**3GPP TSG-SA3 Meeting #105-e *draft\_S3-214063-r2***

**e-meeting, 08 – 19 November 2021** revision of S3-21xxxx

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| *CR-Form-v12.1* |
| **CHANGE REQUEST** |
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|  | **33.203** | **CR** | **0261** | **rev** | **1** | **Current version:** | **16.1.0** |  |
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| ***Proposed change affects:*** | UICC apps |  | ME | **x** | Radio Access Network |  | Core Network | **x** |

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|  |
| ***Title:***  | Recommendation of SHA256 in SIP digest |
|  |  |
| ***Source to WG:*** | Huawei, HiSilicon, T-Mobile US |
| ***Source to TSG:*** | S3 |
|  |  |
| ***Work item code:*** | eCryptPr |  | ***Date:*** | 2021-11-08 |
|  |  |  |  |  |
| ***Category:*** | **B** |  | ***Release:*** | Rel-17 |
|  | *Use one of the following categories:****F*** *(correction)****A*** *(mirror corresponding to a change in an earlier release)****B*** *(addition of feature),* ***C*** *(functional modification of feature)****D*** *(editorial modification)*Detailed explanations of the above categories canbe found in 3GPP [TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm). | *Use one of the following releases:Rel-8 (Release 8)Rel-9 (Release 9)Rel-10 (Release 10)Rel-11 (Release 11)…Rel-15 (Release 15)Rel-16 (Release 16)Rel-17 (Release 17)Rel-18 (Release 18)* |
|  |  |
| ***Reason for change:*** | This contribution propose to add recommended algorithm (i.e., SHA256) in SIP digest with compatibility issue been taken into consideration. |
|  |  |
| ***Summary of change:*** | The HSS shall calculated two hashes based on both SHA256 and MD5 and send them to S-CSCF. S-CSCF shall send Auth\_Challenge with SHA256 and MD5, which are in order of preference, starting with the most preferred algorithm, followed by the less preferred algorithm.UE shall select and use the first algorithm it supports and send back it to S-CSCF. Then, S-CSCF shall behave based on the received algorithm.. |
|  |  |
| ***Consequences if not approved:*** | Weak and unsecure algorithms used in IMS. |
|  |  |
| ***Clauses affected:*** | 2；Annex N, X.2.2.3, X.3.2.3, X.4.2.3 |
|  |  |
|  | **Y** | **N** |  |  |
| ***Other specs*** |  | **x** |  Other core specifications  | TS/TR ... CR ...  |
| ***affected:*** |  | **x** |  Test specifications | TS/TR ... CR ...  |
| ***(show related CRs)*** |  | **x** |  O&M Specifications | TS/TR ... CR ...  |
|  |  |
| ***Other comments:*** |  |
|  |  |
| ***This CR's revision history:*** |  |

**\*\*\*\* Start of 1st Changes \*\*\*\***

# 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 TS 33.102: "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; 3G Security; Security Architecture".

[2] Void.

[3] 3GPP TS 23.228: "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; IP Multimedia (IM) Subsystem".

[4] Void.

[5] 3GPP TS 33.210: "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; 3G Security; Network domain security; IP network layer security".

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

[7] 3GPP TS 21.905: "3rd Generation Partnership Project: Technical Specification Group Services and System Aspects; Vocabulary for 3GPP specifications".

[8] 3GPP TS 24.229: "3rd Generation Partnership Project: Technical Specification Group Core Network; IP Multimedia Call Control Protocol based on SIP and SDP".

[9] 3GPP TS 23.002: "3rd Generation Partnership Project: Technical Specification Group Services and System Aspects, Network Architecture".

[10] 3GPP TS 23.060: "3rd Generation Partnership Project: Technical Specification Group Services and System Aspects, General Packet Radio Service (GPRS); Service Description".

[11] 3GPP TS 24.228: "3rd Generation Partnership Project: Technical Specification Group Core Network; Signalling flows for the IP multimedia call control based on SIP and SDP".

 [12]-[16] Void.

[17] IETF RFC 3310 (2002): "HTTP Digest Authentication Using AKA". April, 2002.

[18] IETF RFC 3041 (2001): "Privacy Extensions for Stateless Address Autoconfiguration in IPv6".

[19] Void.

[20] IETF RFC 2451 (1998): "The ESP CBC-Mode Cipher Algorithms".

[21] IETF RFC 3329 (2003): "Security Mechanism Agreement for the Session Initiation Protocol (SIP)".

[22] IETF RFC 3602 (2003): "The AES-CBC Cipher Algorithm and Its Use with IPsec".

[23] IETF RFC 3263 (2002): "Session Initiation Protocol (SIP): Locating SIP Servers".

[24] 3GPP TS 33.310: "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Network Domain Security (NDS); Authentication Framework (AF)".

[25] Void.

[26] ETSI ES 282 001: "TISPAN - Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); NGN Functional Architecture for NGN Release 1".

[27] IETF RFC 3947 (2005): "Negotiation of NAT-Traversal in the IKE".

[28] IETF RFC 3948 (2005): "UDP Encapsulation of IPsec ESP Packets".

[29] IETF RFC 3323 (2002): "A Privacy Mechanism for the Session Initiation Protocol (SIP)".

[30] IETF RFC 3325 (2002): "Private Extensions to the Session Initiation Protocol (SIP) for Asserted Identity within Trusted Network".

[31] 3GPP TS 23.167: "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; IP Multimedia Subsystem (IMS) emergency sessions”.

[32] IETF RFC 5626 (2009): "Managing Client Initiated Connections in the Session Initiation Protocol (SIP)".

[33] Void.

[34] IETF RFC 2246 (1999): "The TLS Protocol Version 1.0".

[35] Void.

[36] ETSI ES 282 004: “NGN Functional Architecture; Network Attachment Sub-System (NASS)”

[37] ETSI TS 187 001: " Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); NGN SECurity (SEC); Requirements"

[38] Void.

[39] 3GPP TS 29.228: "3rd Generation Partnership Project; Technical Specification Group Core Network and Terminals; IP Multimedia (IM) Subsystem Cx and Dx interfaces; Signalling flows and message contents".

[40] 3GPP2 X.S0011: "cdma2000 Wireless IP Network Standard".

[41] 3GPP2 C.S0023: "Removable User Identity Module for Spread Spectrum Systems".

[42] Void.

[43] 3GPP2 S.S0055: "Enhanced Cryptographic Algorithms".

[44] 3GPP2 S.S0078: "Common Security Algorithms".

[45] 3GPP2 C.S0065: "cdma2000 Application on UICC for Spread Spectrum Systems".

[46] 3GPP TS 23.003: "3rd Generation Partnership Project; Technical Specification Group Core Network and Terminals; Numbering, addressing and identification".

[47] IETF RFC-2407: "The Internet IP Security Domain of Interpretation for ISAKMP".

[48] IETF RFC-2408: "Internet Security Association and Key Management Protocol (ISAKMP)".

[49] IETF RFC-2409: "The Internet Key Exchange (IKE)".

[50] 3GPP TS 23.292: "IP Multimedia Subsystem (IMS) Centralized Services; Stage 2".

[51] 3GPP TS 31.103: "3rd Generation Partnership Project: Technical Specification Group Core Network and Terminals; Characteristics of the IP Multimedia Services Identity Module (ISIM) application".

[52] IETF RFC 5280: "Internet X.509 Public Key Infrastructure Certificate and Certificate Revocation List (CRL) Profile".

[53] IETF RFC 4301: "Security Architecture for the Internet Protocol".

[54] IETF RFC 4303: "IP Encapsulating Security Payload (ESP)".

[55] 3GPP TS 33.401: "3GPP System Architecture Evolution (SAE); Security architecture".

[56] 3GPP TS 23.401: "General Packet Radio Service (GPRS) enhancements for Evolved Universal Terrestrial Radio Access Network (E-UTRAN) access".

[57] ETSI TS 187 003 v3.4.1: "Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); NGN Security; Security Architecture".

[58] Void.

[59] IETF RFC 5245: "Interactive Connectivity Establishment (ICE)".

[60] IETF RFC 6544: "TCP Candidates with Interactive Connectivity Establishment (ICE) ".

[61] IETF RFC 5766: "Traversal Using Relays around NAT (TURN)".

[62] IETF RFC 6062: "Traversal Using Relays around NAT (TURN) Extensions for TCP Allocations".

[63] IETF RFC 2817: "Upgrading to TLS Within HTTP/1.1".

[64] IETF RFC 6623: "Indication of Support for Keep-Alive".

[65] IETF RFC 4169: "Hypertext Transfer Protocol (HTTP) Digest Authentication Using Authentication and Key Agreement (AKA) Version-2”.

[66] 3GPP TS 33.220: "Generic Authentication Architecture (GAA); Generic Bootstrapping Architecture (GBA)".

[67] IETF RFC 6750: "The OAuth 2.0 Authorization Framework: Bearer Token Usage".

[68] IETF RFC 7376: "Problems with Session Traversal Utilities for NAT (STUN) Long-Term Authentication for Traversal Using Relays around NAT (TURN)".

[69] IETF RFC 5389: "Session Traversal Utilities for NAT (STUN)".

[70] IETF RFC 7635: "Session Traversal Utilities for NAT (STUN) Extension for Third Party Authorization".

[71] Void

[72] IETF RFC 6749: "The OAuth 2.0 Authorization framework".

[73] IETF RFC 4106: "The Use of Galois/Counter Mode (GCM) in IPsec Encapsulating Security Payload (ESP)".

[74] IETF RFC 4543: "The Use of Galois Message Authentication Code (GMAC) in IPsec ESP and AH".

[75] IETF RFC 7800: "Proof-of-Possession Key Semantics for JSON Web Tokens (JWTs)".

[x] IETF RFC 7616: " HTTP Digest Access Authentication ".

**\*\*\*\* Start of 2nd Changes \*\*\*\***

Annex N (normative):
Enhancements to the access security to enable SIP Digest

# N.1 SIP Digest

SIP Digest authentication and the requirements in this Annex shall not apply to access networks defined in 3GPP specifications. The P-CSCF can enforce this condition by identifying REGISTER requests relating to SIP Digest according to the rules in Annex P.3 of the present document and discarding them when received over an access network defined in 3GPP specifications.

The provisions in Annex N are optional for implementation. The provisions in Annex N are optional for use. However, the use of one of the authentication mechanisms in the present document is mandated.

SIP Digest shall not be used in conjunction with IPsec.

NOTE 1: The use of SIP Digest in conjunction with IPsec, as specified in the main body and in Annex N of this specification, is technically impossible because SIP Digest does not generate session keys for use with IPsec security associations.

An additional scheme for authentication is SIP Digest as specified in RFC 3261 [6]. SIP Digest achieves mutual authentication between the UE and the HN, and is based on HTTP Digest as specified in RFC 7616 [x]. The identity used for authenticating a subscriber is the private identity, IMPI, which has the form of a NAI. The HSS and the UE share a preset secret (e.g., a password) associated with the IMPI. The generation of the authentication challenge shall be done in the same way as specified in RFC 7616 [x] and the present document.

It is the policy of the HN that decides if an authentication shall take place for the registration of an additional IMPU that is not part of the already registered set of IMPUs associated with the same IMPI.

If a UE supports SIP Digest as well as further authentication methods, the UE shall proceed as follows:

- If the access network is of a type defined in 3GPP specifications then the UE shall not select SIP Digest, in accordance with the requirement at the start of this clause.

NOTE 2: The rules listed in Annex T of this specification say how a UE can select between IMS AKA and GIBA.

- If the access network is of a type not defined in 3GPP specifications then

- if both the UE and network support IMS AKA according to the main body or Annex M of this specification, as determined by the use of sip-sec-agree RFC 3329 [21], the authentication method shall be IMS AKA;

- otherwise the authentication method shall be SIP Digest as specified in Annex N of this specification.

# N.2 Authentication

## N.2.1 Authentication Requirements

### N.2.1.1 Authentication Requirements for Registrations

For the purposes of this subclause, the name "authentication" is used synonymously with "entity authentication".

Before a user can get access to the IM services at least one IMPU needs to be registered and the IMPI authenticated in the IMS at application level. In order to get registered the UE sends a SIP REGISTER message towards the SIP registrar, i.e. the S‑CSCF, cf. figure N.1, which will perform the authentication of the user. The message flows are the same regardless of whether the user has an IMPU already registered or not.



Figure N.1: The IMS Authentication using SIP Digest for an unregistered IM subscriber and successful mutual authentication

The detailed registration procedures are defined in TS 24.229 [8].

The NAT traversal procedures in RFC 5626  [32] and in TS 24.229 [8] clause K.4 shall apply.

NOTE 1: It is recognized that RFC 5626 [32] can be useful for capabilities beyond NAT traversal (e.g. multiple registrations) however this annex does not consider such capabilities at this time.

The UE should include an indication of support for managing client-initiated connections as defined in RFC 5626 [32] in all REGISTER requests. Per RFC 5626 [32], the P-CSCF shall be able to accept registration request with or without an indication of support for managing client-initiated connections. However, the P-CSCF should only accept a register request without support for managing client-initiated connections if it can determine that no NAT is present in the signaling path between the UE and the P-CSCF.

NOTE 2: It is left to stage 3 specifications how a P-CSCF can determine whether the conditions in the preceding paragraph are met. An operator may configure all UEs and P-CSCFs in his network not to use support for managing client-initiated connections (provided there is no roaming). Cf. also the implications of the indication of support for managing client-initiated connections for the P-CSCF procedures after receiving SM11.

SMn stands for SIP Message n and CMm stands for Cx message m which has a relation to the authentication process:

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| SM1:REGISTER(IMPI\*, IMPU) |

“IMPI\*” in SM1 means that the inclusion of the IMPI is optional in SM1.

NOTE 2a: When a registering UE omits the IMPI from the REGISTER request, the IMPI for the registration is derived from the registering IMPU. Since there can be only one registered instance of an IMPI at any point in time, the registering IMPU in this case cannot be shared across multiple UEs.

In SM2 and SM3 the P‑CSCF and the I‑CSCF respectively forwards the SIP REGISTER towards the S‑CSCF. If SM1 does not contain an IMPI, the P-CSCF shall behave according to Annex P.3 and forward the message as SM2 to the I-CSCF.

NOTE 2b: Annex P.3 formulates conditions depending on the presence of an Authorization header. Note that, if SM1 does not contain an IMPI, then SM1 does not contain an Authorization header.

The I-CSCF queries the HSS to find the address of the S‑CSCF. If SM2 does not contain an IMPI the I-CSCF shall derive the IMPI from the IMPU in the REGISTER request as described in 3GPP TS 24.229 [8]. Then the I-CSCF forwards the message as SM3 to the S-CSCF.

After receiving SM3, if the IMPU is not currently registered at the S‑CSCF, the S‑CSCF needs to set the registration flag at the HSS to initial registration pending. This is done in order to handle UE terminated calls while the initial registration is in progress and not successfully completed. The registration flag is stored in the HSS together with the S‑CSCF name and user identity, and is used to indicate whether a particular IMPU of the user is unregistered or registered at a particular S‑CSCF or if the initial registration at a particular S‑CSCF is pending. The registration flag is set by the S‑CSCF sending a Cx-Put to the HSS. If the IMPU is currently registered, the S‑CSCF shall leave the registration flag set to registered. At this stage the HSS has performed a check that the IMPI and the IMPU belong to the same user.

The S-CSCF shall determine the type of authentication based on the rules in Annex P. If SM3 does not contain an IMPI the S-CSCF shall derive the IMPI from the IMPU in the REGISTER request as described in 3GPP TS 24.229 [8]. If the IMS registration request is related to SIP Digest, then the procedures below apply.

Upon receiving the SIP REGISTER the S‑CSCF shall use a SIP Digest Authentication Vector (SD-AV) for authenticating the user. If the S‑CSCF has no valid SD-AV for the specific IMPI, then the S‑CSCF shall send a request for SD-AV(s) to the HSS in CM1 where the number m of SD-AVs wanted is equal to 1.

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| CM1:Cx-AV-Req(IMPI, m) |  |

Upon receipt of a request from the S‑CSCF, the HSS sends one SD-AV to the S‑CSCF using CM2. The SD-AV consists of the qop (quality of protection) value, the authentication algorithm including SHA256 and MD5, realm, and two hashes, called H(A1)\_256 and H(A1), of the IMPI, realm, and password. The H(A1)\_SHA256 is calculated based on SHA256 while the H(A1) is calculated based on MD5. Refer to RFC 7616 [x] for additional information on the values in the authentication vector for SIP Digest based authentication. To maintain backwards compatibility, the MD5 algorithm is still supported but not recommended.

The qop value shall be set to "auth" since SIP Digest, as used in IMS, can only provide authentication, not message integrity.

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| CM2:Cx-AV-Req-Resp(IMPI, realm, algorithms, qop, H(A1)\_SHA256 and H(A1) ) |  |

The S-CSCF generates a random nonce, stores H(A1)\_SHA256 and H(A1) and the nonce against the IMPI, and then sends a SIP 401 Auth\_Challenge i.e., an authentication challenge towards the UE including the nonce in SM4. It also includes the realm, qop and algorithm parameters including SHA256 and MD5, which are in order of preference, starting with SHA256, followed by MD5. RFC 7616 [x] specifies how to populate the parameters of a 401 Auth\_Challenge.

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| SM4:401 Auth\_Challenge(IMPI, realm, nonce, qop, algorithms) |

The I-CSCF forwards the SIP 4xx Auth\_Challenge message towards the P-CSCF as SM5.

When the P-CSCF receives SM5 it shall forward the message to the UE.

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| SM6:401 Auth\_Challenge(IMPI, realm, nonce, qop, algorithms) |

Upon receiving the challenge, SM6, the UE generates a cnonce. It then selects the first algorithm it supports and uses the cnonce as well as parameters provided in the SM6 such as nonce and qop to calculate an authentication response according to RFC 7616 [x]. This response and other parameters are put into the Authorization header and sent back towards the network in SM7. The inclusion of the IMPI, the selected algorithm and an Authorization header in SM7 are mandatory.

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| SM7:REGISTER(IMPI, realm, nonce, response, cnonce, qop, nonce-count, algorithm, digest-uri) |

NOTE 3: As specified in RFC 3261 [6], when the P-CSCF receives a SIP request from the UE, the P-CSCF checks the IP address in the "sent-by" parameter of the Via header field provided by the UE. If the "sent-by" parameter contains a domain name, or if it contains an IP address that differs from the packet source IP address, the P-CSCF adds a "received" parameter to that Via header field value. This parameter contains the source IP address from which the packet was received.

The P‑CSCF forwards the authentication response in SM8 to the I‑CSCF, which queries the HSS to find the address of the S‑CSCF. In SM9 the I‑CSCF forwards the authentication response to the S‑CSCF.

Upon receiving SM9 containing the response, the S-CSCF selects the stored hashes (i.e., H(A1)\_256 and H(A1)) based on the received algorithm selected by UE and calculates the expected response using the received algorithm selected by UE and the selected hash and stored nonce together with other parameters contained in SM9 (e.g., cnonce, nonce-count, qop, as specified in RFC 7616 [x]) and uses this to check against the response sent by the UE. If the check is successful then the user has been authenticated and the IMPU is registered in the S‑CSCF. If the IMPU was not currently registered, the S‑CSCF shall send a Cx-Put to update the registration-flag to registered. If the IMPU was currently registered the registration-flag is not altered.

 NOTE 4: Depending on its local security policy, the S-CSCF may delete H(A1) immediately after checking the Digest response, but this may then lead to an increased exposure of H(A1) on the Cx-interface as H(A1) would then have to be fetched from the HSS more often.

It shall be possible to implicitly register IMPU(s) (see clause 4.3.3.4 in TS 23.228 [3]). All the IMPU(s) being implicitly registered shall be delivered by the HSS to the S‑CSCF and subsequently to the P‑CSCF. The S‑CSCF shall regard all implicitly registered IMPU(s) as registered IMPU(s).

When an IMPU has been registered this registration will be valid for some period of time. Both the UE and the S‑CSCF will keep track of a timer for this purpose but the expiration time in the UE is smaller than the one in the S‑CSCF in order to make it possible for the UE to be registered and reachable without interruptions. A successful registration of a previously registered IMPU (including implicitly registered IMPUs) means the expiry time of the registration is refreshed.

If the user has been successfully authenticated, the S‑CSCF sends a SM10 SIP 2xx Auth\_OK message to the I-CSCF indicating that the registration was successful. The 2xx Auth\_OK message contains the Authentication-Info header with a response digest as specified in RFC 7616 [x]. The response digest allows the UE to authenticate the HN.

In SM11 the I‑CSCF forwards the SIP 2xx Auth\_OK towards the P-CSCF.

The P-CSCF associates the UE's packet source IP address along with the "sent-by" parameter of the Via header, cf. RFC 3261 [6], of the REGISTER message with the IMPI and all the successfully registered IMPUs related to that IMPI. If managing of client-initiated connections as defined in RFC 5626 [32] is used then the P-CSCF shall also include the UE's packet source port of the REGISTER message as part of the association. The P-CSCF stores the associated parameters in an IP address check table. If managing of client-initiated connections is not used then the P-CSCF shall overwrite any existing entry in the IP address check table which has the same IP address, but a different IMPI. If managing of client-initiated connections is used then the P-CSCF shall overwrite any existing entry in the IP address check table which has the same (IP address, port) pair, but a different IMPI.

The P-CSCF forwards the SIP 2xx AUTH\_OK towards the UE.

NOTE 5: If a P-CSCF associated the port with the IMPI even when managing of client-initiated connections was not used then the UE would be unnecessarily restricted in opening new connections during a registration. The restriction is unavoidable in the presence of NAT.

Upon receiving SM12, the UE shall calculate the expected response from the HN as described in RFC 7616 [x]. To authenticate the HN, the UE shall compare its expected response to the response provided by the HN. If the comparison fails the UE shall abort the communication.

### N.2.1.2 Authentication Requirements for Non-registration Messages

For the purposes of this subsection, the name "authentication" is used synonymously with "message origin authentication".

The IP address check table (cf. subclause N.2.1.1) shall be used by the P-CSCF to identify the initiator of subsequent requests as follows: one of the public user identities associated with the packet IP address (and port if applicable) is selected and asserted to the S-CSCF according to the rules in TS 24.229 [8], subclause 5.2.6.3.

In addition, subsequent requests (e.g. INVITE) may be authenticated with SIP Digest, as described in the following:

NOTE 1: The assertion of IMPUs based on checks of IP address (and ports if applicable) provides a reasonable level of security only in environments where the risk from source IP address and port spoofing or from IP address re-assignment unnoticed by the SIP application is sufficiently low. If the environment does not fulfill this condition then it is recommended to use SIP Digest in conjunction with either TLS, as specified in Annex O of this specification, or with the SIP Digest proxy authentication mechanism as specified in this subclause. It is not part of this specification to determine which environments fulfill the conditions in this NOTE. This is left to specifications, possibly maintained by standardization bodies other than 3GPP, describing these environments. More details on the usage of the authentication mechanisms for non-registration messages are provided in Annex Q (informative).

When the S-CSCF receives a SIP request with a method other than the REGISTER method from the UE, the S-CSCF may perform authentication on the SIP request according to the operator's policy and according to the following procedures.

* If the request does not contain a Proxy-Authorization header or the Proxy-Authorization header does not contain a digest response the S-CSCF shall send a 407 (Proxy Authentication Required) response to challenge the UE. The 407 response shall contain digest challenge parameters in a Proxy-Authenticate header as defined by RFC 7616 [x]. The challenge parameters, with the exception of the nonce, shall be taken from the same SD-AV as used for the last successful registration or re-registration message of the UE. The nonce shall be generated freshly by the S-CSCF. Upon receiving the challenge the UE shall extract digest challenge parameters from the Proxy-Authenticate header field and calculate a digest response as indicated in RFC 7616[x]. The UE should store the received digest challenge. The UE then sends a new request to the network containing a Proxy-Authorization header in which the header fields are populated as described in RFC 7616 [x] using the calculated digest response. Upon receiving the new request which contains a digest response, the S-CSCF verifies the user’s identity by validating the digest response information (e.g. the nonce-count) contained in the Proxy-Authorization header field against the expected information based on the same SD-AV as used for generating the challenge;

NOTE 1a: Authorization (used for registration messages, cf. sub-clause N.2.1.1) and Proxy-Authorization (used for non-registration messages, this sub-clause) are handled by logically separated protocol engines and thus each mechanism has its own nonce, cnonce and nonce-count parameters.

NOTE 1b: The usage of the same SD-AV for authentication of non-registration messages and of registration messages requires the storage of the SD-AV in S-CSCF during the authentication of registration messages (cf. subclause N.2.1.1), as retrieval of AVs from HSS is only specified for handling of registration messages. In case of dynamic password change (cf. clause N.2.5), the SD-AV (or SD-AVs) used for generating the challenge(s) are specified in clause N.2.5.

* If the check is successful then the request has been authenticated, and the S-CSCF sends a 2xx AUTH\_OK towards the UE;
* If the check fails, based on local policy the S-CSCF may choose to re-challenge the user by using the same procedure described in this subclause, or reject the request by sending a 403 response.

When the UE is to send a non-REGISTER SIP request it should first check whether it has a digest challenge stored which was previously received in a Proxy-Authenticate header. If such a digest challenge is available in the UE the UE should use it together with the nonce-count mechanism as specified in RFC 7616 [x] to calculate a digest response, include the digest response in a Proxy-Authorization header and send this header together with the non-REGISTER SIP request.

NOTE 2: According to RFC 7616 [x], the S-CSCF may send a 407 (Proxy Authentication Required) as a response to any non-REGISTER request, indicating that the nonce is stale and the digest response shall be recomputed using the fresh challenge sent in the same 407 message.

When the S-CSCF has successfully used the SIP Digest proxy authentication mechanism it shall check if the public user identity asserted by the P-CSCF belongs to the implicit registration set (i.e. the public user identities associated with the authenticated user). If the check is not successful the S-CSCF shall reject the non-registration request.

NOTE 3: Such a rejection may occur when one of the conditions mentioned in NOTE 1 is not fulfilled.

NOTE 4: When TLS according to Annex O is used, or when IPsec according to the main body or Annex M is used, then the failure conditions mentioned in NOTE 1 and Annex Q.3 cannot occur, and the public user identity asserted by the P-CSCF is reliable.

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*end of third change/start of fourth change \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

### X.2.2.3 Procedures

Figure X.2.3-1 shows the registration flow. In this figure SIP over secure WebSocket is used between the WIC and the eP-CSCF. Other protocols (e.g. HTTP RESTful or JSON over WebSocket) can also be used as long as it is able to relay the digest challenge, challenge-response, and auth-info values.

 Solution 1.1 requires that the IMPU and SIP Digest password are made available to the JavaScript in the WIC. The IMPI can be omitted from the initial SIP Register request, and if that is the case the S-CSCF will try to determine its value from the registering IMPU. This requires that IMPUs are not shared between IMS users (see Annex N).

NOTE 1: It is assumed that the credentials are entered by the user via the web GUI or retrieved from the WWSF over HTTPS. Note that the latter option requires that WWSF has authenticated the user previously.

NOTE 2: Unless the SIP Digest password or the intermediate hash value H(A1) (see RFC 7616 [XX]) is stored in the WIC, the password needs to be re-obtained each time a re-registration is performed. If the password is entered manually and if re-registrations occur often, this will result in a negative user experience. This can be avoided by storing the SIP Digest password or H(A1) in the WIC after the initial registration procedure. Ensuring the confidentiality of the SIP Digest password or H(A1) during storage is at the discretion of the implementation and is outside the scope of 3GPP.

NOTE 3: It is recommended that the user does not enter his SIP Digest credentials into the WIC, except possibly once before the initial registration.



Figure X.2.2.3-1: WebRTC IMS Client authentication using SIP Digest

The details of the signalling flows are as follows:

1) **Web page download from WWSF**

From within a WebRTC-enabled browser, the user accesses a URI to the WWSF to initiate an HTTPS connection to the WWSF. The TLS connection provides one-way authentication of the server based on the server certificate. The browser downloads and initializes the WIC from the WWSF.

**2) Establishment of secure Web socket connection between WIC and eP-CSCF**

The WIC opens a WSS (secure Web Socket) connection to the eP-CSCF. The TLS connection provides one-way authentication of the server based on the server certificate. The eP-CSCF verifies in this step that the WIC establishing the signalling connection comes from a trusted domain.

NOTE 3: The protection mechanism works under the assumption that the browser is not under the attacker's control.

**3-10) SIP Digest message flow**

The SIP Digest messages exchanged between the WIC and eP-CSCF and between the eP-CSCF and the I/S-CSCF are as defined in Annex N of this document.

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*end of fourth change/start of fifth change\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

### X.3.2.3 Procedures

The procedure provided in this clause is split into a normative part and non-normative part: the description for the interfaces between eP-CSCF, I-/S-CSCF and HSS is normative while the description for the interfaces W1, W2 and W4 is only by way of example.

NOTE 1: This split into a normative part and a non-normative part is due to 3GPP’s decision not to standardise the interfaces W1, W2 and W4 in the present release.

For the non-normative part, the procedure allows for various realisations that are out of scope of 3GPP for the present release. All realisations have in common that the WAF issues authorization tokens that are provided to the WIC via the WWSF. The WIC presents this authorization token to the eP-CSCF during the IMS registration. The validation of the authorization token by the eP-CSCF is specific to the particular realisation. The authorization token allows the eP-CSCF to retrieve the IMS subscriber identity, the WAF and WWSF identities, validity period, and possible other authorization parameters.

The procedure in the present clause covers two cases of locating the authorization entity (WAF):

- The WAF is located in the IMS provider domain;

- The WAF is located in a third party domain.

NOTE 2: WWSF and WAF realisations can be physically co-located or physically separate; in the latter case, WWSF and WAF can reside in the same or in different domains.

An example signalling flow for the present registration scenario is shown in Figure X.3.2.3-1. In this figure, by way of example SIP over secure WebSocket is used between the WebRTC IMS Client and the eP-CSCF. Other protocols (e.g. HTTP RESTful or JSON over WebSocket) can also be used.

All steps in the procedure below apply to both cases of WAF location unless stated otherwise. For the example of OAuth 2.0 the WAF needs to be located in the IMS provider domain.

For the normative part, the procedure applies Trusted Node Authentication (TNA) specified for IMS in Annex U of the present specification. The trusted node is the eP-CSCF residing in the operator network, according to TS 23.228 [3]. The signalling between the Trusted Node and the rest of the IMS core is unchanged from the signalling flow in Annex U of the present specification with the following exception: if the WAF is located in a third party domain then the REGISTER message is enhanced with additional parameters (WAF and WWSF identity, if available), which are included to satisfy the requirements REQ 2.1 and REQ 2.2 from clause X.3.1 of the present specification.



Figure X.3.2.3-1: WebRTC IMS Client access to IMS using Trusted Node Authentication (example flow)

The details of the signalling flows are as follows:

Each step x in the signalling flow has a part x.1 providing general text applying to all realisations, irrespective of whether the WAF is located in the IMS provider domain or in a third party domain. This part x.1 is followed by text explaining how it would work for a realisation using the example of OAuth. For the example of OAuth, the WAF needs to be located in the IMS provider domain.

In addition, some of the steps contain a second step x.2 that applies only when the WAF is located in a third party domain.

**0. WWSF obtains authorization token**

*0.1 General*:

The WWSF requests an authorization token from the WAF. The WAF or WWSF, depending on the authorization flow used, authenticates the user via “web credentials”, i.e. credentials as commonly used for access to web based services, for example a username and password. The user's web identity is mapped to the corresponding IMS subscriber identity (i.e. IMPI and IMPU(s) ).

NOTE 3: It is assumed that the WWSF or WAF maintains the mapping between a user's web identity and IMPI/IMPU. How this mapping is established (i.e. how REQ 2.5 is satisfied) is out-of-scope of this specification.

*Example of OAuth 2.0*:

 When using the example of OAuth 2.0 then one of the authorization flows defined by OAuth 2.0 is used.

- Authorization Code flow: The WAF authenticates both the user and the WWSF before it issues the access token. The WAF may also request the user to explicitly authorize the WWSF.

- Client Credentials flow: The WAF authenticates only the WWSF and the authorization is performed without user involvement. As part of the authorization, the WAF verifies that the WWSF has the necessary permissions to access the IMS account indicated in the request. It is assumed that the WWSF has authenticated the user prior to sending the token request.

In the example of OAuth 2.0 the authorization token is an access token and IMPI and IMPU are associated with the access token.

Using the terminology of OAuth 2.0, the IMS subscriber corresponds to the resource owner, the WWSF corresponds to the client, the WAF corresponds to the authorization server, and the IMS network corresponds to the resource server.

NOTE 4: Void.

**1. Web page download from WWSF**

*1.1 General*:

An example realisation of this step is as follows:

- From within a WebRTC-enabled browser, the user accesses a URI to the WWSF to initiate an HTTPS connection to the WWSF. The TLS connection provides one-way authentication of the server based on the server certificate. The browser downloads and initializes the WIC from the WWSF. The WWSF forwards the authorization token to the WIC for inclusion in IMS registration procedure (step 3 below).

*Example of OAuth 2.0*: Identical to 1.1.

**2. Establishment of secure connection between WIC and eP-CSCF**

*2.1 General*:

An example realisation of this step is as follows:

The WIC opens a WSS (secure Web Socket) connection to the eP-CSCF. The TLS connection provides one-way authentication of the server based on the server certificate. The eP-CSCF verifies in this step that the WIC establishing the signalling connection comes from a trusted domain.

NOTE 5: The protection mechanism works under the assumption that the browser is not under the attacker's control.

*Example of OAuth 2.0*: Identical to 2.1.

**3. REGISTER request (WebRTC IMS Client to Trusted Node)**

*3.1 General*:

An example realisation of this step is as follows:

The WebRTC IMS Client sends a REGISTER request. The REGISTER request includes an authorization token, which the WebRTC IMS Client has previously obtained.

*Example of OAuth 2.0*:

In addition to 3.1, the Authorization header in the REGISTER request includes the OAuth 2.0 access token obtained in step 1. The access token is of the so called "bearer" token type; see RFC 6750 [67].

NOTE 6: OAuth bearer tokens can be used with signalling protocols that supports the Authorization header defined in RFC 7616 [XX], for example SIP and HTTP.

**4. Validation of security token at eP-CSCF**

*4.1 General*:

An example realisation of this step is as follows:

The eP-CSCF extracts the authorization token and validates it in some unspecified manner ensuring that only an authorized source can have generated the authorization token. The authorization token is associated with a specific resource owner (i.e. the IMS subscriber) and client (i.e. the WWSF) and has a certain lifetime and scope. This authorization information can either be encoded into the token itself and verified through a signature or MAC (so called self-contained token), or retrieved as part of the validation response if the validation is performed against the WAF.

 If the authorization token is valid the eP-CSCF obtains the associated authorization information, including the IMPI and IMPU of the associated user, the WAF and WWSF identities(if available),, and the authorization token scope. The eP-CSCF verifies that the scope includes the value "webrtc-ims-client-access-to-ims"

NOTE 6a: In the present 3GPP release the token format and verification procedure is left out of scope.
It is assumed that the eP-CSCF can check the validity of the token and obtain the subscriber IMPI and IMPU(s), the WWSF identity, lifetime, and scope parameters.

If the token is not valid in some respect, the eP-CSCF declines the register request, closes the web socket and aborts the procedure.

NOTE 7: The value "webrtc-ims-client-access-to-ims" is just a placeholder. The final syntax will be defined in the stage 3 specification.

*Example of OAuth 2.0*: Identical to 4.1.

**From the beginning of step 5 until the end of step 7, the text in the present subclause X.3.2.3 is normative.**

**5. REGISTER request (eP-CSCF to S-CSCF)**

*5.1 General*:

The eP-CSCF proceeds if the previous step has provided it with IMPI, IMPU(s) of the user requesting registration, an assurance that the user is authorised to use this IMPI and IMPU, and an identity of the WWSF and WAF. Then, the eP-CSCF generates a TNA Authorization header and forwards the request to the S-CSCF (via the I-CSCF). The format of the TNA Authorization header is specified in TS 24.292, Clause 6.2 [15], and contains, among others, the user’s IMPI, an integrity-protected directive set to auth-done, and an empty response directive.

*Example of OAuth 2.0*: Identical to 5.1.

 *5.2 Case of WAF located in third party domain*:

In this case, in addition to step 5.1 the eP-CSCF includes the identity of the WAF and WWSF (if available).

**6. Cx: S-CSCF Registration Notification**

*6.1 General*:

Based on the presence of the "integrity-protected" directive set to indicate that authentication has already been performed, the S-CSCF knows that user’s authorization has already been validated by the Trusted Node. The S-CSCF informs the HSS that the user has been registered. Upon being requested by the S-CSCF, the HSS will also include the user profile in the response sent to the S-CSCF. For detailed message flows see TS 29.228 [16].

*Example of OAuth 2.0*: Identical to 6.1.

*6.2 Case of WAF located in third party domain*:

In this case, in addition to step 6.1, the HSS further includes a list of WAF and WWSF identities (if available), outside the IMS provider’s domain allowed for this IMS subscription. If the S-CSCF received an identity of the authorization entity from the eP-CSCF then the S-CSCF checks whether this identity is contained in the list received from the HSS. The S-CSCF further checks whether the identity of the authorization entity received from the eP-CSCF, if any, is not barred. If the performed checks are positive, or no checks need to be performed, the S-CSCF proceeds with the next step; otherwise, it rejects the registration.

NOTE 8: The S-CSCF can obtain information about barred authorization entities from the HSS or via OAM. Barring may be useful in isolating the effects of security breaches in third party domains.

**7. 200 (OK) response (S-CSCF to eP-CSCF)**

*7.1 General*:

The S-CSCF sends a 200 (OK) response to the eP-CSCF (via I-CSCF) indicating that Registration was successful.

When TLS is used between WIC and eP-CSCF, then, similar to the registration procedure for SIP Digest with TLS, the eP-CSCF associates the IMPI and all successfully registered IMPUs with the TLS Session ID when the 200 (OK) is received.

*Example of OAuth 2.0*: Identical to 7.1.

**8. 200 (OK) response (eP-CSCF to WebRTC IMS Client)**

*8.1 General*:

An example realisation of this step is as follows:

The eP-CSCF forwards the 200 (OK) response to the WebRTC IMS Client indicating that Registration was successful.

*Example of OAuth 2.0*: Identical to 8.1.

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*end of fifth change/start of sixth change \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

### X.4.2.3 Procedures

The procedure provided in this clause is split into a normative part and non-normative part: the description for the interfaces between eP-CSCF, I-/S-CSCF and HSS is normative while the description for the interfaces W1, W2 and W4 is only by way of example.

NOTE 3: This split into a normative part and a non-normative part is due to 3GPP’s decision not to standardise the interfaces W1, W2 and W4 in the present release.

For the non-normative part, the procedure allows for various realisations that are out of scope of 3GPP for the present release. All realisations have in common that the WAF issues authorization tokens that are provided to the WIC via the WWSF. The WIC presents this authorization token to the eP-CSCF during the IMS registration. The validation of the authorization token by the eP-CSCF is specific to the particular realisation. The authorization token allows the eP-CSCF to retrieve the IMS subscriber identity, the WAF and WWSF identities, validity period, and possible other authorization parameters.

The procedure in the present clause covers two cases of locating the authorization entity (WAF):

- The WAF is located in the IMS provider domain;

- The WAF is located in a third party domain.

NOTE 4: WWSF and WAF realisations can be physically co-located or physically separate; in the latter case, WWSF and WAF can reside in the same or in different domains.

An example signalling flow for the present registration scenario is shown in Figure X.3.3-1. In this figure, by way of example SIP over secure WebSocket is used between the WebRTC IMS Client and the eP-CSCF. Other protocols (e.g. HTTP RESTful or JSON over WebSocket) can also be used.

All steps in the procedure below apply to both cases of WAF location unless stated otherwise. For the example of OAuth 2.0 the WAF needs to be located in the IMS provider domain.

For the normative part, the procedure applies Trusted Node Authentication (TNA) specified for IMS in Annex U of the present specification. The trusted node is the eP-CSCF residing in the operator network, according to the present specification .

The signalling between the trusted node and the rest of the IMS core is unchanged from the signalling flow in Annex U of the present specification with the following exception: if the WAF is located in a third party domain then the REGISTER message may be enhanced with additional parameters (WAF and WWSF identity, if available), whose inclusion is conditional, to satisfy the requirements REQ 3.2 from clause X.4.1 of the present specification.



Figure X.4.2.3-1: WebRTC IMS Client access to IMS using Trusted Node Authentication (example flow)

The details of the signalling flows are as follows:

Each step x in the signalling flow has a part x.1 providing general text applying to all realisations, irrespective of whether the WAF is located in the IMS provider domain or in a third party domain. This part x.1 is followed by text explaining how it would work for a realisation using the example of OAuth. For the example of OAuth, the WAF needs to be located in the IMS provider domain.

In addition, some of the steps contain a second step x.2 that applies only when the WAF is located in a third party domain.

**0. WWSF obtains authorization token**

*0.1 General*:

The WWSF requests an authorization token from the WAF. The WWSF or the WAF authenticates the user via “web credentials”, i.e. credentials as commonly used for access to web based services, for example a username and password. The WWSF can choose not to authenticate the user if the user is to remain anonymous.

*Example of OAuth 2.0*:

 When using the example of OAuth 2.0 then the following authorization flows defined by OAuth 2.0 is used.

- Client Credentials flow: The WAF authenticates only the WWSF and the authorization is performed without user involvement. As part of the authorization, the WAF verifies that the WWSF has the necessary permissions to access the IMS account indicated in the request. It is assumed that the WWSF has authenticated the user prior to sending the token request unless it is a case of anonymous access granted by the WWSF.

In the example of OAuth 2.0 the authorization token is an access token and IMPI and IMPU are associated with the access token.

Using the terminology of OAuth 2.0, the IMS subscriber corresponds to the resource owner, the WWSF corresponds to the client, the WAF corresponds to the authorization server, and the IMS network corresponds to the resource server. Note that, in this scenario, the WWSF is the IMS subscriber, so resource owner and client co-incide. Note further that the WWSF and the WAF may also co-incide.

NOTE 5: Void.

**1. Web page download from WWSF**

*1.1 General*:

An example realisation of this step is as follows:

- From within a WebRTC-enabled browser, the user accesses a URI to the WWSF to initiate an HTTPS connection to the WWSF. The TLS connection provides one-way authentication of the server based on the server certificate. The browser downloads and initializes the WIC from the WWSF. The WWSF forwards the authorization token to the WIC for inclusion in IMS registration procedure (step 3 below).

*Example of OAuth 2.0*: Identical to 1.1.

**2. Establishment of secure Web socket connection between WIC and eP-CSCF**

*2.1 General*:

An example realisation of this step is as follows:

The WIC opens a WSS (secure Web Socket) connection to the eP-CSCF. The TLS connection provides one-way authentication of the server based on the server certificate. The eP-CSCF verifies in this step that the WIC establishing the signalling connection comes from a trusted domain.

NOTE 6: The protection mechanism works under the assumption that the browser is not under the attacker's control.

*Example of OAuth 2.0*: Identical to 2.1.

**3. REGISTER request (WebRTC IMS Client to Trusted Node)**

*3.1 General*:

An example realisation of this step is as follows:

The WebRTC IMS Client sends a REGISTER request. The REGISTER request includes an authorization token, which the WebRTC IMS Client has previously obtained.

*Example of OAuth 2.0*:

In addition to 3.1, the Authorization header in the REGISTER request includes the OAuth 2.0 access token obtained in step 1. The access token is of the so called "bearer" token type; see RFC 6750 [67].

NOTE 7: OAuth bearer tokens can be used with signalling protocols that supports the Authorization header defined in RFC 7616 [XX], for example SIP and HTTP.

**4. Validation of security token at eP-CSCF**

*4.1 General*:

An example realisation of this step is as follows:

The eP-CSCF extracts the authorization token and validates it in some unspecified manner ensuring that only an authorized source can have generated the authorization token. The authorization token is associated with a specific resource owner (i.e. the IMS subscriber) and client (i.e. the WWSF) and has a certain lifetime and scope. This authorization information can either be encoded into the token itself and verified through a signature or MAC (so called self-contained token), or retrieved as part of the validation response if the validation is performed against the WAF.

 If the authorization token is valid the eP-CSCF obtains the associated authorization information, including the IMPI and IMPU assigned to the user by the WWSF, the WAF and WWSF identity (if available), and the authorization token scope. The eP-CSCF verifies that the scope includes the value "webrtc-ims-client-access-to-ims".

NOTE 7a: In the present 3GPP release the token format and verification procedure is left out of scope.
It is assumed that the eP-CSCF can check the validity of the token and obtain the subscriber IMPI and IMPU(s), the WWSF identity, lifetime, and scope parameters.

NOTE 8: Under certain assumptions, the eP-CSCF can also verify that the IMPI, if it exists at all in the IMS, belongs to an IMS subscription in the pool of IMS subscriptions assigned to the WWSF.Such an assumption would be e.g. that the IMPIs from the pool of IMS subscriptions assigned to the WWSF have a special form, and the IMS provider does not assign IMPIs of this form to any other WWSF. However, the IMPU would not have to follow the same special format as the IMPI.

If the validation fails in some respect, the eP-CSCF declines the register request, closes the web socket and aborts the procedure.

NOTE 9: The value "webrtc-ims-client-access-to-ims" is just a placeholder. The final syntax will be defined in the stage 3 specification.

*Example of OAuth 2.0*: Identical to 4.1.

**From the beginning of step 5 until the end of step 7, the text in the present subclause X.4.2.3 is normative.**

**5. REGISTER request (eP-CSCF to S-CSCF)**

*5.1 General*:

The eP-CSCF proceeds if the previous step has provided it with IMPI, IMPU(s) of the user requesting registration, an assurance that the user is authorised to use this IMPI and IMPU, and an identity of the WWSF and WAF. Then, the eP-CSCF generates a TNA Authorization header and forwards the request to the S-CSCF (via the I-CSCF). The format of the TNA Authorization header is specified in TS 24.292, Clause 6.2 [15], and contains, among others, the IMPI assigned to the user, an integrity-protected directive set to auth-done, and an empty response directive.

*Example of OAuth 2.0*: Identical to 5.1.

*5.2 Case of WAF located in third party domain*:

In this case, in addition to step 5.1, if the eP-CSCF cannot not verify in step 4 that the IMPI, if it exists at all, belongs to an IMS subscription in the pool of IMS subscriptions assigned to the WWSF then the eP-CSCF includes the identity of the WAF and WWSF (if available).

**6. Cx: S-CSCF Registration Notification**

*6.1 General*:

Based on the presence of the "integrity-protected" directive set to indicate that authentication has already been performed, the S-CSCF knows that the user’s authorization has already been validated by the Trusted Node. The S-CSCF informs the HSS that the user has been registered. Upon being requested by the S-CSCF, the HSS will also include the user profile in the response sent to the S-CSCF. For detailed message flows see TS 29.228 [16].

*Example of OAuth 2.0*: Identical to 6.1.

*6.2 Case of WAF located in third party domain*:

In this case, in addition to step 6.1, the HSS further includes a list, if available, of WWSF identities allowed for assigning this IMS subscription. If the S-CSCF received a WWSF identity from the eP-CSCF, the S-CSCF checks whether it is contained in this list. The S-CSCF further checks whether the identities of the WWSF and WAF,received from the eP-CSCF, if any,are not barred. If the performed checks are positive, or no checks need to be performed, the S-CSCF proceeds with the next step; otherwise, it rejects the registration.

NOTE 10: The S-CSCF can obtain information about barred authorization entities from the HSS or via OAM. Barring may be useful in isolating the effects of security breaches in third party domains.

**7. 200 (OK) response (S-CSCF to eP-CSCF)**

*7.1 General*:

The S-CSCF sends a 200 (OK) response to the eP-CSCF (via I-CSCF) indicating that registration was successful.

When TLS is used between WIC and eP-CSCF, then, similar to the registration procedure for SIP Digest with TLS, the eP-CSCF associates the IMPI and all successfully registered IMPUs with the TLS Session ID when the 200 (OK) is received.

*Example of OAuth 2.0*: Identical to 7.1.

**8. 200 (OK) response (eP-CSCF to WebRTC IMS Client)**

*8.1 General*:

An example realisation of this step is as follows:

The eP-CSCF forwards the 200 (OK) response to the WebRTC IMS Client indicating that Registration was successful.

*Example of OAuth 2.0*: Identical to 8.1.

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*end of sixth and last change\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*