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Acapulco, Mexico

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Source: **Vodafone**

Title: **TR on early IMS security, v0.0.2**

Document for: **Information**

A new version of the draft TR on early IMS security has been produced. This version takes into account comments received during SA3#34. A revision-marked and a clean version are attached.

3GPP TR 33.cde V0.0.21 (2004-07)

Technical Report

3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Security Aspects of Early IMS (Release 6)

Keywords

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Contents

Foreword

This Technical Report has been produced by the 3rd Generation Partnership Project (3GPP).

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

Version x.y.z

where:

- x the first digit:
  - 1 presented to TSG for information;
  - 2 presented to TSG for approval;
  - 3 or greater indicates TSG approved document under change control.
- y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.
- z the third digit is incremented when editorial only changes have been incorporated in the document.

Introduction

This clause is optional. If it exists, it is always the second unnumbered clause.

1 Scope

This clause shall start on a new page. No text block identified. Should start:

The present document Ö

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TR 23.981: " Interworking aspects and migration scenarios for IPv4 based IMS Implementations ".

[2] 3GPP TS 33.203: " Access security for IP-based services ".

[3] 3GPP TS 23.228: " IP Multimedia Subsystem (IMS); Stage 2 ".

[4] 3GPP TS 29.061: " Interworking between the Public Land Mobile Network (PLMN) supporting packet based services and Packet Data Networks (PDN) ".

[5] 3GPP TS 23.060: " General Packet Radio Service (GPRS); Service description; Stage 2 ".

[6] RFC 3261: " Session Initiation Protocol ".

3 Definitions, symbols and abbreviations

Delete from the above heading those words which are not applicable.

Subclause numbering depends on applicability and should be renumbered accordingly.

3.1 Definitions

For the purposes of the present document, the [following] terms and definitions [given in ... and the following] apply.

Definition format

***<defined term>**: <definition>.*

example: text used to clarify abstract rules by applying them literally.

3.2 Symbols

For the purposes of the present document, the following symbols apply:

Symbol format

<symbol> <Explanation>

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

Abbreviation format

<ACRONYM> <Explanation>

4 Background and motivation

3GPP IMS provides an IP-based session control capability based on the SIP protocol. IMS can be used to enable services such as push to talk, instant messaging, presence and conferencing. It is understood that ì earlyî implementations of these services will exist that are not fully compliant with 3GPP IMS. For example, it has been recognized that although 3GPP IMS uses exclusively IPv6, as specified in clause 5.1 of TS 23.221, there will exist IMS implementations based on IPv4 [1].

Non-compliance with IPv6 is not the only difference between early IMS implementations and 3GPP compliant implementations. In particular, it is expected that there will be a need to deploy some IMS-based services before products are available which fully support the 3GPP IMS security features defined in TS 33.203 [2]. Non-compliance with TS 33.203 security features is expected to be a problem mainly at the terminal side, because of the potential lack of support of the USIM/ISIM ~~authentication~~ interface (especially in 2G-only devices) and because of the potential inability to support IPsec on some terminal platforms.

Although full support of TS 33.203 security features is preferred from a security perspective, it must be acknowledged that early IMS implementations will exist which do not support these features. Therefore, there is a need to ensure that simple, yet adequately secure, mechanisms are in place to protect against the most significant security threats that will exist in early IMS implementations. Furthermore, to maximise interoperability, it is important that these mechanisms are adequately standardised.

5 Requirements on interim solution

Low impact on existing entities: Any early IMS security mechanisms should be such that impacts on existing entities, especially on the UE, are minimised and would be quick to implement. It is especially important to minimise impact on the UE to maximise interoperability with early IMS terminals. The mechanisms should be quick to implement so that the window of opportunity for the interim solution is not missed.

Adequate level of security: Although it is recognised that the interim solution will be simpler than the full 3GPP IMS security solution, it should still provide an adequate level of security to protect against the most significant security threats that will exist in early IMS implementations. As a guide, the strength of subscriber authentication should be comparable to the level of authentication provided for existing chargeable services in mobile networks.

Smooth and cost effective migration path to 3GPP solution: Clearly, any security mechanisms developed for early IMS systems will provide a lower level of protection compared with that offered by the full set of 3GPP IMS security features. The security mechanisms developed for early IMS systems should therefore be considered as an interim solution and migration to the full set of 3GPP IMS security features should take place as soon as suitable products become available at an acceptable cost. In particular, the interim solution should not be used as a long-term replacement for full 3GPP IMS security. It is important that the interim solution allows a smooth and cost-effective migration path to the full 3GPP solution.

Co-existence with 3GPP solution: It is clear that terminals supporting the interim solution will need to be supported even after 3GPP compliant terminals are deployed. The interim solution should therefore be able to co-exist with the full 3GPP solution. In particular, it shall be possible for the SIP/IP core to differentiate between a subscription using interim security mechanisms and a subscription using the full 3GPP solution.

Protection against bidding down: It should not be possible for an attacker to force the use of the interim solution when both the terminal and the network support the full 3GPP solution.

No restrictions on the type of charging model: Compared with full 3GPP IMS security solution, the interim solution should not impose any restrictions on the type of charging model that can be adopted.

Standardisation of a single interim solution: Interfaces that are impacted by the interim solution should be adequately standardised to ensure interoperability between vendors. To avoid unnecessary complexity, a single interim solution should be standardised.

Support access over 3GPP PS domain: Currently the main requirement is to support secure access over the 3GPP PS domain (including GSM/GPRS and UMTS access). Access based on WLAN scenario 2, or other alternative access networks, is a lower priority.

Editorís note: The solution described in this TR is primarily focused on secure access over 3GPP PS domain. Applicability of the solution to other access networks is ffs.

Low impact on provisioning: The impact on provisioning should be low compared with the full 3GPP solution.

6 Threat scenarios

To understand what controls are needed to address the security requirements, it is useful to describe some of the threat scenarios.

NOTE: There are many other threats, which are outside the scope of this TR.

6.1 Impersonation on IMS level using the ~~public~~ user identity of an innocent user

The scenario proceeds as follows:

- Attacker A attaches to GPRS, GGSN allocates IP address, IPgprs-a
- Attacker A registers in the IMS using his IMS identity, IDims-a
- Attacker A sends SIP invite using his own source IP address (IPgprs-a) but with the IMS identity of B (IDims-b).

If the binding between the IP address on the bearer level, and the public and private user identities is not checked then the attacker will succeed, i.e. A pays for IP connectivity but IMS service is fraudulently charged to B. The fraud situation is made worse if IP flow based charging is used to ëzero rateí the IP connectivity.

The major problem is however that ~~(~~without this binding~~)~~ multiple users within a group ì of friendsî could sequentially (or possibly simultaneously) share Bís private/public user identities, and thus all get (say) the push-to-talk service by just one of the group paying a monthly subscription. Without protection against this attack, operators could be restricted to IP connectivity based tariffs and, in particular, would be unable to offer bundled tariffs. This is unlikely to provide sufficiently flexibility in todayís market place.

6.2 IP spoofing

The scenario proceeds as follows:

- User B attaches to GPRS, GGSN allocates IP address, IPgprs-b
- User B registers in the IMS using his IMS identity, IDims-b

- Attacker A sends SIP messages using his own IMS identity (IDims-a) but with the source IP address of B (IPgprs-b)

If the binding between the IP address that the GGSN allocated the mobile in the PDP context activation and the source IP address in subsequent packets is not checked then the attacker will succeed, i.e. A pays for IMS service but IP connectivity is fraudulently charged to B. Note that this attack only makes sense for IMS services with outgoing traffic only because the attacker will not receive any incoming packets addressed to the IMS identity that he is impersonating.

6.3 Combined threat scenario

The scenario proceeds as follows:

- User B attaches to GPRS, GGSN allocates IP address, IPgprs-b
- User B registers in the IMS using his IMS ~~public~~ identity, IDims-b
- Attacker A sends SIP messages using IMS identity (IDims-b) and source IP address (IPgprs-b)

If the bindings mentioned in the scenarios in section 6.2 and 6.3 are not checked then the attacker will succeed, i.e. A fraudulently charges both IP connectivity and the IMS service to B. Note this attack only makes sense for IMS services with outgoing traffic only because the attacker will not receive any incoming packets addressed to the IMS identity that he is impersonating.

7 Specification of interim IMS security

7.1 Overview

The interim security solution works by creating a secure binding in the HSS between the public/private user identity (SIP-level identity) and the IP address currently allocated to the user at the GPRS level (bearer/network level identity). Therefore, IMS level signaling, and especially the IMS identities claimed by a user, can be connected securely to the SIM-based GPRS security context.

The GGSN, terminating each userís authenticated PDP context, provides the userís IP address / MSISDN pair to the HSS when a PDP context is activated towards the IMS system. The HSS has a binding between the MSISDN and the ~~private user identity~~IMPI, and is therefore able to store the currently assigned IP address from the GGSN against the userís ~~IMS private user identity~~IMPI. The GGSN informs the HSS when the PDP context is deactivated/modified so that the stored IP address can be updated in the HSS. When the S-CSCF receives a SIP registration request or any subsequent requests for a given ~~IMS identity~~IMPI, it checks that the IP address in the SIP header (verified by the network) matches the IP address that was stored against that subscriberís ~~private user identity~~IMPI in the HSS.

The mechanism assumes that the GGSN does not allow a mobile to successfully transmit an IP packet with a source IP address that is different to the one assigned during PDP context activation. In other words, the GGSN must prevent ìsource IP Spoofingî. The mechanism also assumes that the P-CSCF checks that the source IP address in the SIP header is the same as the source IP address in the IP header received from the mobile (the assumption here, as well as for 3GPP compliant IMS systems, is that no NAT is present between the GGSN and the P-CSCF).

The mechanism prevents an attacker from using his own IP address in the IP header but spoofing someone elseís IMS identity or IP address in the SIP header, so that he pays for GPRS level charges, but not for IMS level charges. The mechanism also prevents an attacker spoofing the address in the IP header so that he does not pay for GPRS charges. It therefore counters the threat scenarios given in section 6~~2~~ above.

The mechanism assumes that only one contact IP address is associated with one IMPI. Furthermore, the mechanism supports the case that there may be several IMPUs associated with one IMPI, but one IMPU is associated with only one IMPI.

Editorís Note: It is for further study whether the mechanism shall be extended to support the case that one IMPU may be associated with several IMPIs, or whether the mechanism shall be restricted to only support the case that there is a one-to-one mapping between IMPI and IMPU.

In early IMS the IMS user authentication is performed by linking the IMS registration (based on an IMPI) to an authenticated PDP context (based on an IMSI). The mechanism here assumes that there is a one-to-one relationship between the IMSI for bearer access and the IMPI for IMS access.

Editorís Note: It is for further study whether the mechanism shall be extended to support one-to-many or many-to-many relationships between the IMSI for bearer access and the IMPI for IMS access.

In the following we use the terms P-CSCF and S-CSCF in a general sense to refer to components of an early IMS system. We note however that early IMS solutions may not have the same functionality split between SIP entities as defined in TS 23.228 [3]. Therefore, the requirements imposed on the SIP/IP core are specified in such a way that they are independent of the functionality split between SIP entities as far as possible. Note however that while the exact functionality split of the SIP/IP core may be left open, it is important that any changes to the Cx interface towards the HSS are standardised for vendor interoperability reasons.

7.2 Detailed specification

7.2.1 Update of mobileís IP address in HSS depending on PDP context state

During PDP context request towards the IMS, the GGSN shall send a RADIUS "ACCOUNTING-REQUEST START" message to a RADIUS server attached to the HSS. The message shall include the UEís IP address and MSISDN. The format of the message shall be compliant with 3GPP TS 29.061 [4]. On receipt of the message, the HSS shall use the MSISDN to find the subscriberís IMPI ~~IMS identity~~ (derived from IMSI) and then store the IP address against the ~~IMS identity~~IMPI.

NOTE: It is assumed here that the RADIUS server for handling the accounting request to receive the IP address from the GGSN is different to the RADIUS server that the GGSN may use for access control and IP address assignment. However, according to TS 23.060 [5] there is no limitation on whether RADIUS servers for Accounting and Access control have to be separate or combined.

Editorís note: An alternative approach would be to re-use the AAA architecture of I-WLAN i.e. the 3GPP AAA Proxy or Server and its capability to perform RADIUS to DIAMETER conversion such that the HSS will not specifically need to support RADIUS (existing DIAMETER functionality of HSS can be re-used). This is ffs.

GGSN shall not activate the PDP context if the accounting start message is not successfully handled by the HSS. In particular, it shall not be possible to have an active IMS PDP context if the corresponding IP address is not stored in the HSS.

In case of PDP context deletion, the GGSN sends an "ACCOUNTING-REQUEST STOP" message to the HSS after the idle timer in the GGSN expires. The HSS shall then start the 3GPP HSS-initiated de-registration procedure.

If the UE establishes a new PDP context and therefore gets a new IP address, the UE shall start the IMS initial registration procedure. Because the idle timer in the GGSN could be set with a large value, e.g. 1 hour, it is quite likely that the UE will send a PDP context creation request before the idle timer expires. Two cases are distinguished:

- If the PDP context creation request is processed by the same SGSN as the old PDP context, then the SGSN will assign the existing PDP context to the UE. Therefore the IP address of the UE is unchanged and the IMS registration is still valid.

- If the PDP context creation request is processed by a different SGSN compared to the old PDP context, e.g. in case of a routing area update, the SGSN will create a new PDP context for the UE. In this case the GGSN shall send an "ACCOUNTING-REQUEST START" to the HSS with the new IP address. Because this IP address is different to the IP address the UE registered with, the HSS shall start the 3GPP HSS-initiated de-registration procedure. Later, the idle timer for the old PDP context expires and the old PDP context will be deleted by the GGSN. The HSS will be informed about the event via the "ACCOUNTING-REQUEST STOP" message. The HSS checks the IP address indicated by the "ACCOUNTING-REQUEST STOP" message against the IP address stored in the HSS. If they are the same, a network-initiated de-registration procedure shall be started. In this case they are different, so the HSS shall then ignore the message.

7.2.2 Protection against IP address spoofing in GGSN

All GGSNs that offer connection to IMS shall implement measures to prevent source IP address spoofing. Specifically, a UE attached to the GGSN shall not be able to successfully transmit an IP packet with a source IP address that is different to the one assigned by the GGSN during PDP context activation. If IP address spoofing is detected the GGSN shall drop the packet and log the event in its security log against the subscriber information (IMSI/MSISDN).

7.2.3 Source IP address checking in the P-CSCF and S-CSCF

A UE shall not be able to spoof its assigned IP address and successfully receive service from the IMS. The following mechanisms are required to prevent IP address spoofing in the IMS domain.

7.2.3.1 P-CSCF mechanisms

As mandated by section 18.2.1 of RFC 3261 [6] the P-CSCF will check the IP address in the ìsent-byî parameter of the top ìViaî header field. Specifically, if the host portion of the "sent-by" parameter contains a domain name, or if it contains an IP address that differs from the packet source IP address, the server will add a "received" parameter to that Via header field value. This parameter contains the source IP address from which the packet was received. After this processing, the P-CSCF forwards the SIP message to the I-CSCF or S-CSCF.

7.2.3.2 S-CSCF mechanisms

S-CSCF shall use the ~~IMS public user identity~~IMPI to retrieve the IP address stored during PDP context activation. For all requests, the S-CSCF first checks whether a ìreceivedî parameter exists in the top ìviaî header field. If a ìreceivedî parameter exists, S-CSCF shall compare the IP address recorded in the ìreceivedî parameter against the UEís IP address stored during registration. If no ìreceivedî parameter exists in the top ìviaî header field, then S-CSCF shall compare IP address recorded in the ìsent-byî parameter against the IP address stored during registration. In both cases, if the HSS retrieved IP address and the IP address recorded in the top ìviaî header do not match, the S-CSCF shall reject the registration with a 403 Forbidden response.

~~It should be noted that i~~If the request sent is an initial REGISTER, then the S-CSCF shall always query the HSS to retrieve the IP address registered during PDP context activation. The IP address fetched during a initial SIP REGISTER shall be stored in the S-CSCF and used for checking subsequent non-REGISTER SIP requests and non-initial REGISTER requests. The S-CSCF shall implement procedures to recover the registration information (including IP address) from the HSS ~~stored~~ in case of a system failure.

~~Note that t~~The S-CSCF ~~should~~ shall check the IP address for every SIP request, but it shall only ~~needs to~~ contact the HSS to fetch the IP address during the~~a~~ initial SIP Register.

NOTE: The~~is~~ S-CSCF only needs to contact the HSS to fetch the IP address during the initial SIP REGISTER~~is~~ because any change in IP address at the GPRS level will trigger the ~~HSS~~ UE to send an initial REGISTER ~~initiate a re-registration at the SIP level~~. Furthermore, the GGSN always notifies the HSS when the IP address is deallocated and the HSS then immediately deregisters the user. This mechanism requires that the S-CSCF can distinguish between initial REGISTER requests and re-REGISTER requests. Contacting HSS for every SIP message would place too high a load on the HSS.

Editorís Note: It is for further study whether an alternative approach where the IP address is checked in the HSS rather than in the S-CSCF should be adopted. With this alternative the HSS would provide the IP address to the HSS during each initial REGISTER and accept the REGISTER only if the HSS returns a positive result. For subsequent non-initial REGISTER requests, the S-CSCF would then check the received IP address against the IP address stored during the initial REGISTER.

7.2.4 Identification of terminals supporting the interim solution

At some stage, it is expected that both fully 3GPP compliant terminals and terminals implementing the interim security solution will access the same IMS. Therefore, some indication ~~needs to~~shall be given that a terminal supports the interim solution rather than the full 3GPP solution.

Editorís note: The exact format, and means to carry this information, is for further study.

7.2.5 Message flows

Editorís Note: The exact specification of message contents is for further study. Changes to the Cx interface MAR/MAA commands would need to be specified in the appropriate CN4 specifications.

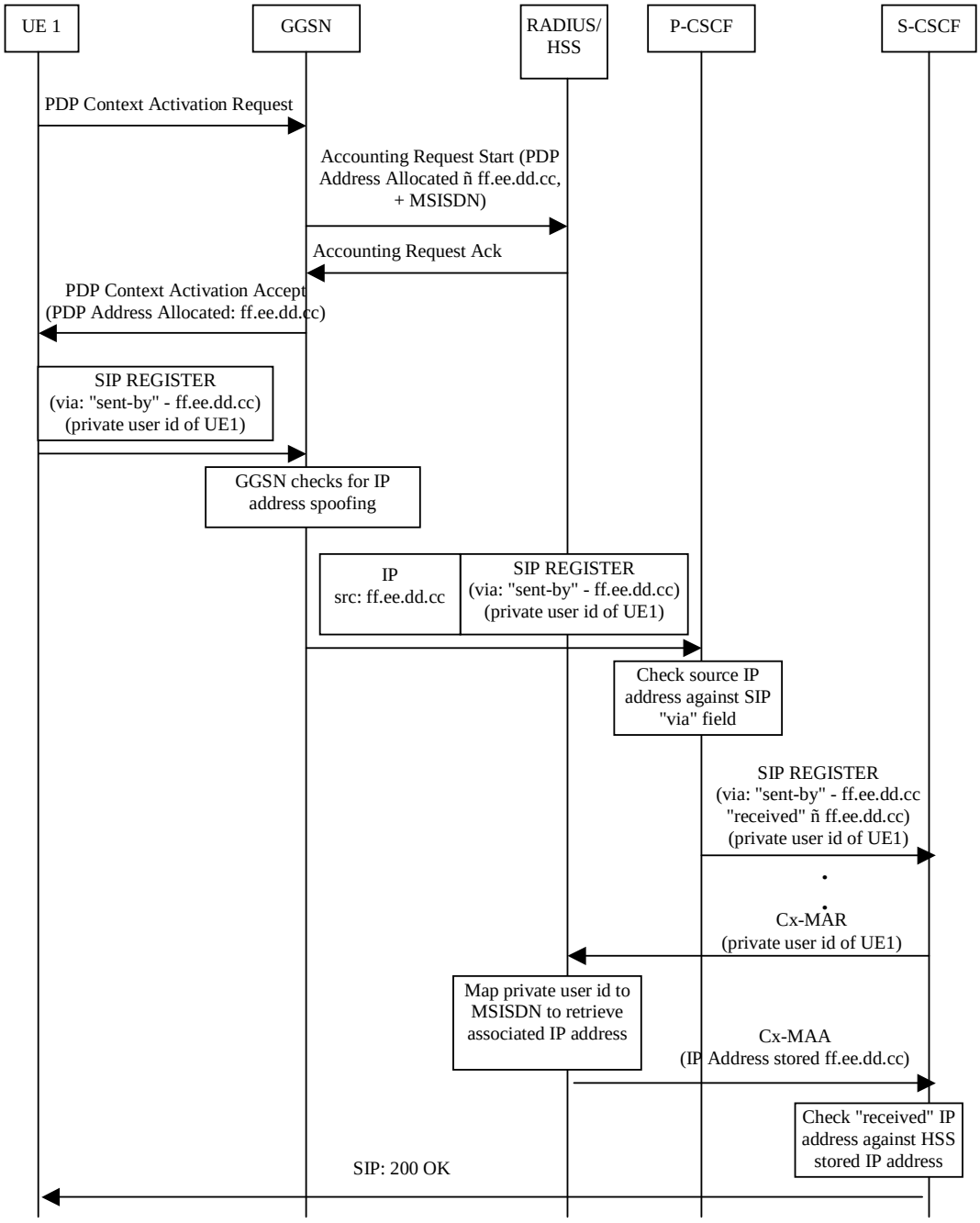
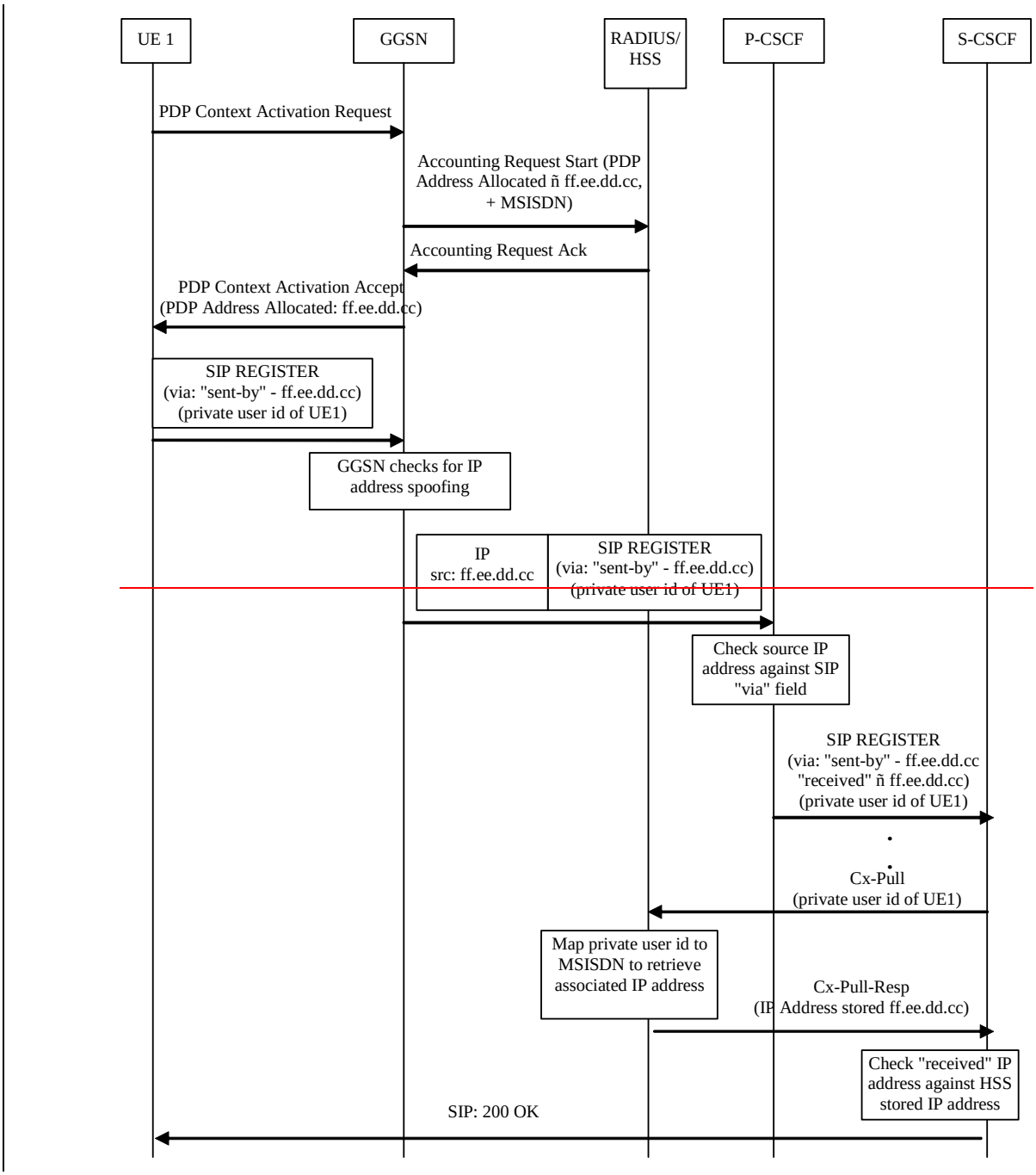


Figure 1 below describes the message flow for successful registration to the IMS that is specified by the interim security solution.

Note, that the ìreceivedî parameter is only sent from P-CSCF to S-CSCF under the conditions given in section 7.2.3.1.


UE 1
GGSN
RADIUS/ HSS
P-CSCF
S-CSCF
PDP Context Activation Request
Accounting Request Start (PDP Address Allocated ñ ff.ee.dd.cc, + MSISDN)
Accounting Request Ack
PDP Context Activation Accept (PDP Address Allocated: ff.ee.dd.cc)
SIP REGISTER (via: "sent-by" - ff.ee.dd.cc) (private user id of UE1)
GGSN checks for IP address spoofing
IP src: ff.ee.dd.cc
SIP REGISTER (via: "sent-by" - ff.ee.dd.cc) (private user id of UE1)
Check source IP address against SIP "via" field
SIP REGISTER (via: "sent-by" - ff.ee.dd.cc "received" ñ ff.ee.dd.cc) (private user id of UE1)
Cx-Pull (private user id of UE1)
Map private user id to MSISDN to retrieve associated IP address
Cx-Pull-Resp (IP Address stored ff.ee.dd.cc)
Check "received" IP address against HSS stored IP address
SIP: 200 OK

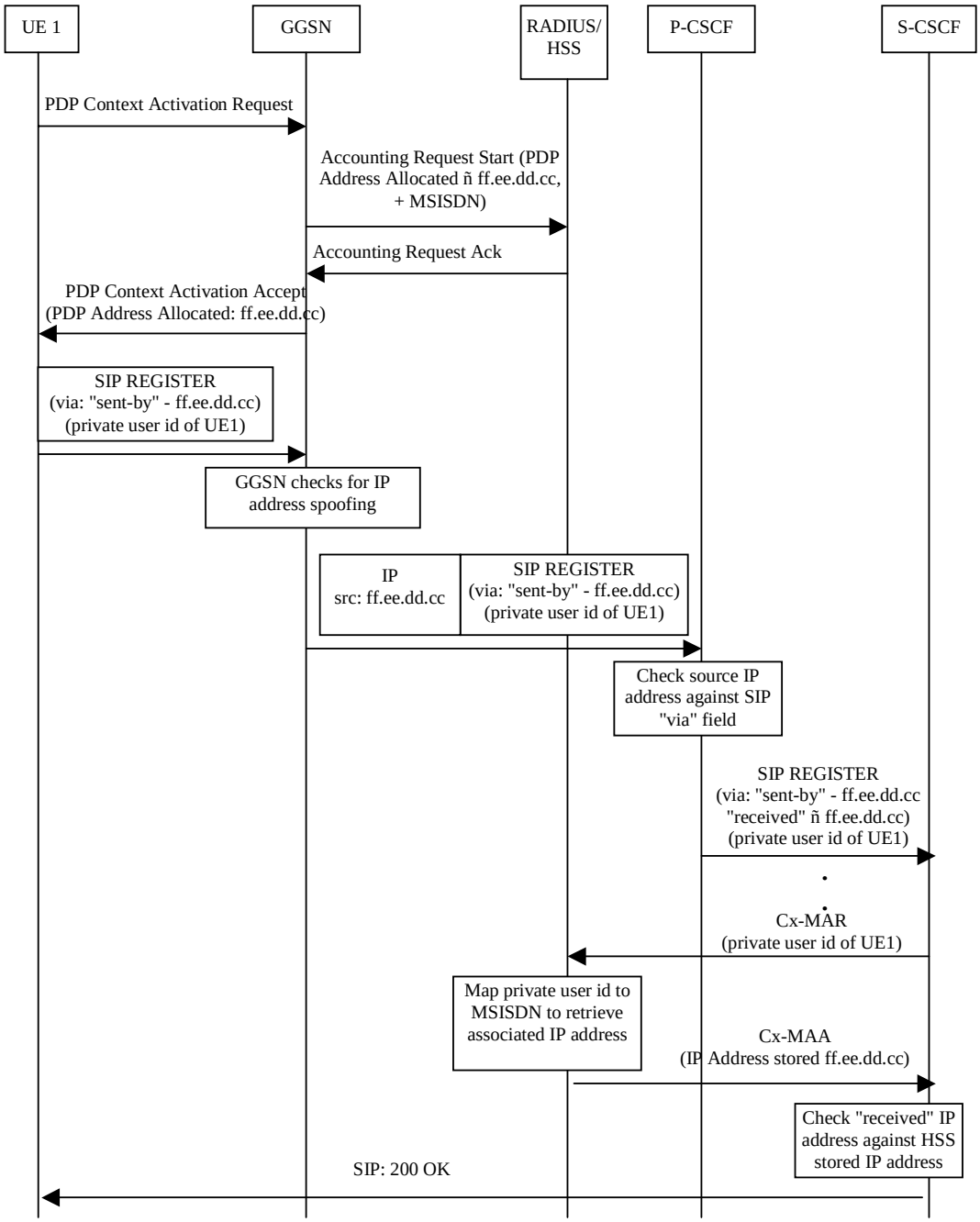


Figure 1: ~~Possible~~ Message Sequence for Interim Security Solution (successful registration)

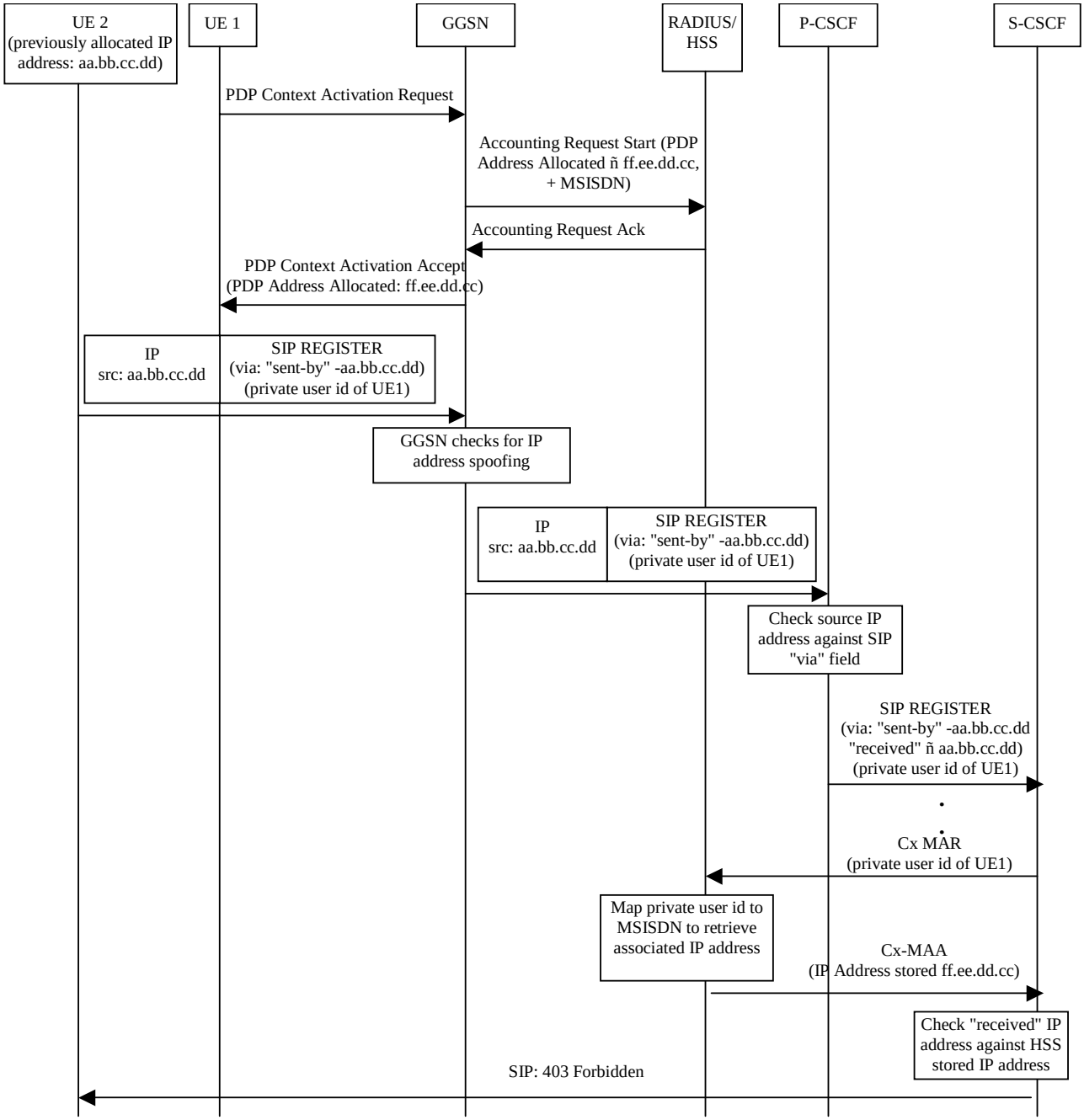
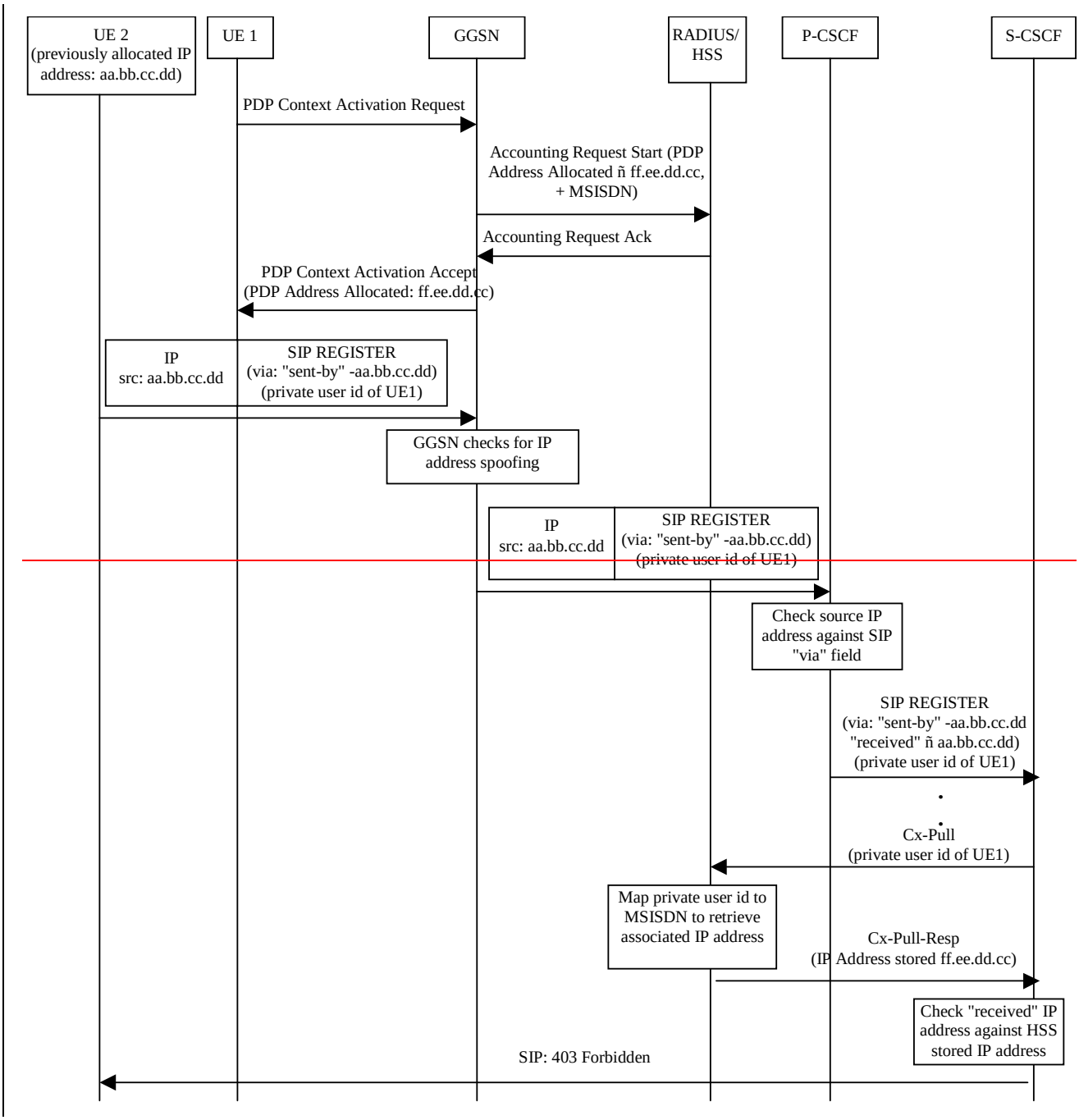


Figure 2 below gives an example message flow for the unsuccessful attempt of an attacker trying to spoof the IMS identity of a valid IMS user.

Again, the ìreceivedî parameter is only present between P-CSCF to S-CSCF under the conditions given in section 7.2.3.1.


UE 2
(previously allocated IP address: aa.bb.cc.dd)
UE 1
GGSN
RADIUS/ HSS
P-CSCF
S-CSCF
PDP Context Activation Request
Accounting Request Start (PDP Address Allocated ñ ff.ee.dd.cc, + MSISDN)
Accounting Request Ack
PDP Context Activation Accept (PDP Address Allocated: ff.ee.dd.cc)
IP src: aa.bb.cc.dd
SIP REGISTER (via: "sent-by" -aa.bb.cc.dd) (private user id of UE1)
GGSN checks for IP address spoofing
IP src: aa.bb.cc.dd
SIP REGISTER (via: "sent-by" -aa.bb.cc.dd) (private user id of UE1)
Check source IP address against SIP "via" field
SIP REGISTER (via: "sent-by" -aa.bb.cc.dd "received" ñ aa.bb.cc.dd) (private user id of UE1)
Cx-Pull (private user id of UE1)
Map private user id to MSISDN to retrieve associated IP address
Cx-Pull-Resp (IP Address stored ff.ee.dd.cc)
Check "received" IP address against HSS stored IP address
SIP: 403 Forbidden

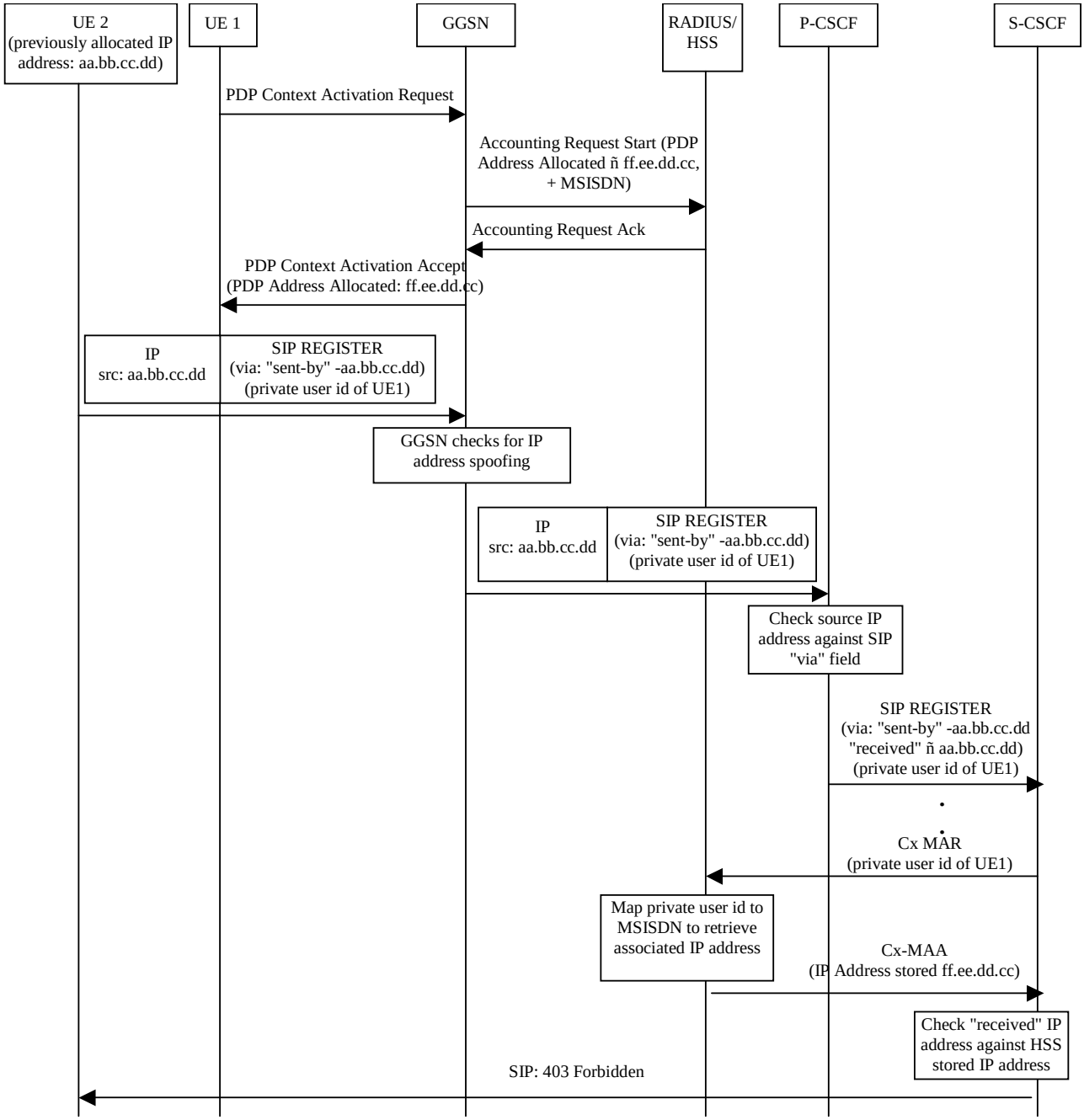


Figure 2: ~~Possible~~ Message Sequence for Interim Security Solution showing an~~(~~ unsuccessful~~)~~ identity theft

Annex A:
Comparison with alternative approaches

An alternative approach is to use password-based authentication for early IMS implementations. For example, HTTP Digest could be used for authenticating the IMS subscriber. This method would require a subscriber-specific password to be provisioned on the IMS terminal. Compared with the approach specified in section 7, password-based authentication has the following disadvantages:

- It imposes restrictions on the type of charging schemes that can be adopted. In particular, if a subscriber could find out his or her own password from an insecure implementation on the terminal, then he or she could share the IMS subscription with friends. This could impact revenue for the operator if bundled or partly subscription based tariffs are used rather than purely usage based tariffs. For example, a subscriber could take out a subscription for 100 instant messages and then share this with his or her friends. Although contractual obligations could be

imposed on customers to prohibit this behaviour, in practice this would be difficult to enforce. If charging were purely usage based then there would be no incentive for the subscriber to do this (and no impact on operator revenue). The solution specified in section 7 is flexible in allowing a range of different charging models including bundled or partly subscription based tariffs.

- It provides a weak form of subscriber authentication compared with the levels of authentication used for other services offered over 3GPP networks, where authentication is typically based directly or indirectly on the (U)SIM. This has implications on the reliability of charging, and on the level of assurance that can be given to the customer that their communications cannot be masqueraded. In the solution specified in section 7, authentication of the IMS subscriber is indirectly based on (U)SIM authentication at the GPRS level. The level of security is similar to that currently used for certain WAP services, where the userís MSISDN is provided by the GGSN to the WAP gateway. Security does not rely on the terminal securely storing any long-term secret information (e.g. passwords).

- Provisioning is more complex since subscriber-specific information (i.e. passwords) must be installed in each mobile.

Annex B:
Change history

Change history							
Date	TSG #	TSG Doc.	CR	Rev	Subject/Comment	Old	New
29/6/04					First version based on input from S3-040264 and S3-040265.		0.0.1
8/7/04					Incorporates comments received at SA3#34.	0.0.1	0.0.2

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- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document.*

[1] 3GPP TR 23.981: " Interworking aspects and migration scenarios for IPv4 based IMS Implementations ".

[2] 3GPP TS 33.203: " Access security for IP-based services ".

[3] 3GPP TS 23.228: " IP Multimedia Subsystem (IMS); Stage 2 ".

[4] 3GPP TS 29.061: " Interworking between the Public Land Mobile Network (PLMN) supporting packet based services and Packet Data Networks (PDN) ".

[5] 3GPP TS 23.060: " General Packet Radio Service (GPRS); Service description; Stage 2 ".

[6] RFC 3261: " Session Initiation Protocol ".

3 Definitions, symbols and abbreviations

Delete from the above heading those words which are not applicable.

Subclause numbering depends on applicability and should be renumbered accordingly.

3.1 Definitions

For the purposes of the present document, the [following] terms and definitions [given in ... and the following] apply.

Definition format

***<defined term>**: <definition>.*

example: text used to clarify abstract rules by applying them literally.

3.2 Symbols

For the purposes of the present document, the following symbols apply:

Symbol format

<symbol> <Explanation>

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

Abbreviation format

<ACRONYM> <Explanation>

4 Background and motivation

3GPP IMS provides an IP-based session control capability based on the SIP protocol. IMS can be used to enable services such as push to talk, instant messaging, presence and conferencing. It is understood that ì earlyî implementations of these services will exist that are not fully compliant with 3GPP IMS. For example, it has been recognized that although 3GPP IMS uses exclusively IPv6, as specified in clause 5.1 of TS 23.221, there will exist IMS implementations based on IPv4 [1].

Non-compliance with IPv6 is not the only difference between early IMS implementations and 3GPP compliant implementations. In particular, it is expected that there will be a need to deploy some IMS-based services before products are available which fully support the 3GPP IMS security features defined in TS 33.203 [2]. Non-compliance with TS 33.203 security features is expected to be a problem mainly at the terminal side, because of the potential lack of support of the USIM/ISIM interface (especially in 2G-only devices) and because of the potential inability to support IPsec on some terminal platforms.

Although full support of TS 33.203 security features is preferred from a security perspective, it must be acknowledged that early IMS implementations will exist which do not support these features. Therefore, there is a need to ensure that simple, yet adequately secure, mechanisms are in place to protect against the most significant security threats that will exist in early IMS implementations. Furthermore, to maximise interoperability, it is important that these mechanisms are adequately standardised.

5 Requirements on interim solution

Low impact on existing entities: Any early IMS security mechanisms should be such that impacts on existing entities, especially on the UE, are minimised and would be quick to implement. It is especially important to minimise impact on the UE to maximise interoperability with early IMS terminals. The mechanisms should be quick to implement so that the window of opportunity for the interim solution is not missed.

Adequate level of security: Although it is recognised that the interim solution will be simpler than the full 3GPP IMS security solution, it should still provide an adequate level of security to protect against the most significant security threats that will exist in early IMS implementations. As a guide, the strength of subscriber authentication should be comparable to the level of authentication provided for existing chargeable services in mobile networks.

Smooth and cost effective migration path to 3GPP solution: Clearly, any security mechanisms developed for early IMS systems will provide a lower level of protection compared with that offered by the full set of 3GPP IMS security features. The security mechanisms developed for early IMS systems should therefore be considered as an interim solution and migration to the full set of 3GPP IMS security features should take place as soon as suitable products become available at an acceptable cost. In particular, the interim solution should not be used as a long-term replacement for full 3GPP IMS security. It is important that the interim solution allows a smooth and cost-effective migration path to the full 3GPP solution.

Co-existence with 3GPP solution: It is clear that terminals supporting the interim solution will need to be supported even after 3GPP compliant terminals are deployed. The interim solution should therefore be able to co-exist with the full 3GPP solution. In particular, it shall be possible for the SIP/IP core to differentiate between a subscription using interim security mechanisms and a subscription using the full 3GPP solution.

Protection against bidding down: It should not be possible for an attacker to force the use of the interim solution when both the terminal and the network support the full 3GPP solution.

No restrictions on the type of charging model: Compared with full 3GPP IMS security solution, the interim solution should not impose any restrictions on the type of charging model that can be adopted.

Standardisation of a single interim solution: Interfaces that are impacted by the interim solution should be adequately standardised to ensure interoperability between vendors. To avoid unnecessary complexity, a single interim solution should be standardised.

Support access over 3GPP PS domain: Currently the main requirement is to support secure access over the 3GPP PS domain (including GSM/GPRS and UMTS access). Access based on WLAN scenario 2, or other alternative access networks, is a lower priority.

Editorís note: The solution described in this TR is primarily focused on secure access over 3GPP PS domain. Applicability of the solution to other access networks is ffs.

Low impact on provisioning: The impact on provisioning should be low compared with the full 3GPP solution.

6 Threat scenarios

To understand what controls are needed to address the security requirements, it is useful to describe some of the threat scenarios.

NOTE: There are many other threats, which are outside the scope of this TR.

6.1 Impersonation on IMS level using the user identity of an innocent user

The scenario proceeds as follows:

- Attacker A attaches to GPRS, GGSN allocates IP address, IPgprs-a
- Attacker A registers in the IMS using his IMS identity, IDims-a
- Attacker A sends SIP invite using his own source IP address (IPgprs-a) but with the IMS identity of B (IDims-b).

If the binding between the IP address on the bearer level, and the public and private user identities is not checked then the attacker will succeed, i.e. A pays for IP connectivity but IMS service is fraudulently charged to B. The fraud situation is made worse if IP flow based charging is used to ëzero rateí the IP connectivity.

The major problem is however that without this binding multiple users within a group ìof friendsî could sequentially (or possibly simultaneously) share Bís private/public user identities, and thus all get (say) the push-to-talk service by just one of the group paying a monthly subscription. Without protection against this attack, operators could be restricted to IP connectivity based tariffs and, in particular, would be unable to offer bundled tariffs. This is unlikely to provide sufficiently flexibility in todayís market place.

6.2 IP spoofing

The scenario proceeds as follows:

- User B attaches to GPRS, GGSN allocates IP address, IPgprs-b
- User B registers in the IMS using his IMS identity, IDims-b

- Attacker A sends SIP messages using his own IMS identity (IDims-a) but with the source IP address of B (IPgprs-b)

If the binding between the IP address that the GGSN allocated the mobile in the PDP context activation and the source IP address in subsequent packets is not checked then the attacker will succeed, i.e. A pays for IMS service but IP connectivity is fraudulently charged to B. Note that this attack only makes sense for IMS services with outgoing traffic only because the attacker will not receive any incoming packets addressed to the IMS identity that he is impersonating.

6.3 Combined threat scenario

The scenario proceeds as follows:

- User B attaches to GPRS, GGSN allocates IP address, IPgprs-b
- User B registers in the IMS using his IMS identity, IDims-b
- Attacker A sends SIP messages using IMS identity (IDims-b) and source IP address (IPgprs-b)

If the bindings mentioned in the scenarios in section 6.2 and 6.3 are not checked then the attacker will succeed, i.e. A fraudulently charges both IP connectivity and the IMS service to B. Note this attack only makes sense for IMS services with outgoing traffic only because the attacker will not receive any incoming packets addressed to the IMS identity that he is impersonating.

7 Specification of interim IMS security

7.1 Overview

The interim security solution works by creating a secure binding in the HSS between the public/private user identity (SIP-level identity) and the IP address currently allocated to the user at the GPRS level (bearer/network level identity). Therefore, IMS level signaling, and especially the IMS identities claimed by a user, can be connected securely to the SIM-based GPRS security context.

The GGSN, terminating each userís authenticated PDP context, provides the userís IP address / MSISDN pair to the HSS when a PDP context is activated towards the IMS system. The HSS has a binding between the MSISDN and the IMPI, and is therefore able to store the currently assigned IP address from the GGSN against the userís IMPI. The GGSN informs the HSS when the PDP context is deactivated/modified so that the stored IP address can be updated in the HSS. When the S-CSCF receives a SIP registration request or any subsequent requests for a given IMPI, it checks that the IP address in the SIP header (verified by the network) matches the IP address that was stored against that subscriberís IMPI in the HSS.

The mechanism assumes that the GGSN does not allow a mobile to successfully transmit an IP packet with a source IP address that is different to the one assigned during PDP context activation. In other words, the GGSN must prevent ìsource IP Spoofingî. The mechanism also assumes that the P-CSCF checks that the source IP address in the SIP header is the same as the source IP address in the IP header received from the mobile (the assumption here, as well as for 3GPP compliant IMS systems, is that no NAT is present between the GGSN and the P-CSCF).

The mechanism prevents an attacker from using his own IP address in the IP header but spoofing someone elseís IMS identity or IP address in the SIP header, so that he pays for GPRS level charges, but not for IMS level charges. The mechanism also prevents an attacker spoofing the address in the IP header so that he does not pay for GPRS charges. It therefore counters the threat scenarios given in section 6 above.

The mechanism assumes that only one contact IP address is associated with one IMPI. Furthermore, the mechanism supports the case that there may be several IMPUs associated with one IMPI, but one IMPU is associated with only one IMPI.

Editorís Note: It is for further study whether the mechanism shall be extended to support the case that one IMPU may be associated with several IMPIs, or whether the mechanism shall be restricted to only support the case that there is a one-to-one mapping between IMPI and IMPU.

In early IMS the IMS user authentication is performed by linking the IMS registration (based on an IMPI) to an authenticated PDP context (based on an IMSI). The mechanism here assumes that there is a one-to-one relationship between the IMSI for bearer access and the IMPI for IMS access.

Editorís Note: It is for further study whether the mechanism shall be extended to support one-to-many or many-to-many relationships between the IMSI for bearer access and the IMPI for IMS access.

In the following we use the terms P-CSCF and S-CSCF in a general sense to refer to components of an early IMS system. We note however that early IMS solutions may not have the same functionality split between SIP entities as defined in TS 23.228 [3]. Therefore, the requirements imposed on the SIP/IP core are specified in such a way that they are independent of the functionality split between SIP entities as far as possible. Note however that while the exact functionality split of the SIP/IP core may be left open, it is important that any changes to the Cx interface towards the HSS are standardised for vendor interoperability reasons.

7.2 Detailed specification

7.2.1 Update of mobileís IP address in HSS depending on PDP context state

During PDP context request towards the IMS, the GGSN shall send a RADIUS "ACCOUNTING-REQUEST START" message to a RADIUS server attached to the HSS. The message shall include the UEís IP address and MSISDN. The format of the message shall be compliant with 3GPP TS 29.061 [4]. On receipt of the message, the HSS shall use the MSISDN to find the subscriberís IMPI (derived from IMSI) and then store the IP address against the IMPI.

NOTE: It is assumed here that the RADIUS server for handling the accounting request to receive the IP address from the GGSN is different to the RADIUS server that the GGSN may use for access control and IP address assignment. However, according to TS 23.060 [5] there is no limitation on whether RADIUS servers for Accounting and Access control have to be separate or combined.

Editorís note: An alternative approach would be to re-use the AAA architecture of I-WLAN i.e. the 3GPP AAA Proxy or Server and its capability to perform RADIUS to DIAMETER conversion such that the HSS will not specifically need to support RADIUS (existing DIAMETER functionality of HSS can be re-used). This is ffs.

GGSN shall not activate the PDP context if the accounting start message is not successfully handled by the HSS. In particular, it shall not be possible to have an active IMS PDP context if the corresponding IP address is not stored in the HSS.

In case of PDP context deletion, the GGSN sends an "ACCOUNTING-REQUEST STOP" message to the HSS after the idle timer in the GGSN expires. The HSS shall then start the 3GPP HSS-initiated de-registration procedure.

If the UE establishes a new PDP context and therefore gets a new IP address, the UE shall start the IMS initial registration procedure. Because the idle timer in the GGSN could be set with a large value, e.g. 1 hour, it is quite likely that the UE will send a PDP context creation request before the idle timer expires. Two cases are distinguished:

- If the PDP context creation request is processed by the same SGSN as the old PDP context, then the SGSN will assign the existing PDP context to the UE. Therefore the IP address of the UE is unchanged and the IMS registration is still valid.

- If the PDP context creation request is processed by a different SGSN compared to the old PDP context, e.g. in case of a routing area update, the SGSN will create a new PDP context for the UE. In this case the GGSN shall send an "ACCOUNTING-REQUEST START" to the HSS with the new IP address. Because this IP address is different to the IP address the UE registered with, the HSS shall start the 3GPP HSS-initiated de-registration procedure. Later, the idle timer for the old PDP context expires and the old PDP context will be deleted by the GGSN. The HSS will be informed about the event via the "ACCOUNTING-REQUEST STOP" message. The HSS checks the IP address indicated by the "ACCOUNTING-REQUEST STOP" message against the IP address stored in the HSS. If they are the same, a network-initiated de-registration procedure shall be started. In this case they are different, so the HSS shall then ignore the message.

7.2.2 Protection against IP address spoofing in GGSN

All GGSNs that offer connection to IMS shall implement measures to prevent source IP address spoofing. Specifically, a UE attached to the GGSN shall not be able to successfully transmit an IP packet with a source IP address that is

different to the one assigned by the GGSN during PDP context activation. If IP address spoofing is detected the GGSN shall drop the packet and log the event in its security log against the subscriber information (IMSI/MSISDN).

7.2.3 Source IP address checking in the P-CSCF and S-CSCF

A UE shall not be able to spoof its assigned IP address and successfully receive service from the IMS. The following mechanisms are required to prevent IP address spoofing in the IMS domain.

7.2.3.1 P-CSCF mechanisms

As mandated by section 18.2.1 of RFC 3261 [6] the P-CSCF will check the IP address in the ìsent-byî parameter of the top ìViaî header field. Specifically, if the host portion of the "sent-by" parameter contains a domain name, or if it contains an IP address that differs from the packet source IP address, the server will add a "received" parameter to that Via header field value. This parameter contains the source IP address from which the packet was received. After this processing, the P-CSCF forwards the SIP message to the I-CSCF or S-CSCF.

7.2.3.2 S-CSCF mechanisms

S-CSCF shall use the IMPI to retrieve the IP address stored during PDP context activation. For all requests, the S-CSCF first checks whether a ìreceivedî parameter exists in the top ìviaî header field. If a ìreceivedî parameter exists, S-CSCF shall compare the IP address recorded in the ìreceivedî parameter against the UEís IP address stored during registration. If no ìreceivedî parameter exists in the top ìviaî header field, then S-CSCF shall compare IP address recorded in the ìsent-byî parameter against the IP address stored during registration. In both cases, if the HSS retrieved IP address and the IP address recorded in the top ìviaî header do not match, the S-CSCF shall reject the registration with a 403 Forbidden response.

If the request sent is an initial REGISTER, then the S-CSCF shall always query the HSS to retrieve the IP address registered during PDP context activation. The IP address fetched during a initial SIP REGISTER shall be stored in the S-CSCF and used for checking subsequent non-REGISTER SIP requests and non-initial REGISTER requests. The S-CSCF shall implement procedures to recover the registration information (including IP address) from the HSS in case of a system failure.

The S-CSCF shall check the IP address for every SIP request, but it shall only contact the HSS to fetch the IP address during the initial SIP Register.

NOTE: The S-CSCF only needs to contact the HSS to fetch the IP address during the initial SIP REGISTER because any change in IP address at the GPRS level will trigger the UE to send an initial REGISTER . Furthermore, the GGSN always notifies the HSS when the IP address is deallocated and the HSS then immediately deregisters the user. This mechanism requires that the S-CSCF can distinguish between initial REGISTER requests and re-REGISTER requests. Contacting HSS for every SIP message would place too high a load on the HSS.

Editorís Note: It is for further study whether an alternative approach where the IP address is checked in the HSS rather than in the S-CSCF should be adopted. With this alternative the HSS would provide the IP address to the HSS during each initial REGISTER and accept the REGISTER only if the HSS returns a positive result. For subsequent non-initial REGISTER requests, the S-CSCF would then check the received IP address against the IP address stored during the initial REGISTER.

7.2.4 Identification of terminals supporting the interim solution

At some stage, it is expected that both fully 3GPP compliant terminals and terminals implementing the interim security solution will access the same IMS. Therefore, some indication shall be given that a terminal supports the interim solution rather than the full 3GPP solution.

Editorís note: The exact format, and means to carry this information, is for further study.

7.2.5 Message flows

Editorís Note: The exact specification of message contents is for further study. Changes to the Cx interface MAR/MAA commands would need to be specified in the appropriate CN4 specifications.

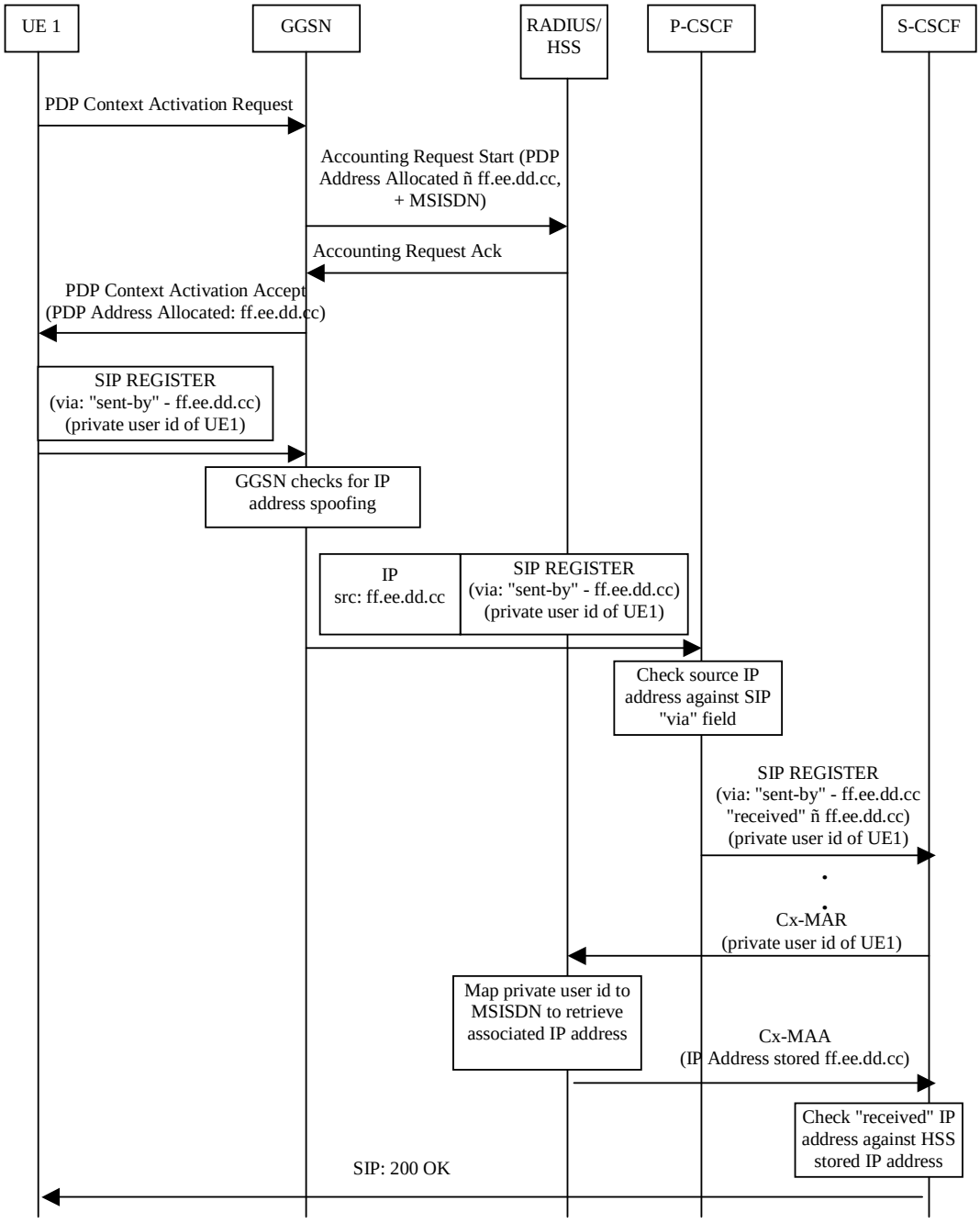

Figure 1 below describes the message flow for successful registration to the IMS that is specified by the interim security solution.

Note, that the ìreceivedî parameter is only sent from P-CSCF to S-CSCF under the conditions given in section 7.2.3.1.

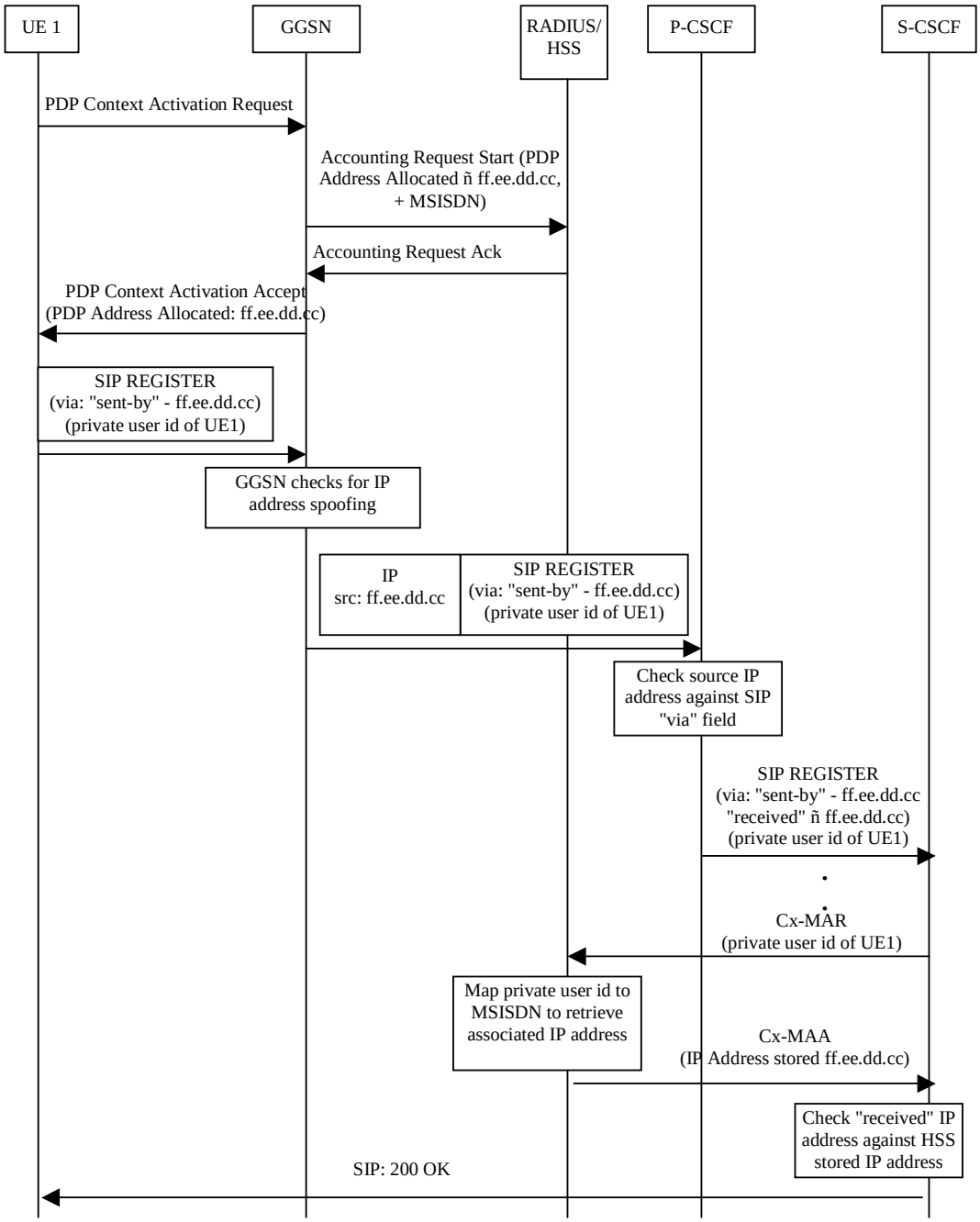

Figure 1: Message Sequence for Interim Security Solution (successful registration)

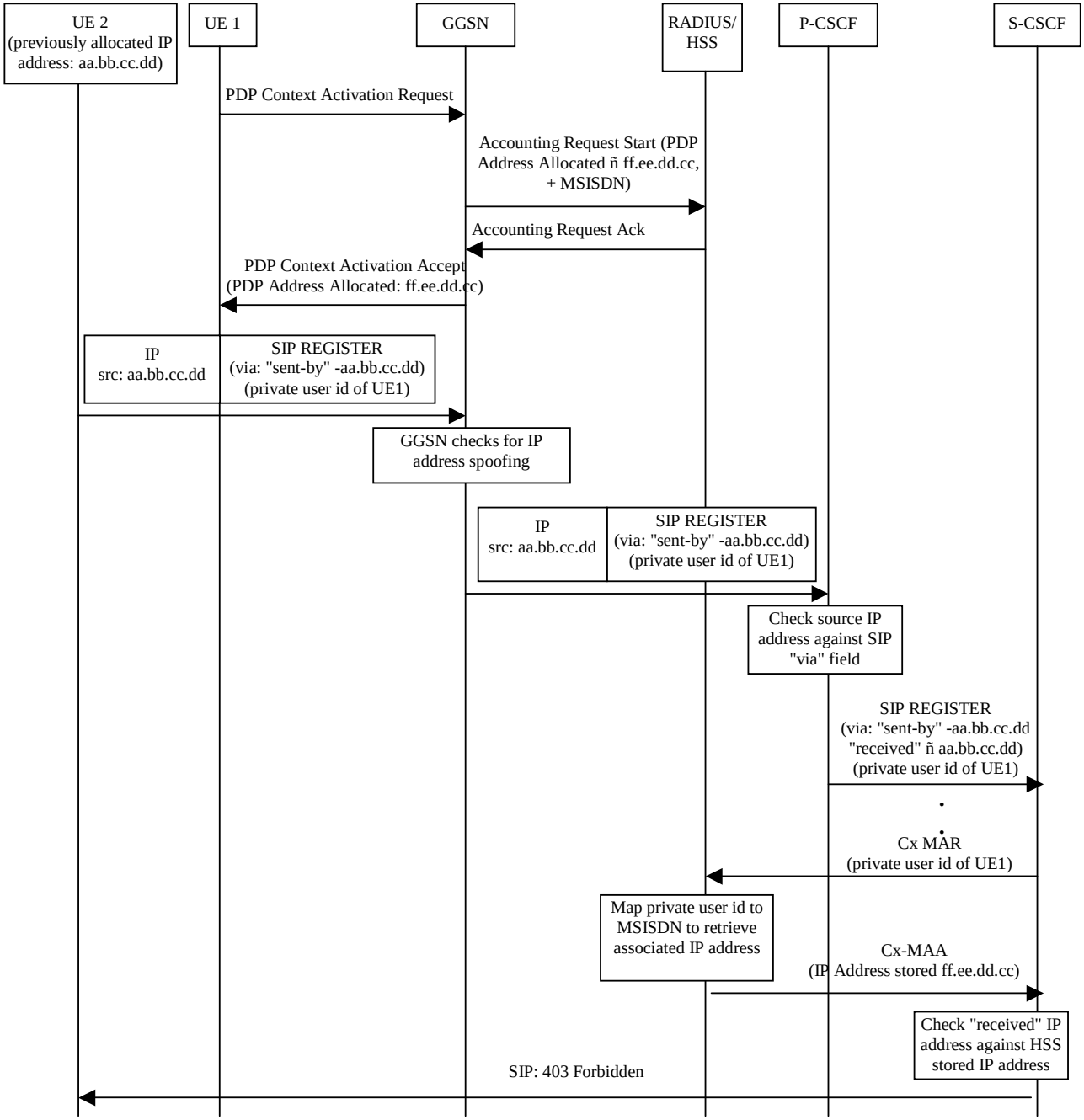

Figure 2 below gives an example message flow for the unsuccessful attempt of an attacker trying to spoof the IMS identity of a valid IMS user.

Again, the ìreceivedî parameter is only present between P-CSCF to S-CSCF under the conditions given in section 7.2.3.1.

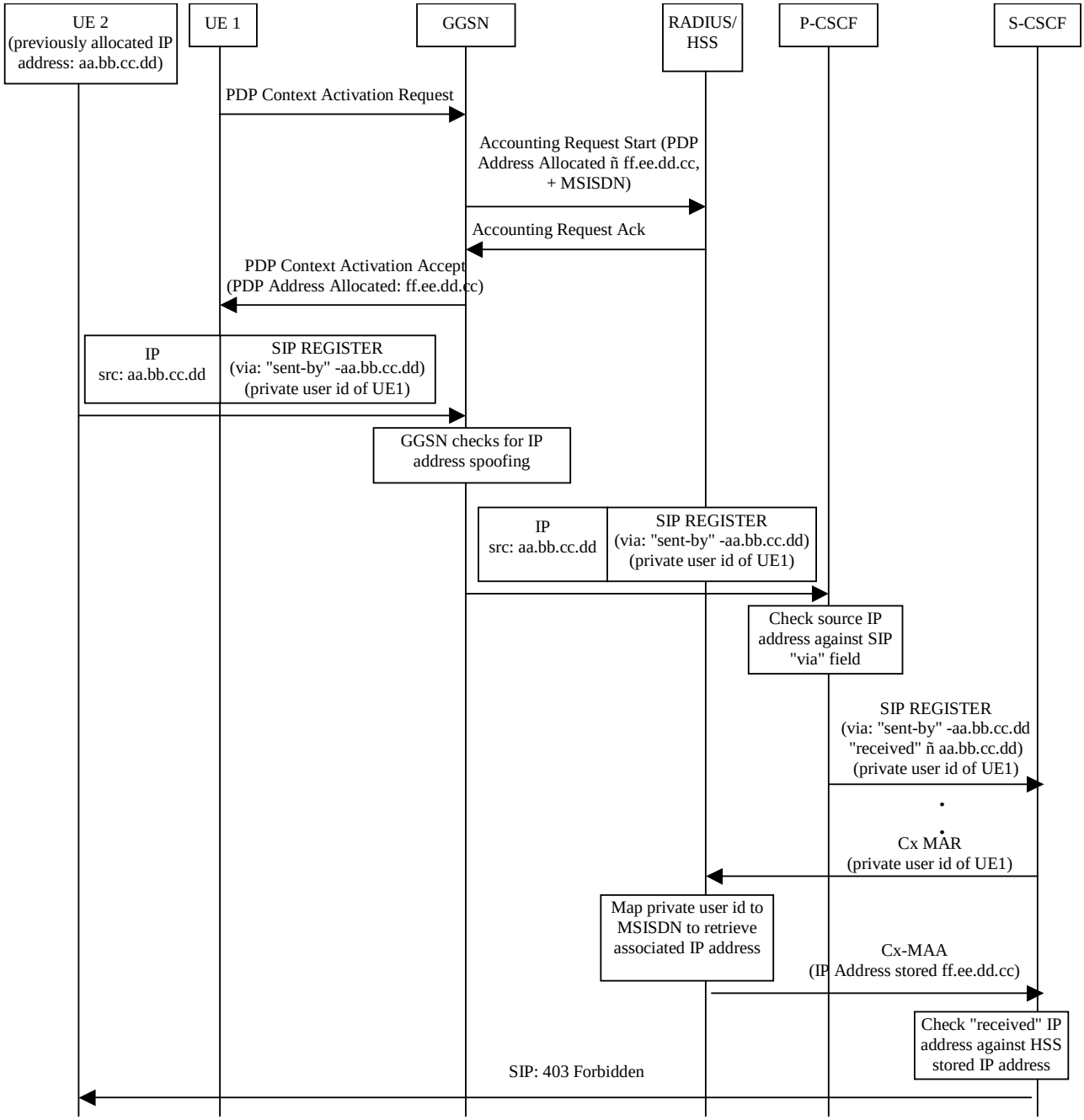

Figure 2: Message Sequence for Interim Security Solution showing an unsuccessful identity theft

Annex A: Comparison with alternative approaches

An alternative approach is to use password-based authentication for early IMS implementations. For example, HTTP Digest could be used for authenticating the IMS subscriber. This method would require a subscriber-specific password to be provisioned on the IMS terminal. Compared with the approach specified in section 7, password-based authentication has the following disadvantages:

- It imposes restrictions on the type of charging schemes that can be adopted. In particular, if a subscriber could find out his or her own password from an insecure implementation on the terminal, then he or she could share the IMS subscription with friends. This could impact revenue for the operator if bundled or partly subscription based tariffs are used rather than purely usage based tariffs. For example, a subscriber could take out a subscription for 100 instant messages and then share this with his or her friends. Although contractual obligations could be

imposed on customers to prohibit this behaviour, in practice this would be difficult to enforce. If charging were purely usage based then there would be no incentive for the subscriber to do this (and no impact on operator revenue). The solution specified in section 7 is flexible in allowing a range of different charging models including bundled or partly subscription based tariffs.

- It provides a weak form of subscriber authentication compared with the levels of authentication used for other services offered over 3GPP networks, where authentication is typically based directly or indirectly on the (U)SIM. This has implications on the reliability of charging, and on the level of assurance that can be given to the customer that their communications cannot be masqueraded. In the solution specified in section 7, authentication of the IMS subscriber is indirectly based on (U)SIM authentication at the GPRS level. The level of security is similar to that currently used for certain WAP services, where the userís MSISDN is provided by the GGSN to the WAP gateway. Security does not rely on the terminal securely storing any long-term secret information (e.g. passwords).

- Provisioning is more complex since subscriber-specific information (i.e. passwords) must be installed in each mobile.

Annex B:
Change history

Change history							
Date	**TSG #**	**TSG Doc.**	**CR**	**Rev**	**Subject/Comment**	**Old**	**New**
29/6/04					First version based on input from S3-040264 and S3-040265.		0.0.1
8/7/04					Incorporates comments received at SA3#34.	0.0.1	0.0.2