



INTERNATIONAL TELECOMMUNICATION UNION

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

Q.1244

(07/2001)

SERIES Q: SWITCHING AND SIGNALLING
Intelligent Network

Distributed functional plane for intelligent network capability set-4

CAUTION !

PREPUBLISHED RECOMMENDATION

This prepublication is an unedited version of a recently approved Recommendation. It will be replaced by the published version after editing. Therefore, there will be differences between this prepublication and the published version.

FOREWORD

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

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

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

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

INTELLECTUAL PROPERTY RIGHTS

ITU draws attention to the possibility that the practice or implementation of this Recommendation may involve the use of a claimed Intellectual Property Right. ITU takes no position concerning the evidence, validity or applicability of claimed Intellectual Property Rights, whether asserted by ITU members or others outside of the Recommendation development process.

As of the date of approval of this Recommendation, ITU [had/had not] received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementors are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database.

© ITU 2001

All rights reserved. No part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from ITU.

DISTRIBUTED FUNCTIONAL PLANE FOR INTELLIGENT NETWORK CAPABILITY SET-4

SUMMARY

Intelligent Network Capability Set-4 (IN CS-4) is the fourth standardized stage of the Intelligent Network (IN) as an architectural concept for the creation and provision of services, including telecommunication services, service management services and service creation services. This Recommendation gives the Distributed functional plane for IN CS-4. It describes the main characteristics and overall capabilities of IN CS-4 and defines the network aspects and functional relationships that form the basis of the IN CS-4 capabilities.

This Recommendation is the second to be produced in the Q.124x series of Recommendations devoted to IN CS-4, which builds on the architectural principles of IN as described in the Q.121x, Q.122x and the Q.123x series of Recommendations.

The IN CS-4 Recommendations form a detailed and stable basis for implementing IN CS-4 telecommunication services. They also provide high level guidelines for supporting service management services, service creation services and some partially supported telecommunication services. The IN CS-4 Recommendations are intended to give the same degree of technical information as the IN CS-3 Recommendations .

1. Introduction

Intelligent Network Capability Set-4 (IN CS-4) is the fourth standardized stage of the Intelligent Network (IN) as an architectural concept for the creation and provision of network services, including telecommunication services, service management services and service creation services. This Recommendation gives the distributed functional plane for IN CS-4. It describes the main characteristics and overall capabilities of the IN CS-4 functional architecture, network aspects and functional relationships that form the basis for IN CS-4. Chapter 4 describes the generic functional model at the control plane and illustrates how IN and IP may be seen to inter-work. Chapter 5 describes the relationships and interfaces that are enhanced, when related to the previous IN Capability Sets. Chapter 6 illustrates a number of important scenarios for inter-working and interoperability between IN and other networks not specified before in earlier IN Capability Sets. Annex B describes the relation between the generic control plane functional architecture and other allied functions that may be present in the underlying network.

2. Phased Standardization

The phased approach of IN Capability Sets has been described in ITU-T Recommendation Q.1201. IN CS4 extends the service aspects, network aspects and management aspects of IN CS-3 as specified in the Q.123x series of Recommendations. Definition of IN CS-4 service features may be found in Recommendation Q.1241.

3. References

3.1 Normative references

The following ITU-T recommendations and other references contain provisions which, through reference in the text, constitute provision of this recommendation. At the time of publication, the editions indicated were valid. All recommendations and other references are subject to revisions; all users of this recommendation are therefore encouraged to investigate the possibility of applying the most recent editions of the recommendations and other references listed below. A list of a currently valid ITU-T recommendations is regularly published.

- [1] ITU-T Recommendation Q.1241 Introduction to Intelligent Network Capability Set-4
- [2] ITU-T Recommendation Q.1248 Interface Recommendation for Intelligent Network CS-4
- [3] ITU-T Recommendation Q.1222 Service plane for intelligent network Capability Set 2
- [4] ITU-T Recommendation Q.1223 Global functional plane for intelligent network Capability Set 2
- [5] ITU-T Recommendation Q.1224 Distributed functional plane for intelligent network Capability Set 2

- [6] ITU-T Recommendation Q.1225 Physical plane for intelligent network Capability Set 2
- [7] ITU-T Recommendation Q.1228 Interface Recommendation for intelligent network Capability Set 2
- [8] ITU-T Recommendation Q.1231 Introduction to intelligent network Capability Set 3
- [9] ITU-T Recommendation Q.1236 Intelligent Network Capability Set-3 Management Information Model Requirements and Methodology
- [10] ITU-T Recommendation Q.1237 Extensions to Intelligent Network Capability Set-3 in support of B-ISDN
- [11] ITU-T Recommendation Q.1238 Interface Recommendation for intelligent network Capability Set 3
- [12] ITU-T Recommendation Q.1290 Glossary of Terms Used in the Definition of Intelligent Networks
- [13] ITU-T Recommendation H.323 Packet Based Multimedia Communications Systems; ITU-T 1998
- [14] ITU-T Recommendation H.248 Media Gateway Control Protocol; ITU-T 02/2000

3.2 Bibliography

The documents listed in this clause provide informative background information for the reader and are not normative within this Recommendation.

- [15] ETSI Standard ES 301 xyz “API for Open Service Access (OSA)” draft SPAN 12 ES 120070
- [16] IETF RFC 2543 (March 1999); Session Initiation Protocol; Schulzrinne, Handley, Schooler and Rosenberg.
- [17] IETF RFC 2947 (October 2000); “The SIP INFO Method”; S. Donovan.
- [18] draft-ietf-sip-rfc2543bis-01 (August 2000): “SIP: Session Initiation Protocol”.
- [19] IETF RFC 2484, “The Pint Service Protocol: Extensions to SIP and SDP for IP Access to Telephone Call Services” (June 2000); S. Petrack and L. Conroy
- [20] IETF RFC 2327 (April 1998): “SDP: Session Description Protocol”; Schulzrinne, Handley, Schooler and Rosenberg.
- [21] Charging for IN CS-3 draft ETSI Standard (SPAN-03wxyz version).
- [22] 3GPP Technical Specification 29.198 Technical Specification Group Core Networks; Mapping of Virtual Home Environment / Open Service Architecture to CAP/INAP.
- [23] 3GPP Technical Specification 23.127 Technical Specification Group Services and System Aspects; Virtual Home Environment / Open Service Architecture.
- [24] ETSI Guide EG 201 xxx-1 “Requirements on an API for Open Service Access (OSA)”;
draft ETSI Guide SPAN 141606 part 1 (release 1999)

- [25] ETSI Guide EG 201 xxx-2 “Requirements on an API for Open Service Access (OSA)”; draft ETSI Guide SPAN 141606 part 2 (release 2000)
- [26] IETF Working Group draft “The SPIRITS Architecture” <draft-slutsman-spirits-architecture-00.txt> L. Slutsman, I. Faynberg H. Lu, M. Weissman

4. Distributed functional model for IN CS-4

The functional model proposed is an extension of the IN CS-2 functional model (see Figure 4-1/Q.1244). It is intended to support IN CS-4 benchmark services, Internet based service customisation and termination of Voice over IP to reach users in the telephone domain as well as general IN capabilities.

4.1 Functional Entities to Support IN CS-4 Benchmark Features

The option to have minimal support for accessing IN from H.323 Gatekeepers and SIP/SDP proxy redirection servers for implementing services that require explicit handling of the call configuration is agreed working assumption for IN CS-4, considered below:

For INAP CS-4 the following minimum capabilities are considered:

- redirection services,
- charging, the charging operations defined in ETSI [21] need to be restricted for H.323 and the exact definition of the control of the CDR's will be standardised.
- number translation services including the storage of related information (time of day) for e.g. portability and 800 based services.

Note: It is further required to define the service capabilities INAP provides to H.323 or SIP call control. And also define the arming and configuration of Trigger conditions.

Note: Triggering criteria can only be based on e.g. E.164 addresses in INAP CS-3 and therefore the limitation on the alias Address has to be indicated, or extension proposed.

For the H.323 architecture the translation of alias addresses to IP transport addresses is to be performed by gatekeeper. The gatekeeper will also map the specific H.323 parameters to the INAP parameters. Mapping analysis is therefore requested and specific information must be identified. It is proposed that the information should not be sent in a container e.g. Mapping of the cause values will be as specified in the H.225 Recommendation towards the Q.850 causes values.

The following lower layer protocol gateways, mapping functions may be required depending on the protocol Architectures employed in each domain:

- Signalling Gateway Function (S-GF)
- Service Control Gateway Function (SC-GF)

4.1.1 PINT Server

A PINT server accepts PINT requests from PINT clients. It processes the requests and returns responses to the clients. A PINT server may perform these functions as a proxy server or a redirect server. A proxy server makes requests to another PINT server on behalf of its clients; a redirect server returns to its client's addresses of other PINT servers to which requests can be redirected. The gateway capability includes the ability to communicate with a so-called Executive System located outside the IP network domain that will actually perform the service call requested by a PINT Client.

Additionally, this function transfers data (e.g. fax, data) between IP-networks and the IN, and associates IP-network entities with the related entities in gateway function. This function is situated at the edge of the IP-network domain, where the Application Association with PINT Client/Server is subject of standardisation of the IETF and where the Application Association with SCF in the IN domain is subject of standardisation

The functions related to PINT Server are:

- In case the Executive System is an IN system, the PINT Server delivers received PINT requests to the SCF. It provides the SCF with the necessary information to control service requests, identify users and authenticate data,

and protect the IN from misuse or attacks from the IP-network. Furthermore, it hides the SCF/ SRF from entities in the IP-network domain and acts as a mediation device between the IP-network and the IN.

- It also relays requests from an SCF to the IP-network domain to perform services (e.g. user notification).

4.1.2 Service Application Gateway Function (SA-GF)

The Service Application Gateway Function allows the inter-working:

- between the service control layer in Intelligent and Distributed Service Logic applications (API based functions).
- between the Call Manager Function and Distributed Service Logic.

Note: Inter-working of the CCF (representing specific functionality in a VoIP environment. e.g. SIP Proxy or GK) and the SA GF in the particular VoIP environment is not subject of IN CS-4 standardisation.

For IN CS-4, on the application level, the types of API based functionality may include:

- CORBA platforms
- JAVA platforms
- JAIN platforms
- Other API based platforms

Additionally this functionality may provide protocol mapping/service mediation.

4.1.3 Call Control Function (CCF)

CCF is an enhanced functional entity, responsible for handling call signalling on either network. The CCF communicates with the SM using Registration and admission capabilities. To support ISUP signalling, the CCF has to implement H.246 Annex C. In that case it appears to the IN side CCF as being another CCF. This functionality includes handling the management of the call processing, and call signalling.

This entity is responsible for passing service related information to and from IN service layer, namely the SCF, and managing the service control relationship. As such, the CCF may contain a SSF-like functionality or subset thereof, to model the pre and post conditions that are required to interact with an SCF.

A Call Control function could be seen as a logical switch (CCF). Call control signalling (e.g. H.225.0, Q.931-like) and connection control signalling (H.245) for VoIP is transferred via the RM/MM, which make network routing decisions.

A Call Control Function can require SCF assistance for these routing decisions, e.g. for 1-800 numbers, number portability, user profile consultation, VPN support.

The functions related to Call Control Function are:

- - Inter-working for:
 - Number Portability;
 - Freephone Translations;
 - VPN support;
 - O.A.&M.
- - General functions that need to be supported by this function
 - - Data filtering/parsing/mapping
 - - Security/Authentication
 - - Real Time data collection (billing/parsing)
 - - Configuration/dimensioning
- Flow control
- Circuit switching and ancillary processes are removed.
- The H.323 or SIP server inter-working functions are added.

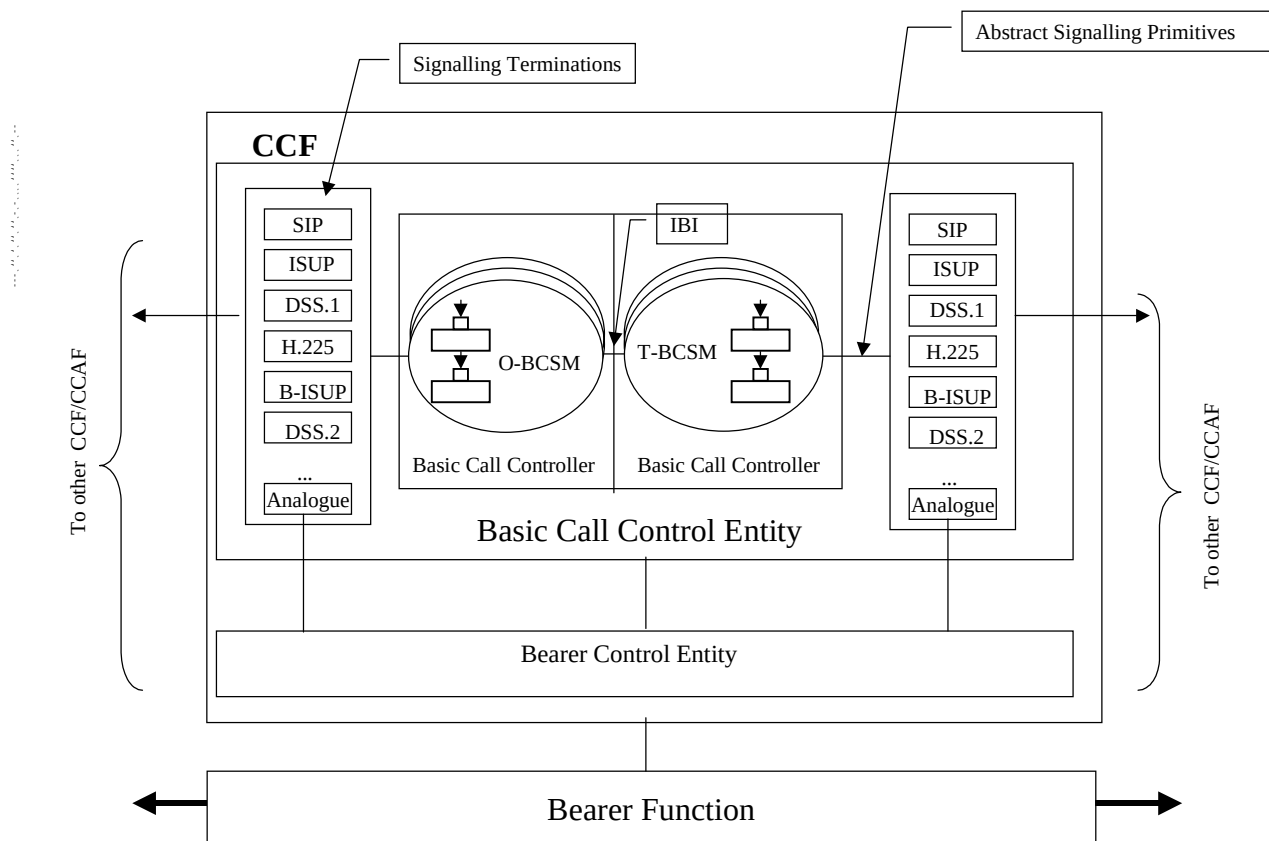


Figure 4-1/Q.1244: CCF decomposition overview

The Call Control function, as shown in Figure 4-1/Q.1244, also contains a resource manager function, analogous to the high layer resource control function in the decomposed H.323 version 4 gateway. This MGC like function is responsible for controlling the lower layer resource control function in the decomposed H.323 version 4 gateway, commonly referred to as MG. An example of a protocol on this reference point is the H.248 Media Gateway Control Protocol. This functionality includes handling the management of the logical channels, e.g. H.245 control signalling.

The resource manager part of a Call Control function could be seen as a logical Bearer Control Function (BCF). When using connection control signalling (H.245) for VoIP that is transferred via the CCF, the CCF makes network routing decisions.

It is agreed that INAP interacts with and maps to the underlying call control signalling (e.g. Q.931, ISUP, BICC, H.225.0 and SIP) in the SSF. The call control may invoke H.248 media and connection operations, for legs, media, packages independent of before or after the IN interaction. Where a Call Control protocol is encapsulated in an H.248 package, mapping to this package or to the embedded protocol may also need to be specified.

Notes:

Physical Location: The H.323 Gatekeeper/SIP Server and 'SSF', which is in Q.1244 figures 6-1, 6-3, 6-4, 6-5 or 6-6 may be located in any network since INAP CS-4 signalling is standardised for international use. And is call control protocol independent.

Physical Realisation: From the control of VoIP viewpoint the Service Capability Server and the H.323 Gatekeeper/SIP Server may be combined in one network entity or may be separate in separate network entities. If they are separate, standardisation of the interface may be required.

IP PDU Routing: For the routing of IP call control packets to/from the H.323 Gatekeeper/SIP Proxy Server it is simply assumed that appropriate addressing and routing takes place.

4.1.4 Session Manager (SM)

The Session Management function is responsible for managing the IP network services. On the IP side it exposes the Registration interface, but one cannot assume that service interactions are only based on Registration flows. The session manager may initiate activities caused by call control signalling events, in case of collocated session manager and call manager. The session manager shall participate in domain/zone management and call signalling..

General functions that need to be supported by this session manager

- Service Profile Data filtering/parsing/mapping
- Security/Authentication
- Real Time data collection (billing/parsing) Triggering of services (in the IN domain or in the IP-network domain)
- Configuration/dimensioning
- Flow control

This entity is responsible for passing registration and admission related information to and from IN service layer, namely the SCF. As such, the session manager may contain a SSF-like functionality or subset thereof, to model the pre and post conditions that are required to interact with an SCF.

4.1.5 Service Switching Function (SSF)

The enhanced SSF interacts with the SCF (the INAP CS-4 Service Control Function SCF) and the CCF (The IP representation of the Call Control Function) mapping the Call Control Protocol into the INAP events trigger points and procedures, where applicable.

The relation of the SSF to the classical SSF is as follows:

- Many processes, such as call control, database and billing are retained or enhanced.
- Triggering of services (in the IN domain or in the IP-network domain)
- Feature Interaction Management

The interface between the H.323 Gatekeeper/SIP Server and the SSF call control processes must:

- a) Carry sufficient call data for the SSF to function correctly and to deliver the necessary information to the SCF so that service logic decisions can be made.
- b) Allow the SCF (in combination with SSF and CCF Emulator) to control VoIP calls (e.g. change 'B' party address) and manipulate call information (such as presentation number).

It is proposed that the CCF to SSF interface is presently not subject for standardisation. However, a mapping of parameters may be required to demonstrate the mapping in the SSF to the H.323 Gatekeeper/SIP Proxy Server call control protocol, states and events. Thereby enabling the CCF to model either a H.323 Gatekeeper or a SIP Proxy server.

This Functional Architecture is flexible enough to cover all underlying IP, Media and bearer independent call control protocols though specific mapping between the INAP procedures, trigger criteria and events against the procedures, conditions and call states of the underlying call control protocol may need specification. This mapping is technology dependent.

Note that Click to Dial type of services can be supported based on IN CS-3 capabilities.

4.1.6 Specialised Resource Function (SRF)

This function has to be extended by capabilities to exchange data with gateway functions to IP-networks. Additionally, for some of the services it needs to support specialised resources with media transformation functions such as:

- Text-to-fax
- Text-to-speech (already covered in Q.1224, Section 3.3.6.2 as TTS function)
- Speech-to-text

- Fax-to-text

4.1.7 Service Control Function (SCF):

Extensions or are *for further study*.

4.1.8 Service Data Function (SDF):

For some services there may be a need for the SCF to access a database type of entity with service related information to be shared between the IN and the IP-network. For example this may be the case, for Internet dialup access and Internet call waiting, where the association between a PSTN number and an IP-address needs to be obtained.

Therefore the following functionality needs to be added to the SDF description:

"SDF contains data pertaining to modem usage/available factor for Internet dial-up access."

4.2 Functional Interfaces

The following interfaces are to be considered (Figure 4-2/Q.1244):

- IF1: PINT Server-to-Service Control Function interface:
- IF2: PINT Server-to-SRF interface
- IF4: SCF-to-SRF interface
- IF5: CCF-to-CCF interface
- IF7: Service Control Function-to-SSF interface
- IF8: SCF-to-Service Application Gateway Function interface
- IF9: Service Application Gateway Function-to-GF for distributed service logic platforms interface

There is a need for an interface between the service control in the IN and the call control for VoIP within the IP network to extend IN based services in the IP-network domain.

4.2.1 IF1: PINT Server-to-Service Control Function (SCF) Interface

This interface is used to trigger the SCF with service requests, to allow the SCF to instruct the collection of information necessary to execute the service (identity, charging and authenticity information), and to control the gateway during service execution.

The SCF should be able to send service or modification requests to the IP-network; possibly via the SC-GF if used.

For example, for the Internet Call Waiting service, the SCF needs to notify the Internet user of an incoming call. Then, IF1 should allow the SCF to request Internet services.

This interface will relay requests either from the IN or the IP-network. This interface is modelling the information relay, The information transfer on this interface is specified in the SIP Pint extensions in [19].

The IETF PINT working group has developed a set of protocol extensions set based on the Session Initiation and Session Description Protocols (SIP and SDP). The architectural configuration envisaged is that end users will make service requests. These requests will be marshalled and converted into SIP/ SDP messages by a dedicated PINT client that will be sent to an optional PINT Server. The PINT Server will further relay the service requests to the Service Control Function. From the perspective of the IP-network requesting user, this PINT Gateway with its connected Executive System is responsible for processing and executing their service feature request; any entities (such as the IN entities) are "hidden" behind this PINT Server function, and their operation is transparent to the IP-network users.

4.2.2 IF2: PINT Server-to-SRF interface

This interface may not require standardisation, as it will be a data stream to e.g. the SRF text conversion function. IF2 is used to establish a data connection and to exchange data between the SRF and the Pint Server (on request of the SCF). Data are to be exchanged if the respective service requires not only to control the PSTN/ IN, but also to transfer data between the GF and the PSTN. The PINT RFC specifies extensions to file transfer to illustrate the use of this interface.

4.2.3 IF4: SCF-SRF interface

This interface will require enhancements to the existing ITU-T standard for this reference point. This interface reflects an extension of the existing SCF-SRF relationship. It is used to request the SRF by the SCF to retrieve the appropriate data from the gateway function. This may require transfer of correlation information to address the GF and the appropriate data. In addition, the SCF instructs the SRF to transform the retrieved data into other formats and to transfer this data over the PSTN/ PLMN to the end user.

4.2.4 IF5: CCF-to-CCF interface

This interface reflects the requirements pertinent to the IF5 interface. This is the requirement to carry an ISDN control plane signalling protocol for Multimedia services. This interface relays the IP Multimedia user plane received from the CCF (Call Control Function). This interface is required for Voice over IP based services.

This interface may require standardisation but is not expected to be IN specific, work is progressing on this in ETSI TIPPHON, IETF, SG11 BICC and SG16 H.246 Annex C.

4.2.5 IF7: SCF – SSF interface

This interface reflects the requirements pertinent to the IF7 interface. This is the requirement to carry an IN-based signalling protocol for IP and Multimedia services. This interface relays the IP Multimedia control plane triggered events to and from the SCF.

This interface may require standardisation.

This interface is required to trigger and control value added services from a SIP proxy or H.323 gatekeeper function in the IP network e.g. for multimedia access from the Internet "dial-up" access.

4.2.6 IF8: SCF - Service Application Gateway Function interface

This interface reflects the requirements pertinent to the IF9 interface. However, the possibility of physically or functionally co-locating these functional entities would remove this from standardisation.

4.2.7 IF9: Service Control Gateway Function-to-GF for distributed service logic platforms interface

SA-GF to distributed service logic platforms: this interface represents standard APIs allowing an Application Service Provider to control defined capabilities offered by the underlying network via the SA GF. The service logic execution of the application offered by the ASP typically is located in a separated domain than the SA GF offering the API.

4.3 *Explanation of diagram*

The following network architecture depicts the distribution of network intelligence.

Figure 4-2/Q.1244 identifies the IN DFP model for IN CS-4. This diagram depicts the functional entities and relationships applicable to IN CS-4. This diagram is a subset of the generic IN DFP model described in 2/Q.1204. A general explanation of functional entities, relationships, and the diagram are contained in 2.1/Q.1204.

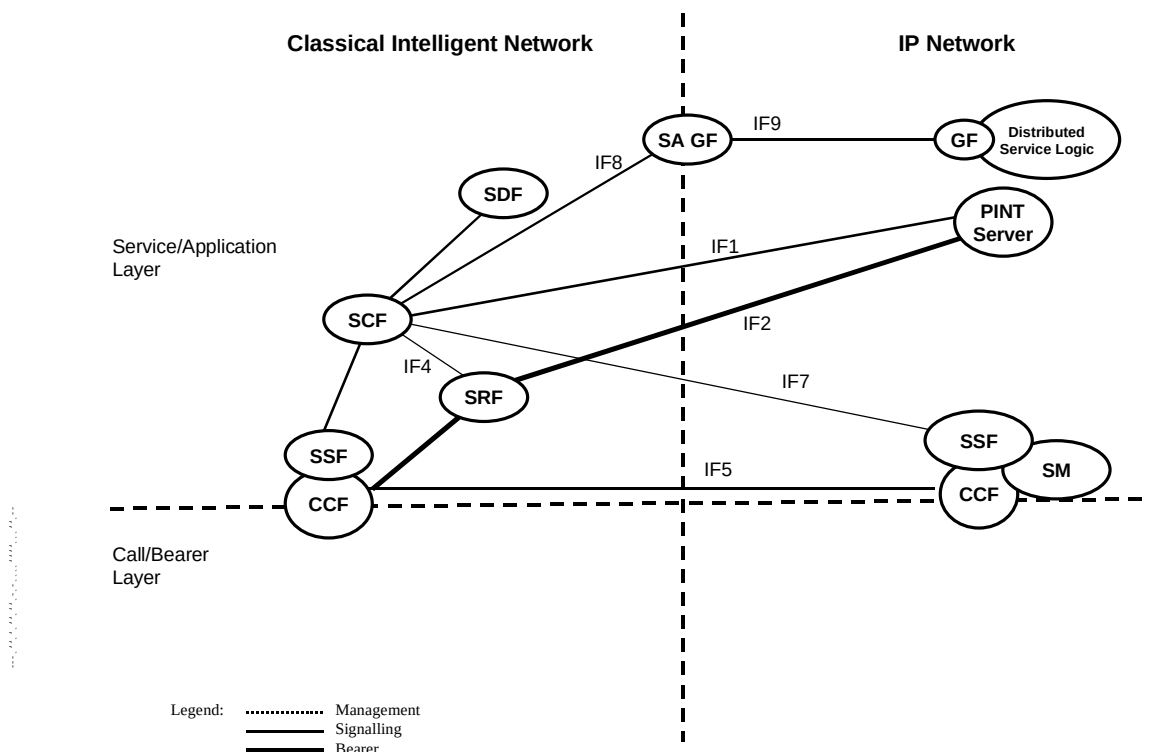


Figure 4-2/Q.1244: Enhanced Functional Architecture for IN support of IP-networks

Table 1

Interface	Functional Entities	Protocols	Reference
IF1	PINT Server to SC-GF	SIP(PINT) Protocol	Over (TCP)UDP/IP or Over SCCP/MTP
IF2	PINT Server to SRF	FTP(PINT) Protocol	Relayed over(TCP)UDP/IP or Over SCCP/MTP
IF4	SCF to SRF	INAP	Over TC/SCCP/MTP
IF5	CCF to CCF	ISUP Control Plane/BICC or SIP call Control	Over MTP or SCTP/IP
IF7	SCF to SSF	INAP Call or RAS related	Over TC/SCTP/IP or Over TC/SCCP/MTP
IF8	SCF to SA-GF	Service Provider Application API	Over TC/SCCP/MTP
IF9	SA-GF to GF for Distributed Service Logic	Service Provider Application API	Over TC/SCTP/IP

Note: that this architecture can be deployed entirely within an ISDN/PSTN or IP network or a combination of both.

Note: the SRF is independent of the classical IN or IP Domain if may be located on either side of the functional architecture. Its location will impact the protocol stack used to control this entity.

Note: IF5: is illustrated since it indicates Call Control across this reference point, these Call Control requirements are required as they give rise to the Call States which result in the IN triggering conditions.

4.4 Lower Layer Protocol Gateway and Mapping Functions

The following lower layer protocol gateways, mapping functions may be required depending on the IP network architectures employed in each domain. If required these functions will be implied at the CSN/IP domain boundary.

4.4.1 Service Control Gateway Function (SC-GF)

The Service Control Gateway Function allows the inter-working between the service control layer in Intelligent Network and IP-networks. For IN CS4 on the service control level the relations between the IN and the following entities in the IP-network are supported:

- This is a layer 2 mapping and addressing function.
- The SCF will be able to select one or more appropriate SSF/SIP Proxies/H.323 GKs dependent on different parameters (class of service requested by the user, placement of gateways, tariff, etc.). The SC-GF will be able to perform correct lower layer protocol and address translation functions.
- The SC-GF will allow inter-working with several SSF/SIP Proxies/H.323 GK (Gatekeepers).
- PINT Server,
- SIP Proxy
- H.323 GateKeeper Function
- others are for further study

4.4.2 Signalling Gateway Function (S-GF)

The Service Control Gateway Function allows the inter-working between the Call control signalling in the ISDN and IP-networks. This functional entity is optional, as it need not be required in all implementations. The following cases may be supported:

- This is a layer 2 mapping and addressing function.
- The S-GF will be able to perform correct lower layer protocol and address translation functions.
- The S-GF will be able to re-map between ISUP over SCCP/MTP and ISUP over SCTP/IP.
- The S-GF will allow inter-working with several SSF/SIP Proxies/H.323 GK/H.248 MGCs.
- SIP Proxy
- H.323 Gatekeeper Function
- H.248 MGC functions
- Other functions are for further study

5. Functional Relationships and Interfaces

This section describes the relationships between various Functional Entities identified earlier and Control Classes in IN CS-4.

5.1 Functional Relationships and Control Classes

Five groups of control capabilities, called control classes, have been identified to support the functional relationships:

- 1) Bearer Connection Control: the class of capabilities to establish, and clear the bearer connections (e.g., voice paths through the network), and provide surveillance.
- 2) Non-IN Call Control: the class of capabilities to invoke the user and provide an end-to-end control required for the non-IN delivery of supplementary services. The non-IN delivery does not involve the structured separation of the CCF, SSF, and SCF.
- 3) IN Service-Control: the class of capabilities that involve the structured separation of the SSF from SCF.
- 4) Service Management Control: the classes of capabilities that involve service deployment, service provisioning, service operation control, and service monitoring.
- 5) Non-IN Call Unrelated Control: the class of capabilities to establish, provide monitoring, and clear a non-bearer connection (e.g., out-channel interaction via the DSS1 D-channel without a bearer connection).

Figure 5-1/Q.1244 depicts the classes of control capabilities required for the functional relationships. The following subsections further describe the control relationships for each control class, respectively. A control relationship is the relationship between a functional relationship and a control class.

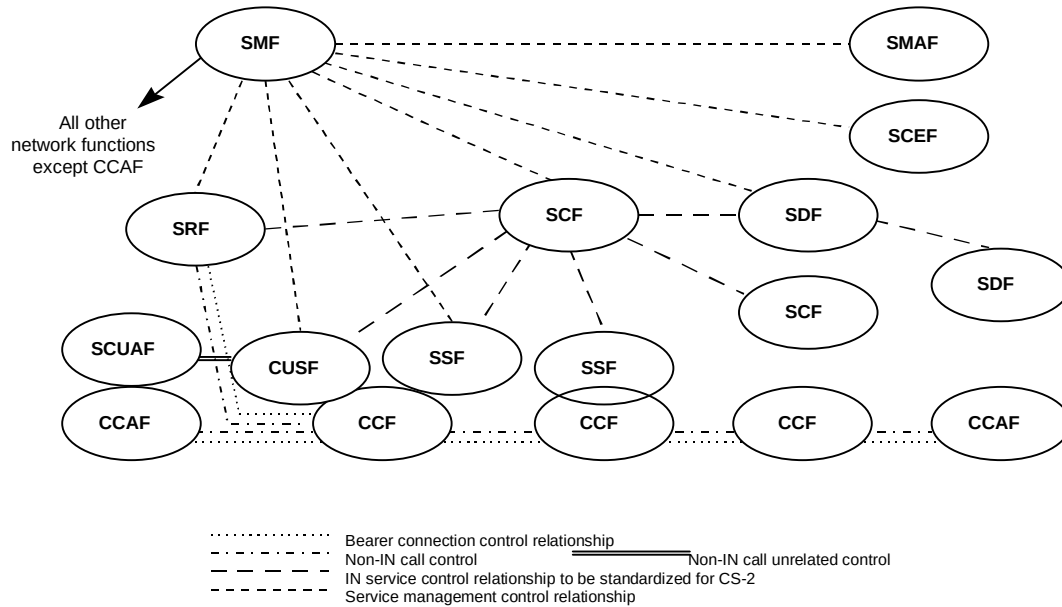


Figure 5-1/Q.1244
Functional Relationships and Control Classes for IN CS-4

5.1.1 Bearer Connection Control

Control relationships exist between the bearer connection control class and the CCAF-CCF, CCF-CCF, and CCF-SRF functional relationships, respectively. Standard interfaces are employed to realize these control relationships and are listed below by the involved functional relationships:

CCAF-CCF:	DSS1/Q.931
CCF-CCF:	SS7/ISUP
CCF-SRF:	DSS1/Q.931; SS7/ISUP

5.1.2 Non-IN Call Control

Control relationships exist between the non-IN call control class and the CCAF-CCF, CCF-CCF, and CCF-SRF functional relationships, respectively. Standard interfaces are employed to realize these control relationships and are listed below by the involved functional relationships:

CCAF-CCF:	DSS1/Q.932
CCF-CCF:	SS7/ISUP
CCF-SRF:	DSS1/Q.932; SS7/ISUP

5.1.3 IN Service Control

Control relationships exist between the IN service control class and the SCF-CUSF, SCF-SCF, SCF-SDF, SCF-SRF, SCF-SSF, and SDF-SDF functional relationships, respectively. They can be realized through SS7/TCAP/INAP.

5.1.4 Service Management Control

Control relationships exist between the service management control class and the SMF-CUSF, SMF-SCF, SMF-SCEF, SMF-SDF, SMF-SMAF, SMF-SRF, and SMF-SSF functional relationships, respectively. They can be realized through CMIP/Q.812. No modification to INAP (i.e., Q.1228) is foreseen for management aspects. In addition, no modification to the IN Physical Plane (i.e., Q.1225) is foreseen; namely, no additional Physical Entities (PEs) are required assuming basic PEs exists for management aspects.

5.1.5 Non-IN Call Unrelated Control

Control relationships exist between the non-IN call unrelated control class and the CCAF-CCF, CCF-CCF, and CCF-SRF functional relationships, respectively. Standard interfaces are employed to realize these control relationships and are listed below by the involved functional relationships:

CCAF-CCF:	DSS1/Q.931
CCF-CCF:	SS7/ISUP
CCF-SRF:	DSS1/Q.931; SS7/ISUP

5.2 Control Architecture Principles

As stated in Section 3.2 (Basic Features), the service scope of IN CS-4 includes multi-point of control services. The scope is however still restricted to single-ended services. This section identifies principles for the control architecture of IN CS-4, in the context of this service scope.

This section is organised around three control aspects:

- service invocation and control,
- end-user interaction with and without the SRF,
- feature interaction, and
- service management.

5.2.1 Service Invocation and Control

This control aspect involves the MGC, Gatekeeper, CCF, SSF and SCF.

As in IN CS-1, IN CS-2 and IN CS-3 the following key principles remain in force for IN CS-4:

1. The CCF, MGC and Gatekeeper retain ultimate responsibility for integrity and control of the local connection at all times.
2. The SSF to SCF relationship is, by definition, service-independent. Therefore the CCF (or MGC) and SSF should never contain service logic specific to IN CS-2 supported services.
3. In the event of SCF malfunction, or time-out in the SCF to SSF response, the SSF/CCF (or MGC/Gatekeeper) combination should be capable of reverting to a default 'call completion' sequence, with appropriate announcement(s) to the calling and/or called party.
4. The SSF should never have to interact with more than one SCF at any given time in order to complete a sequence of query/response interactions on behalf of a calling or called party.
5. Call hand-offs (transfer of responsibility) between SCFs, and between SSFs are permitted in IN CS-3. However, the hand-off must be explicit, and must not violate principle 4.

5.2.2 End-User Interactions

As part of the process of formulating a response to the SSF, the SCF may need to enter into a dialogue with the calling or called party. This would take the form of a prompt and collection sequence with the aid of an SRF, or the form of call unrelated/out-channel call related interactions, which are consistent with IN CS-2.

Again, the following key principles apply, when the SRF is being used in IN CS-4:

1. The SCF has full IN-supported service control of instruction formulation and sequencing with respect to the SRF and SSF.
2. As a corollary to principle 1, there shall be no direct service control interaction between the SSF and SRF for IN CS-4 based services. The SSF and SRF have a peer-peer relationship for the control of IN CS-4 based services, and both are subsidiary to the SCF.
3. The SCF will require the capability of suspending processing of an IN CS-4 based service on behalf of a calling or called party, and then resuming on behalf of the same party at a later time.

5.2.3 Feature Interactions

As in IN CS-1, the constraints placed on the IN CS-4 architecture have been put in place primarily to minimise and control feature interactions within single domains of responsibility.

The single-endedness of IN CS-4 based services means that all aspects of a call are under the control of one CCF/SSF and one SCF at any point in time. The SCF and SSF are therefore responsible for the handling of interactions between IN CS-4 based SSF/CCF capabilities, and non-IN features already provided in the basic network.

5.2.4 Service Management

The control aspects covered in 7.2.1 and 7.2.2 address the real-time interactions between IN CS-4 functions on behalf of a particular calling or called party. In contrast, the service management aspect primarily addresses the network

operator's interaction with the SSF, SCF, SDF, and SRF. This interaction normally takes place outside the context of a particular call or service invocation.

However, IN CS-2 must neither preclude nor constrain the capability of service customers to interact directly with customer-specific service management information (e.g., a personal service profile).

The following points capture key principles for IN CS-4:

1. The SMF may be used to add, change or delete IN CS-4-based service-related information or resources in the SSF/CCF, CUSF, SCF, SDF, and SRF. Such changes should not interfere with IN CS-4 based service invocations or calls that are already in progress.
2. The SMAF may be used to add, change, or delete appropriate customer-specific information. The mechanism and safeguards that are put into place by the network operator for this interaction may take advantage of IN CS-2 functions and capabilities.
3. Service providers who introduce new services may use the SCEF. The task of deploying the service is the role of the SMF and is initiated from within the SMF.

5.3 Internetworking

Internetworking is the process in which several networks (potentially of different types, such as IN-structured, non-IN-structured, public and private) co-operate to provide a service. The need for internetworking capabilities results from the fact that customers may want to access services that span multiple networks. A typical situation is when the data needed by a service (e.g., UPT, VPN and Global Network Services) reside in a network that is different from the one in which the call has originated.

IN CS-4 identifies the SCF-SCF, SCF-SDF, SCF-IAF, SDF-SDF and SMF-SMF relationships for internetworking purposes. Distributed service logic, but not distributed service control, is supported. Additionally, inter-network management interactions and distributed data handling processes are supported.

5.3.1 Internetworking between IN-Structured Networks

General requirements for internetworking capabilities are presented in Section 2.2.6 of ITU-T Recommendation Q.1201.

Although the involved networks may have different access types (e.g., PSTN and ISDN), as well as different levels of IN structure, IN CS-4 internetworking services are to be provided to customers in a consistent way, regardless of such differences.

Similar to Figure 7-1/Q.1231, which depicts the functional relationships between the IN functions within one network, Figure 5-2/Q.1244 depicts possible functional relationships between the IN functions that are located in two different networks.

The following observations can be made concerning the applicability of Figure 5-2/Q.1244 to IN CS-4:

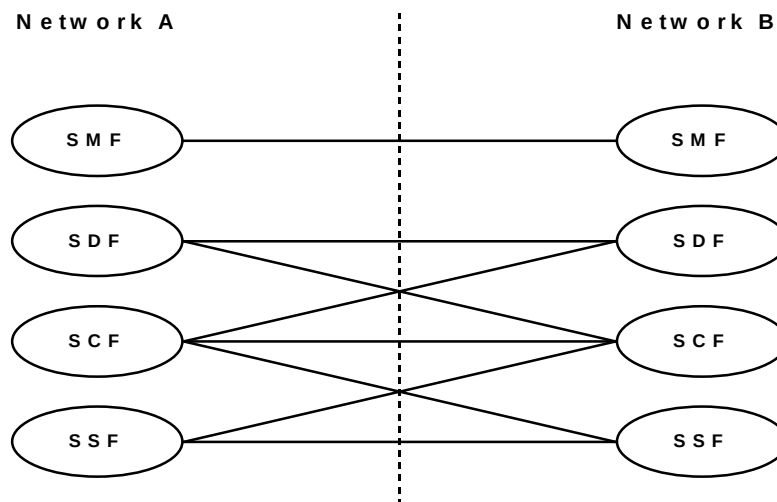


Figure 5-2/Q.1244
Possible IN Network Inter-working Functional Relationships

5.3.2 Internetworking with Non-IN-Structured networks

The previous section defines the internetworking relationships for two networks, both of which have a structure compatible with the IN functional architecture. For IN CS-4, the Intelligent Access Function (IAF) provides access between the SCF of an IN-structured network and an entity of a non-IN-structured network. This latter entity may be other networks or customers (e.g., private networks, simple databases used for instance in the Customer Call Routing service, terminals, and PABXs). It

- a) provides access to and from the SCF of the IN-structured network; and
- b) maps the information between the internal and external representation.

As such, for the subscriber's each incoming call, information (for instance, dialled number, calling number, and caller entered digits) may be conveyed, for example, from a public network to a private one for the latter to determine how that call will be handled. A private network is defined as a network that provides services only to a specific set of users.

Similar to Figure 5-2/Q.1244, which depicts possible functional relationships between the IN functions that are located in two different IN-structured networks, Figure 5-3/Q.1244, depicts a possible functional relationship between the SCF located in an IN-structured network and the IAF located in a non-IN-structured network.

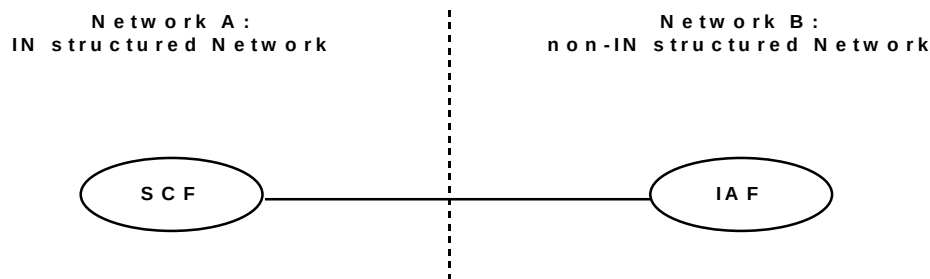


Figure 5-3/Q.1244
IN to non-IN Network Inter-working Functional Relationship

5.3.3 Security

Security is a general property which relates to safe and reliable operation. The high level requirements of a secure system are:

- Confidentiality, which is defined in ITU-T Recommendation X.800 as «the avoidance of the disclosure of information without the permission of its owner». Thus, confidentiality may be considered as a property which ensures that conversations or interactions remain private.
- Integrity, which is defined in ITU-T Recommendation X.800 as «the property that data has not been altered or destroyed in an unauthorised manner». Integrity may then be considered as a property which ensures that operations occur as they are expected to.
- Availability, which may be considered as a property relating to the readiness of resources for authorised use.
- Accountability, which may be considered as a property which ensures that any operational request can be correctly attributed in case of doubt or dispute.

The components of an IN system must be assembled and operated in such a way as to provide a defined level of security.

To assist in this, any interface within the IN functional architecture may have the need to apply security assisting functions to the information flows passing across the interface such as:

- Network access security functions : This includes user/terminal authentication (i.e. the result of a process by which a service user proves his or her identity to an IN system), user profile verification (i.e. the verification that a user is authorised to use a functionality).
- Internetworking security functions: This includes peer entity authentication (i.e., a process which allows a communicating entity to prove its identity to another entity in the network), signalling data or TMN data integrity, non-repudiation, confidentiality, entity profile verification (i.e. the verification that an entity is authorised to use a functionality).

ITU-T Recommendation Q.1228 defines a generic set of security mechanisms and procedures to offer some of the generic properties described above. In any particular circumstance, a set of network elements will be required to be configured according to some security scheme.

The definition of IN CS-2 offers the provision of certain security assisting functions at the SCF-SDF, SDF-SDF, and SCF-SCF interfaces. Additional security functions may be required depending on the security schemes in place.

5.3.4 Screening

Screening refers to the ability to filter the messages and the contents of the messages sent and/or received across the internetworking interfaces. The high level screening requirements are:

INAP protocol screening, which ensures the control per inter-network relationship of the signalling capabilities and the handling of INAP operations, parameters and parameter contents.

INAP Application Context screening, which ensures the control per inter-network relationship of the Application Context of the INAP capability set.

ITU-T Recommendation Q.1248 defines screening requirements for internetworking interfaces. The definition of IN CS-4 offers the provision of certain screening functions at the SCF-SCF interface. Additional functions may be required depending on the security and screening schemes in place.

6 IN/IP Implementation Scenarios

6.1 IN/IP Inter-working for IN CS-4 to Support SIP Systems

To provide a better understanding of the applicable SIP based call control network architecture, the SIP based call control functional entities are introduced, which may be contained within SIP entities as defined in the standard. This is an attempt to accommodate the new concept of a decomposed SIP Call Control Proxy, defined in H.248, and the applicable bearer control Configurations, which may utilise bearer control protocols from BICC or H.245 as required from various protocol related studies.

The functional names have been chosen with the intent of minimising confusion. They do not intend to imply a specific implementation.

6.1.1 The SIP architecture

The SIP architecture has 5 functional elements defined in [16], [17], [18]:

- **User agent client:** The user agent client is the functional entity that may initiate a SIP request.
- **User agent server:** The user agent server is the functional entity that may initiate a SIP response.
- **Proxy server:** This functional element is functionally similar to the user agent server, except it is not expected to retain significant call control state. In essence the proxy server is comprised of both a SIP client and a SIP server.
- **Redirect server:** The redirect server is not responsible for call control but will simply respond to SIP requests with a new address.
- **Registrar server:** The registrar server simply responds to registrar requests. Typically this is co-located with either the proxy or the redirect server, and may be adapted to perform location-based services.

6.1.2 SIP State Call Models

In SIP based systems a SIP proxy with call control intelligence is defined. This intelligence will enable nominated SIP proxies to location retain significant call control state. This will enable standards to be developed to synchronise the SIP Call State model with the IN Basic Call State model as defined in Q.1224 and Q.1237/Q.1238. In essence the proxy server is comprised of both a SIP client and a SIP server. It is required to analyse which BCSM states have meaning in a SIP based service context, and how bearer and multimedia support can be added to both this SIP call model and understood in the extension of the IN call control model.

6.1.3 Functional Model

Figure 6-1/Q.1244 shows the functional model involving IN and SIP inter-working. As indicated above, possible groupings in Intelligent SIP Proxy are depicted.

Note: The single Intelligent SIP Proxy as modelled in these figures can in fact represent several different physical instances in the network, for example with one Intelligent SIP Proxy in charge of the terminal or access network/domain, and another in charge of the interface to the Switched Circuit Network.