9
Advanced Concepts in an IN-Switching Platform
Standards and IN

Jørgen Dyst
L. M. Ericsson
Sluseholmen 8, 1790 København V, Denmark
Tel: +45 33 88 3 325, Fax: +45 33 88 31 28
E-mail: lmdjd@lmd.ericsson.se

1 INTRODUCTION

In this document it is assumed that the network is an IN-structured network. The description is based on standardized IN, e.g. the ITU-T IN- recommendations like Q.1214 for the CS-1 Distributed Functional Plane Architecture and ETSI Core INAP [1, 2]. The described Open Switching concept is based on the main ideas described in [3].

The focus is on advanced concepts in an IN switching platform, basic switching functionality and associated network aspects related to the application of IN technology within the N-ISDN network.

The following items are discussed:

- Open Switching IN-Platform
- Open Networking
- IN-Services in a Network Perspective

2 OPEN SWITCHING IN-PLATFORM

The Intelligent Network architecture is built above the basic Call Control Function (CCF), adding the Service Switching Function (SSF) to enable the recognition of calls that require IN support, linking call and service control to another functional entity, the Service Control Function (SCF).

An Open Switching architecture is to separate the basic switching functionality of IN calls from the Service Control Function. This separation enables third party call and service control.

A service switching architecture that clearly describes the relationship between basic call handling and services is essential for this external call and service control.

D. Gaïti (ed.), *Intelligent Networks and Intelligence in Networks*

This control relationship is to be symmetric as IN services may be requested during call handling (i.e. from CCF), but a service (i.e SCF) may also initiate a new call (e.g. a wake-up call).

The basic switching functionality integrates the aspects of user & network access, connection handling (transmission) and call handling made up of the IN functional entities CCF and SSF - and optional SRF (Specialised Resource Function).

Message interfaces with defined procedure handling are used between the call handling and the service applications. Between SSF and SCF these message interfaces are standardized IN Application Protocols (INAPs). Open Switching allows to support different call and service control interfaces.

A protocol manager in SSF have to translate from standard protocols such as the ETSI Core INAP* to an internal protocol - a so called 'open switching' protocol - that establishes the connection to core SSF internal parts like DP Processing/Call Control Server. The internal protocol in SSF is to offer one uniform interface to the lower layer by integrating the different INAP protocols supported by the Service Control Functions. As a first step an Open Switching protocol may support e.g. only the ETSI CS-1 Core INAP protocol. However other INAP protocols for CS-2 and CS-3 will follow - with possible INAP protocol subsets (e.g. an INAP CS-1+) inbetween in support of different market demands.

The CCF builds-up, maintains and releases connections. The CCF functions have been modelled through the definition of the Basic Call State Model (BCSM) which represents the various phases of a basic call, on both the originating and terminating ends (i.e. O_BCSM and T_BCSM). The purpose of this model is to allow the implementation of services on the basic call structure and to identify call check points (Detection Points) that can be used to recognize the Intelligent Network services. These points are known as Trigger Detection Points and Event Detection Points.

The CCF contains mechanisms to detect IN requests demanding the IN (SSF) invocation on the basic call. The CCF includes the BCSM (Basic Call State Model) which provides a high-level model of CCF activities required to establish and maintain communication paths for users. The BCSM identifies the DPs at which transfer of control to SCF can occur to allow IN service logic instances in SCF to interact with basic call and connection control capabilities. It also contains mechanisms to detect service requests and to process incoming control messages from an IN service in SCF. These are extensions to normal existing basic call handling.

The SSF is the core part of an Open Switching architecture; it is to offer a logical view on call handling and connection handling that abstracts from switch system specific details. SSF also provides the open message interface by means of INAP to the SCFs.

Furthermore, SSF mechanisms for call event handling, charging event handling and SSF's role as a server for call control and connection control are needed for Open Switching.

The service control part can be subdivided into three main parts:

- Service Control Function (SCF)
- Service Creation and Service Management function (SCE, SMS)
- Service Data Function (SDF).

---

* The CS-1 INAP protocol, defined within ITU-T, was reviewed and refined within ETSI with the aim of eliminating redundancies, superfluous operations and parameters in an European compatible version defined as the ETSI 'core INAP'.

A complete IN-platform also comprises the above products which are not further described here.

3 CONCEPTS FOR OPEN SWITCHING

The separation of call handling into PICs (Points In Call) and DPs (Detection Points) as defined in the BCSM is the basis for the call state model that enables the SSF to abstract from switch-internal details. The SCF needs an abstract description of what happens during the PICs and the information which DPs are supported.

An explicit description of the basic switching functionality is needed for external call control. For example, IN service designers need a precise description of the set of supported DPs and the call manipulation INAP operations and procedures.

3.1 Implementation aspects of Open Switching Architecture

Open switching functionality can be built into the call handling structure of existing switching systems without needing to redesign or redevelop the existing software.

A solution is to implement 'hooks' between the call processing software for the A-side and the B-side. These 'hooks' are here called a Service Switching Function Handler (SSFH).
Figure 1 shows an IN basic two-party call with SSFH represented by an IN Call Segment. The SSFH may for example have been invoked due to a number based trigger or a line based trigger on behalf of the calling party or the called party, implying the use of an O_BCSM respective an T_BCSM instance on the two-party call.

The Basic Call State Models (BCSMs) for the originating and the terminating ends, i.e. the 'half-call' models are build by the SSFH based on the messages that are exchanged between the A-side and the B-side.

These Basic Call State Models (O/T_BCSM) support the required detection point mechanisms to enable call manipulation by IN service logic instances.

The operation mode of a SSFH can be illustrated by an example as follows:
If a DP in the O_BCSM is reached upon receipt of a message from the A-side, then the message is buffered and an event report is generated and sent to DP Processing in SSF. The event report informs the SSF about the DP currently reached. The SSF responds either by sending a message to let call handling continue or, if an IN service is triggered and invoked in SCF to take over call control, a directive toward the basic call is awaited from the SCF.

In the latter case an IN service logic instance is activated in the SCF, and may request to influence call handling. In support of this the SSF may modify parameters of the buffered message before that message is sent to the B-side - or it may even generate new parameters and/or messages for the B-side or even for the A-side call handlers that are sent instead of or in addition to the original message.

If no IN service logic instance in SCF is activated or if an service logic instance do not want to interact, then the stored call handling message is forwarded to the intended receiver - in this example the B-side.

The SSFH is to provide basic call control capabilities independent of the line or trunk type. The existing call handling software (A-side and B-side) provides interworking toward the specific line or trunk signalling systems applied. The messages sent by SSFH on the switch internal information channel between A-side and B-side may be based on ISUP.

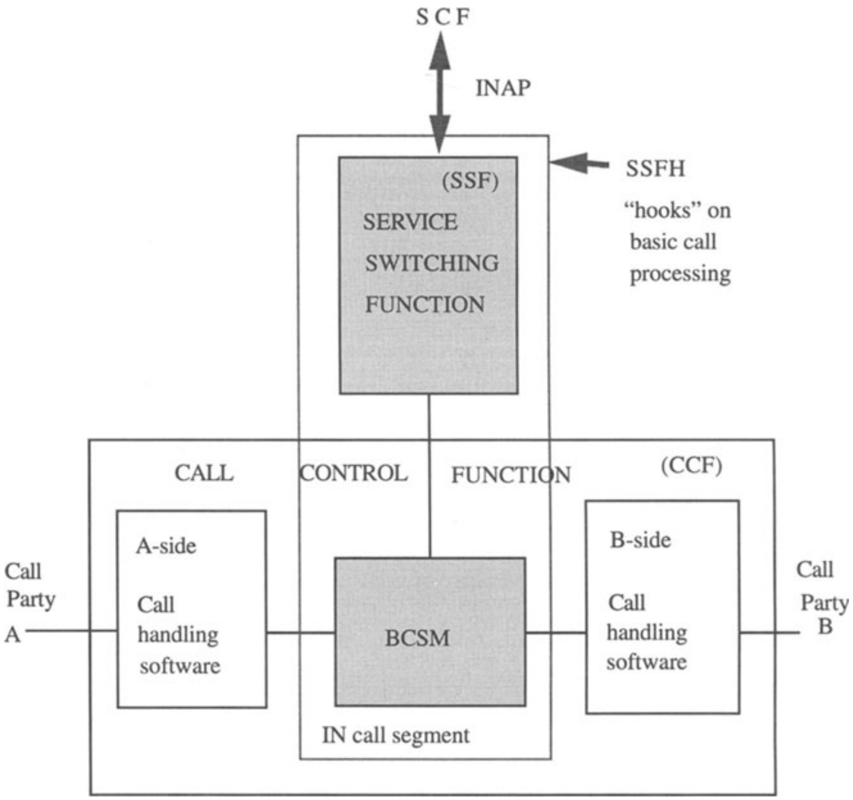

Figure 1 IN Open Switching Architecture applied on a two-party call

The integration of a SSFH with basic switching functionality allowing messages from the A-side to the B-side and vice versa to be intercepted by the SSF, checked, modified and again placed on the switch internal information channel, provides a flexible mechanism in support of call control (e.g. signalling manipulations) , but it also puts strong real-time requirements on efficient coding of especially this part of the implementation. However, the SSFH is only invoked on calls for which IN-services may be triggered- and the overhead in processing capacity occurs basically only where armed DPs are encountered.

4 DP PROCESSING PRINCIPLES

In the following a description is given to illustrate the principles of operation in the SSF in relation to DP processing, i.e. how an SSF may interact with the CCF (BCSM) and the SCF (via INAP).

4.1 Hand over IN basic call control

The point (DP) in a BCSM that may hand over the control and/or send event reports to service logic instances in SCF (s) is defined as a check-point where a trigger analyser and/or event handler within the DP Processing in the SSF may be called.

Within DP Processing an trigger analyser in the SSF decides whether a new IN-service is to be invoked, when a DP is armed as Trigger DP (TDP).

The trigger analyser transfers the control from the BCSM to the service logic instance in SCF only if it is possible to execute a service. Besides the encountering of an armed TDP other trigger criteria may have to be fulfilled to allow IN service invocation.

There may be several IN services invoked simultaneously from the two-party call segment in a IN basic call, but only one IN service will be allowed to have a control relationship (i.e. manipulate basic call processing). All other services will be in a monitor relationship and only be allowed to receive notification events.

Within DP Processing an event handler handles DPs armed as Event DPs (EDP-R/Ns), i.e. it distributes event reports to already invoked service logic instances in SCFs. The DP processing rules described in ITU-T recommendation Q.1214 applies [1].

Return to IN basic call control:

The following call control message types may be sent to BCSM call handling:

- Continue
  call handling continues at the same place where it was interrupted
- Continue with new parameters
  call handling continues with modified and/or new parameters or even new messages may be generated (for example for text sending)
- Proceed at PIC-n
  a 'go to' order to force call handling to proceed at PICn

A Call Control Server in SSF performs the state transitions on the BCSM instance used in the IN basic call.

4.2 Trigger Table Concept

The concept trigger-table as used in IN is generalised for the use as a basis for the triggering in the IN service switching platform on which also other switch based services are possible. This implies that especially the subscriber category handling and digit analysis handling in the basic call process becomes part of the trigger table concept.

The IN trigger process includes both the CCF and the SSF entities and may be considered as a two-step call related process:

- first step is to invoke the SSFH (O_BCSM or T_BCSM instance) in the basic call with armed TDPs, i.e. a prelimary trigger process.
- second step is the monitoring of the basic call process, i.e. the BCSM and on encountering of an DP armed as TDP invocation of the service logic in a SCF, if allowed.

The invocation of SSFH from CCF on a basic call may be defined on demand in the Digit Analysis to accomplish office (number) based triggering and in Subscriber Analysis data to accomplish line based triggering.

5 OPEN NETWORKING

5.1 IN Technology impacts the existing Network Architecture

The usage of IN technology provides added "network intelligence", but IN also brings specific IN-related problems. It may prevent some existing switch based services from being provided. These problems need to be solved in a open networking environment. In particular, signalling systems need to be enhanced!

The need for enhancements of existing signalling system capabilities can be illustrated with the usage of the existing switch based ISDN 'COnnected Line Presentation' service (COLP) together with IN technology.

A service example is where the calling party is using the IN credit card calling service and that in-band user interaction with SCF has occurred. This implies that a speech path has been set up from the calling party to the SSP e.g. on transit exchange level. With existing signalling systems it may imply that an 'early' answer message (ANM) is generated and sent from the SSP to the local exchange in order to establish the connection to SRF as needed for user interaction.

'Early' ANM sending and its consequences

An 'early' answer message is generated independent of the terminating access. It may be sent e.g. when an IP (SRF) is to be connected by SSP. The sending of an 'early' answer (ANM) message impacts the basic call and supplementary services which may be applied on the call.

After an ANM message has been sent backward to the calling user (corresponding to the answer of the called party for the first call), it is not possible to send back information received from the called user in the ACM and ANM or CON for the second and further calls.

Therefore information concerning the called party are lost for the originating local exchange. Moreover, it prevents some ISDN supplementary services from being offered to the calling user such as Connected Line Presentation (COLP) and User-to User signalling Services (UUS) during call setup.

This 'early ANM' method has impact on basic call and supplementary services in fixed/mobile networks. Existing signalling systems needs to be upgraded to avoid the consequences on 'early ANM' sending.

5.2 IN basic call requirement

An IN basic call should support the following versatile IN basic call handling concept: The IN basic call signalling capabilities (end to end message sending) should only be limited on demand. A limitation may take effect at the execution of an IN service due to imposed signalling system constraints. However, it should still be allowed to adopt improvements/enhancements in existing signalling systems, i.e. to remove limitations when signalling system upgrades will enable it.

There should in general be no restriction in the allowed service control level from SCF. The interactions with the IN basic call for the execution of an IN based service are defined in SCF on a per service basis or on a per service feature basis. However, the result of some specific interactions when applied on a call may be a restricted call signalling capability level.

5.3 Proposed near-term signalling system improvements

For user interaction (playing announcement and collecting in-band information), the transmission path has to be through connected in both directions from the calling user to the SSP. It may also be needed to stop network protection timers (e.g. T9). With existing ISUP procedures, the sending of an early ANM is necessary for both aspects.

A solution to avoid sending of early ANM by a SSP when this message is only needed to ensure through connection of the transmission path and/or to stop T9 'Awaiting answer' is being worked out in standardization bodies.

In this solution a new parameter is added in the backward direction in the ACM/CPG message to order the originating local exchange to through connect and stop T9 'awaiting answer'. Another parameter sent in the IAM message in the forward direction is to inform the SSP that the originating local exchange (OLE) has the capability of performing the through-connection and/or of stopping T9 on receipt of the backward parameter. However, the originating exchange is allowed to start a new timer Tuid, when it receives the order to stop or not to start timer T9. Thus, this new timer Tuid enables to guard the connection in the originating local exchange during the inband user interaction.

Hereby a mechanism is provided which enables to avoid the sending of an ANM when it is only needed for through connection and/or stopping T9 purposes. This mechanism is only applicable if the originating local exchange has the capability to perform it. When it has not, the SSP falls back on the sending of 'early' ANM. This solution is therefore compatible with existing exchanges not supporting this new mechanism.

However the problem with ANM sending remains related to follow-on calls (second and further calls) in IN, i.e. the problem how to carry information received in an ANM/CON message, to preceding exchange, when ANM has already been sent once.

If the intention is to solve the problem of all limitations, included for supplementary services (such as COLP), it implies a major impact on existing signalling systems.

The examples given is to illustrate the networking problems imposed with the introduction of IN CS-1. However, it is anticipated that IN technology also in forthcoming capability sets will put new requirements on the existing signalling systems. From IN CS-2 can be mentioned as an example OCCRUI (Out-Channel Call Related User Interaction) which denotes a proposed mechanism to be used to provide new IN services requiring the transparent transfer of information between a User and a Service (SCF) on a call. This will affect signalling protocols (DSS1, ISUP and INAP).

5.4 Main aspects

Open Networking demands that existing Signalling Systems needs to be upgraded to cope with the INAP capabilities:

- Align Signalling System capabilities (ISUP and DSS1) with the INAP capabilities.
- Impose network operators to implement this aligned ISUP and DSS1.

The associated call handling procedures in the SSP as well as in local exchange have to be defined, where affected by IN.

The impact on existing switching systems will depend on the level of information (for basic call and supplementary services) that is decided to be transferred for IN calls, i.e. is all known limitations to be resolved?

6 IN-SERVICES IN A NETWORK PERSPECTIVE

Third parties should be able to develop their services independently from other third parties as to foster competition.

The objective here is only to describe a few technical aspects in relation to a support of such competitive demands.

6.1 Types of services in a network

Some types of services it may not be desirable to be provided by third parties due to their nature. Services such as user to user signalling (UUS) are so 'entangled' with the network signalling procedures and capabilities that it is simply not possible for a third party to provide them. Furthermore, some services implying difficult service interaction issues should better not be provided by third parties when raising service-interaction problems. Unresolved service interaction problems may endanger network integrity.

Roughly we can define two types of services:

- Type A services using the existing network transport capability for providing information to the user.
- Type B services that are related to network internal capabilities (e.g. routing, charging...)

The first type of service does not raise any problems, i.e. could be opened for competition. The second type of services is not that easy to open for free competition because two services of this type may interact and not work if introduced independently at the same time

In ITU-T Recommendation Q.1211 this corresponds to Type A and Type B services, where CS-1 standards is targeted to support Type A services only.

The possibility to support multiple IN services at the same time is a problem. IN CS1 assumes single ended, single point of control technology at any time of the call.

CS1 and CS2 allows only one SCF to interact with one call segment association in the SSF. Multiple-point -of-control capability is considered as too complex and not implemental with present switching technology. For instance, how to resolve contradictory requests applied to the same call segment from two different SCFs [4].

The 'single point of control' technology implies in order to provide two services at the same time, it is necessary that both services are implemented in the same service logic program instance (SLPI) in the SCF. The SCF is then responsible for handling service interference. This approach may be preferable for type B services which otherwise may have serious service interaction problems.

However, it is likely that with IN services widely deployed, users will want to access multiple IN services simultaneously. Many IN-services could be activated on a single call; each providing specialized complex services and each operating seamless on the call.

6.2 Multiple SCF control relationships

The IN-CS2 (predicted release early 1997) is to include functions capable of supporting Call Party Handlingl (e.g. conference call) and enable triggering (e.g. midcall) in different phases of the call. Furthermore a support for global services like international freephone services etc. as well as a first limited set of capabilities to handle service interference between IN services in the network are included.

With increasing IN services' deployment, the handling of IN-IN service interworking becomes more and more important. IN services which are subject to office based trigger criteria (e.g. specific dialled digit strings) play a major role in many networks.

A support for independent service execution is needed. This is to allow for example two different IN services to be invoked during the same call, and if these services are provided by different service providers independent execution of both services is required.

An example where more points of control is applicable may be where a calling user via a Credit Card Call service wants to make a call to a premium rate service, both deployed as IN services.

In order to allow the SCF(s) to have multiple control relationships within a single call, a call segment model as used by Ericsson is presented that extends the model used for a basic two party call. Hereby a two-party call consists of a 'chain' of call segment associations, starting with an originating basic call segment and terminated by an terminating basic call segment, each representing the existing call handling software (A-side and B-side). In between a number of call segment associations may be invoked, here called IN call segments.

This IN Call Segment model allows more applications to be active on a single call at the same time. A call can be characterized as an originating or terminating type (O_BCSM or T_BCSM) dependent on how the IN call segment is invoked (IN trigger).

A separate control relationship must be established for each service logic program that can be invoked on the IN basic call. Each IN service is triggered in the IN switching system independently. This is enabled by the call segment model representing the basic two-party call as consisting of a number of independent call segment associations.

While processing a call the IN switching system detects an armed TDP-R and invokes the IN service logic program instance (SLPI). The IN service logic can initiate a persistent control relationship (EDP-Rs armed). During subsequent call processing the IN switching system (i.e. CCF) can detect another trigger event outside the call context of a previous invoked IN service. A subsequent call segment is 'linked' in the basic call to handle the new IN service logic instance in a SCF, which also may initiate a persistent control relationship - independently of any previous invoked IN service logic instances.

An example with two IN services invoked is shown in figure 2. Both services may have been invoked e.g. due to an office (number) based trigger whereby two independent BCSM instances are invoked on the call, each within a separate IN call segment as to allow independent IN service control. Both of the services (SLPI 1 and SLPI 2) may have a persistent control relationship with SSF as an SSFH instance is invoked for each of the control relationships.

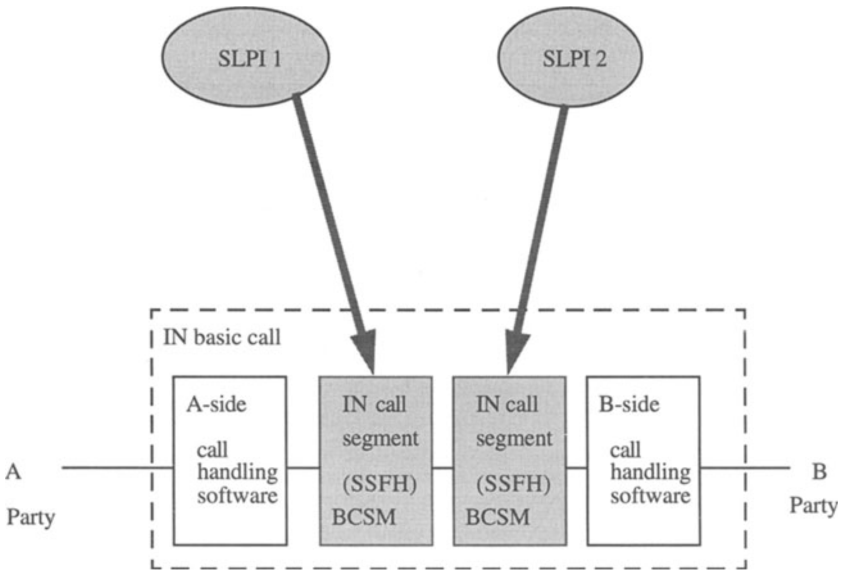

Figure 2 SCF control relationships, IN basic call, IN call segment model

The control capabilities allows for IN to IN service interworking and is for IN CS-1 applicable only to services (Type A) that do not have feature interference problems with each other. This is to avoid adverse interference between IN services simultaneously active on the same call.

For IN CS-2 service compatibility checks is to be added to the trigger mechanisms in the SSF for IN to IN service interference handling. On a call this enables to reject the invocation (triggering) of a new IN-service dependent on which IN-services may previously have been invoked.

In order to allow the same feature interference treatment independent of whether triggering occurs in the same SSP or in another SSP, the ISUP is required to be capable to convey this service/feature compatibility information.

6.3 DP processing rules

Event Detection Point processing requested by any of the involved IN service logic instances is performed as if triggering occurred in different BCSMs, which are separated by an ISDN network interface. This is secured by the invocation of an BCSM instance in a separate IN call segment for each subsequent IN call triggering. It is not visible for the involved IN services if triggering occurs in physically different SSP nodes or within the same SSP node.

The chain arrangement defines the priority of event handling. That is, originating events propagate down the call chain from the A-party towards the B-party and terminating events propagate down the call chain from the B-party towards the A-party.

7 MAIN ASPECTS

- IN demands distribution of services

  It is likely that with IN services widely deployed, users will want to access multiple IN services simultaneously. Moreover these services may be deployed in a multi-vendor environment. Therefore a demand beyond the CS-1 and CS-2 `single-point of control' exist to enable multiple services to be active on an IN call.
- Network topology should be transparent to IN service logic

  The IN services works independently of each other and need not to know how SSF functionality is distributed (e.g. between different SSPs or in a single SSP). Each IN service logic instance (SCF) invoked on the call has via its Call Segment Association own independent call models (e.g. Connection View states and BCSM).
- The Call Segment Model provides multiple IN control relationships

  The Call Segment Model provides a mechanism for handling the demanded distribution of services in a IN structured network. The model supports that event reports and sending of call control directives can be managed by the IN switching platform independently for each active IN service invoked on the call, enabling multiple services, i.e. multiple control relationships to be invoked simultaneously on the same IN call. This allows for a multi-vendor environment with distributed services (multiple SCPs).

8 ADDENDUM

The advanced concepts described herein before are based on the implementation of an IN CS-1 switching platform within Ericsson AXE10 switching systems.

9 REFERENCES

[1] Revised ITU-T Recommendation Q.1214, Distributed Functional Plane for Intelligent Networks CS-1 ITU-T Recommendation Q.1214 (May 1995)

[2 Intelligent Network (IN); IN Capability set 1 (CS1), Core Intelligent Network Application Protocol (INAP), Part 1: Protocol Specification. ETS: 300 374-1, (September 1994).

[3] Open Switching - Extending Control Architectures to Facilitate Applications, Martin Elixman, Bart L. de Greef, Armand M.M. Lelkens, Karl W. Neunast, Hermann Tjabben, Philips, ISS '95 Berlin (April 1995).
[4] Open Networking: is it technically possible, Roberto Kung, France Telecom/CNET-PAA-CER, ISS'95 Berlin (April 1995).

10 BIOGRAPHY

Jørgen Dyst was promoted IN Expert on April 1, 1994. He participates in IN standardization work in ITU-T and ETSI and works in the field of IN system management. Before assuming his present position, he served as IN Senior Specialist working with specification and analysis of new IN functionality and as operative IN product manager. He has been contributing to development on the Ericsson AXE10 advanced IN switching systems since the start. He has a background in the fields of switching and call control. Mr. Dyst attended Copenhagen Teknikum college of engineering and received a BS degree in Electrical Engineering in 1979.