Planning the Capacity and Performance of Intelligent Networks based on the ITU-TS IN Capability Set 1

Marcos Bafutto[*]
Telecomunicações Brasileiras S.A. - Telebrás
SAS Q. 6, Bl. H, 8. Andar
70313-900 Brasília - DF, Brazil

Michael Schopp
University of Stuttgart
Institute of Communications Switching and Data Technics
Seidenstr. 36, D-70174 Stuttgart, Germany

Abstract

A large number of new services is expected to arise with the wide introduction of the IN concept. There is the necessity to have network performance and capacity figures already available in the service specification phase. It is also important to properly consider the IN as an integrated part of a telecommunication network. The additional load generated by these new IN services may lead to a performance degradation that can spread beyond the IN environment, which, in turn, affects not only the quality of the new IN services, but also the services already offered by the switched network. In this work, a model approach for the Intelligent Network Application Protocol (INAP) derived directly from ITU-TS Recommendations is presented. The modelling approach is based on the construction of submodels for the various components of the IN architecture leading to a multiple-chain queueing network system. The analysis is conducted using hierarchical decomposition techniques, allowing a detailed consideration of the signalling network protocol. The resulting model includes aspects like, e.g., the traffic mix corresponding to the IN and non-IN (ISDN, PLMN, PSTN) services and multivendor implementations of the signalling network. These concepts are used as a basis to develop a planning tool concept for the IN environment. The developed planning tool concept covers particularities of the IN service creation process and allows the consideration of various aspects of different implementation strategies for the IN infrastructure. A simple case study outlines the application of the tool concept to a network supporting the Credit Card and Freephone services.

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1 Introduction

The planning process in an IN environment contain aspects that must be carefully handled. One of these aspects is a direct consequence of the provided platform for the delivery of new services in a fast and flexible manner. The large number of expected new services may be characterized by a complex traffic profile. There is the necessity of network performance and capacity figures to be available already in the service specification phase.

In this article, a modelling approach for the INAP protocol is presented. The resulting model allows the incorporation of aspects of the support network like, e.g., the signalling traffic mix corresponding to the IN and non-IN (ISDN, PLMN, PSTN) services and multivendor implementations of the signalling network. For the purposes of the IN planing tool concept, the set of reusable functions, the Service Independent Building Blocks (SIBs), standardized by the ITU-TS are redefined in terms of information flow between the IN components. Based on these premises, a planning tool is developed. The tool is suitable to support the planning of intelligent networks already in the service definition phase according to given service profile, load and grade of service figures, or to detect bottlenecks.

2 Intelligent Network Concepts

The IN concept [12], [19], [20], which in the first phase is known as IN Capability Set 1, is currently subject to international standardization effort and a set of recommendations have already been made avaliable [6]. A framework for the design and description of the IN architecture is given by the IN Conceptual Model. This model is divided in four planes addressing service aspects, global functionality,distributed functionality and physical aspects of an IN.

The service plane represents an exclusively service-oriented view and no aspects regarding the implementation of the services are handled.The services of the service plane are mapped onto the service logic in the global functional plane. A service logic is a chained sequence of standardized, monolithic, and reusable network capabilities called Service Independent Building Blocks (SIBs). The SIBs are service independent and describe a single complete activity. The ITU-TS has standardized a set of 13 SIBs.

The functionality required to support the realization of the SIBs are contained in the functional entities of the distributed functional plane.These functions include end user access and interactions, service invocation and control, and service management.The interface between the user and network call control is the Call Control Agent Function (CCAF). The call/service processing and control is provided by the Call Control Function (CCF). The real-time call processing service logic is contained in the Service Control Function (SCF). The Service Switching Function (SSF) is the set of functions required for interaction between CCF and SCF, e.g., recognition of service control triggers, signalling management, etc. The customer and network data are stored in the Service Data Function (SDF). The resources necessary for user interaction are represented by the Specialized Resource Function (SRF).

These functional entities are mapped onto the physical entities of the physical plane. The physical entities of the IN CS 1 architecture consists of Service Switching Points (SSP), Service Control Points (SCPs), Intelligent Peripherals (IPs), Adjuncts (ADs), and Service Nodes (SNs).

The SSPs (IN Switches) are switches that have the capability to detect and handle an IN call. In an IN environment, the call control of an IN Switch has the capability to identify the invocation of an IN feature through the detection of a trigger event. The SCPs are the nodes that provide real-time call processing service logic for the IN calls.The Adjuncts contains the same functions as the SCP, but they are directly connected to an SSP through a high speed interface.The SNs allow the offering of particular and complex IN services, when a close coupling between service logic and resources exists. The IP provides a flexible information interaction platform between the user and the network. Examples for such interactions are represented by voice announcements, voice recognition, dual tone multi-frequencies (DTMF), digit collection, etc.

The interface between the IN Switches and the SCP is based on the signalling network capabilities. The IPs may also be connected through the signalling network depending on the implemented architecture option. The Adjuncts and the Service Nodes are directly connected to the IN Switches using other communication interfaces (Q.931 and Q.932[1]).

The support for the interactions between the functional entities of the IN Capability Set 1 is provided by the Intelligent Network Application Protocol (INAP). The INAP is a ROSE like user protocol. ROSE capabilities are contained in the TCAP block of the signalling network protocol and in DSS 1 (Q.932[8]). If the communication support is the signalling network, the related Application Protocol Data Units (APDUs) are transported by TCAP messages. Otherwise, the Q.931 REGISTER, FACILITY and Call Control messages in DSS 1 are used.

In this paper, only the case where the supporting protocol is the Signalling System No. 7 is considered.The set of protocol standards for the signalling network [13], [16] has been standardized by the ITU-T[5].The functional structure of Signalling System No. 7 is divided into the Network Service Part (NSP) and various User Parts (UPs).The NSP consists of the Message Transfer Part (MTP) and the Signalling Connection Control Part (SCCP), while the UPs are the Telephone User Part (TUP), the Integrated Services Digital Network User Part (ISUP), and the Transaction Capabilities (TC). The TC can be further subdivided into the Transaction Capabilities Application Part (TCAP) and the Intermediate Service Part (ISP), which is currently empty.

3 Modelling Framework and Analysis

The INAP recommendations provide a description of the interfaces between the elements of the IN architecture, with the respective information flows and data format. The internal functionality is defined in terms of state transition diagrams, and the internal behavior of the underlying element cannot be deduced straightforwardly. Therefore, it is not possible to determine an exact model without knowledge about the particular implementation.

However, in an approach proposed by Kritzinger[14] the model for a protocol is derived directly from the state transition diagram description. The state transition diagram is transformed into an equivalent transition relation diagram. Here, the idea is the construction of a model based on the processing of events in a Finite State Machine (FSM) diagram, i.e, the transitions.The vertex in this new graph corresponds to a transition in the state transition diagram. The advantage is that this latter formulation allows the assignment of a distinct time spentin each state. In this new diagram two main types of states are distinguished, the active states represent the execution of acertain amount of instructions by a local processor, and the delay related to some response, e.g., time-out, are designated as passive states. The resulting model can be viewed as a multiple-chain queueing network model.

The application of these concepts to the INAP protocol, allows to model the IN elements as service centers, with the routing chains representing the different services. The transitions in the IN elements are derived from the information flow contained in the recommendations. The time spent in a transition is the processing time of this event/message in the physical processor. The principles of this modelling methodology can be explained using the sequence of events in a simplified version of the Credit Card Service. An actual service implementation would be more complex by considering exception conditions, e.g.,incorrect input, service interruption, etc., but the basic methodology still can be applied straightforwardly.

- *In the IN Switch*: The user dials the code for the service and the called number. A trigger in the Basic Call State Model (BCSM) indicates that the call is to be handled as an IN call. Then a transition is observed (IDLE ⇒ TRIGGER PROCESSING). The processing actions are to check if any overload control mechanism, e.g., call gapping or limiting, is active, and to determine the SCF accessibility, if any Detection Point (DP) criteria is met, etc. An operation "Collected Information" (chain A1 from SSP to SCP in **Figure 1**) is sent to the SCF, and a transition occurs (TRIGGER PROCESSING ⇒ WAITING FOR INSTRUCTIONS).

- *In the SCP:* An instance of an SCF Call State Model (SCSM) is created and the corresponding Service Logic is invoked. The corresponding transition is (IDLE ⇒ PREPARING SSF INSTRUCTION). The service logic determines that an announcement must be played and some digits collected, e.g., card number and personal identification number. This implies the transition (PREPARING SSF INSTRUCTION ⇒ ROUTING TO RESOURCE & DETERMINE MODE). The SCF determines that the SSF has no SRF capability, i.e., no local IP is available. An operation "Establish Temporary Connection" " (chain A1 from SCP to SSP in **Figure 1**) containing the SRF address, i.e., IP address, is sent to the SSF. The transition in the FSM diagram is (ROUTING TO RESOURCE & DETERMINE MODE ⇒ ROUTING TO RESOURCE & WAITING FOR ASSIST INSTRUCTIONS).

- *In the IN Switch:* The incoming message is processed and a signal is released to the ISUP requesting the establishment of a connection to the remote IP. This event produces the transition (WAITING FOR INSTRUCTIONS ⇒ WAITING FOR END OF TEMPORARY CONNECTION). A signalling activity

corresponding to the call set-up between the IN Switch and the IP is observed on the signalling network.

- *In the IP:* The bearer signalling is detected, and causes the transition (IDLE ⇒ CONNECTED). The call set-up message from the IN Switch has no operation concatenated, and an operation "Assist Request Instructions Needed" (chain A3 from IP to SCP in **Figure 1**) is sent to the SCF.

- *In the SCP:* The SCF decides the announcement to be transmitted to the user and that some information is to be collected. The operation "Play Announcement and Collect Information" (chain A3 from SCP to IP in **Figure 1**) is sent to the SRF with the permission to release the connection with the IN Switch when the operation is completed. The resulting transition is (ROUTING TO RESOURCE & WAITING FOR ASSIST INSTRUCTIONS ⇒ USER INTERACTION)

The remaining actions are not further listed, but they can be determined in the same way. The complete set of actions performed for the example are represented in **Figure 1**. In this case the IN elements are considered as single servers and the signalling network is represented by an infinite server (IS). The consideration of all supported services results in a multiple-chain queueing network system.
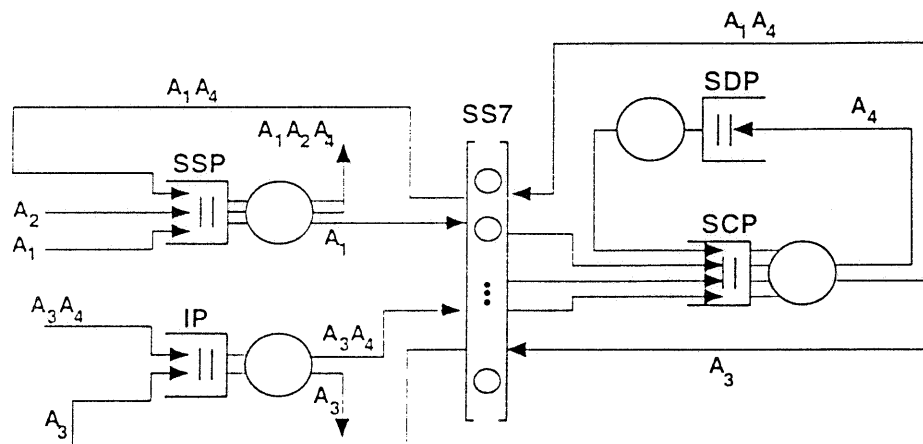

Figure 1 - Model for the simplified version of the credit card service

In the IN level, the signalling network is considered as a "black box".The transit times are analyzed by a separate procedure, therefore, the results are assumed to be known and were modelled by an infinite server. In order to allow a more detailed modelling and the consideration of the signalling traffic corresponding to PSTN, ISDN, and PLMN, a hierarchical decomposition is applied. The signalling network is modelled using the methodology described in[22]. Each submodel is derived directly from the CCITT functional specifications [5] including internal mechanisms such as segmenting/forking of messages, thus reflecting the internal behavior of the underlying functional blocks. The basic idea is the observation that, in the CCITT specifications, both the set of functional entities and the distinct information flows through these entities are precisely defined. From this, it is possible to construct "virtual" processor models. In a further step, these virtual models are mapped onto particular implementations, allowing the analysis of

signalling networks in a multivendor environment. The reader is referred to [1], [3] for more details on the analysis of the signalling network.

The analysis of the IN environment is conduced considering the IN application and the signalling network separately. A hierarchical decomposition is applied to the signalling network part of the model. The principle of decomposition is to break up a complex system into its subsystems in order to achieve a reduction in the complexity of the whole system. This approximation is valid if the system can be classified as nearly decomposable [10], [15], i.e., the interactions between the subsystems are largely dominated by the local interactions inside each subsystem. The rest of the system is approximated by a flow equivalent service center, that meets the residence time and flow rate characteristics of a customer.

The application of the hierarchical decomposition to the signalling network part of the IN model allows the representation of the signalling network as a flow equivalent service center. In this work the corresponding flow equivalent service center is approximated as an infinite server. The resulting model for the IN is a multiple chain queueing network.

The signalling network in its turn is analyzed approximately using decomposition and traffic aggregation technics (see [3]). The signalling links, which correspond to MTP Levels 1 and 2, are analyzed using the formulas contained in CCITT Recommendations [5]. The models for the remaining functional blocks (MTP Level 3, SCCP, TCAP, and ISUP) are classified as M/GI/1 queueing systems with feedback. These systems are analyzed using the method of moments to derive mean performance values. This approach was introduced in [21], and later extended in [17], [18] to consider branching, forking, and more sophisticated scheduling strategies.

The results of the SS7 analysis yields the mean sojourn time for the messages in the infinite server representing the SS7 in the IN model. The analysis approach for the IN model is similar to the one addopted for the SS7: the arrival processes to the IN elements are approximated as Poisson processes and the IN elements are analysed separately as M/GI/1 systems.

The end-to-end delay of a IN operation arrises from the composition of the partial delays in the network elements along the path between the origin and destination.

There are other aspects not included in the above methodology. The INAP protocol includes procedures to manage overload situations based on a call gapping mechanism. The service user may also determine, through the Limit SIB, the upper limit for the number of calls related to a service. In this work stationary conditions are assumed, but the behavior of the traffic pattern for some services, e.g., televoting, may have a bursty characteristic. In the IN Switches, the implementation of the SSF functionality may be strongly coupled with the call control, e.g., through update of the switch software, resulting in difficulties to determine the load values. In the SCP the variation in the grade of complexity of the services may not allow a homogeneous distribution of the supported services among the processing units. In the database (SDF) there are problems related to data contention (Locking, Deadlock) and resource contention (IO channel) that are neglected.

4 Outline of a Planning Tool Concept for the IN

With the wide application of the IN concept a large number of new services may be expected. In this case, it is desirable that the performance implications as well as the impact of a service introduction on the physical network are already known in the service specification phase.

The development of a tool concept for the IN must be able to take into considerationthe integration of the IN in a telecommunication environment.The IN shares the signalling network capabilities with a variety of services.e.g., ISDN, mobile communications, UPT, etc., and the resulting trafficmix must be considered in the IN analysis.Previous work concerning the development of a planning tool for the signalling network has already been done [1], [3]. Therefore, the IN planning framework was implemented as a modular extension of a existing tool for the signalling networks. The planning tool concept is composed by the following steps:

4.1 Step 1: Service Logic Definition

The basic components of IN service definitions are the SIBs. A SIB can result in distinct information flows in the physical plane. The User Interaction SIB, for example, impacts the network in different forms depending on factors like, e.g., number of announcements to be played, amount of information to be collected, the location of the IP, etc. There are also exception situations derived from the logic of a SIB that should be taken into account, e.g., when the interactionis interrupted by the user, time-out mechanisms, etc.

In this first step a more detailed view of the SIBs in terms of information flow between functional entities (FEs) is considered. All the combinations for the input and the possible results of a SIB are identified and isolated as a new element denominated sub-SIB. The objectives of the sub-SIBs is to cater for the set of combinations which may influence the global network performance. Therefore, from the protocol description of the recommendations all information flows between FEs defined in the INAP protocol are also included into the sub-SIBs. These elements have the additional advantage to provide the service designer with a more detailed description of the SIB behavior.

The "Queue" SIB for example allows 5 logic outputs: "ResourceAvailable", "Call Party Abandon", "Queue Timer Expiry","Queue Full", and "Error". These logic outputs are not enough to define the impact of the SIB on the network resources. It is also necessary to consider additional situations that may influence the network performance, like, e.g., if an announcement is played to the queued call, if timers must be reset, etc.The consideration of these factors leads to a set of 10 sub-SIBs for the original "Queue" SIB.

The recommendation Q.1214 defines 13 SIBs and from these original SIBs over 120 sub-SIBs were derived. However, the last report of the SG-11[7] includes a new SIB (Authentication SIB) defined for the interface between the SCF and the SDF based on the X.500. These reports will be submitted for approval in the next ITU-T meeting and are not considered in this work.

The identified sub-SIBs are available in a catalog as the new basic elements for the service logic definition in the developed planning environment. The resulting information

flow between FEs for each individual sub-SIB can be exactly determined from the ITU-T recommendations. The FEs are, in this point only functional elements that must be further mapped on the real entities (the PEs). There are sub-SIBs that require the same information flow between FEs. In this case a distinction is still necessary, since the message length is determined by the operation parameters.

A new service is defined as a chain of these sub-SIBs. Generally, the service logic depends on decision events and consequently the chain of sub-SIBs approaches a tree structure. For the tool purposes, this tree structure is not feasable and all possible paths are represented linearly in scenarios of the service logic, as shown in the **Figure 2**.
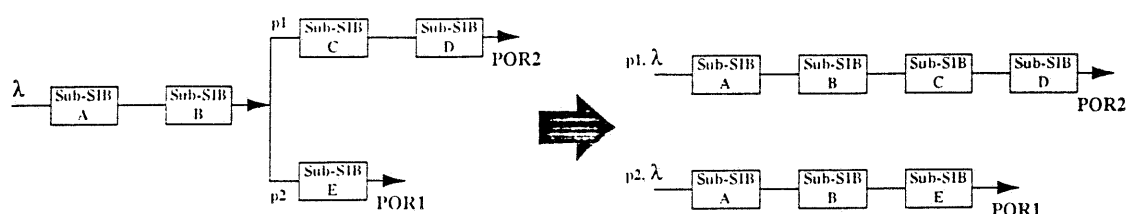

Figure 2 - Linearization of the service logic

4.2 Step 2: Mapping of the FEs on the PEs

The definition of the service logic occurs without considering the physical network structure and the service developer is not informed about how a SIB is realized on the physical network. A "User Interaction" SIB, for example, may require the set-up of a connection to an IP, if no SRF function is available in the underlaid IN switch. Therefore, a further step is the description of the IN physical structure, i.e., the mapping of the FEs involved in the service logic description on the IN elements. This information allows an automatic transformation of the information flow between FEs derived for the sub-SIBs in messages exchanged between physical entities.

Additional information concerning the exchanged IN operations must be provided. For the individual operations the mean processing time required for an operation „x" in a network element as well as the corresponding message length must be determined. This value may be obtained from measurements of the required mean processing load for an operation „x" in an empty system. This information is implementation dependent and must be available for the equipments supporting the IN platform.

At this point, a defined service logic corresponds to a scenario of messages exchanged between the IN elements. This scenario still needs to be complemented with non-IN related signalling. These signalling is required to set-up and clear connections over the supporting network. This is also necessary for the consideration of the case where the originating switch has no IN capabilities and a connection must be set-up to the next SSP.

4.3 Step 3: The IN-Traffic Matrix

The traffic values for the scenarios corresponding to the supported service logic between two end points are contained in the traffic matrix. Consequently, there is one traffic matrix for each deployed service. The description of the traffic matrix in an IN environment is more complex than for the traditional telephony. In a deregulated environment, it is possible that in a given city the market for a given service is shared between diffenrent service providers. These competition between IN service providers can lead to a spliting of the originating traffic of an IN switch to several SCPs. The same argument is valid for centralized IN elements, like, e.g., the IPs. In the cases where this situation is identified the user must also provide the splitting factor of the originating traffic to these elements.

4.4 Step 4: The Traffic Flow Analysis

With these input data, a global traffic flow analysis is performed in order to determine the amount of information passing through the network elements. Therefore, the mean call attempt loading for each type of IN operation is calculated for the SS7 network, IN Switches, Adjuncts, SCP, and IPs. At this phase, the output information concerning the mean utilization of the elements is generated. In order to provide a better survey on the impact of the introduction of a new service in an existing network, the load information is already given with respect to each service at this stage of the analysis.

4.5 Step 5: The SS7 Analysis

One of the results of the flow analysis is the call arrival rate of IN operations to the SS7 network. This information is then used as input data for the already available signalling network planning tool. Additional traffic figures corresponding to the non-IN services, e.g., ISDN, mobile communication, etc., are mixed with the IN messages in order to provide a more realistic view of the signalling network environment. The results of the signalling network planning tool allow the evaluation of the impact of the additional IN service on the signalling network, as well as the end-to-end message transfer delay for the IN messages.

4.6 Step 6: The IN Analysis

The results obtained from the signalling network analysis are returned to the IN model. Here, the signalling network corresponds to an infinite server with the mean delay time for each message type obtained from the signalling network delay analysis. The IN network is analyzed considering the system as a multiple-chain queueing network. The results yield the mean time required for every particular operation. This results are returned to the service designer and the impact of the new service introduction on the IN performance can be evaluated. The tool execution is schematized in **Figure 3**.

5 A Simple Case Study

In order to provide an overview on the application of the modelling concept, a simple case study is provided. A network topology consisting of an SCP, an IP, and two SSPs interconnected by an STP is considered. A real network would be much more complex, with a larger number of SSPs and different topology arrangements, but nevertheless, the analysis can be carried out in the same way.
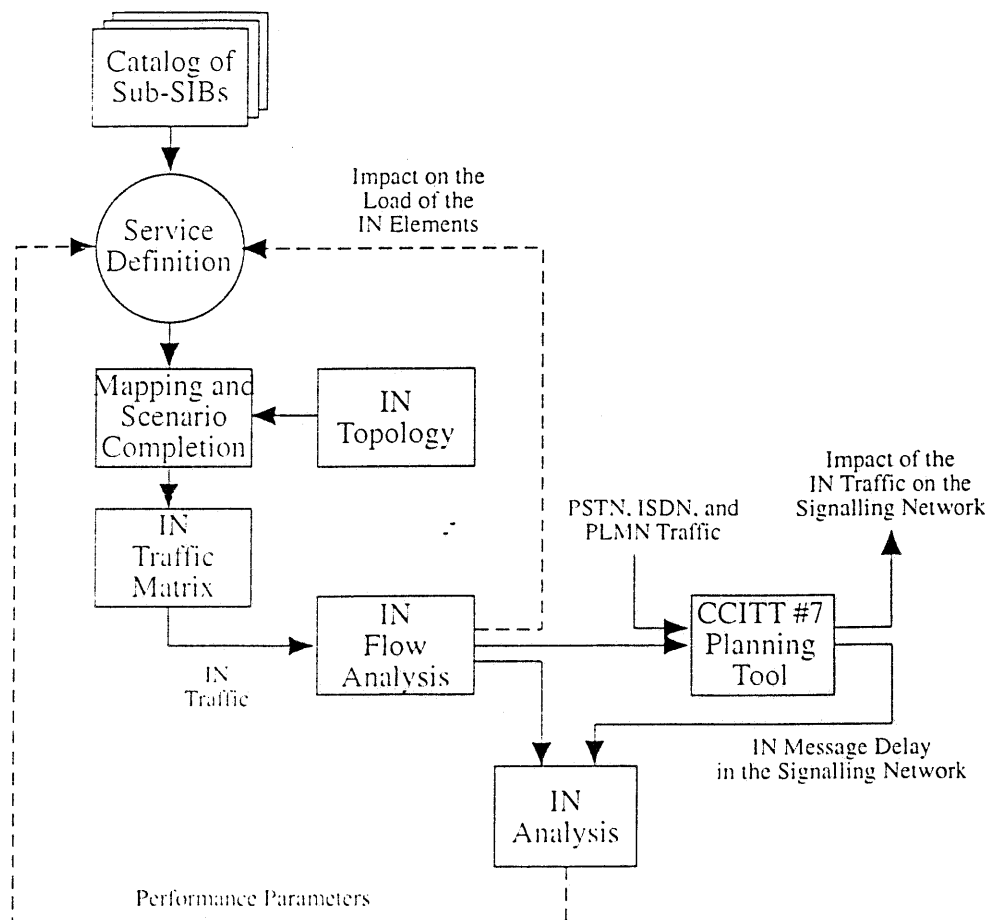

Figure 3 - Planing tool concept for the IN

The IN services implemented in the network are the Freephone and the Credit Card Service. The service script of the Freephone service requires an address translation to determine the call routing and may be designed using a sub-SIB of the Translate SIB. The Credit Card service is performed as described in Section 4 using sub-SIBs of the User Interaction SIB and the Screen SIB. The information flow between the FEs are described in the sub-SIB catalog. The FEs are further mapped onto the physical entities considering the IN topology. The topology and the corresponding model for the network supporting the underlying services are depicted in Figure 4. The chains identified by (A) and (B) correspond, respectively, to the Credit Card and Freephone service originated at the SSP with code 100. The same services generated at the SSP with code 200 are represented by the chains (C) and (D) respectively. The resulting model in this case is a multiple-chain open queueing network. The number of chains is a function of the complexity of the related services and may be large for networks with a great variety of services.

The realization of the IN services requires the exchange of messages over the signalling network for the set-up and release of connections. These signalling scenarios are not represented in the IN model, but they must be considered in the analysis of the signalling network. The credit card service, for example, requires additionally the set-up of a
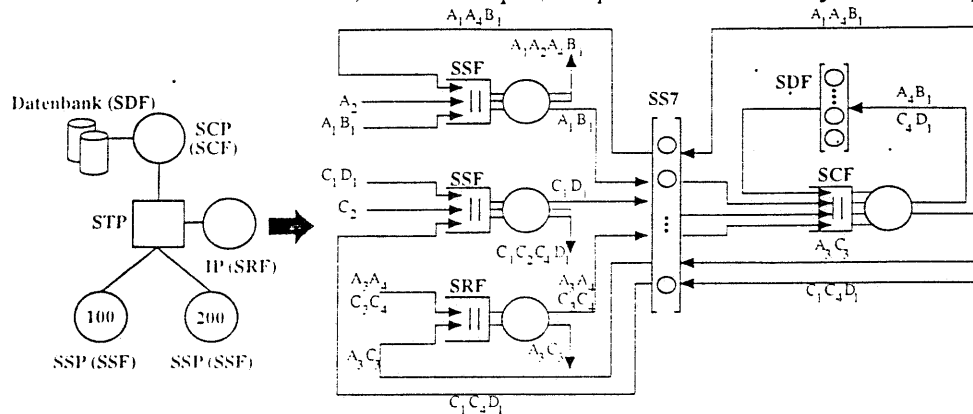

Figure 4 - Topology and derived model for the IN case study

connection between the originating SSP and the IP. These scenarios completes, from the point of view of the signalling network, the description of the information exchange. In addition, the message processing times in the servers of the IN model must be provided. The processing times for the chains in the servers are given by **Table 1**. In order to incorporate the data retrieval delay, a mean service time of 200 ms is attributed to the SDP infinite server.

Table 1 - Service time for the chains

Node	A1	A2	A3	A4	B1	C1	C2	C3	C4	D1
SSP(100)	20	10	-	20	15	-	-	-	-	-
SSP(200)	-	-	-	-	-	20	10	-	20	15
IP	-	-	25	20	-	-	-	25	20	-
SCP	15	-	5	10	10	15	-	5	10	10

The IN planning process aims to accommodate a given service demand with a specific grade of service. However, the characteristics of the IN environment require the provision of the necessary infra-structure without any forecast of service mix or traffic levels. Therefore, the effect of several traffic profiles on the network must be carefully analyzed. In this case study two traffic profiles are considered. The traffic profile 1 consists of 20% credit card calls and 80% Freephone calls. In a second case, the same traffic values are assumed for both services: 50% each. The originating IN traffic is the same for both SSPs.

The grade of service of interest for the Freephone service is the retrieval time of routing information in the SCP (operations B1 and D1). In the credit card service, the time between the end of the dialing and the reception of the recorded message requiring the user identification is considered. This time interval for the SSP with code 100 is given by the summation of the times required for operation A1, operation A3, and the connection set-up time between the SSP and the IP. The analysis is interrupted as soon as any IN element is overloaded. All results are presented as a function of the IN call rate.

The IN message flow analysis yields the mean load of the IN components, i.e., the impact of the IN services on the various elements. This information allows the dimensioning of

the IN elements according to the given service mix and traffic figure. Another output of this phase is the IN information flow through the signalling network. The IN information flow through the signalling network is represented by TCAP messages. The length of these TCAP messages are generally variable. In this example it is assumed that for the Freephone service the TCAP messages are 20 and 30 bytes long depending on the component portion (INVOKE or RESPONSE). The same messages for the Credit Card service are 60 and 70 bytes long respectively.

The messages are mixed with the signalling traffic of the non-IN services, and used as input data in a separate signalling network planning tool. The signalling network related parameters are assumed to be the same as in [2], with the non-IN signalling traffic represented by the ISDN scenarios. It is assumed that the non-IN traffic between the SSPs are represented by ISDN calls. The ISDN call rate in each direction is 4.0 Calls/s. The results of the signalling network analysis for a traffic profile consisting of 20% of credit card and 80% of freephone calls are shown in **Table 2**.

Table 2 - Results of the signalling network analysis for the traffic profile 1 (in ms)

IN Calls/s	Signalling Network Analysis						Connection Set-up Time
	Operation						
	A1		A3		B1		
	INV	RES	INV	RES	INV	RES	
0.0	94.4	78.9	94.3	78.8	84.3	68.9	295.8
4.0	96.1	80.5	95.4	79.9	86.1	70.5	297.0
8.0	98.2	82.5	96.7	81.3	88.2	72.5	300.7
12.0	100.8	84.9	98.5	83.1	90.8	74.9	304.3
16.0	104.5	88.3	101.1	85.6	94.5	78.3	309.9
20.0	109.7	93.2	105.1	89.5	99.7	83.2	318.9

The analysis results for the retrieval time of routing information in the SCP considering the assumed traffic profiles are depicted in **Figure 5**. **Figure 6** shows the results for the time between the end of the dialing and the reception of the recorded message requiring the user identification of the credit card service.
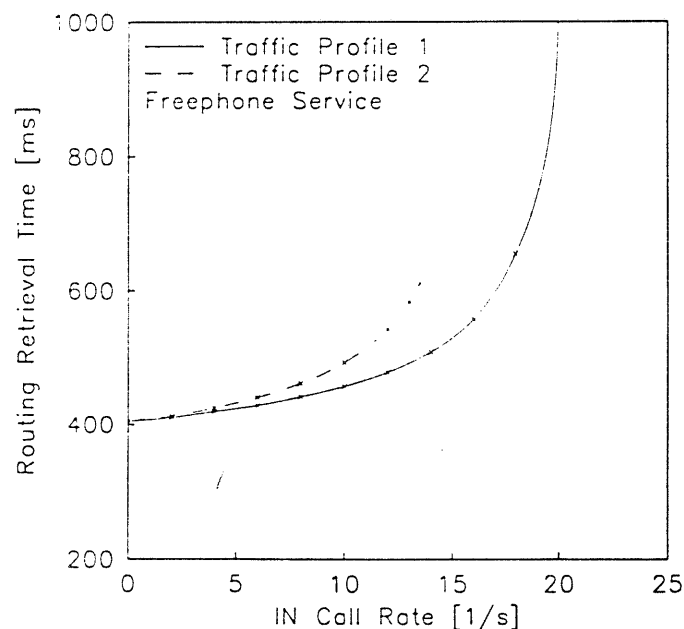

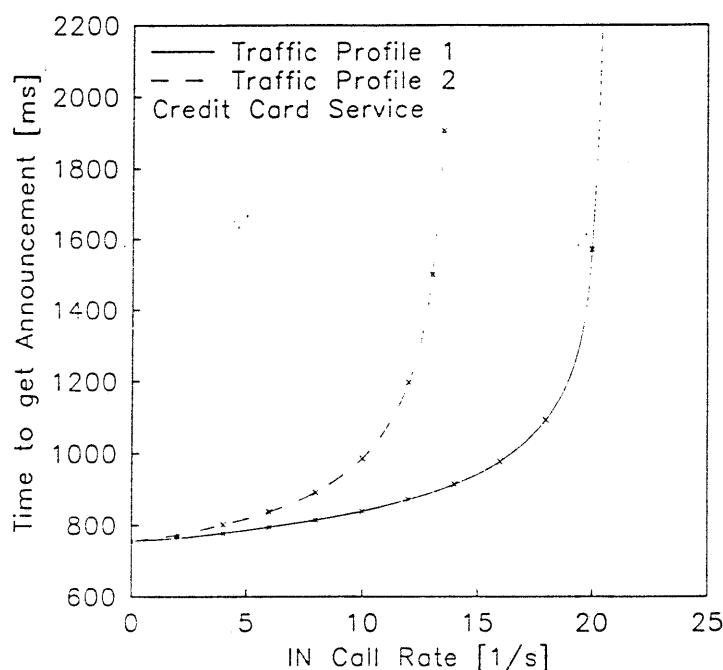Figure 5 - Routing retrieval time in Freephone service

Figure 6 - Time between end of dialing and reception of recorded message in credit card service

6 Conclusions

The impact of the introduction of new IN services on some resources, like e.g. the signalling network must be properly analysed considering the already established services represented by the ISDN, PSTN or PLMN. The additional load generated by the new IN services may lead to a performance degradation that can spread beyond the IN network, which, in turn, affects not only the quality of the new IN services, but also the services already offered by the support network. Therefore, it is crucial that the performance and capacity figures for the IN, as well as the corresponding impact on the signalling network are available already in service specification phase.

In this paper, an approach for the modelling of an IN network has been presented. It is based on the construction of submodels for the various components of the IN network using a generic modelling approach that derives a multiple-chain queueing network system from the state transition diagrams of the network elements. The model is analyzed with hierarchical decomposition technics.

Based on this modelling framework, a planning tool for the IN CS 1 was implemented taking advantage of an already existing software basis for the support of the signalling network planning process. The implicit consideration of the IN and non-IN traffic mix in the signalling network and the detailed description of the IN mechanisms through the sub-SIBs allow to plan the introduction of new IN services in a network already in the service specification phase, considering load and grade of service figures, and to detect potential system bottlenecks.

Acknowledgments

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Programme

Regional International Teletraffic Seminar

4 - 8 September 1995

South Africa 1995

Monday 4 September 1995

Time	Session	Speaker	Country
07:30	Registration		
08:45	Welcome	Derek Fyfe, Technology Strategist: Telkom	South Africa
08:50	Opening ceremony	Dr Brian Clark, Managing Director and Chief Executive Officer: Telkom	South Africa
09:00	Keynote address		
	Teletraffic Engineering: From fundamentals to applications	Dr Paul Kuhn, President of the International Teletraffic Congress ·	Germany
09:30	Economics of good measurements, models and methods	Dr Charles Pack, Executive Director: Bellcore	USA
10:00	**Tea**		

Session Chairman: Americo da Silva

Time	Session	Speaker	Country
10:30	"House rules"	Amanda Singleton, Senior Manager: Corporate Communications Telkom	South Africa
10:45	Evolution of telecommunication services and its impact on the CCS 7 network load	Dr Volker Kesling	Germany
11:15	Throughput performance at upper layer in ATM networks with fairness Discarding	Dr KT Ko, SCH Chan, EWM Wong	Hong Kong
11:45	"The ATM Lab"	Marcello Ruiz, Nico de Jager	South Africa
12:15	Support for open multi service networks	Kobus van der Merwe, Shaw-Cheng Chaung	South Africa
12:45	**Lunch**		