Technical Aspects of Interconnect Management of Multimedia IP-based Networks

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Abstract – **In this paper some possible interconnection architectures regarding VoIP service are taken in consideration. The integration of the service functionality of Internet and PSTN/ISDN is a long process, which has to be carefully investigated in order to increase the operability of the service functions and to define appropriate architectures for the management of the QoS, the efficiency and the financial aspects of the network operation.**

Keywords – **Interconnection, NGN, VoIP, Quality of services, Service integration**

I. INTRODUCTION

In this work some interconnection aspects are introduced. Especially the possible ways to interconnect between PSTN/ISDN and NGN are examine. On the base of versatile architectural decisions some scenarios for end-user connections are proposed and analysed. As a part of Multimedia services the VoIP service is taken in deeper consideration.

II. INTERCONNECTION ASPECTS

A. Quality of Services in NGN and NGI

This work deals with aspects of network interconnections between both NGN and NGI as well as between NGN and PTST/ISDN and between NGI and PSTN/ISDN. The delays in IP-based network elements of a connection must be added up over the continuous network elements in order to determine voice quality. It can be concluded that short delays over a connection link with high-quality and fast connections, particularly in NGN, make it interesting for a small ISP to tolerate increased delays in their own IP network. These incentives are particularly like to occur with regional ISPs using lower-quality und slower connections due to their low traffic concentration. The quality of the connection is constantly determined, however, by coding the voice signal with the lowest standard.

Therefore, voice services in IP-based networks can be given varying quality. Ensuring a quality comparable with PSTN/ISDN would require compliance with adjusted QoS parameter values like those for termination in PSTN/ISDN when terminating a voice connection from a PSTN/ISDN operator to an IP network operator with E.164 call number. Otherwise the voice quality deteriorates, either over the entire duration (if coding with reduced voice quality as G.711 is used) or occasionally, if time delays in the IP network jitter exceeding the permitted limit values. In these cases, the termination cannot be compared to the former PSTN/ISDN termination capacity from a QoS point of view. The question arises if and to what extent this affects former termination charges for mixed-type IP-PSTN/ISDN connections.

For a detailed analysis of the interconnection of several networks, here an existing interconnection system and its technical network foundations is described. To summarize, it can be said that the PSTN/ISDN and the former IP broadband network have a similar hierarchy, however, with a highly differing number of locations at the various hierarchical levels and totally different interfaces between the levels.

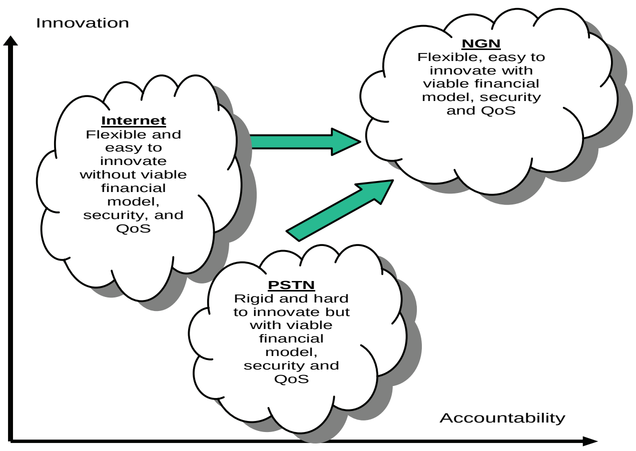

Fig. 1. Figure example [1]

On the Figure 1 one in the past year proposed interconnection architecture is shown [1].

The following can be drawn from this: The local traffic in PSTN/ISDN is transferred early to limit transit traffic in the exchanges of the core network. Contrary to this, IP routers in the core network are more heavily loaded with transit traffic since there is no local transfer in the access network (not least because of the dominant client-server connection structure of traditional IP services. With regard to traffic structures in PSTN/ISDN and for broadband services, it can be concluded that the traffic in PSTN/ISDN is mainly determined by dialog traffic between the terminal equipment from which a heavily meshed traffic structure is derived. A star-shaped traffic structure results for IP broadband traffic from the dominant

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www traffic and other client/server applications, which is also the reason why traffic cannot be transferred locally, since the servers are typically installed at high-traffic locations in the core area of an IP network.

B. Interconnection Scenarios

Interconnection scenarios between national network operators and their NGN or PSTN/ISDN are below. A top-down implementation of the NGN (i.e. implementation originating in the core network) is assumed in this case with the expansion (in terms of the geographical extension) of the PSTN/ISDN being maintained in a first step. The following can be concluded:

- Connections between users from the PSTN/ISDN of various networks are routed as before via the appropriate external interconnection point.

Voice connections from a broadband user of the NGN to a PSTN/ISDN user of another network operator are routed as long as possible within the network of the "originating operator" with a view to as short and low-cost a termination as possible. The VoIP traffic originating in the NGN is routed by the network operator via their interconnection point (NGN to PSTN/ISDN) into their own PSTN/ISDN to then transfer the traffic as close to the B-subscriber as possible into the destination PSTN via the external PSTN interconnection point.

- If these are voice connections from a PSTN/ISDN user to another NGN broadband user of another operator, both PSTN networks must be interconnected again. The terminating network operator transfers the PSTN traffic to their NGN destination network to terminate it there.

It can also be drawn from the top-down approach for the implementation of the NGN that the voice traffic of major exchanges (trunk exchange, local exchange) is first integrated at the locations of the IP core network (NGN). PSTN/ISDN islands develop where traffic is routed among itself via internal PSTN-NGN interconnection points. It can therefore be described as an IP core network developing into an NGN. Since this development (due to the top down assumption) takes place at large locations first, the external interconnection point to another PSTN/ISDN installed there must be replaced by a Trunk Media Gateway (TMGW). The number of external interconnection points to other PSTN/ISDN, however, remains unchanged during this phase.

For medium-term development, it is assumed that other exchanges, their traffic and their PSTN users are integrated into the NGN concept. Assuming that an external interconnection to another PSTN/ISDN is always realized at an IP core network node by means of TMGW, the number of external interconnection points to another PSTN/ISDN is reduced converging to the locations of the IP core network nodes of an NGN in the long run. Based on even development of the PSTN/ISDN integration into the NGN with all major national PSTN/ISDN, this reduction is realized more or less simultaneously and a long-term migration takes place with external interconnection of PSTN/ISDN networks with each other being replaced by external interconnection between NGN networks. However, it cannot yet be identified whether this external interconnection for the termination of VoIP traffic is limited to the locations of IP network nodes or if interconnection at a lower level between the locations of the BAN is possible. Thus, the question concerning the number of external interconnection points between NGNs of various operators remains open from a technical and economic point of view.

In addition, it can be concluded that mainly regional or local PSTN/ISDN network operators are affected by the reduced number of interconnection points, in particular if the external interconnection points that they have been using so far together with their PSTN/ISDN networks, are discontinued by the national operators.

C. Existing Interconnect Regimes

Today exists a Interconnect Regime for PSTN/ISDN based on an Element Based Cost (EBC) model. It is proposed that the PSTN/ISDN is divided into two main parts – a backbone and access network. The backbone is further divided into two layers – Wide Transport Exchange Network (WTXN) and Regional Transport Exchange Network (RTXN). The RT Exchange contains the Interconnect Exchange points. On the access layer the Subscriber Exchanges (SE) are placed. The End-Users may be connected to the SE directly or via Concentrating Units (CU). The proposed architecture is shown on Figure 2.

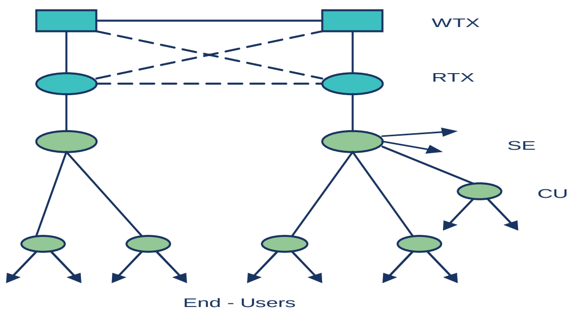

Fig. 2. Example of Interconnect Regime

The same layered architecture may be applied for

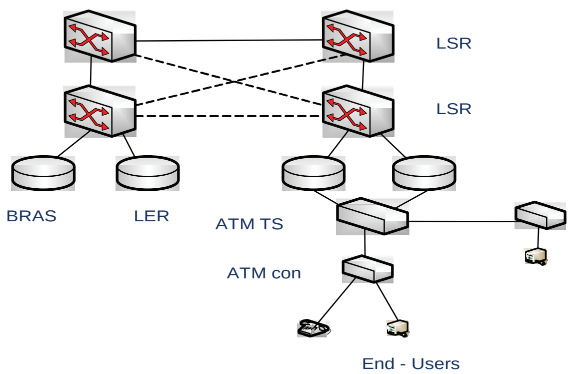

Fig. 3. Proposed Broadband IP – network architecture

structuring of Broadband networks and of Data networks as well. Nowadays such networks are based on the integration of the ATM technology and the overlaid IP – Network. So arises the hierarchical structure of the Broadband IP – based network regarding to access point to stream-like services (Figure 3).

The following table proposes a short comparison between both architectures and their building elements. The correspondence between the elements allows the definitions of interconnect scenarios according end-to-end connections in such integrated structures.

Network	Layer	Equipment	
		PSTN/ISDN	IP BBN
Backbone	high	WTX	LSR
	low	RTX	LER/LSR
	interface	RTX	BRAS/ATM TS
Access	high	SE	ATM con
	low	CU	DSLAM

Table 1. Comparison between Network components

As shown in the table WTX corresponds to the Label Switch Router (LSR) in the MPLS – backbone network. Most interesting might be that the interface position differs in both networks. RTX is meanwhile part of the backbone and of the interface between two layers. In the IP Broadband Network (IP BBN) there are different elements for the corresponding functions – LER/LSR (Label Edge Router/LSR) and BRAS/ATM TS (Broadband Remote Access Router/ATM Traffic Selector). On the access level in the IP BBN the well known ATM Concentrators and DSLAM (DSL Access Multiplexer) are placed.

III. Interconnection Scenarios for Voice Services

Both architectures and the corresponding functionality on the same network layers are the base for the following scenarios propositions, which serve a purpose of the mentioned interconnection aspects in part II.

A. Interconnection between NGN and their precursor

NGN is actually the integration of PSTN and IP-Platform through one network operator. This integration process passes from top to bottom. That means – PSTN/ISDN networks have to operate for a relative long next period – together with the NGN. This is the reason why such interconnection has to be proposed and investigated (Figure 4).

Some important conclusions regarding the process mentioned above may be defined as follows:

- Connections between PSTN subscribers from different networks will remain unchanged – it will appear through the existing interconnection points on the PSTN level (the short dashed line).

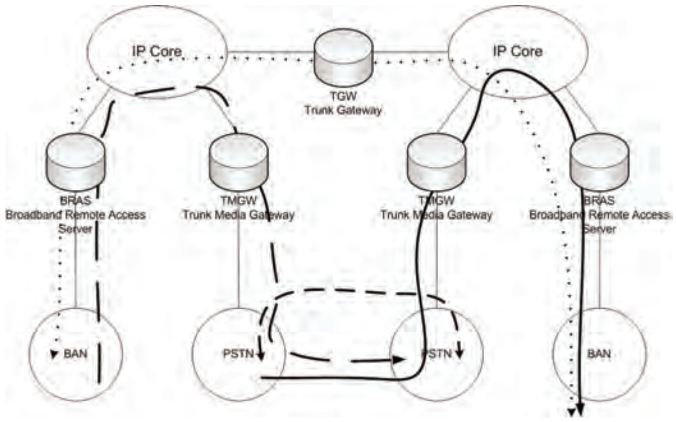

Fig. 4. Interconnection NGN – PSTN/ISDN

- Voice connections from a Broadband user (BBU) to a PSTN subscriber will be switched to the PSTN level of the same Network operator and then to the other PSTN network as described above (the long dashed line).
- Conversely – the connection from PSTN user to a BBU will be switched first on PSTN level and than to the BBU through BAN (Broadband Access Network) of the second Network operator (the thick line).
- Finally – a voice connection between BBU's goes to the higher level – the IP Core using well known VoIP protocols (the pointed line).

B. Interconnection between National Network Operators and Internet Service Providers

On the next figure the possible way for interconnection between IP – network operators on a national level and local ISP (Internet Service Providers) is shown. The assumptions is made that the national operator has already performed the integration to NGN and the ISP enhances the functionality of it own network for distribution of voice services. The same way as above different type of connections may be defined.

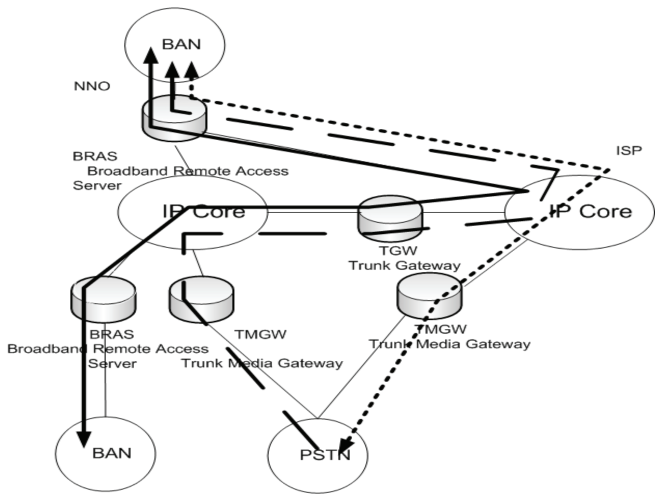

Fig. 5. Interconnection NNO - ISP

The considerations are made by the assumption that the ISP disposes of no or small broadband access infrastructure. So the connections regarding traditional IP services go from the BBU of the ISP to BBU of the NNO through an external interconnection point – BRAS of NNO to LAS of ISP (the thick line).

Almost the same way are the voice connections from PSTN users to an ISP BBU. It goes either an internal TMGW (Trunk Media Gateway) to it's IP Core or through an external TMGW directly to the ISP's IP Core (the long dashed and the short dashed lines on the figure 4).

C. Interconnection between National Network Operator and Regional Network Operators

Finally the case of a local network operator or Regional Network Operator (RNO) will be considered. The assumption is made that the RNO of its own BAN disposes (figure 6).

The short dashed line shows a connection equal to this in the first case described.

Equal to the case mentioned are the connections between BBU's in both networks and the connection between a BB user in the network of the National network operator and a PSTN user from the network of the Regional network operator.

There is a difference regarding the opposite connection – a PSTN user in the NNO network builds a connection to BBU in the RNO network (the thick line on the figure).

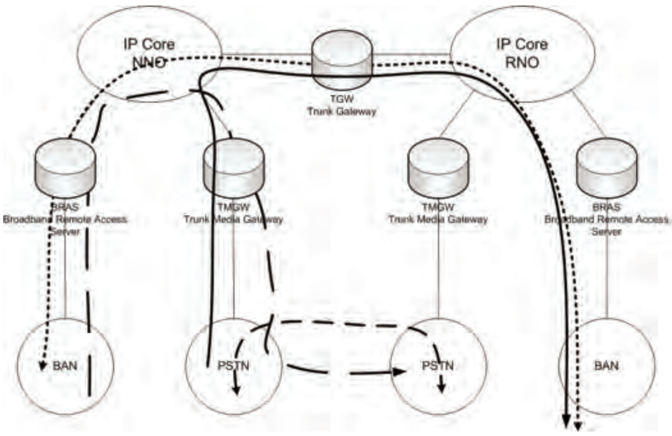

Fig. 6. Interconnection NNO - RNO

IV. CONCLUSIONS

The most important results of the analysis are summarized and initial conclusions for an interconnection system with and between IP-based networks drawn in the seventh and last chapter of the core report.

- Both national network operators and ISPs are striving towards an integrated voice and data offering with national operators generally establishing a centralized control platform - separate from the transport layer - into which the services from the PSDN/ISDN can be integrated. So-called soft switches are used for controlling the connections of the services. This new network concept is also called NGN. ISPs on the other hand improve their IP-infrastructures with peripheral intelligence in the form of SIP proxies and session border gateway controllers and media gateway controllers at network gateways and introduce additional protocols to ensure QoS parameter values; this method of network expansion is also called NGI. No major difference can be identified between the NGN and NGI concepts in terms of the transport layer.
- The central control layer of the NGN allows services offered by pure service providers to be integrated only in close technical and economic coordination with the NGN operator. On the other hand, the integration of separate services can be perceived more flexibly in the NGI.
- The three main QoS parameters (average delay, jitter of delay and packet loss rate) mean different things for the various services. Overdimensioning, prioritizing and capacity reservation have been introduced and examined as strategies for QoS realization with overdimensioning requiring the least additional QoS management effort and capacity reservation the highest.
- The service features of voice services (billing, connection availability, scaling, protocol stability, security and GoS/QoS) that are to be integrated into the NGN or NGI can be compared to those of the PSTN/ISDN (except for billing features). However, until these networks have been fully implemented and voice services having to be realized during this transitional period with hybrid infrastructures, restrictions in terms of scaling, protocol stability, security and GoS/QoS must be expected, particularly in the NGI concept.

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