3GPP TSG SA WG3 Security — S3#22 **S3-020022**

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3GPP TSG-SA WG2 meeting #22 **Tdoc S2-020291**
Phoenix, USA, 14 - 18 January 2002

Title: Liaison Statement on " IP version interworking on the transport plane"
Source: SA2
To: CN4, CN2, SA3, SA5, RAN3
Cc: -

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Attachments: S2-020161

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1. Description:

During SA2#22, SA2 has evaluated the architecture implications of using IPv6 in the transport plane for the PS domain. The following agreement has been made in principle for release 5:

1. IPv6 capable GGSNs shall be dual stack nodes (at least for the initial migration period).
2. IPv6 capable SGSNs shall be dual stack nodes (at least for the initial migration period).
3. The charging, CAMEL and LI services shall use the IPv4 address of the GGSN for correlation purposes (at least for the initial migration period).
4. IPv6 capable GGSNs should, when supplying an IPv6 address to an SGSN in the PDP context activation procedure, also give an IPv4 address.
5. When a new SGSN (in a RAU procedure) initiates the Update PDP Context procedure, both the Update PDP Context Request and the Update PDP Context Response message shall have the possibility to simultaneously include both an IPv4 and an IPv6 address.

The attached contribution provides a detailed analysis on this issue.

SA2 kindly asks the concerned working groups to investigate the implications of these principles on their respective specifications and to implement the necessary changes, if any. SA2 would also like to recommend to RAN3 to investigate the principles of allocation of addresses between dual stack nodes and, where applicable, to follow similar principles as above.

2. Actions:

CN4: Investigate any necessary changes to TS 29.060 to incorporate this functionality.

CN2: Investigate the implications of these principles on CAMEL specifications and implement the necessary changes, if any.

SA3: Investigate the implications of these principles on LI specifications and implement the necessary changes, if any.

SA5: Investigate the implications of these principles on charging specifications and implement the necessary changes, if any.

RAN3: Investigate the principles of allocation of addresses between dual stack nodes and, where applicable, follow similar principles as above.

3. Date of Next SA2 Meetings:

SA2 #23	18th – 22nd February 2002	Sophia-Antipolis, France
SA2 #24	22nd – 26th April 2002	Madrid, Spain

3GPP TSG-SA-WG2, Meeting #22 **Tdoc S2-020161**
14-18 January 2002,
Phoenix, USA

Agenda Item: 8

Source: Ericsson

Title: Architectural and protocol issues when introducing IPv6 GSN nodes

Document for: Discussion and Approval

Date: 2002-01-09

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1 Introduction

This contribution assumes there should be a requirement that MSs should not lose their PDP contexts when roaming from one SGSN to another SGSN, even if one of the involved nodes is only capable of handling IPv4 in the backbone while the other is capable of handling IPv6. Based on this requirement, the contribution gives a guiding in architectural and protocol impacts when some GSN nodes supporting IPv6 in the transport plane start being deployed.

2 Discussion

At PDP context activation, the SGSN determines a suitable GGSN from the APN by means of a DNS query. The DNS response returns a number of IP addresses of GGSNs serving the requested APN, some of which might be IPv6 addresses and some others IPv4. The SGSN then selects a suitable IP address among these and sends the Create PDP Context to that address. An IPv4-only SGSN will then select an IPv4 address, while an IPv6-capable SGSN will typically select an IPv6 address, if available.

The SGSN and the GGSN exchange their IP addresses for subsequent communication in the GTP-C messages. Currently in GTP-C, it is possible to carry only one type of IP address at a time from the SGSN to the GGSN and vice versa. As IPv6 network nodes are becoming more common, enhancements to the current mechanism are needed. This becomes visible when looking at roaming traffic cases.

If a GGSN indicated only one IPv6 address to an IPv6-SGSN in the activation procedure of the PDP context, this SGSN has no problem handling the PDP context. But if the MS roams to an IPv4-SGSN, this SGSN is not capable of communicating with the GGSN using the IPv6 address(es) received from the old IPv6-SGSN. Thus the new IPv4-SGSN can not update the GTP tunnel(s) towards the GGSN, even if the GGSN also supports IPv4.
Therefore, IPv6 capable GGSNs should be dual stack (at least for the initial migration period), and they should, when contacted on an IPv6 address, give both an IPv4- and an IPv6-address to the SGSN in the PDP context activation procedure.

The above example applies also if the GGSN indicates an IPv4 address to an IPv4-SGSN in the PDP context activation procedure. When the MS moves to an SGSN that support IPv6, this SGSN can not communicate with the GGSN with IPv6 even if the GGSN supports IPv6 and they both prefer to use IPv6.
Therefore, when a new IPv6-SGSN in a RAU procedure initiates the Update PDP Context procedure to a GGSN, the new SGSN should give both an IPv4- and an IPv6-address if it is capable of doing so when it prefers to use IPv6. The GGSN should in this case return both the IPv4- and the IPv6-addresses if it prefers to use IPv6 for the PDP context.

To cope with IPv6 capable SGSNs, there are three possibilities.

1. One solution is that such SGSNs are also dual stack nodes. The traffic cases will then become simple, and such an SGSN will then use IPv4 if it communicates with an IPv4 node, and otherwise IPv6 is used. This is briefly described in chapter 3.1.
2. Another solution is that such SGSNs have a single IPv6 stack, but gateways are added in the network to perform a mapping from/to IPv6 headers to/from IPv4 headers on the IP layer. This approach means that the IPv6 capable SGSN must know the corresponding IPv4 addresses of the gateway so that these IPv4 addresses can be supplied to an SGSN or to a GGSN in the relevant GTP-C messages. This is briefly described in chapter 3.2.
3. A third solution is that such SGSNs have a single IPv6 stack, but application layer gateways are added in the network to perform a mapping both in the GTP layer and in the IP layer (from/to IPv4 headers to/from IPv6 headers). This is briefly described in chapter 3.3.

These possible solutions are described in more detail in chapter 3.

3 Detailed traffic case examples

3.1 Roaming when an IPv6 capable SGSN is dual stack.

For such SGSNs the traffic cases for roaming become straight forward.

If an MS roams from an IPv4-SGSN to a dual stack SGSN, the dual stack SGSN will use the ‘old RAI’ parameter from the RAU Request to determine that the old SGSN only handles IPv4. The dual stack SGSN will therefore also use IPv4 in this case.

If an MS roams from a dual stack SGSN to an IPv4-SGSN, the dual stack SGSN will receive the SGSN Context Request message on an IPv4 interface. Therefore the dual stack SGSN will again use IPv4 in this case.

The interface between an SGSN and a GGSN is de-coupled from the inter SGSN interface, and therefore the IP addresses of the SGSN for this communication is handled separately. This means that although an SGSN uses an IPv4 address towards another SGSN at roaming, the SGSN can use IPv6 addresses towards GGSNs.

3.2 MS roams from an IPv6 only SGSN to an IPv4 SGSN and performs a RAU procedure when using a gateway to map on the IP layer

The below text is a simplified extract of the RAU procedure, containing the aspects that are important when considering an IPv6 capable SGSN.

1. The new IPv4-SGSN will receive a RAU Request message from an MS. The IPv4-SGSN will then look up old RAI of MS to find which IPv4 address to use when sending the SGSN Context Request message. This IPv4 address will be the address of a gateway situated between the old and the new SGSN, and each IPv6-only GSN must have a separate IPv4 address in the gateway. The new IPv4-SGSN then sends the GTP message SGSN Context Request towards the old IPv6-SGSN. This GTP message contains, in the GTP layer, the IPv4 address of the new IPv4-SGSN, and the IP layer of the GTP message contains only an IPv4 header.
2. Somewhere between the new and the old SGSN, there must be a gateway that maps the IP layer to an IPv6 header, and when doing this, the gateway maps both the source and the destination IP addresses to IPv6 addresses. The GTP layer can remain untouched.
3. Upon receiving this message, the old IPv6-SGSN then sends the GTP message SGSN Context Response to the new IPv4-SGSN. This GTP message must then contain an IPv4 address in the GTP layer, and this will indicate which IP address the new IPv4-SGSN should use when sending further control messages to the old IPv6-SGSN. This IPv4 address is then the address of a gateway, and the gateway must then know where to forward messages received on this address, i.e. to the IPv6-SGSN.

The SGSN Context Response message contains for each of the transferred PDP contexts, both the control plane and the user plane IP addresses of the GGSN that is involved. Since it cannot be assumed that the new IPv4-SGSN is capable of handling any IPv6 address in the backbone, the IPv6 capable GGSNs should be dual stack, and the old IPv6-SGSN must have received both the IPv4 address(es) and the IPv6 address(es) of the GGSNs. The IPv4 addresses of the involved GGSNs will be supplied to the new IPv4-SGSN.
Also, the SGSN Context Response message is sent from the IPv6-SGSN using an IPv6 header. The IPv6-SGSN must know which IPv6 address to use in the IP layer for the received IPv4 address mentioned in step 1 when sending the SGSN Context Response message, and the gateway must map the IP layer of this message from IPv6 to IPv4.

FINDING: Particular care must be taken to ensure that both the IPv4-SGSN and the IPv6-SGSN are configured with consistent addresses in the gateway, thus adding to the O&M burden on the operator and to the risks of faulty configuration.
GGSNs should be dual stack when supporting IPv6 in the backbone, and the GGSNs should also include IPv4 address(es) when the SGSN uses IPv6 address(es) in the PDP context activation procedure.

4. Upon receiving the SGSN Context Response, the new IPv4-SGSN sends the SGSN Context Acknowledge message to the old IPv6-SGSN. Again, the gateway must map the IP layer from being IPv4 to IPv6. This message will contain the IPv4 address telling where the new IPv4-SGSN wants to receive forwarded data packets from the old IPv6-SGSN.
5. When the old IPv6-SGSN forwards IP packets to the new IPv4-SGSN, the IPv6-SGSN will use IPv6 headers. The IPv6-SGSN must know which IPv6 address to use in the IP layer for the received IPv4 address mentioned in step 4. The gateway must map all IP packets from IPv6- to IPv4-format.

3.3 MS roams from IPv6 only SGSN to IPv4 SGSN and performs a RAU procedure when using a gateway to map on both the GTP layer and the IP layer

For this scenario, the IPv4-SGSN and the IPv6-SGSN will not communicate directly. They will only know about and communicate with an application layer gateway, and this gateway will propagate the messages towards the other node. The IPv4-SGSN will use IPv4 addresses both in the GTP layer and in the IP layer, the IPv6-SGSN will use IPv6 addresses both in the GTP layer and in the IP layer, and the application layer gateway will perform a mapping between the IPv4 format and the IPv6 format, both in the GTP layer and in the IP layer.

3.4 Brief summary of the proposals for IPv6 capable SGSNs

To introduce gateways, as described in chapter 3.2. and 3.3, increases the complexity of the network. It also means additional configuration effort for the operator, and this again means higher cost and higher probability of introducing errors.
Also, NATs are performance bottlenecks and single points of failure.
Therefore it is recommended that an IPv6 capable SGSN be dual stack (at least for the initial migration period).

4 Impacts on charging, CAMEL and LI

Since the IP address of the GGSN is used for correlation of the charging-, CAMEL- and LI-services and that this IP address must not change during the lifetime of the PDP context, it is suggested that these services use the IPv4 address of the GGSN in the initial migration period.

5 Proposal

It is proposed that the following is agreed:
– IPv6 capable GGSNs shall be dual stack nodes (at least for the initial migration period).
– IPv6 capable SGSNs shall be dual stack nodes (at least for the initial migration period).

- The charging-, CAMEL-, and LI-services shall use the IPv4 address of the GGSN for correlation purposes (at least for the initial migration period).
- IPv6 capable GGSNs should, when supplying an IPv6 address to an SGSN in the PDP context activation procedure, also give an IPv4 address.
- When a new SGSN (in a RAU procedure) initiates the Update PDP Context procedure, both the Update PDP Context Request and the Update PDP Context Response message shall have the possibility to simultaneously include both an IPv4- and an IPv6-address.
- CN4 should receive an LS where this is stated, together with a request to include the associated functionality in 29.060 for release 5.