Signalling cases and QoS management within TISPAN NGN residential environments

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***Abstract*— The TISPAN group from ETSI is currently working on the specification a Next Generation Network (NGN), based on the IP Multimedia Subsystem (IMS) as the service control architecture. This NGN provide a extensible platform that supports the delivering of next generation multimedia services with QoS requirements over multiple access network technologies. Nevertheless, the QoS solutions developed by TISPAN in the first release of specifications for the NGN are mainly focused on the access network, and QoS coverage is not provided for the core network and the residential environment, where the end user terminals are located. In this paper a proposal is presented to extend the TISPAN QoS solution to the residential environment, by means of a Residential Gateway (RGW). This RGW will process the signalling messages that are exchanged between the end user terminals and the Core IMS in the NGN, performing an adequate QoS resource management within the residential environment. Several signalling scenarios are presented, covering the cases related to the establishment and release of multimedia sessions within the TISPAN NGN. For each case, the procedures executed in the RGW in respect to the signalling and QoS management are detailed.**

***Index Terms*— TISPAN Next Generation Network, QoS, Residential Gateway, IMS signalling.**

I. INTRODUCTION

The concept of Next Generation Network (NGN) provides a new network infrastructure with features and capabilities that support the provision of value-added multimedia services over multiple and heterogeneous QoS enabled transport technologies. In this respect, the ETSI TISPAN group [1] is working on the specification of an NGN based on the IP Multimedia Subsystem (IMS).

IMS was introduced in the release 5 of 3GPP standards in 2002, as an IP-based architecture to control of the new value-added services with QoS requirements that were envisioned for UMTS. But, although IMS has conceptually been designed to be independent from the technology used in the access network, the standards developed by the 3GPP are mainly focused on the UMTS IP connectivity access network. From the previous work done by the 3GPP, ETSI and 3GPP started to cooperate in 2004 in the ETSI TISPAN group, in order to define a Core IMS suitable for wireless and wireline networks. The first release of standards for TISPAN NGN [2] was published at the beginning of 2006, being currently the second release under development.

On the other hand, several initiatives are being proposed nowadays in multi-service access networks. The MUSE [3] European project is one of these initiatives, and its main objective is the research and development of a future, low-cost, multi-service access network. In MUSE there is an end-to-end view about QoS provisioning. Nevertheless, in the model defined by the first release of TISPAN NGN the QoS solutions are focused on the access network segment.

This paper continues the work initiated in [4], where a general solution was presented to extend the TISPAN QoS provision mechanisms to the residential environment. The solution was based on the figure of a Residential Gateway (RGW) that is currently being developed within the MUSE project framework. In this paper, more details about the RGW are provided, focusing on the architecture and the QoS provisioning, in order to give to the reader a clear view of the extensions that are necessary to integrate the RGW within a TISPAN NGN residential environment. These extensions will be clearly defined, specifying the different functional entities that will be necessary to introduce in the RGW architecture so as to fulfil with this integration. Finally, several TISPAN NGN signalling scenarios are presented, in order to show how these functional entities cooperate in the RGW to manage the QoS in the residential environment, according to the particularities of each signalling case.

The rest of the article is structured as follows. In the next section, a brief overview of TISPAN NGN Release 1 is presented, focusing on the resource and admission control solutions. Section III covers the details about the RGW that has been implemented within the MUSE project in the scope of high speed access networks. Section IV details the extensions that are necessary in the RGW architecture so as to be able to manage the QoS within the TISPAN NGN residential environment, as well as the operation of these extensions in different signalling scenarios. Finally, Sect. V concludes describing the main contributions achieved along this article.

II. TISPAN NGN OVERVIEW

A. TISPAN NGN functional architecture

Figure 1 shows a simplified overview of the functional architecture of TISPAN NGN release 1. This functional

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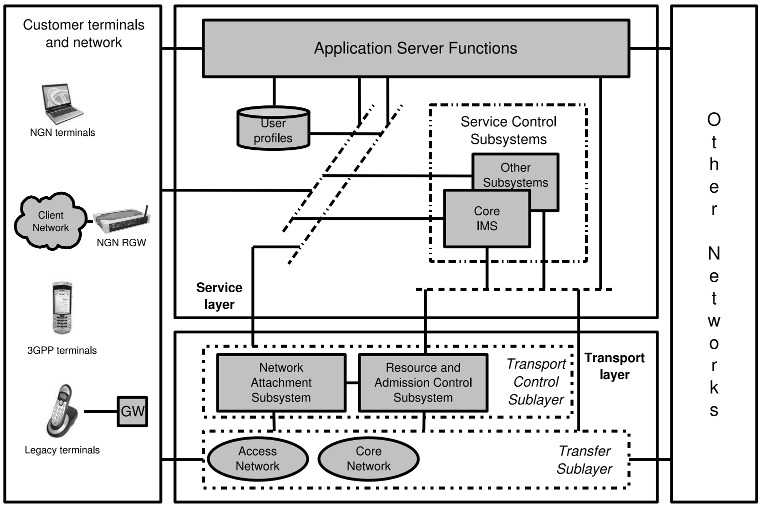

Figure 1. TISPAN NGN architecture overview

architecture is covered in detail in [5].

As it it indicated in the figure, the architecture is structured in two layers, the transport layer and the service layer, that are built up by a set of subsystems and functional entities.

The **transport layer** provides IP connectivity to the user equipment in client premises. The functionality supported by this layer is in turn divided in two sublayers, a transport control sublayer and a transfer sublayer.

Regarding QoS provision mechanisms, in the transport control sublayer the most relevant component is the Resource and Admission Control Subsystem (**RACS**). This subsystem performs policy control, resource reservation and admission control functions in the NGN. The RACS subsystem provides applications with the capability of reserving resources from the transport networks, guaranteeing QoS provision for the value-added services in the NGN. Further details can be found in [6]. On the other hand, the functional entities that constitute the transfer sublayer are covered in detail in [5].

The **service layer** comprises a set of subsystems that provide service control functionalities. Among them, the **Core IMS** [7] provides the means to negotiate SIP-based multimedia services to NGN terminals. It is a subset of the IMS as it was defined in the 3GPP Release 6 specifications, restricted to the session control functionalities. Finally, the service layer also provides a set of common components. One of these components is the Application Server Function (ASF). The functionality of the ASF in the NGN architecture consists of providing value-added services to the NGN terminals.

B. QoS provisioning in TISPAN NGN

The Resource and Admission Control Subsystem (**RACS**) is the TISPAN NGN subsystem that provides QoS reservation mechanisms over the transport layer. The RACS subsystem provides the Service Layer with a single interface to request transport control services, acting as an intermediary between the service layer entities (ASFs and Service Control Subsystems) and the functional entities in the transfer sublayer. This way, the RACS ensures that service layer entities do not need to be concerned with details related with transport networks, like the network topology and transmission technologies.

On the other hand, in the first release of TISPAN NGN, the access network is viewed as the most critical segment to provide end-to-end QoS. For this reason, TISPAN NGN Release 1 is mainly focused on this segment of the transport network in respect to QoS provisioning, assuming that QoS in the core network is provided by other means, such as over provisioning. Therefore, in Release 1 the RACS scope is limited to the access network, to the interconnection points between the access network and the core network and to the interconnection points between core networks.

The basic RACS functionalities in TISPAN NGN are indicated below:

- Policy Control. The RACS subsystem applies to resource reservation requests a set of policy rules to check if these requests can be authorized and to determine how must they be served. Policy control is also performed in the access network, applying network policies specific to each particular access line.
- Admission Control. The RACS subsystem verifies if the requested QoS demands can be satisfied with the resources that are available in the involved access network.
- Resource reservation. The RACS subsystem provides the means to reserve bearer resources on the access network.
- NAT/Gate Control. The RACS subsystem controls NAT functionalities and performs gate control functions, at the limit between the access and core networks and in the limit between core networks.

The RACS subsystem supports several modes of operation in respect to resource management, two of which are explained below:

- A reserve-commit resource management scheme, where resources are reserved in a first phase and are finally made available after a commit procedure.
- A single-stage resource management scheme, where the commit procedure is implicit to the reservation request.

Finally, the RACS subsystem supports two different models for QoS control over the transport network. These models are the following:

- Guaranteed QoS. In this model the QoS is guaranteed with absolute bounds on some or all of its parameters, like throughput or jitter. Guaranteed QoS is configured on the access network with the application of techniques such as throughput control and traffic policing in the IP edge node.
- Relative QoS. In this model the QoS is provided by class based differentiation. This QoS differentiation is configured in the IP edge node of the access network, where functionalities like packet marking are provided.

In [4] an overview of the different elements within the functional architecture of the RACS subsystem is provided. Further details can be found in [6].

C. Session establishment and resource reservation

The session establishment process in IMS is based on the Session Initiation Protocol (SIP) [8], and involves an end-to-end signalling dialogue between the terminals participating in the session. To negotiate the parameters associated with the media which is going to be transferred during the session, such us the type of media streams, codecs or IP addresses and ports, the Offer/Answer model [9] of the Session Description Protocol (SDP) [10] is used. SDP provides the support to describe multimedia sessions, and the Offer/Answer model applied to this protocol allows the end terminals to reach an agreement about the session description.

In the Core IMS architecture, the P-CSCF (Proxy-Call Session Control Function) is the functional entity which acts as the entry point for the users to the system. Therefore, all the SIP signalling messages that come from or go to the user terminal must necessarily pass through this functional entity.

In TISPAN NGN Release 1, the P-CSCF in the Core IMS interacts with the RACS subsystem to request QoS provision for the services negotiated between the end users. As it is detailed in [11], the P-CSCF sends service information to the RACS subsystem after receiving every SIP message with a SDP answer payload. This service information is derived from that SDP answer and from its corresponding SDP offer. Jointly, the SDP offer and SDP answer contain enough information to describe the session as it has been negotiated up to that moment, such us the IP addresses, ports and bandwidth requirements for the media streams that will be exchanged. Annex B in document [11] describes the mapping process that must be performed by the P-CSCF to convert SDP information to relevant service information to be transferred to the RACS subsystem. In addition, the P-CSCF can request from the RACS subsystem a reserve-commit or a single-stage resource management scheme in the QoS reservation request.

Further details about the session control procedures in TISPAN NGN can be found in [12] and [13].

III. QoS IN RESIDENTIAL ENVIRONMENTS

A. The MUSE project

MUSE [3] is an integrated research and development project funded by the 6th Framework Program of the European Commission. The main objective to be achieved by its large consortium (36 partners, including almost all the major players in Europe with system and component vendors, telecom operators, SMEs, universities and research institutes) is to reach a common view of the future access and edge broadband network.

One of the most important features being studied for such an access environment is the capability of extending the different QoS models (like the one that has been previously described) in order to include the whole connectivity path from the end user terminal to the application server (or terminal to terminal in case of existing peer to peer communications). And this would imply that the Residential Gateway (RGW), that stands in between the end user network and the access network, must be enhanced so as to support the intended end to end QoS environment.

In this respect, the organization of the project includes an specific steering Task Force dedicated to the figure of the RGW, where the RGW prototype that will be described in this section has already been implemented. This prototype is planned to be enhanced with the proposal made in section IV.

B. RGW architecture

The architecture of the RGW prototype implemented in MUSE is the one depicted in Fig. 2 (it has been demonstrated in [14]). The architecture has been mapped in two implementation layers. The application layer is mainly based on flexible Java components capable of managing the lower layers and capable of treating different signalling and application level protocols. The data layer, based on the Click! modular router platform [15], provides all the specific data switching functionality.

As it can be seen, incoming and outgoing traffic flows are represented and the two separate paths show that these two flows never use the same resources at Click! level. Dotted arrows represent signalling traffic that is sent by Click! towards the corresponding Signalling Process (SP) responsible for handling the protocol under consideration and for returning the frame afterwards to the Click! level so that it can be properly forwarded.

The main idea of this mechanism is that it is possible to define in the gateway different rules based on the IP addresses, ports, protocol type, etc. so that only these

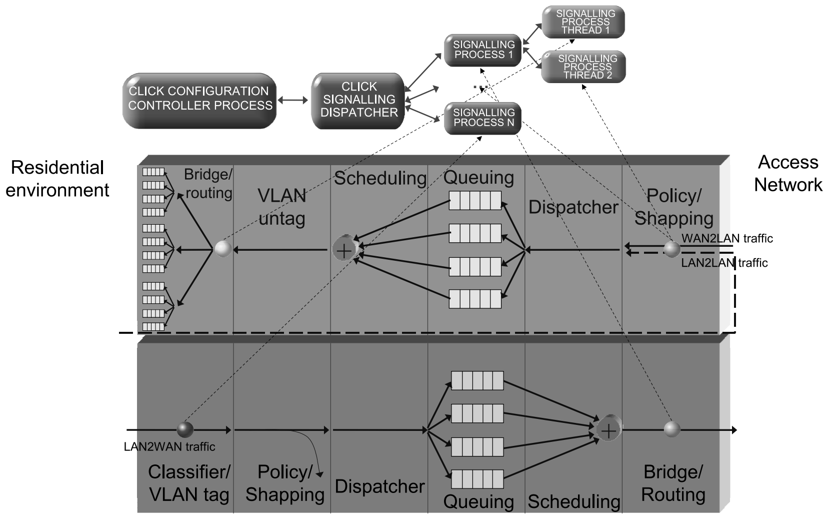

Figure 2. RGW prototype architecture

certain signalling packets are sent to the application level and to the specified port (where the corresponding SP will be listening) whenever they go through the specified hook (depicted as round bullets in the figure). There are four hooks defined in the architecture (although more of them could be defined if needed), located for each direction after the queue system and NAT processing and before these functionalities.

Different signalling processes can be implemented in order to treat for example IGMP messages (IGMP snooping can be automatically managed by an SP), RTSP (real time sessions can be automatically managed and configured by an SP) or IMS-SIP messages (as it will be detailed in the following section). Based on these incoming packets the SPs may reconfigure the RGW, defining new flow rules, opening new interfaces for multicast forwarding, etc. These reconfiguration intentions are communicated to the Click Configuration Controller Process (**CCCP**) module (by means of a flexible XML document capable of expressing many different actions) which is responsible for centralizing all the desired actions in order to avoid any kind of race conditions or inconsistent states.

Once the message is processed, it can be reinserted again in any hook so that it can continue its path towards its destination.

C. QoS provisioning in the RGW

In order to be able to provide a certain QoS to the different flows that go through the RGW a priority parameter is used.

Traffic coming from the access network will typically have the priority assigned. In MUSE project for instance, an all Ethernet scenario is assumed in the access and priority is assumed to come included in the priority bits of the 802.1p/q Ethernet frame. If the QoS is wanted to be maintained in the RGW, it will first have to treat incoming flows according the assigned priority. This process is seen in the upper part of the picture with a first general classification, four queues system with strict priority queuing scheduling (needed in order to guarantee the precedence during the switching decision) and after the switching decision a classification per interface (needed in order to guarantee the precedence during the transmission).

For flows going in the upstream direction, it is necessary to manually configure the priority to be assigned to every flow so they can be properly treated in the RGW (at the bottom part of the picture with the four queues system) and afterwards can also be properly treated in the rest of the path towards their destinations.

There are some particular cases also under study like for instance the treatment of internal LAN traffic. If the QoS is going to be extended further than the RGW it is first needed to map the tagging schema used in the access network to the corresponding tagging schema used in the specific LAN technology. And since internal LAN traffic would be merged with the rest of the traffic it is also important that all this internal traffic is also switched through the RGW so that it can be conveniently treated together with the rest of the traffic.

The interface to manually configure the RGW is generic and different mechanisms have been enabled (Web access, TR-069 access or even SNMP for some functionalities).

IV. IMS SIGNALLING MANAGEMENT IN THE RGW

As is has been detailed in Sect. II, in the first release of TISPAN NGN the QoS solutions are mainly focused on the access network. Nevertheless, the real QoS that is perceived by the end users is end to end QoS, being also determined by the transport capabilities that are available in the core network and in the residential environment. But, whereas the QoS in the core network may be easily guaranteed by certain means, such as over provisioning, it does not occur the same in the residential environment where the availability of resources may be limited.

On the other hand, the previous section covers the QoS solutions that have been developed in the MUSE project for residential environments within the scope of high speed access networks. As it has been indicated, the

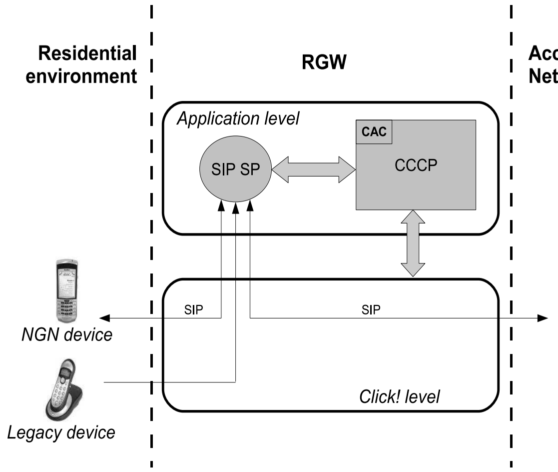

Figure 3. Extensions to the functional architecture of the RGW

QoS is achieved in the end user network by means of a key element, the RGW.

This section proposes certain extensions to the architecture of the RGW that has been detailed in Sect. III. These extensions will allow to introduce the RGW in the residential environment of a next generation network compliant with the release 1 of TISPAN NGN. In this scenario, the RGW will process the SIP signalling messages that are exchanged between the end user terminals and the Core IMS to establish and to release multimedia sessions, an will perform a suitable management of the QoS in the residential environment. The proposal detailed in this section will allow to extend the QoS solutions specified in TISPAN NGN release 1 to the residential environment, in order to finally provide real end to end QoS. The extensions to the architecture of the presented RGW are shown in Fig. 3.

The SIP Signalling Process (**SIP SP**) will process all the SIP signalling messages exchanged between the end user terminals, in the residential environment, and the Core IMS. The data level in the RGW will be configured to redirect all the SIP signalling messages received in the upstream and downstream traffic directions to the SIP SP. In a previous work [16] this model was validated, assuring that the RGW could process all these messages without a significant performance degradation.

The main functionalities of the SIP SP are indicated below:

- AF functionality: during the IMS session establishment procedure, after receiving every SIP message containing an SDP answer it will derive the corresponding service information from the SDP offer and the SDP answer. This service information will contain the parameters for each media stream that will be exchanged during the multimedia session, such as the IP addresses and ports, the traffic direction (upstream or downstream), the bandwith requirements and the required priority level (best effort, elastic, real time or low latency). With this infomation, the SIP SP will contact the CCCP, to perform the admission control and resource reservation procedures on the residential environment. In addition, if a reserve-commit resource reservation scheme is used, once the IMS session is established it will contact the CCCP to start the commit process for the reserved resources.
  On the other hand, the IMS session establishment may fail in the RGW, for example because there are not available resources in the residential environment to cover the QoS demands for the multimedia session being established. In that case, the RGW will be in charge of terminating the SIP dialogue and contacting the CCCP to release the transport resources that had previously been reserved within the residential environment.
  Finally, during the IMS session release, the SIP SP will provide the CCCP with the necessary information to release the transport resources that were previously reserved within the residential environment for the multimedia session.
- SIP signalling proxy functionality: this functionality will be necessary when the customer terminal in the residential environment is not TISPAN NGN compliant. In this scenario, the SIP SP will behave as a signalling proxy on behalf of legacy terminals, by generating and exchanging the SIP signalling associated with the upstream and downstream traffic with the Core IMS. In addition, the SIP SP will process each SDP offer and answer pair to request from the CCCP the corresponding admission control and resource reservation procedures in the residential environment.

The **CCCP** will be extended by means of a new Call Admission Control (**CAC**) module. This module, with the service information provided by the SIP SP, will perform the admission control procedures, verifying if the QoS demands for every media stream can be satisfied with the available transport resources in the residential environment. If so, the CCCP will install the necessary traffic policies in the the RGW to guarantee the QoS provision. The CCCP will support the single-stage and the reserve-commit resource management schemes. As the current RGW architecture provides the QoS control by means of packet marking functions, the CCCP will support a relative QoS provision mechanism.

The next subsections cover the TISPAN signalling cases management within the RGW, as well as the corresponding QoS configuration procedures in the residential environment.

A. Session establishment scenarios

Figure 4 shows an example of IMS session establishment for a VoIP call. The figure shows the SIP signalling exchange between an end user terminal, that initiates the call from the residential environment, and the Core IMS. The admission control and the resource reservation procedures on the residential environment are also indicated in the figure. In the example, it is assumed

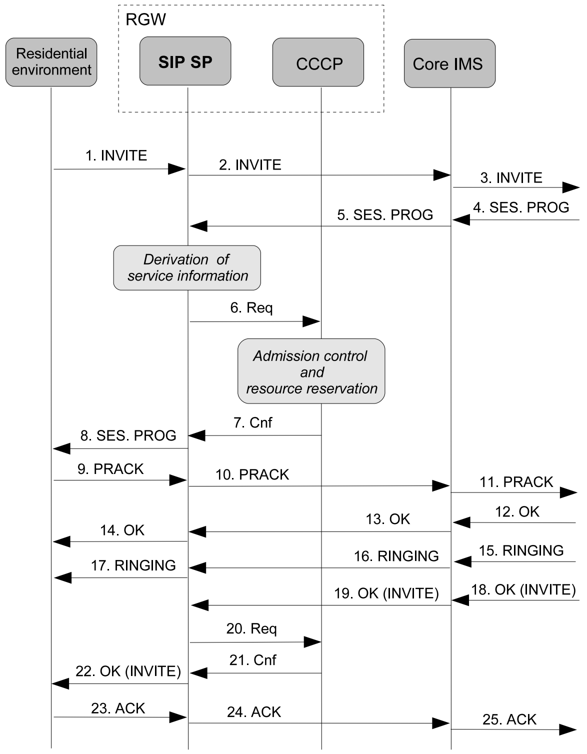

Figure 4. IMS session establishment and QoS management in the residential environment

that a reserve-commit resource management scheme is being used in the RGW.

The procedure is as follows:

1-3 The end user terminal sends a SIP INVITE request from the residential environment, including a SDP offer, to its P-CSCF in the Core IMS. The INVITE request arrives to the RGW and is redirected by the Click! data level to the SIP SP. The SIP SP stores the SDP offer and forwards the INVITE request towards the P-CSCF in the Core IMS. Finally, the request is processed in the Core IMS and forwarded towards the IMS domain of the destination user.

4 The destination terminal answers back with a SIP Session in Progress response that contains an SDP answer. The message is received by the Core IMS that processes it and sends it to the originator terminal in the residential environment.

5 The Session in Progress response reaches the RGW and it is redirected by the Click! data level to the SIP SP. The SIP SP stores the SDP answer and derives the corresponding service information from the SDP offer and answer. As it has been indicated before, this service information contains all the parameters that describe the media streams that will be exchanged within the multimedia session. With this information, the SIP SP constructs a resource reservation request that is sent to the CCCP.

6-7 The CAC module in the CCCP performs the admission control procedures for the request. If the QoS demands can be satisfied with the resources that are available within the residential environment, then the CCCP installs the traffic policies that are necessary in the RGW to guarantee the QoS provision. These traffic policies are based on packet marking functions. Finally, the CCCP informs the SIP SP about the outcome of the request.

8 The SIP SP forwards the Session in Progress response towards the end user terminal in the residential environment.

9 The end user terminal decides the SDP parameters offered for the session and confirms the reception of the Session in Progress response with a SIP PRACK request. This message may also contain an SDP payload that may be the same as the one that was received in the previous message or a subset. The terminal can also include new media components in this SDP offer, or even in subsequent requests by means of SIP UPDATE requests. Anyway, each SDP offer/answer exchange that causes a change in the parameters of the media streams will involve a new interaction between the SIP SP and the CCCP in the RGW. The RGW receives the PRACK request, which is redirected by the Click! data level to the SIP SP.

10-11 The SIP SP forwards the PRACK request towards the P-CSCF in the Core IMS. The Core IMS processes the request and sends it towards the Core IMS of the destination terminal.

12-14 The destination terminal acknowledges the SIP PRACK request with a SIP OK response. If the PRACK request included an SDP offer, the OK response will also contain an SDP answer. If the session description has changed, a new interaction between the SIP SP and the CCCP will be performed as it has been stated in 9. The OK response finally reaches the originator terminal in the residential environment.

15-17 The destination terminal alerts its user about the incoming call and sends a SIP RINGING response to the originator terminal.

18-19 When the destination user picks up the phone, the destination terminal sends a SIP OK response for the SIP INVITE request. This response reaches the RGW and is redirected to the SIP SP.

20-21 The SIP SP sends a request to the CCCP to commit the resource reservation for the multimedia session. The CCCP commits the reservation, by opening the ”gates” in the data layer for the media streams that are going to be transmitted within the session. Finally, the CCCP reports to the SIP SP that the commitment has been performed.

22 The SIP SP forwards the SIP OK response to the end user terminal in the residential environment.

23-25 The SIP OK response arrives to the originator terminal, and the user can start sending media. Finally, the terminal sends a SIP ACK request, which arrives to the SIP SP and is forwarded towards the Core IMS, where it is processed and finally sent towards the Core IMS of the destination terminal.

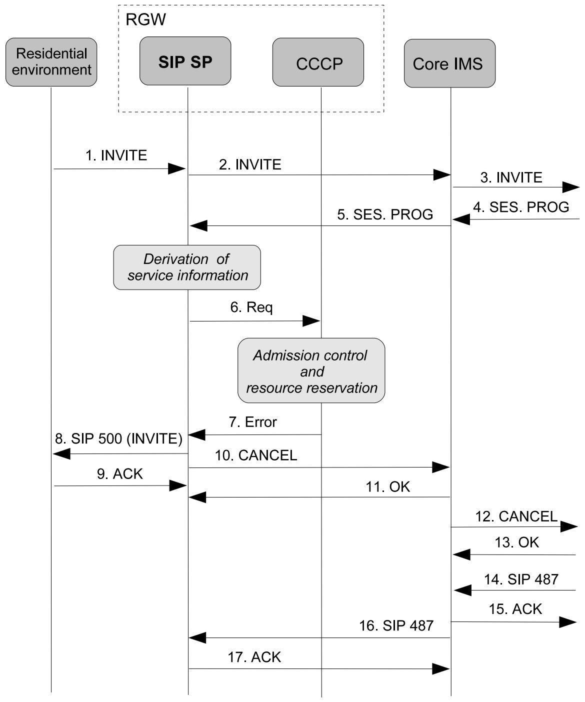

Figure 5. Cancelling the IMS session establishment

This way, with a reserve-commit resource management scheme early traffic is forbidden over the data layer during the session establishment, as the "gates" in the RGW are opened once the session is set up with the SIP OK response to the SIP INVITE request. Nevertheless, if the operator policy allows early traffic during the session setup, a single-stage resource management scheme can be used. In this case the gates would be opened after the resource reservation request (steps 6-7).

Figure 5 shows an example where the session can not be established because the QoS demands can not be satisfied with the available resources in the residential environment.

Such signalling scenario will be managed by the RGW as follows:

1-5 The session establishment process proceeds as in the previous case, until the SIP Session in Progress response reaches the SIP SP in the RGW. The SIP SP derives the service information from the SDP offer and answer and sends a resource reservation request to the CCCP.

6-7 Next, the CAC in the CCCP determines that the available resources in the residential environment cannot grant the QoS demands contained in the request. In this case, the CCCP answers back the request with an error response, indicating that the resource reservation was not successful.
At this point, the SIP SP has received the Session in Progress response from the destination terminal. This Session in Progress response has passed through the Core IMS of the destination and originator terminals, so the resource reservation has been successfully performed along path towards the destination terminal on the access networks serving the residential environments of both terminals (in any other case, an error indication would have been received instead of the Session in Progress response).

8-9 So, as the end to end QoS can not be guaranteed for the multimedia session, and this QoS is currently configured in the rest of the path, the only thing the SIP SP can do is to cancel the session establishment. To do that, the SIP SP answers the SIP INVITE request with a SIP 500 (Server Internal Error) response, which is sent to the originator terminal in the residential environment. After receiving the SIP 500 response, the end user terminal deletes all the information related to the SIP dialogue and the multimedia session and sends a SIP ACK to the SIP SP. The terminal may retry the SIP INVITE request after some time.

10-13 In parallel with step 8, the RGW sends a SIP CANCEL request towards the destination terminal. This SIP CANCEL request is used to cancel the SIP INVITE request that has been previously sent to establish the session. The CANCEL request is a hop-by-hop request, meaning that is responded by a SIP OK response by each stateful SIP proxy that receives it. The CANCEL request is finally sent to the Core IMS of the destination terminal.

14-17 Once the destination terminal receives the SIP CANCEL request, as the cancelled request is the SIP INVITE, the destination terminal answers back with a SIP 487 (Request Terminated) response. The SIP 487 response is finally delivered hop-by-hop to the SIP SP in the RGW, confirmed at each hop by a SIP ACK.

The procedures to cancel the session establishment will be the same in case that the resource reservation can not be granted after receiving an SDP answer in a OK response to a PRACK or UPDATE request. The only difference would be that the RGW would have to release the resources that were reserved as the result of the previous SDP offer and answer exchange.

B. Session release scenarios

Figure 6 shows two examples of IMS session release, for the session that was established in the previous subsection. The first part of the figure shows an example with the procedures performed by the RGW when the end user terminal initiates the session release. These procedures are indicated next:

1 The end user hangs up the call, and a SIP BYE request is sent from the end user terminal towards the destination terminal. The BYE request arrives to the RGW and is redirected by the Click! data level to the SIP SP.

2-3 Next, with the service information corresponding to the multimedia session, the SIP SP constructs a resource release request which is sent to the CCCP. The CCCP releases the resources that were reserved

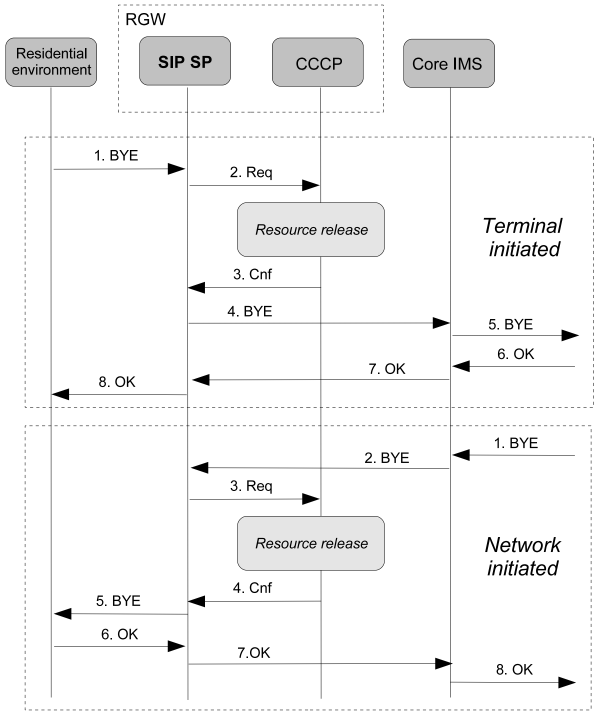

Figure 6. IMS session release

for the session and confirms back the release to the SIP SP.

4-5 The SIP SP forwards the BYE request to the Core IMS, where it is processed. Finally, the Core IMS forwards the BYE request to the IMS domain of the destination user.

6-8 Eventually, the destination user receives the BYE request and answers back with a SIP OK response. The SIP OK response reaches the RGW, where it is redirected to the SIP SP. The SIP SP deletes all the information related to the SIP dialogue and the multimedia session, and finally forwards the OK response towards the end user terminal.

The second part of the figure shows an example with the procedures performed by the RGW when the network initiates the session release (i.e the Core IMS of the originator or destination terminal). These procedures are the same as the previously presented for the user initiated release scenario.

V. Conclusion

Nowadays, new broadband access technologies are being developed and deployed by the telecommunication operators, supporting the delivering of new value-added multimedia services to the end users. In this respect, the specifications of the TISPAN Next Generation Network define an extensible platform to support the next generation services that are envisioned for the future. The TISPAN NGN infrastructure will allow to deliver these services with QoS guarantees over multiple and heterogeneous access network technologies. However, in the first release of TISPAN NGN, the QoS solutions are only provided for the access network segment, not covering the core network and the end user residential environment.

In this paper a proposal has been presented to extend the TISPAN QoS provision model to the residential environment, by means of the RGW that is being currently developed within the MUSE European project. The architecture of this RGW has been presented in the context of high speed access networks, and extensions to this architecture have been defined to support, in a TISPAN NGN residential environment, the signalling cases and QoS management during the establishment and release of multimedia sessions.

Nevertheless, some other issues must also be considered before having a fully operational RGW within a TISPAN NGN residential environment. First, new extensions will have to be defined for the RGW architecture to solve the problems related to SIP and NAT traversal. On the other hand, the admission control mechanisms performed by the CAC module in the CCCP must be designed and implemented in order to guarantee an adequate resource reservation in the end user residential environment.

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References

[1] TISPAN, “Telecommunications and Internet converged Services and Protocols for Advanced Networking.” Internet, Jan 2007, http://www.etsi.org/tispan/.

[2] TISPAN, “ETSI TR 180 001 V1.1.1: Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); NGN Release 1; Release definition.” March 2006.

[3] MUSE, “Multi Service Access Everywhere,” Internet, Jan 2007, http://www.ist-muse.org/.

[4] I. Vidal, J. Garcia, F. Valera, I.Soto, and A. Azcorra, “Adaptive quality of service for next generation residential gateways.” *LNCS*, vol. 4267, pp. 183–194, 2006, 9th IFIP/IEEE International Conference on Management of Multimedia Networks and Services (MMNS 2006).

[5] TISPAN, “ETSI ES 282 001 V1.1.1: Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); NGN Functional Architecture Release 1.” August 2005.

[6] TISPAN, “ETSI ES 282 003 V1.1.1: Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); Resource and Admission Control Sub-system (RACS); Functional Architecture.” March 2006.

[7] TISPAN, “ETSI ES 282 007 V1.1.1: Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); IP Multimedia Subsystem (IMS); Functional Architecture.” June 2006.

[8] J. Rosenberg, H. Schulzrinne, G. Camarillo, A. Johnston, J. Peterson, R. Sparks, M. Handley, and E. Schooler, “SIP: Session Initiation Protocol,” RFC 3261 (Proposed Standard), June 2002, updated by RFCs 3265, 3853, 4320. [Online]. Available: http://www.ietf.org/rfc/rfc3261.txt

[9] J. Rosenberg and H. Schulzrinne, “An Offer/Answer Model with Session Description Protocol (SDP),” RFC 3264 (Proposed Standard), June 2002. [Online]. Available: http://www.ietf.org/rfc/rfc3264.txt
[10] M. Handley and V. Jacobson, “SDP: Session Description Protocol,” RFC 2327 (Proposed Standard), Apr. 1998, updated by RFC 3266. [Online]. Available: http://www.ietf.org/rfc/rfc2327.txt
[11] TISPAN, “ETSI TS 183 017 V1.1.1: Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); Resource and Admission Control; DIAMETER protocol for session based policy set-up information exchange between the Application Function (AF) and the Service Policy Decision Function (SPDF): Protocol specification.” March 2006.
[12] TISPAN, “ETSI TS 182 006 V1.1.1: Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); IP Multimedia Subsystem (IMS); Stage 2 description.” March 2006.
[13] TISPAN, “ETSI ES 283 003 V1.1.1: Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); IP Multimedia Call Control Protocol based on Session Initiation Protocol (SIP) and Session Description Protocol (SDP) Stage 3.” July 2006.
[14] F. Valera and J. Garcia and C. Guerrero and V. M. Ribeiro and V. Pinto, “Demo of triple play services with qos in a broadband access residential gateway.” in *IEEE Infocom*, April 2006, barcelona, Spain.
[15] E. Kohler, R. Morris, B. Chen, J. Jannotti, and M. F. Kaashoek, “The Click Modular Router Project.” Internet, May 2006, http://www.read.cs.ucla.edu/click/.
[16] C. Guerrero, J. Garcia-Reinoso, F. Valera, and A. Azcorra, “Qos management in fixed broadband residential gateways.” *LNCS*, vol. 3754, pp. 338–349, 2005, 8th International Conference on Management of Multimedia Networks and Services (MMNS 2005).

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