Point-to-multipoint call modelling for IN/B-ISDN integration.¹

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Abstract

This paper deals with integration of IN and B-ISDN for the support of new sophisticated multimedia multipoint services. A survey of results of the ACTS INSIGNIA project is given, successively some enhancements of the INSIGNIA architecture in order to integrate advanced B-ISDN capability are discussed. In particular, the impact of point-to-multipoint on the IN call modelling is considered and the needed enhancements of the Basic Call State Model are presented. Moreover, the evolution of the IN *Service Switching Functions* (SSF) entity and of the interface with the IN *Service Control Function* (SCF) entity is investigated. Finally an experimental test-bed developed in the framework of the CORITEL IBIS project is described. This test bed aims at validating, with reference to the control-plane, the main features of the proposed architecture.

Keywords

IN, B-ISDN, call modelling, point-to-multipoint

¹ This work has been carried out within the CORITEL laboratory in the frame of a joint research project between industry and university.

1 INTRODUCTION

The introduction of ATM technology will permit the B-ISDN to support new and greatly advanced services. Suitable functional architectures and protocols which can support these services with the desired flexibility need to be deployed. The Intelligent Network (IN) concept seems very suitable for this purpose. Some reasons push towards the IN B-ISDN integration:

- IN allows a fast and flexible definition and development of services by means of independent, normalised and reusable, modular elements (Service Independent Building Block - SIB);
- IN infrastructure can be utilised to provide supplementary services in a broadband environment so avoiding to define dedicated ad-hoc protocols;
- IN could guarantee service portability and personalization capabilities in a broadband environment.

This approach has been proposed in some papers [1,2] and is the main purpose of an ad-hoc ACTS projects named INSIGNIA.

In this paper we start with a survey of current results of INSIGNIA project; we next propose some enhancements of the INSIGNIA architecture in order to support advanced B-ISDN capability, i.e. point to multipoint calls. In particular, the impact of point-to-multipoint on the IN call modelling is considered and the needed enhancements of the Basic Call State Model (BCSM) are discussed. Moreover, the evolution of the IN Service Switching Functions (SSF) entity and of the interface with the IN Service Control Function (SCF) entity is investigated.

Finally a test-bed developed in the framework of the CORITEL IBIS project is described. This simple test bed demonstrates, with reference to the control-plane, the main features of the proposed architecture.

In Sec.2, basic assumptions of the INSIGNIA project are reported. In Sec. 3, operation of point-to-multipoint call are summarised together with the main requirements for IN intervention. Enhancements of the BCSM for modelling of the point-to-multipoint calls are discussed in Sec. 4, whereas Secs. 5 and 6 are devoted to the handling of the SCP initiated calls and to the discussion of the new information flows between SCF and SSF, respectively. Finally, Secs. 7 and 8 deal with a brief presentation of IBIS, the experimental test-bed developed in CORITEL for validation of control procedures arising from IN/B-ISDN integration.

2 THE INSIGNIA APPROACH

The main objective of the INSIGNIA project is to define, to implement and to demonstrate an advanced architecture integrating IN and B-ISDN signalling. Two field trials are planned for the demonstration (respectively in the mid '97 and in the 2nd half of '98), so the project has been split in two phases with increasing

capabilities. The trials will use the ATM Pan-European pilot network to interconnect broadband islands located at the German, Italian and Spanish national hosts. In this section we will first mention the services considered in the INSIGNIA project and then we will give an overview of the technical approach, which represents the starting point for the proposals contained in this work.

2.1 INSIGNIA services

Three services have been chosen for the trial demonstration: Interactive Multimedia Retrieval (IMR), Broadband Video Conference (B-VC), and Broadband Virtual Private Network [3].

The IMR is a generalisation of the "Video on Demand" service and provides the user the means to select a multimedia application and to retrieve an audio-video information stored in information centres. The information is sent on demand and can be retrieved and controlled on an individual basis. The IN will provide a brokering facility among different service providers, will perform authentication and authorisation and will control the setup and the release of the connections between the user and the different servers.

The B-VC service consists of a real-time conferencing in which both audio and video can be exchanged among a group of users via the B-ISDN. The exchange of data (images, documents) is also possible. The IN will control the whole set of connections required to allow these multi-point to multi-point flows, will keep the information about the global call/service configuration and will support the conference management functionality.

The B-VPN service will offer virtual private network functionality like private numbering plans, control of access and egress authorisation etc. The B-VPN can be seen more as a "network" service, rather than a service directly offered to end users, and can be combined with other services.

2.2 INSIGNIA functional architecture

The functional architecture developed by INSIGNIA [4] is an extension of the well known IN architecture. Four control domains have been envisaged (see Figure 1):

- *Service control domain*: contains the overall control of the IN service, which is carried out by the Service Logic in the Service Control Function (SCF).
- *Session control domain*: this is a new concept proposed by INSIGNIA to represent the association of a set of calls and connections to provide a suitable topology for the realisation of an IN service. The session view is handled at the Service Switching Function level and represents the capabilities that can be offered by the network to the control of service logic.

- *Call control domain*: this domain includes the call control functionalities in a B-ISDN and their interaction with the IN architecture. It will be included in the IN Call Control Function together with the Connection control domain.
- *Connection control domain*: this domain includes the B-ISDN functionalities for the control of bearer connections (bc) and their interaction with the IN architecture.

The role of the IN has been extended far beyond the traditional support of supplementary services. In the INSIGNIA architecture the IN service logic decides the topology of calls / connections needed to provide a service instance, instructs the network to realise this configuration and controls the status of the different connections. The session concept is the main tool for this kind of sophisticated IN control of network resources.

Figure 1 Functional Architecture and Control Domains.

The session model represents a complex configuration of call/connections, as perceived by the IN. This model gives a common view shared between SSF and SCF of the underlying network activities. The INSIGNIA session model is reported in Figure 2.

The session object model is constituted by: *Parties* which represent the users and the “virtual party” SCP; *Bearer Connections* which represent the B-ISDN connections; *Legs* which represent the link of a party to a *Bearer Connection*.

The set of information flows on the SSF-SCF interface is based on this model: the SCF can ask to create or remove objects (i.e. *Parties*, *Bearer Connections*), the SSF reports any information in terms of these object and their states. The SSF also maps the requests of the SCF into requests for the B-ISDN network in terms of basic call/connections. In Table 1 the list of the information flows defined by

INSIGNIA for the first phase of the project is reported. A brief explanation of the flows is provided hereafter.

Figure 2 INSIGNIA session object model.

A *Service request* is sent by the SSF to the SCF to invoke an IN service, typically as a consequence of a trigger coming from call processing (e.g. a called party number is an IN number). An instance of the session is created in the SSF; it will last for the lifetime of the service relationship with the SCF. The *Request Report SSM change* allows the SCF to require the report of a possible future change of an object status. For example, these changes will happen when a connection has been successfully setup or has been released. The SSF will send a *Report SSM change* when the status change takes place. The remaining flows allow the SCF to build and to tear down the required connection topology, sending the requests to the SSF in terms of session objects. For example, *Add Bearer to session* contains a couple of existing *Party* objects as parameters and will be mapped by the SSF in the setup of a call/connection between the two corresponding users.

Table 1 Information flows at the SSF-SCF interface

<i>Information flow</i>	<i>Direction</i>
Service request	SSF → SCF
Request report SSM change	SCF → SSF
Report SSM change	SSF → SCF
Join party to session & link leg to bearer	SCF → SSF
Join party & bearer to session	“ “
Add Parties & bearer to session	“ “
Add bearer to session	“ “
Drop Session	“ “
Drop Party	“ “
Release Bearer	“ “

As outlined above, the SSF maps the requests coming from the SCF into requests for the B-ISDN call/connection processing. A typical case is the setup of a call between two parties. Therefore a core feature of INSIGNIA architecture is the “SCP initiated call setup”. The concept is similar to “third party call setup” which is proposed for future capability set of the B-ISDN, where the third party is represented by the SCP, i.e. by the IN service logic. The main assumption in the specification of this feature has been not to modify the B-ISDN signalling at the UNI and the NNI. The defined solution consists in the use of two independent calls (outgoing from the node) and in a proper modification of the call handling within the node. This enhanced call handling will correlate the signalling messages, will dialogue with IN service logic, and will control the through-connection of the user plane links.

It is worth spending some words on the relation between the INSIGNIA session model and the evolution of B-ISDN capability. To cope with the availability of equipment for the trials the INSIGNIA assumption on B-ISDN capability has been mainly limited to the “Signalling Capability Set 1” i.e. point to point moon-connection calls. However the proposed model is really open to future evolution. Two different approaches can support this evolution. In some cases, the enhancements of B-ISDN could be hidden to IN service logic and handled at the SSF level, where the mapping between the session domain and the connection domain is performed. In other cases, the session model can be easily enhanced with the adding of new object and/or new attributes to offer the new capabilities to the IN service logic control. This last approach will be followed for the introduction of the B-ISDN point-to-multipoint call into the INSIGNIA architecture, as will be described in section 5.

3 BASIC POINT-TO-MULTIPOINT OPERATIONS AND REQUIREMENTS FOR IN INTERVENTION

A point-to-multipoint call/connection allows the distribution of an unidirectional flow of data from one source, the root party, to a set of sinks, the leaf parties. In Figure 3 a general example of a point-to-multipoint call is depicted, the multicasting is performed in the local exchanges 1 and 2 and in the transit exchange. The basic point-to-point call at the User Network Interface (UNI) is specified by the ITU-T recommendation Q.2931. The recommendation Q.2971 extends the Q.2931 functionality for the support of the point-to-multipoint call/connection. Messages and information elements of the Q.2971 are an extension of those ones described in the Q.2931. The point to multipoint calls are initiated by the root by sending a SETUP message in which the point-to-multipoint configuration is specified in the Broadband Bearer Capabilities information element. This message also contains the Endpoint Reference information element which is used to distinguish the different remote parties. The

root party can send ADD PARTY messages to add further leaves and DROP PARTY messages to remove a party from the call. A leaf party can only drop itself from the call, but cannot join itself to a point-to-multipoint call. The call can be explicitly torn down by the root by sending a RELEASE message, which releases all the leaves. At the Network Node Interface (NNI) the point-to-multipoint calls are specified by the ITU recommendation Q.2721.1. It supports the same procedures defined for the UNI, obviously mapping the UNI messages into NNI messages. The Q.2722.1 allows the use of the same connection (i.e. Virtual Circuit) at the NNI for the user plane flow when the route towards two or more leaf parties is the same.

Figure 3 Example point-to-multipoint call/connection configuration

Let us consider now for what services we could benefit from IN support along with point-to-multipoint calls. A first simple case is the extension of some IN based supplementary services, like number translation services and reverse charging services to point-to-multipoint. The number translation services could be extended to point-to-multipoint calls with a one-to-many translation feature: a single called party number contained in a SETUP or ADD PARTY message could trigger IN service logic which could add a predefined set of leaves to the point to multipoint call. Broadband Virtual Private Network services could be extended to support point-to-multipoint with features like access control and private numbering planes. Finally a large set of services based on the INSIGNIA concepts could benefit from the adoption of the point-to-multipoint. On one hand, services like B-VC already considered in the INSIGNIA project could be realised in a more efficient way by using point to multipoint connections. On the other hand, distributive services with centralised control which have not been included in the INSIGNIA could be defined using the session concepts and the point-to-multipoint connections. To give an example, by means of IN control we could handle requests coming from users that want to receive an information flow which is being distributed (for example a TV channel a TV-distribution service, or a specific lesson in a Distance Learning service).

3.1 Requirements for B-ISDN point-to-multipoint call modelling in IN

The call processing and signalling activities of the switching network are modelled in the IN architecture by means of the so called Basic Call State Model (BCSM). The BCSM is a tool for representing Call Control Function (CCF) activities which can be monitored and controlled by the IN service logic.

The first requirement for an IN call model for a point-to-multipoint call is therefore to allow the control of the following features in a *basic* point-to-multipoint call (i.e. initiated by the root using Q.2971 UNI signalling):

- Call Setup (e.g. detection of an IN Called Party Number)
- Party Addition (e.g. detection of an IN Called Party Number)
- Party Answer (detection of the remote party answer)
- Call Release (detection of the release of the call)
- Party Release (detection of the release of a remote party).

Following the INSIGNIA approach for IN initiated operation, the additional requirements for an IN call model are to support:

- SCP initiated Party Addition (addition of parties to an already established pmp call on behalf of the IN)
- SCP initiated IN point-to-multipoint Call Establishment (establishment of a point-to-multipoint configuration on behalf of the IN)

4 BASIC CALL STATE MODEL (BCSM) FOR POINT-TO-MULTIPOINT CALL

The available IN standards describe the call model for a point-to-point call with a single connection, as suitable for POTS and N-ISDN network. The advances in the capability of the B-ISDN imply a more advanced modelling. The requirements coming from the multi-connection calls and from the point to multipoint calls lead to the proposals of layered call models [5]. The INSIGNIA project has developed a call model which is compatible to multi-connection (even if this capability has not been used in the field trials for practical reasons). In this section we will describe this model and propose the enhancements for the support of point-to-multipoint connections.

The INSIGNIA project has proposed a Basic Call State Model for IN and B-ISDN integration which is composed of two finite state machines, the "Call Control Manager" and the "Bearer Connection Control Manager". The former takes care of the modelling of the "call" related aspects while the latter takes care of the aspects related to the bearer connection. If we consider the evolution of the signalling toward the multiconnection, this modelling choice is future proof. Using only basic B-ISDN point-to-point call (i.e. supported by B-ISDN Signalling Capability Set 1) the call and the bearer are always in an one-to-one relationship, so that the two finite state machine are tightly coupled. When the a basic call is

established a couple of “CCM” and “BCCM” are instantiated to follow the evolution of the call/connection. This redundancy is a characteristic of the conceptual model, but does not introduces redundancies (and inefficiency) in the actual implementation. In fact for the modelling of a simple point-to-point call the Detection Points can be armed only at one level (typically at the CCM level), as it is specified in the IN Capability Set 1. The two levels model will be fully exploited when the multi-connection call will be available at the B-ISDN level: a “CCM” will represent the state of the call while a set of “BCCM” will be instantiated to represent the evolution of the different connections. While in the traditional IN modelling the BCSM is different for the originating and terminating side, the INSIGNIA project has proposed to use an unified BCSM which can be used on either side, as well as for the SCP initiated calls. However, in the following discussion on point-to-multipoint BCSM we can consider all the state machines as originating.

The INSIGNIA modelling needs to be extended for the support of the point-to-multipoint call in order to describe the evolution of the call and of the different parties. In a point-to-multipoint call there is a set of parties which can evolve independently, making it not feasible to control them within a single state machine. The proposed solution foresees to use the defined CCM and BCCM and to add a state machine representing each remote party, called “Party Control Manager”. Figure 4 and Figure 5 show the state machines for Call Control Manager and Bearer Connection Control Manager as specified by INSIGNIA, Figure 6 shows the proposed Party Control Manager.

Figure 4 Finite state machine for the Call Control Manager

Figure 5 Finite state machine for the Bearer Connection Control Manager

Figure 6 Finite state machine for the Party Control Manager

We will show how to use the proposed call modelling to control both a “traditional” point to multipoint call and the new features which are added in an IN integrated architecture i.e. the adding of parties on behalf of the IN and the SCP initiated point to multipoint. Let us describe the model behaviour analysing the setup of a traditional point to multipoint (i.e. setup by the root). As soon as the setup indication for a point to multipoint call is received, a PCM is instantiated and will evolve in parallel with the CCM/BCCM couple which is instantiated as in the point-to-point case. The CCM represents the call state while the PCM represents the state of the first remote party. The CCM is in the PIC “Call Attempt”, the BCCM is in the PIC “Bearer Attempt”, while the PCM is in the PIC “Add Party Attempt”. When the first party answers the call, the three state machines will respectively go in the Call Active, Bearer Active and Party Active PIC. The remote parties that will be successively connected are monitored by new instances of the Party Control Manager, as shown in Figure 7. No Bearer Connection Control Manager has been added below the Party Control Manager, because only mono-connection point-to-multipoint calls are envisaged.

Figure 7: BCSM instances for the control of a point-to-multipoint call

The detection points (DP) in the PCM can be armed according with the service logic requirements. A complete description of the PICs, DP and possible transitions is beyond the scope of this paper². We will give some examples of the use of the most important DPs in the PCM to show the capability of the model. Let us consider the DP “Add Party Attempt” which is encountered when the root sends an ADD PARTY message. If it is needed to monitor each adding of a new party, to allow an IN based access control service or accounting service, this DP will be armed to report each attempt, with an interruption of call processing for the access control service or with a simple notification for the accounting service. It could be needed to monitor whether the ADD PARTY message contains a

² For a complete description of INSIGNIA BCSMs (CCM and BCCM) see [4]. The PCM is quite similar to CCM.

called party number which requires IN intervention (for example a number translation service), so the "Add Party Attempt" DP will be armed with a suitable criteria.

The DP "Party Answer", together with the DPs "P_No_Answer", "P_Called_Party_Busy", allow the service logic to monitor the result of the setup phase, while the DP "Party released" allow the service logic to monitor the release of a party.

All the above detection points can be armed independently for each leaf. For example in a given service one could want to monitor only the status of a subset of the parties which are mandatory without bothering the service logic with the status of the other parties.

The detection points in the Call Control Manager allow to monitor the state of the whole call: for example the DP "Call Released", if armed, can detect the release of the whole call requested by the root party.

5 ADDING OF NEW PARTIES AND SCP INITIATED POINT-TO-MULTIPOINT CALLS

Two additional features have been introduced in this integrated architecture: i) the adding of new parties on behalf of the IN, ii) the SCP initiated point-to-multipoint call. The introduction of these two features implies a new BCSM modelling and the adding of new capabilities in the call handling inside the nodes, with minimal impact on the signalling. The proposed approach to extend the capability of the B-ISDN signalling is similar to the INSIGNIA approach for SCP initiated point-to-point calls described in section 2.

For the adding of parties on behalf of the IN, the call handler for point-to-multipoint has to be modified to receive requests from the IN and to control the signalling toward the leaf party on the outgoing UNI or NNI link. The adding of these parties will not be communicated to the root at the signalling level because the Q.2971 procedures do not allow it. The modified call handler will also intercept signalling messages from the leaves (e.g. DROP PARTY messages) which cannot be reported to the root. As far as the BCSM modelling is concerned, the parties which are added on behalf of the IN service logic will be modelled by instances of Party Control Manager as if they were added by the root. Therefore all the above described features of the PCM model also apply to this parties, allowing the IN control.

The SCP initiated point-to-multipoint call setup is supported via enhancements of the call handling functionality, without modification of signalling. As at the UNI a node can not setup a point-to-multipoint call toward a root party, a point-to-point call is established to support an unidirectional connection from the root to the node, then an independent (with respect to B-ISDN signalling) point-to-multipoint call towards the leaf parties is setup. As in the point-to-point case, the

modified call handler will correlate the signalling messages, will dialogue with IN service logic, and will control the through-connection of the user plane links. In this case the adding of new parties will be performed only by IN, as the root is not even aware at the signalling level to be part of a point-to-multipoint call. The two steps for the setup of an IN initiated point-to-multipoint call are depicted in Figure 8. The thin arrows show the control plane relationships (the direction represents the party who receive the setup) while the thick arrows show the user plane links (the direction represent the flow of data).

Figure 8: Setup of a SCP initiated point-to-multipoint call

In the BCSM modelling, the leaf parties will be represented by the PCMs, with the usual capabilities to control the result of the party setup, to monitor the release of the parties etc.

Due to the particular handling of the SCP initiated point-to-multipoint calls the CCM represents only the status of the root party. The CCM will go in the active state when the root has answered the call, and will reflect the status of this link, for example notifying a release coming from the root. The reason for this modelling is that it could be allowed to have an active link toward the root with no leaf party connected. This is different to the traditional point-to-multipoint where the call can be in the active state if at least one leaf party is connected. For example, broadcast services could require this capability to have always data flow ready to be distributed to user requiring it.

6 SESSION AND INAP INFORMATION FLOW ADVANCES

The session model developed by the INSIGNIA project needs to be slightly enhanced to support the point-to-multipoint calls. The *Bearer Connection* object will be extended to support a set of more than two *Legs*. A new attribute “*Configuration*” is added to the bearer connection object with possible values

“point-to-point” and “point-to-multipoint”. The *Leg* objects will represent the root and the set of leaves which compose a point-to-multipoint calls. The *Leg* objects are therefore used to reflect the state of the leaf parties. The detection points monitored at the Party Control Manager level will cause object state changes in the *Leg* objects within the session. The service logic can request the monitoring of these state changes with the *Request Report SSM change* info flow as explained in section 2. There is no substantial difference at the session level in the handling of *Leg* objects for “root initiated” or “SCP initiated” point-to-multipoint calls. The set of information flows for the support of point-to-multipoint has been extended with two new flows as reported in Table 2:

Table 2 New SSF-SCF information flows for the support of point-to-multipoint

<i>Information flow</i>	<i>Direction</i>
Add point-to-multipoint bearer	SCF → SSF
Join parties to point-to-multipoint bearer	SCF → SSF

The *Add point-to-multipoint bearer* info flow allows the service logic to establish a SCP initiated point-to-multipoint call providing the root party and the list of leaf parties to be connected. A *Bearer Connection* object will be created with the *Configuration* attribute set to “point-to-multipoint”, the *Party* objects will be created if the parties does not still exist in the session, one *Leg* object for each party will be created to represent the link with the *Bearer Connection*. The *Join parties to point-to-multipoint bearer* info flow allows the service logic to add a set of new leaf parties to a point-to-multipoint (both “root initiated” and “SCP initiated”) call. An existing *Bearer Connection* object is provided in the message, while the rules for creating *Party* and *Leg* objects are the same described above.

7 TEST BED FOR THE PROPOSED MODELLING

The proposed modelling has been implemented in a test bed running in a local area network, in the context of a CORITEL project called IBIS (Implementation of integrated B-ISDN and IN Signalling). Only control aspects have been considered in this test bed. The functionalities of the different network elements have been described with the SDL language and implemented using the Telelogic SDT. The reference functional architecture is reported in Figure 9. At the UNI a suitable subset of the recommendation for point-to-point (Q.2931) and point-to-multipoint (Q.2971) has been implemented realising the protocol state machines for the user side and the network side of UNI. These machines send and process the signalling messages on the UNI and offer a primitive based interface towards the switch call handling processes (i1). A call handler has been developed within the SSP to control a set of UNIs. This call handler controls the basic point-to-point and point-to-multipoint calls and integrates the BCSM functionality to allow

the interaction with IN, acting as the CCF. An internal interface towards the SSF has been defined (i2) starting from INSIGNIA specifications. The SSF realises the session model and is capable to dialogue with the SCF using the information flows presented in the paper (interface i3). Finally a “dummy” SCF has been developed to complete the test-bed environment. This SCF can send and receive a predefined sequence of information flow to test the overall functionality.

Figure 9 Reference functional architecture for the test bed implementation

The software architecture of the test bed is shown in Figure 10. A set of stand-alone applications for the different users and one application for the SSP have been developed. The UNI messages among these applications are formatted according to recommendation and are exchanged using socket interfaces provided by the UNIX operating system. The internal interfaces i1, i2, i3 within the Network Application are based on the exchange of SDL signals.

8 MESSAGE SEQUENCE CHART FOR A SAMPLE SCENARIO

In this section we provide a scenario to highlight some features of the proposed architecture. User A requires a point-to-multipoint call providing an “IN” called party number which triggers IN involvement. We assume that the IN service consists in the adding of a set of leaf parties, and in the monitoring that all the required party are connected. A Message Sequence Chart output from the test-bed simulation is reported for this sample scenario in Figure 11 (only parties B and C

are added in this simplified scenario). All signals internal to SSF, CCF and UNI machines have been removed from the MSC showing only the messages on the i1, i2, i3 and all the signals parameters have been removed.

On the interface i1 the primitives from and to the UNI signalling machines are shown. The first primitive is the setup indication coming from the UNI connected to user A. On the interface i2 the CCF reports the Detection Points to the SSF, the SSF requests the CCF to arm the DPs, to complete a call, to add a new call. On the interface i3 the SSF-SCF information flows are reported.

Figure 10: Architecture of the test-bed

9 CONCLUSIONS

In this paper we have presented the INSIGNIA approach for IN and B-ISDN integration and its extension towards the introduction of point-to-multipoint calls. We have proven that the INSIGNIA architecture is open to the evolution of network capability. We have considered the impact of point-to-multipoint in the Call Control Function proposing the needed enhancements to Basic Call Modelling, in the SSF showing the enhancements to the Session model, and in the SSF-SCF interface proposing new information flows to be added to this interface. The proposed architecture has been implemented in a simple test bed.

Figure 11 Message Sequence Chart for an "IN" point-to-multipoint call

10 REFERENCES

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BIOGRAPHIES

Marco Listanti received his Dr. Eng. degree in Electronics Engineering from the University "La Sapienza" of Roma in 1980. He joined the Fondazione Ugo Bordoni in 1981, where has been leader of the TLC network architecture group until 1991. In November 1991 he joined the University of Roma, where he is currently an Associate Professor in Switching Systems. He also holds lectures at the University of Roma "Tor Vergata" on Communications Networks. His current research interests focus on multimedia broadband communications, high throughput switching architectures and integration between the Intelligent Network and the B-ISDN.

Stefano Salsano was born in Rome in 1969. He received his degree with honours in electronic engineering from University of Rome "Tor Vergata" in 1994, with a thesis on evaluation of signalling load in a IN based PCS environment. Then he has been with CORITEL, a research institute on telecommunications, as a scholarship holder. Now he is a Ph.D. student at the INFOCOM department, University of Rome "La Sapienza". Currently, his research interest include architectures and signalling protocols for broadband networks, focusing on the integration of the B-ISDN with Intelligent Network.