ADDRESS TRANSLATION PROBLEMS IN IMS BASED NEXT GENERATION NETWORKS

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Summary The development of packed based multimedia networks reached a turning point when the ITU-T and the ETSI have incorporated the IMS to the NGN. With the fast development of mobile communication more and more services and content are available. In contrast with fix network telephony both the services and the devices are personalized in the "mobile world". Services, known from the Internet - like e-mail, chat, browsing, presence, etc. – are already available via mobile devices as well. The IMS originally wanted to exploit both the benefits of mobile networks and the fancy services of the Internet. But today it is already more than that. IMS is the core of the next generation telecommunication networks and a basis for fix-mobile convergent services. The fact however that IMS was originally a "mobile" standard, where IPv6 was not oddity generated some problems for the fix networks, where IPv4 is used. In this article I give an overview of these problems and mention some solutions as well.

1. INTRODUCTION

The concept of NGN is often differently interpreted by different companies, organizations. In order to have a common understanding on the terms I give a definition and a short description on NGN that is based on the ITU-T and ETSI approach:
A Next Generation Network (NGN) is a packet-based network able to provide services including Telecommunication Services and able to make use of multiple broadband, QoS-enabled transport technologies and in which service-related functions are independent from underlying transport-related technologies. It offers access by users to different service providers. It supports generalized mobility which will allow consistent and ubiquitous provision of services to users.
For the purposes of this document the NGN is characterized by the following fundamental aspects:

- Packet-based transfer
- Separation of control functions among bearer capabilities, call/session, and application/ service
- Decoupling of service provision from network, and provision of open interfaces
- Support for a wide range of services, applications and mechanisms based on service building blocks (including real time/ streaming/ non-real time services and multi-media)
- Broadband capabilities with end-to-end QoS and transparency
- Interworking with legacy networks via open interfaces
- Generalized mobility
- Access by users to different service providers
- A variety of identification schemes which can be resolved to IP addresses for the purposes of routing in IP networks
- Unified service characteristics for the same service as perceived by the user
- Converged services between Fixed/Mobile
- Independence of service-related functions from underlying transport technologies
- Compliant with all Regulatory requirements, for example concerning emergency communications and security/privacy, etc.

2. NGN EVOLUTION

The standard of third generation (3G) mobile networks was created in the ITU, and its name is IMT-2000 i.e. International Mobile Telecommunications 2000. The main goal of this specification to make the telecommunication services available via radio links. The standard was developed not only by the ITU but the 3GPP (Third Generation Partner Project) and 3GPP2 have also contributed. This document is a milestone since the IMS was defined here for the first time. [1] With the concept of GII (Global Information Infrastructure) the ITU-T aimed to orient towards development of information networks and services to advance global economic growth, education and quality of life. This organization would have liked to implement a realization of the GII in 2001 under the name of NGN (Next Generation Network). The specification of NGN first appeared in Y.2001 where an initial architecture was defined as well. The TISPAN group was established in 2003 within the ETSI (European Telecommunications Standardisation Institut) by the merge of the TIPHON (Telecommunication and Internet Harmonization over Networks) and SPAN (Services and Protocols for Advanced Networks) groups. Their major goal was to standardize the convergent networks and to take the preliminary steps in migrating the PSTN to the NGN.
The ETSI and the 3GPP work on the same topic (NGN) but from different approaches. The common

part of their work is the IMS that fact emphasizes the importance of this subsystem.

3. IMS BASED ARCHITECTURES

The functional elements of the NGN architecture, specified by the ETSI TISPAN [4] can be matched to the parts of the NGN specification of the ITU-T [5]. These are divided to two parts: transport and service plane. The service plane consists of the following subsystems:

- IP Multimedi Subsystem (IMS)
- PSTN/ISDN Emulation subsystem
- Streaming subsystems (for IPTV, video on demand, etc.)
- Common components that are used by more subsystems (accounting, security elements, OAM elements, etc.)

This subsystem based architecture (see Figure 1.) makes it possible to introduce new subsystems and the connection to non standardized structures.
It is the transport layer that assures the IP connection for the CPEs (Figure 1.) with the control of the NASS and RACS subsystems.

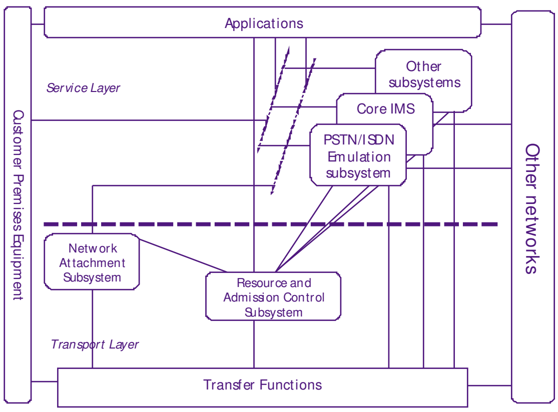

Fig. 1. ETSI TISPAN NGN architecture

4. NETWORK ATTACHEMENT SUBSYSTEM (NASS)

The most important tasks of the NASS are the following [6]:

- Dynamic provision of the IP addresses and other user equipment configuration parameters (e.g. using DHCP)
- User authentication prior or during the IP address allocation procedure
- Authorization of network access based on user profile
- Access network configuration based on user profile
- Location management

Further tasks of this subsystem are to assure the conditions for nomadic services.

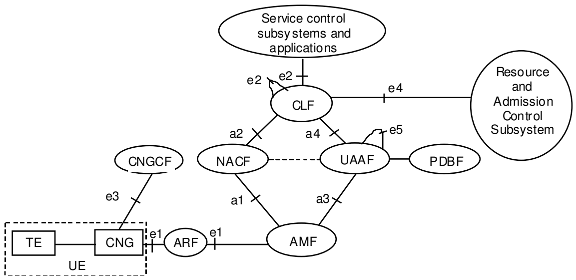

Fig. 2. NASS

The major functions of the NASS are the following:

- The Network Access Configuration Function (NACF) is responsible for the IP address allocation to the UE. It may also distribute other network configuration parameters such as address of DNS server(s), address of signalling proxies for specific protocols
- The Access Management Function (AMF) translates network access requests issued by the UE. It forwards the requests for allocation of an IP address and possibly additional network configuration parameters to/from the NACF. AMF forwards requests to the User Access Authorisation Function (UAAF) to authenticate the user, authorize or deny the network access, and retrieve user-specific access configuration parameters.
- The Connectivity Session Location and Repository Function (CLF) registers the association between the IP address allocated to the UE and related network location information provided by the NACF, i.e.: Logical Access ID, Physical Access ID, Address Realm, etc.
- The User Access Authorisation Function (UAAF) performs user authentication, as well as authorisation checking, based on user profiles, for network access.
- The Profile Database Function (PDBF) is the functional entity that contains user authentication data (e.g. user identity, list of supported authentication methods, authentication keys…) and information related to the required network access configuration: these data are called “user network profile”
- The CNGCF is used during initialization and update of the UE. The UECF provides to the UE with additional configuration information (e.g. configuration of a firewall internally in the UE, QoS marking of IP packets,…). This data differs from the network configuration data provided by the NACF.

5. RESOURCE AND ADMISSION CONTROL SUBSYSTEM (RACS)

RACS is the NGN subsystem responsible for elements of policy control, resource reservation and admission control. RACS also includes support for Border Gateway Services including Network Address Translator (NAT).
RACS essentially provides policy based transport control services to applications. This enables applications to request and reserve transport resources from the transport networks within the scope of RACS.

RACS offers to Applications Functions the following functionality on a one per RACS resource reservation session request basis:

- Admission Control: RACS implements Admission Control to the access and aggregation segment of the network. One can imagine various types of admission control going from a strict admission control where any overbooking is to be prevented, to admission control that allows for a certain degree of over subscription or even a trivial admission control (where the authorization step is considered sufficient to grant access to the service).

- Resource reservation: RACS implements a resource reservation mechanism that permits applications to request bearer resources in the access and aggregation networks.

- Policy Control: RACS uses service based local policies to determine how to support requests from Applications for transport resources. Based on available information about resource availability and on other policy rules (e.g. priority of the application) RACS determines if a request can be supported and (if successful) RACS authorises appropriate transport resources and defines L2/L3 traffic polices that are enforced by the bearer service network elements.

- NAT Traversal: RACS controls the traversal of far end (remote) NAT.

- NAT/Gate control: RACS controls near-end NAT at the borders of the NGN core network and at the border between a core network and an access network.

6. OVERVIEW OF IMS FUNCTIONS

The IMS system makes it possible to set up and manage multimedia sessions. The most important is the voice transmission that is realized via the so called PSTN simulation service. Figure 3. shows the functional architecture of the IMS. [8]

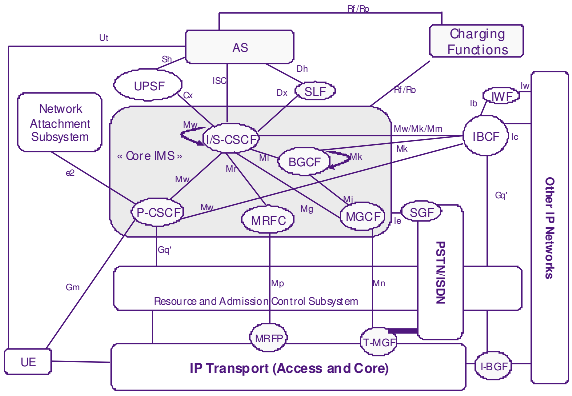

Fig. 3. IMS

The most important elements of this architecture are the CSCFs (Call Session Control Function) that are responsible for the set up, monitoring and management of multimedia connections. A CSCF can be proxy, serving or interrogating CSCF.
The P-CSCF is the entry point to the IMS from the point of view of the CPE. This covers and inbound and outbound SIP proxy function. Its major tasks are the termination of IPSec connections, user authentication, authorization, protocol compression and the generation of accounting data. [1] The S-CSCF manages the statuses of the sessions. It can act as a SIP registrar as well. The I-CSCF is a SIP proxy located at the edge of an administrative domain. The address of the I-CSCF is listed in the DNS records of the domain. When a SIP server follows SIP procedures to find the next SIP hop for a particular message the SIP server obtains the address of an I-CSCF of the destination domain. Additionally, the I-CSCF may optionally encrypt the parts of the SIP message that contains sensitive information about the domain, such as the number of servers in the domain, their DNS names, or their capacity. This functionality is referred to as THIG (Topology Hiding Inter-network Gateway).
The UPSF is the central storage for user related information. This includes the actual location of users, authentication information, and the user profile that contains the preferences of a user in connection with a certain service.
The only signaling protocol that is used in IMS is the SIP.

7. SIP AND ADDRESS TRANSLATION

There are four header fields in SIP that can determine the routing of a message. These are: From, Via, Contact and Record-route. All these fields have similar functionalities (to determine where the packet comes from) that makes sometimes difficult to route a request or a response through NAT-ed (Native Address Translated) networks. The reason is that SIP is an application layer signaling protocol and when passing through some address translated networks the source and/or the destination addresses are manipulated at the third OSI (Open System Interconnection) layer (=network or IP layer). However, network layer addresses in the SIP application header fields can not be modified with simple (=network layer) routers. This can result an inconsistency between network layer addresses in the IP header and network layer addresses in the SIP header.

One solution to this anomaly can be not only to modify addresses in IP layer but in application layer as well. The entity, able to realize this kind of modifications is called Application Level Gateway (ALG). This can be considered as a router with advanced functionalities, in practice.

In a VoIP scenario both the servers and the client can be behind a NAT box and the type of the address translation can also be different. There are four types of NATs:

1. Full Cone
2. Restricted Cone
3. Port Restricted Cone
4. Symmetric

For a given internal address, the first three types of NAT maintain a mapping of this internal address that is independent of the destination address being sought. The fourth type of NAT will allocate a new mapping for each independent destination address.

Unless the NAT has a static mapping table, the mapping that opens when the first packet is sent out from a client through the NAT may only be valid for a certain amount of time (typically a few minutes), unless packets continue to be sent and received on that IP:port.

8. SUMMARY

As in IMS SIP is the only signaling protocol, most of the CSCFs act as a SIP proxy and IPv4 is used (supposing the TISPAN architecture) all the address translation problems can occur that is mentioned in chapter 6. To overcome this problem, 3GPP suggests the use of IPv6, while the application of session border controllers can also be a proper solution.

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