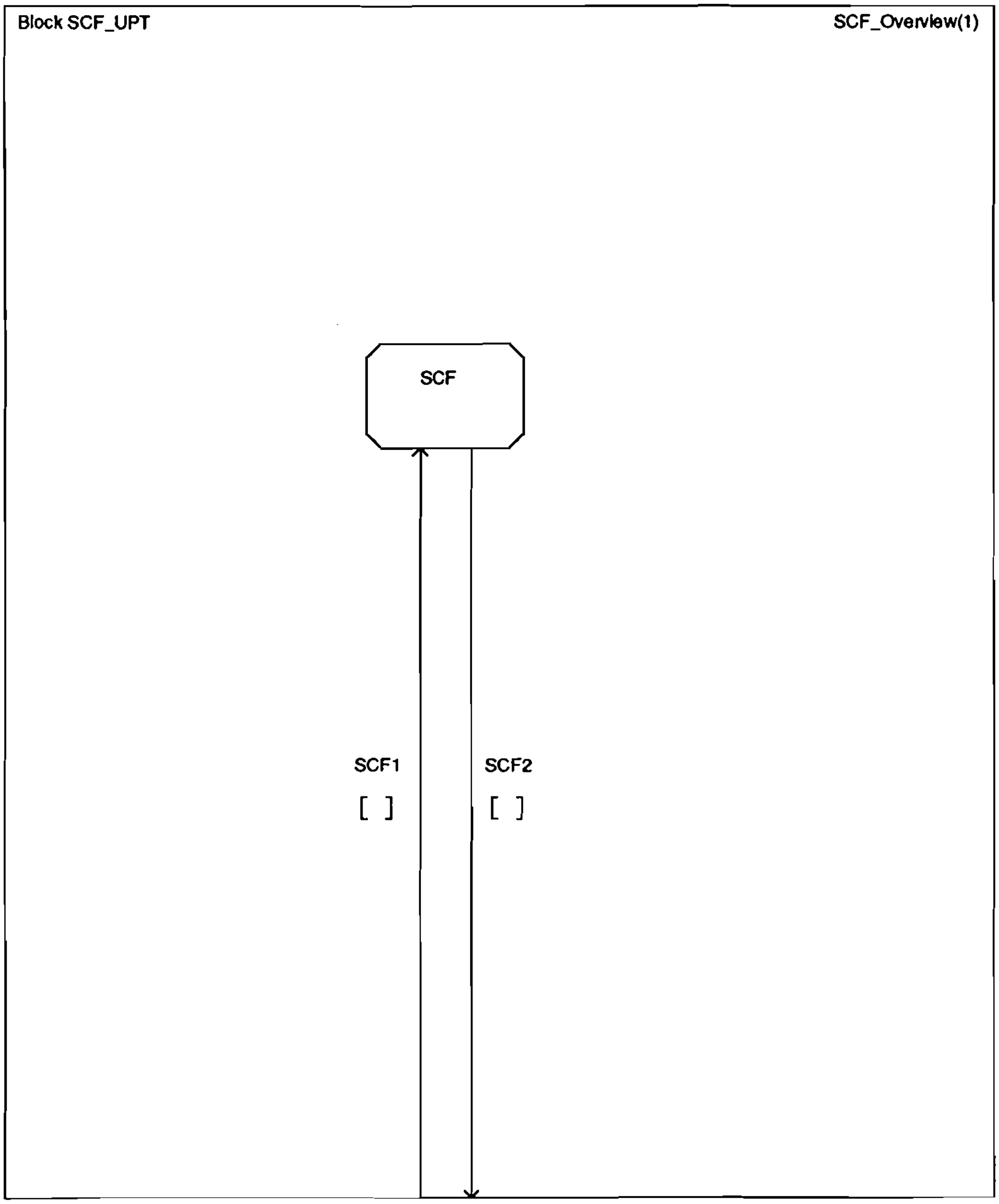

Process SSF
UPT_SSF6(8)
Reference:
Q.76 Figure 4-1 (6/7)
Monitoring
This message has to be sent from Call_Model to SSF!
PointDetected (17:T_Disconnect) from Call_Model
Q.71 information flow RELEASE req.ind from B party
Awaiting SL Response on DP
Service logic processing Detection Point report
Last EDP-N /* DP 9*/
EDP-R
Event Report BCSM req.ind to SCF
Event Report BCSM req.ind to SCF
Waiting for Instructions
Call information Report pending
Yes
No
Call Information Report req.ind. to SCF
Disconnect B parties as in Q.71
IDLE

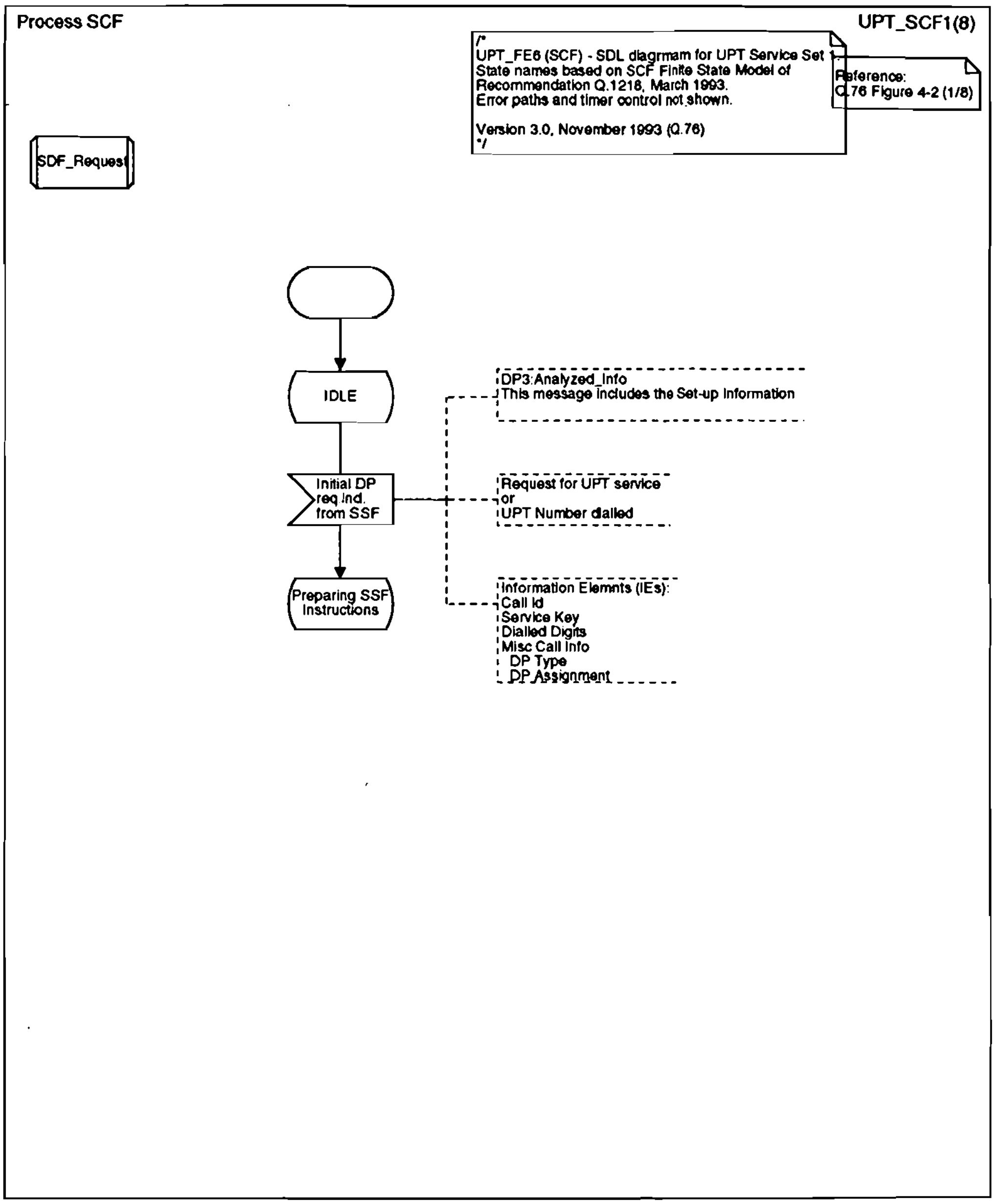

Process SSF
UPT_SSF7(8)
/*
A party abandon sequence.
SRF may or may not be connected
DP10 armed as EDP-N
*/
Reference:
Q.76 Figure 4-1 (7/7)
*IDLE
Any state except IDLE
DISCONNECT req.ind from CCAF
Q.71 Information flow
Detection Point analysis not shown
RELEASE req.ind. to SRF
Q.71 Information flow only if required: analysis not shown
Clear down A party as in Q.71
Event Report BCSM req.ind. to SCF
Call Information reports pending
Yes
No
Call Information Report req.ind. to SCF
IDLE

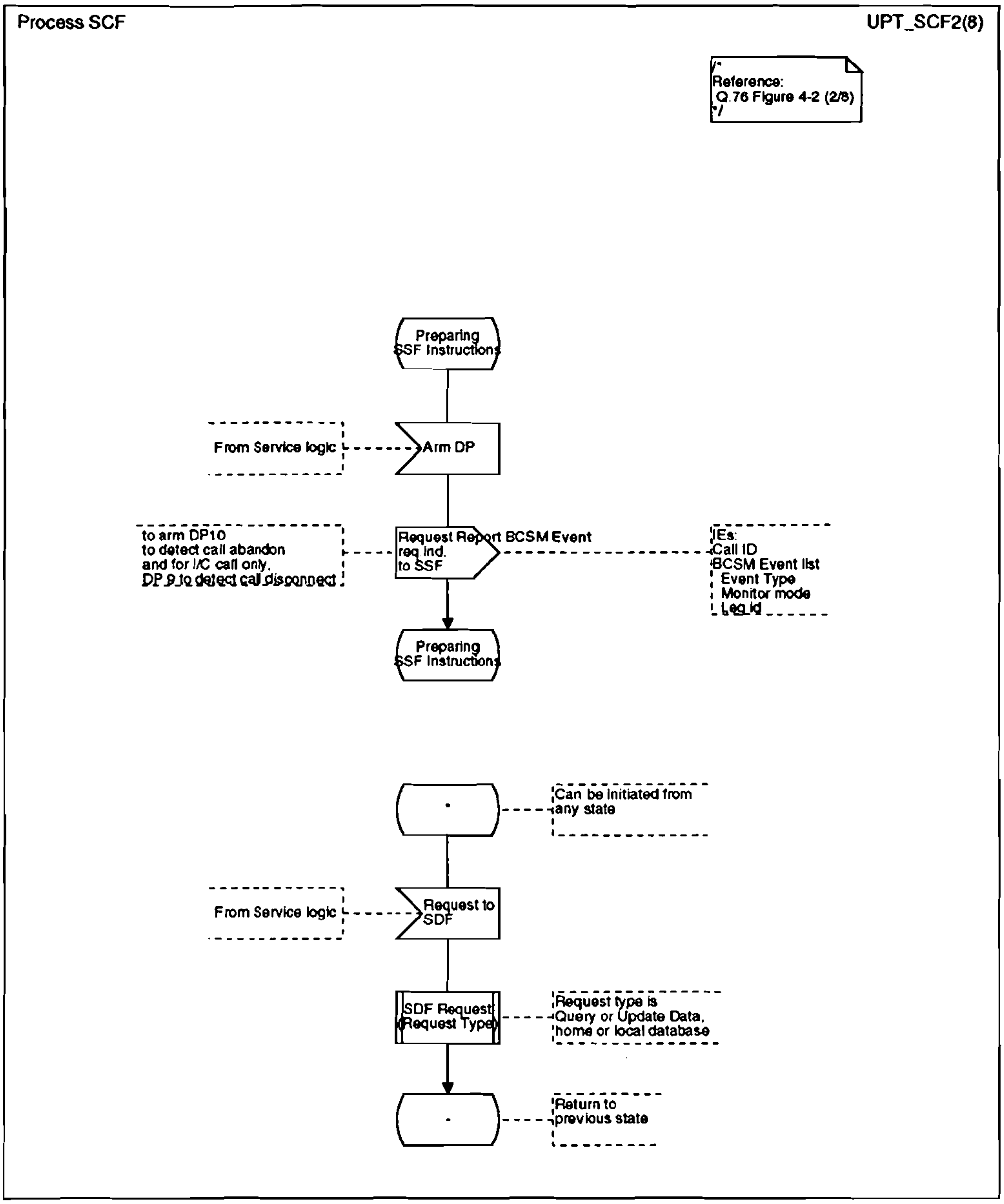

IDLE
PointDetected
(17: T_Disconnect)
From what side?
Originating
Terminating
Process DP
SET (NOW+RECONNECTION)
TIMER IN
Continue
TO Call_Model
Wait
reconnect
IDLE
TIMER IN
RECONNECT
(EXTRA)
Continue
TO Call_Model
r1-r2
ACTIVE
IDLE
A switch to the active state
in the call model has to be
made possible


Block ISDN_O_SupServ_Control
1(1)
This FE includes the outgoing CUG control entity, as described in Q.85.
[ ]
[ ]
CUG_outgoing_control


Process CUG_outgoing_control
1(1)
IDLE
Reference:
Q.85,1992, figure 1-11
ENQUIRY1
req.ind.
Perform Outgoing
CUG Control
- Perform validation checks
according to table 1-9/Q.85, 1992.
- Convert the CUG index to an interlock code
Results
OK
Reject
TO Call_Model
(CUG)FE2
ENQUIRY1
resp.conf.
(REJECT REASON)
ENQUIRY1
resp.conf.
("OK")
IDLE
IDLE

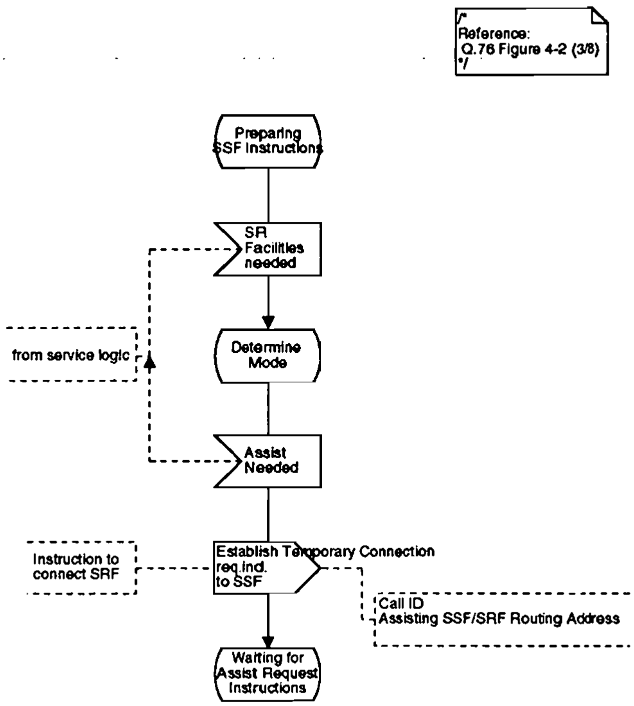

Block SCF_UPT
SCF_Overview(1)
SCF
SCF1
[ ]
SCF2
[ ]


Process SCF
UPT_SCF1(8)
/*
UPT_FE6 (SCF) - SDL diagrmam for UPT Service Set 1.
State names based on SCF Finite State Model of
Recommendation Q.1218, March 1993.
Error paths and timer control not shown.
Version 3.0, November 1993 (Q.76)
*/
Reference:
Q.76 Figure 4-2 (1/8)
SDF_Request
IDLE
Initial DP
req ind.
from SSF
Preparing SSF
Instructions
DP3:Analyzed_Info
This message includes the Set-up information
Request for UPT service
or
UPT Number dialled
Information Elemnts (IEs):
Call Id
Service Key
Dialled Digits
Misc Call Info
DP Type
DP Assignment

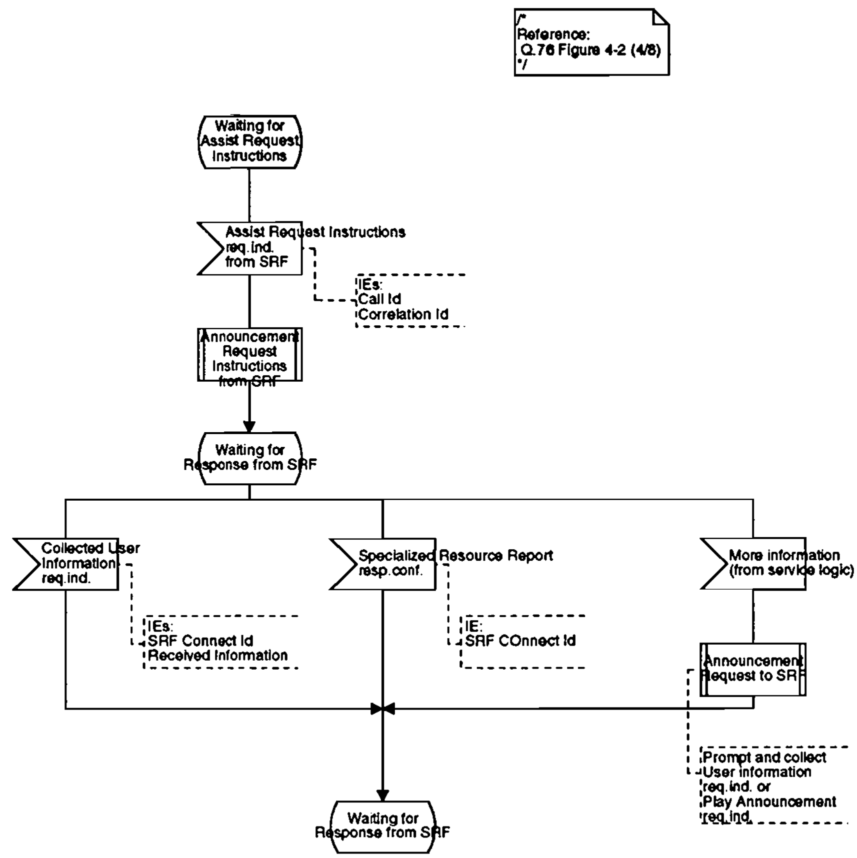

Process SCF
UPT_SCF2(8)
/* Reference: Q.76 Figure 4-2 (2/8) */
Preparing SSF Instructions
From Service logic
Arm DP
to arm DP10 to detect call abandon and for I/C call only, DP 9 to detect call disconnect
Request Report BCSM Event req ind. to SSF
IEs: Call ID BCSM Event list Event Type Monitor mode Leg id
Preparing SSF Instructions
*
Can be initiated from any state
From Service logic
Request to SDF
SDF Request (Request Type)
Request type is Query or Update Data, home or local database
-
Return to previous state

Process SCF

UPT_SCF3(8)

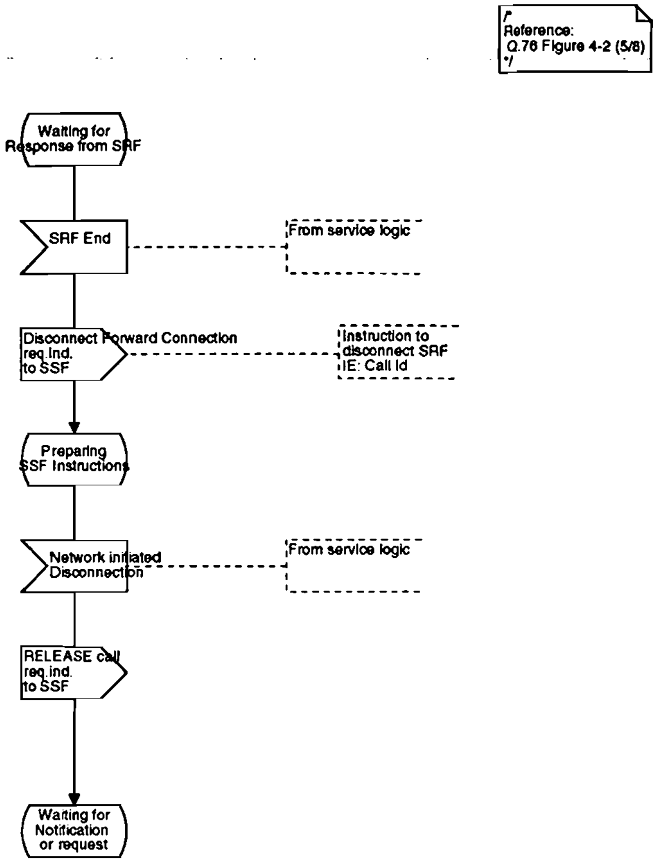


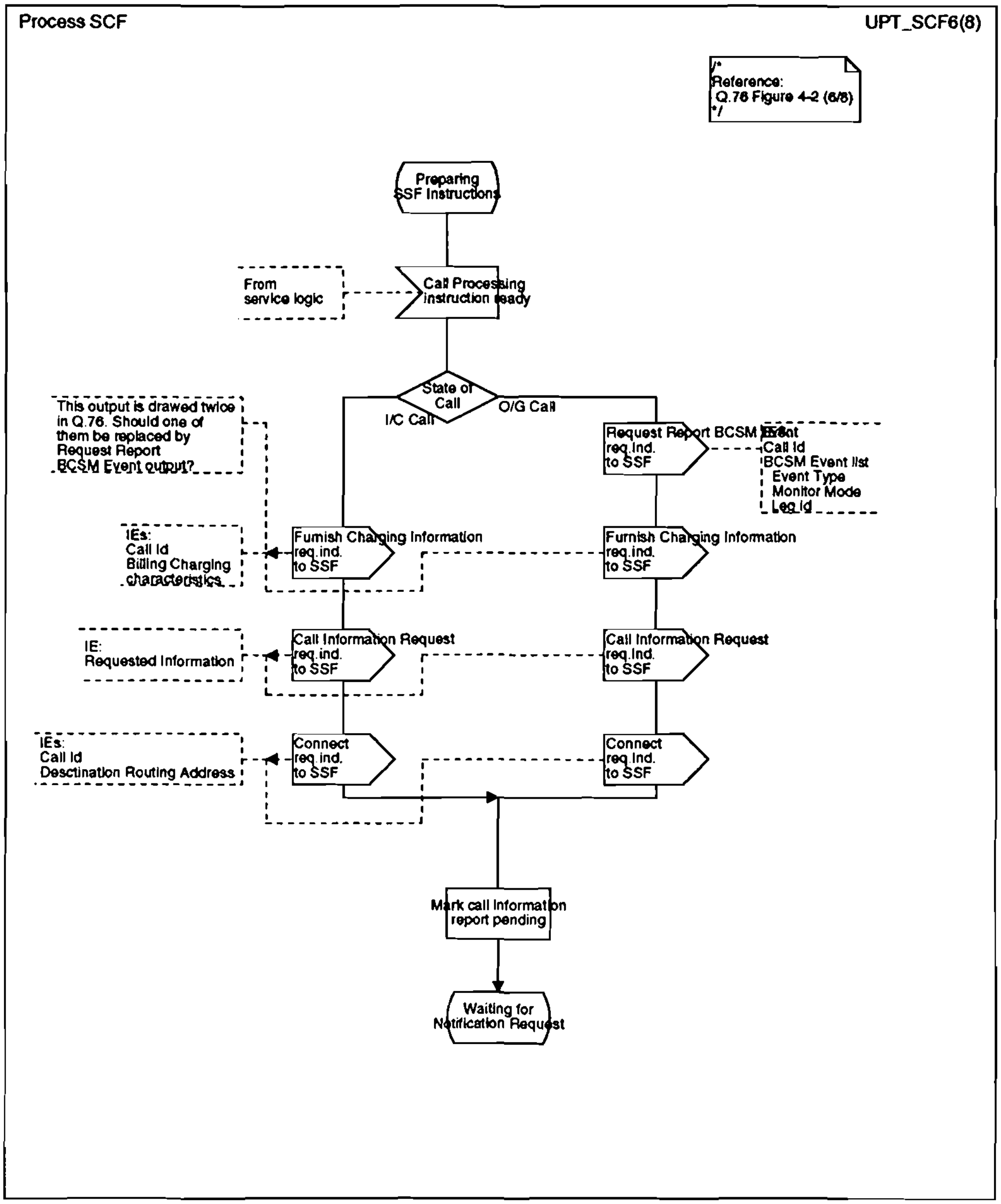
Process SCF UPT_SCF4(8)

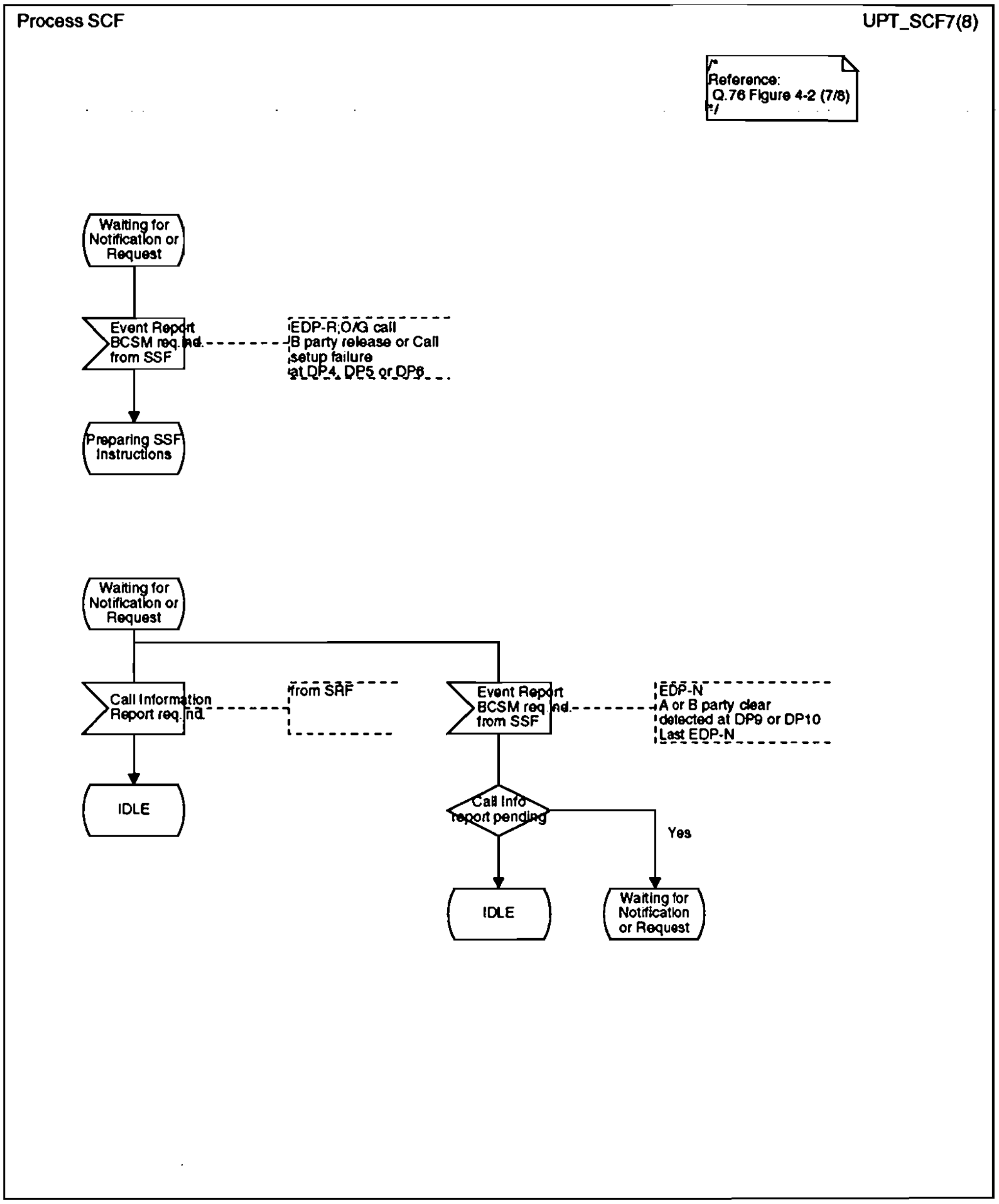


Process SCF

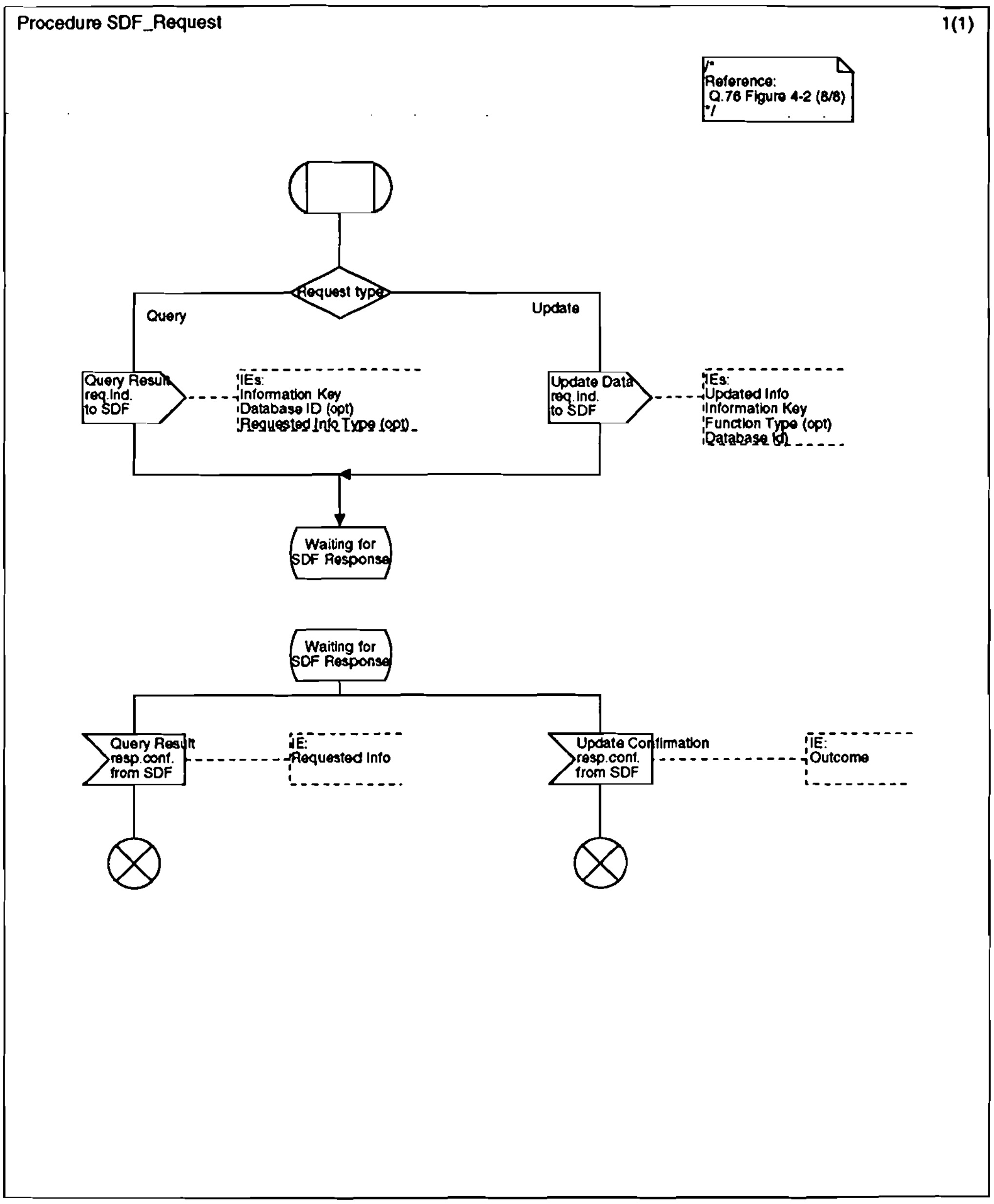
UPT_SCF5(8)

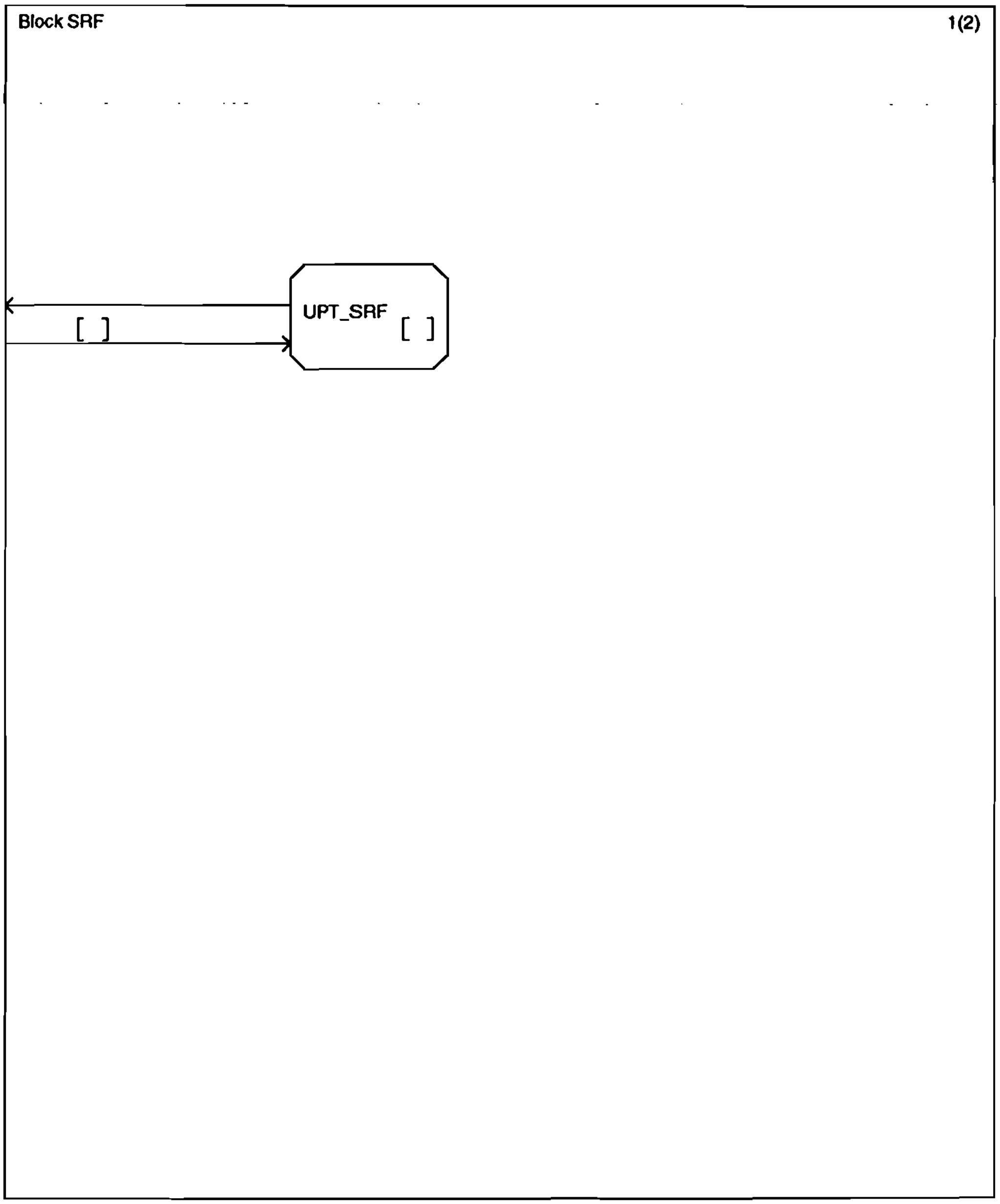



Process SCF
UPT_SCF6(8)
/*
Reference:
Q.76 Figure 4-2 (6/8)
*/
Preparing SSF Instructions
From service logic
Call Processing instruction ready
State of Call
I/C Call
O/G Call
This output is drawed twice in Q.76. Should one of them be replaced by Request Report BCSM Event output?
Request Report BCSM Event req.ind. to SSF
Call Id
BCSM Event list
Event Type
Monitor Mode
Leg Id
IEs:
Call Id
Billing Charging characteristics
Furnish Charging Information req.ind. to SSF
Furnish Charging Information req.ind. to SSF
IE:
Requested Information
Call Information Request req.ind. to SSF
Call Information Request req.ind. to SSF
IEs:
Call Id
Desctination Routing Address
Connect req.ind. to SSF
Connect req.ind. to SSF
Mark call information report pending
Waiting for Notification Request

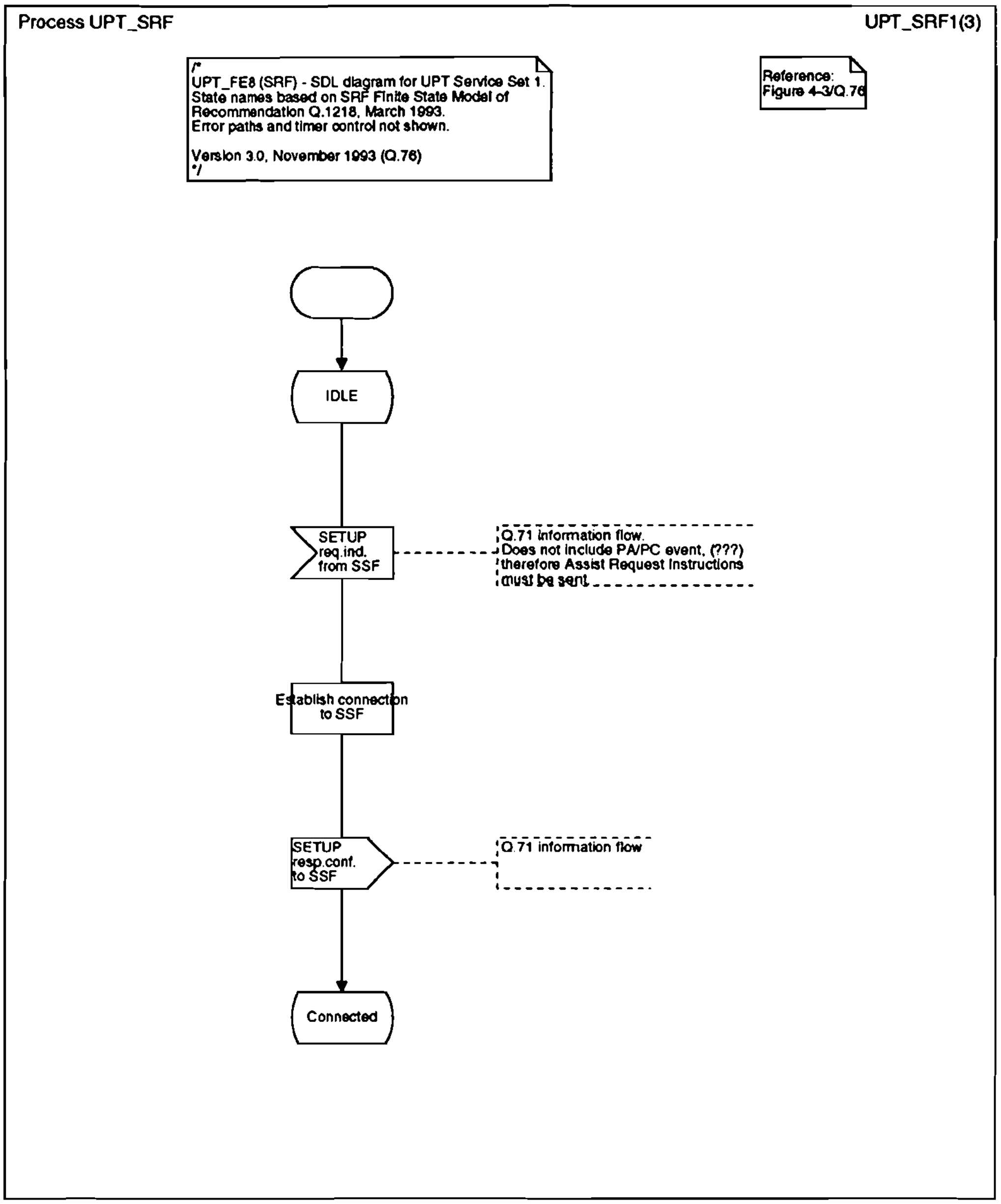

Process SCF
UPT_SCF7(8)
/*
Reference:
Q.76 Figure 4-2 (7/8)
*/
Waiting for Notification or Request
Event Report BCSM req.ind. from SSF
EDP-R;O/G call B party release or Call setup failure at DP4, DP5 or DP6
Preparing SSF Instructions
Waiting for Notification or Request
Call Information Report req.ind.
from SRF
Event Report BCSM req.ind. from SSF
EDP-N A or B party clear detected at DP9 or DP10 Last EDP-N
IDLE
Call Info report pending
Yes
IDLE
Waiting for Notification or Request

Process SCF UPT_SCF8(8)

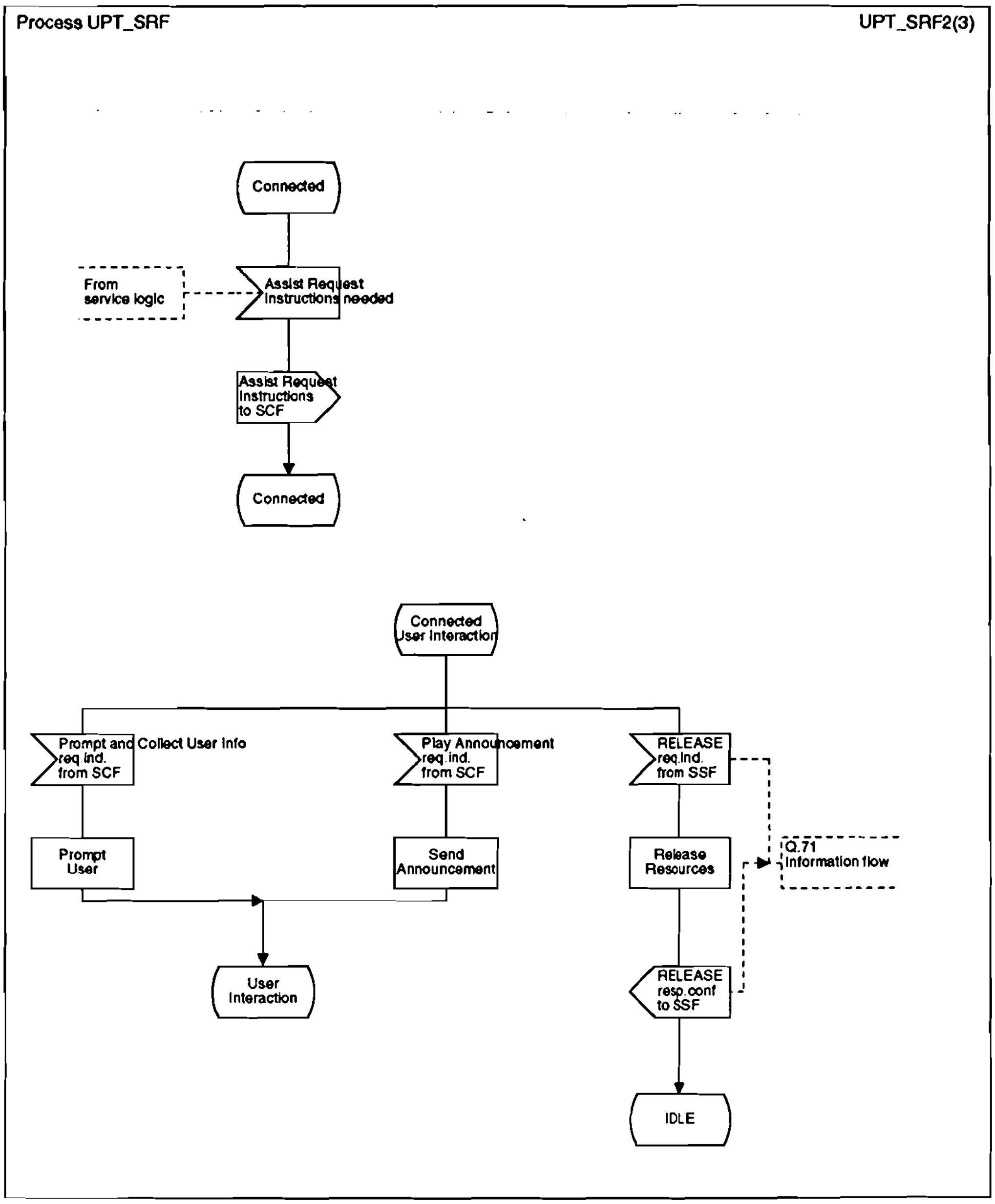

Procedure SDF_Request
1(1)
/*
Reference:
Q.76 Figure 4-2 (8/8)
*/
Request type
Query
Update
Query Result
req.ind.
to SDF
IEs:
Information Key
Database ID (opt)
Requested Info Type (opt)
Update Data
req.ind.
to SDF
IEs:
Updated Info
Information Key
Function Type (opt)
Database Id)
Waiting for
SDF Response
Waiting for
SDF Response
Query Result
resp.conf.
from SDF
IE:
Requested Info
Update Confirmation
resp.conf.
from SDF
IE:
Outcome



Block SRF
1(2)
UPT_SRF
[ ]
[ ]



Process UPT_SRF
UPT_SRF1(3)
/*
UPT_FE8 (SRF) - SDL diagram for UPT Service Set 1.
State names based on SRF Finite State Model of
Recommendation Q.1218, March 1993.
Error paths and timer control not shown.
Version 3.0, November 1993 (Q.76)
*/
Reference:
Figure 4-3/Q.76
IDLE
SETUP
req.ind.
from SSF
Q.71 information flow.
Does not include PA/PC event, (???)
therefore Assist Request Instructions
must be sent
Establish connection
to SSF
SETUP
resp.conf.
to SSF
Q.71 information flow
Connected


Process UPT_SRF
UPT_SRF2(3)
Connected
From service logic
Assist Request Instructions needed
Assist Request Instructions to SCF
Connected
Connected User Interaction
Prompt and Collect User Info req.ind. from SCF
Play Announcement req.ind. from SCF
RELEASE req.ind. from SSF
Prompt User
Send Announcement
Release Resources
Q.71 Information flow
User Interaction
RELEASE resp.conf to SSF
IDLE

Process UPT_SRF

UPT_SRF3(3)