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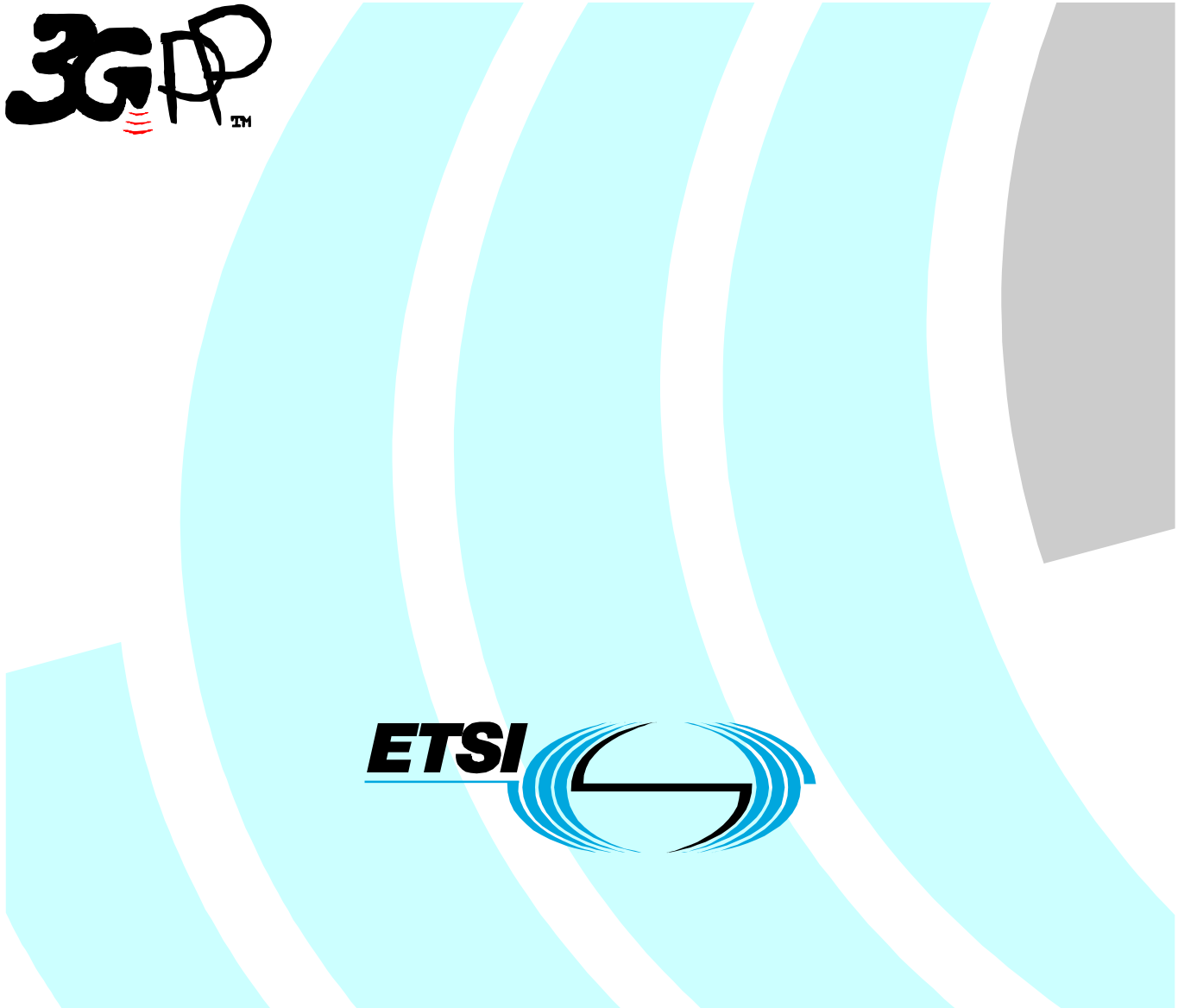
Technical Report

Universal Mobile Telecommunications System (UMTS);
Generic Authentication Architecture (GAA);
System description
(3GPP TR 33.919 version 6.1.0 Release 6)



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Foreword

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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:

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Introduction

This section provides an introduction on the context of GAA and some clarification of why this TR was written (with some reference to three related Technical Specifications).

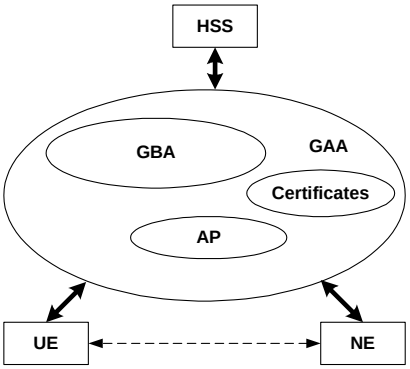


Figure 1: Schematic illustration of GAA

A number of applications share a need for mutual authentication between a client ((i.e. the UE) and an application server before further communication can take place. Examples include (but are not limited to) communication between a client and a presence server (possibly via an authentication proxy), communication with a PKI portal where a client requests a digital certificate, communication with a content server, a BM-SC, etc.

Since a lot of applications share this common need for a peer authentication mechanism, it has been considered useful to specify a Generic Authentication Architecture (GAA). This GAA describes a generic architecture for peer authentication that can *a priori* serve for any (present and future) application.

This TR can be considered as a framework document for the generic authentication architecture as is illustrated in Figure 1. GBA, AP and Certificates are building blocks of the GAA and they are specified each in a separate TS. How they fit together in GAA is explained in this document.

1 Scope

This 3GPP Technical Report aims to give an overview of the different mechanisms that mobile applications can rely upon for authentication between server and client (i.e. the UE). Additionally it provides guidelines related to the use of GAA and to the choice of authentication mechanism in a given situation and for a given application.

To this end the TR puts the different GAA specifications that are related to peer authentication, into perspective. It clarifies the logic for having three technical specifications, sketches their content and explains the inter-relation between these three TSs and their relation with this TR.

Figure 1 depicts protocols used over GAA interfaces and the relationships between different GAA specifications. New GAA specifications will be added to the figure as they become available. Also other protocols may be added in the future. In particular, new kinds of Ua interfaces could be added in the future and then other protocols may be added below the Ua interface.

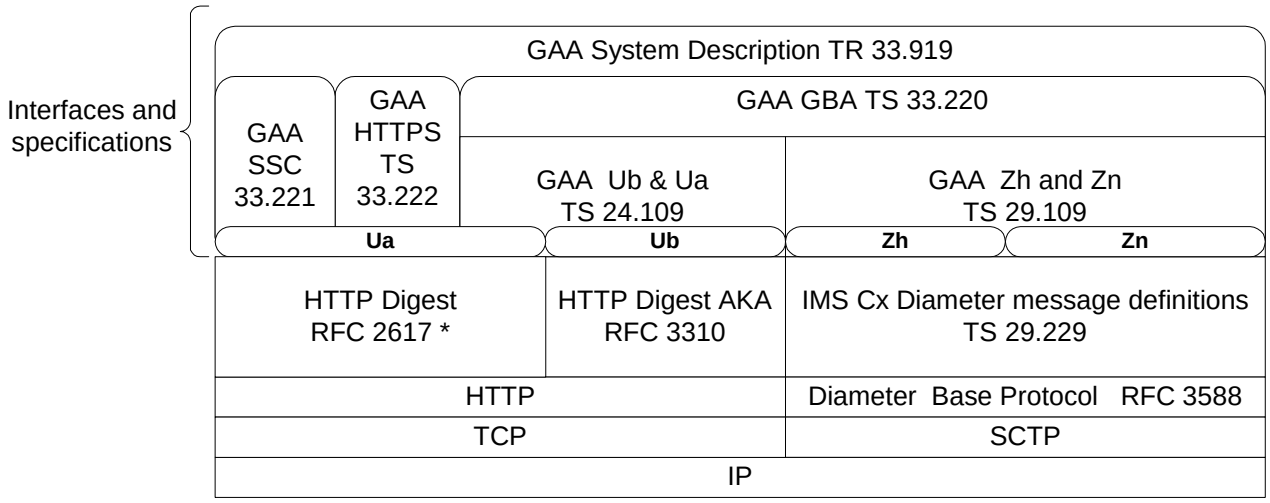


Figure 2: Relationships between GAA specifications and the protocols used by GAA interfaces

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] 3GPP TS 33.220: "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; 3G Security; Generic Authentication Architecture (GAA); Generic bootstrapping architecture".

[3] 3GPP TS 33.221: "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; 3G Security; Generic Authentication Architecture (GAA); Support for subscriber certificates".

[4] 3GPP TS 33.222: "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; 3G Security; Generic Authentication Architecture (GAA); Access to network application functions using secure hypertext transfer protocol (HTTPS)".

[5] IETF RFC 2818: "HTTP Over TLS".

[6] 3GPP TS 29.109: "3rd Generation Partnership Project; Technical Specification Group Core Network; Generic Authentication Architecture (GAA); Zh and Zn Interfaces based on the Diameter protocol; Protocol details".

[7] 3GPP TS 24.109: "3rd Generation Partnership Project; Technical Specification Group Core Network; Bootstrapping interface (Ub) and Network application function interface (Ua); Protocol details".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply.

Subscriber certificate: a certificate issued by a mobile network operator to a subscriber based on his/her subscription. It contains the subscriber's own public key and possibly other information such as the subscriber's identity in some form.

3.2 Abbreviations

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

AKA	Authentication and Key Agreement
AP	Authentication Proxy
AS	Application Server
BSF	Bootstrapping Server Function
GAA	Generic Authentication Architecture
GBA	Generic Bootstrapping Architecture
HSS	Home Subscriber System
NAF	Network Application Function
NE	Network Element
PKI	Public Key Infrastructure
SSC	Support for Subscriber Certificates
UE	User Equipment

4 Generic Authentication Architecture

4.1 GAA overview

There are generally speaking two types of authentication mechanisms. One is based on a secret shared between the communicating entities, the other one is based on (public, private) key pairs and digital certificates. Also in GAA these are the two options that are a priori available for mobile applications as is illustrated in Figure 3.

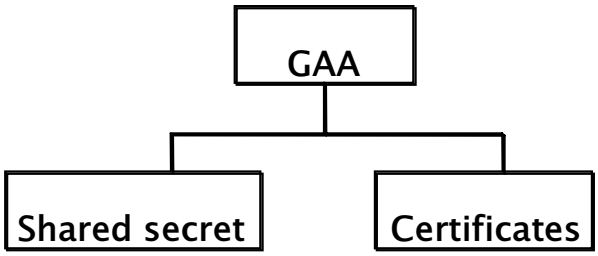


Figure 3: GAA schematic overview

4.2 Authentication using shared secret

There are several authentication protocols that rely on a pre-shared secret between the two communicating entities. Popular examples include HTTP Digest, IKE with pre-shared secret and a priori any mechanism based on username and password.

The main problem with these mechanisms is how to agree on this pre-shared secret. Clause 5.2 and GBA TS 33.220 [2] describe how in a mobile context an AKA based mechanism can be used to provide both communicating entities with a pre-shared secret.

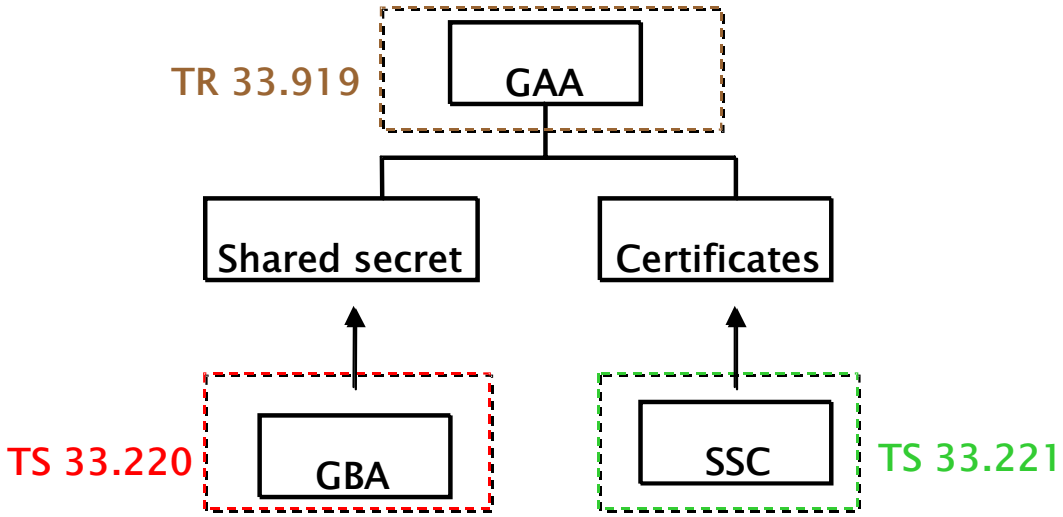
4.3 Authentication based on (public, private) key pair and certificates

An alternative to using shared secrets for authentication is to rely on asymmetric cryptography. This assumes that the entity that needs to be authenticated (one or both partners in the communication) possesses a (public, private) key pair and a corresponding digital certificate. The latter validates the key pair and binds the key pair to its legitimate owner. Well-known protocols whose authentication is based on (public, private) key pairs include PGP and HTTP over TLS, RFC 2818 [5] (the later is commonly called by its protocol identifier, "HTTPS").

The main disadvantage of this type of authentication is that a PKI is needed and that asymmetric key cryptographic operations often require substantially more computational effort than symmetric key operations. Clause 5.3 and SSC TS 33.221 [3] describe how a mobile operator can issue digital certificates to its subscribers (hence providing a basic PKI).

5 Issuing authentication credentials

5.1 Schematic overview



NOTE: Other mechanisms for issuing authentication credentials may exist but are out of scope for this TR.

Figure 4: Illustration of mechanisms to issue authentication credentials

Figure 3 illustrates the relation between this TR and TS 33.220 [2] and TS 33.221 [3]. There are on the one hand authentication methods that are based on shared secrets and GBA, described in TS 33.220 [2], specifies a mechanism to provide communicating parties with such a shared secret. On the other hand there are authentication methods that rely on (public, private) key pairs and digital certificates and SSC, described in TS 33.221 [3], specifies how to issue certificates to mobile subscribers.

5.2 GBA: Mechanism to issue shared secret

TS 33.220 [2] specifies an application independent mechanism based on the 3GPP AKA mechanism to provide a client and an application server with a common shared secret. This shared secret can subsequently be used to authenticate the communication between the client and an application server.

5.3 SSC: Mechanism to issue subscriber certificates

TS 33.221 [3], specifies a mechanism to issue a digital certificate to a mobile subscriber.

Once a mobile subscriber has a (public, private) key pair and has obtained a certificate for it, he can use the certificate together with the corresponding key pair to produce digital signatures in e.g. m-commerce applications but also to authenticate to a server (e.g. in TLS).

6 GAA building blocks

6.1 GAA structural overview

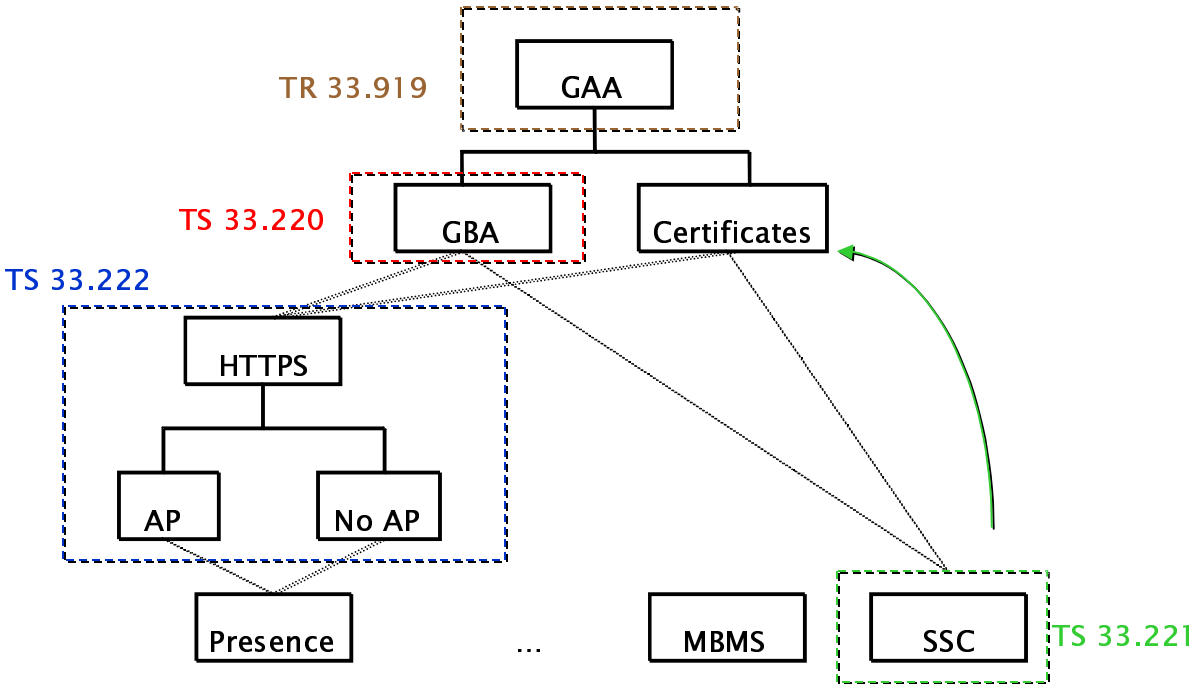


Figure 5: Detailed overview of inter-relation of GAA building blocks

This clause gives a high level overview of the content of the different GAA documents and describes how these documents fit together.

6.2 GAA

GAA refers to this TR that describes the general framework of the Generic Authentication Architecture.

6.3 GBA

As briefly indicated in clause 5.2, GBA provides a general mechanism based on 3GPP AKA to install a shared secret between a UE and a server.

AKA is a very powerful mechanism that mobile networks make use of. GBA takes benefit of this mechanism and re-uses AKA to bootstrap application security. GBA introduces a new network element (NE) called the Bootstrapping Server Function (BSF). This BSF has an interface with the HSS. The UE runs AKA with the HSS via the BSF. From the resulting (CK, IK), a session key is derived in BSF and UE. An application server (called Network Application Function (NAF) in TS 33.220 [2]) can fetch this session key from the BSF together with subscriber profile information. In this way the application server (NAF) and the UE share a secret key that can subsequently be used for application security, in particular to authenticate UE and NAF at the start of the application session (possibly also for integrity and/or confidentiality protection although that might not be strictly in the scope of GAA). The communication between the UE and the BSF as well as that between NAF and BSF and between BSF and HSS are application independent and are described in TS 33.220 [2].

The following argument lead to the introduction of this new NE (BSF):

- keep the number of different types of NEs as well as the total number of NEs that retrieve AVs from the HSS to a minimum.

One generic mechanism for different applications avoids a large diversity of mechanisms and allows to address security issues once and in a consistent way.

6.4 SSC

If a client wants to make use of asymmetric encryption technology, he needs a digital certificate that is created by a certification authority (CA). Such a certificate binds a public key to the identity of its legitimate owner and certifies the validity of the public key. If a mobile subscriber wants to have and make use of a (public, private) key pair, the key pair and a certificate should either be preloaded or the subscriber must have the means to either generate or obtain a key pair and dynamically obtain a corresponding digital certificate. As briefly indicated in clause 5.3, SSC specifies a mechanism to dynamically issue a digital certificate to a mobile subscriber.

To dynamically obtain a digital certificate a UE must send an appropriate certificate request to a PKI portal of his home operator, and the PKI portal must authenticate the certificate request. The certificate enrolment process i.e. the issuing of a certificate to a subscriber and the corresponding communication session between a UE and a PKI portal is in fact an example of a mobile application. As with many mobile applications it requires authentication of the communicating entities, in this case the UE and the PKI portal (the latter plays the role of the application server). As for any other application there are 2 options for this authentication: pre-shared secret based or based on asymmetric cryptography and certificates. The latter is only an option when a new certificate is requested from the PKI portal while another still valid certificate is already loaded in the UE. The former method requires a shared secret between the PKI portal and the UE. If the shared secret is not pre-configured, GBA can be used to obtain such a shared secret.

As indicated in Figure 4, the result of the process of issuing a certificate to a mobile subscriber which is described in the SSC TS 33.221 [3] is that the UE is loaded with a certificate corresponding to its (public, private) key pair. This is indicated by the green upward arrow.

Once the certificate is in place it can be used (together with the corresponding (public, private) key pair) to authenticate the UE. This is indicated by the black dotted lines that connect "certificates" to the underlying applications (HTTPS and SSC in Figure 4). The (public, private) key pair and the corresponding digital certificate can also be used for integrity protection (or less likely confidentiality) but these are not part of the scope of GAA.

6.5 Access to Network Application Functions using HTTPS

It is envisaged that HTTPS (or HTTP/TLS) may be used in a number of services to secure the application session between the UE and the application server (Ua interface in TS 33.220, see TS 33.222 [4]). TS 33.222 [4] describes the details of the possible authentication options when HTTPS is used between a UE and an application server. Any existing or future application based on HTTPS can refer to TS 33.222 [4] for details on authentication and the set up of a secure HTTPS session.

6.5.1 HTTPS with Authentication Proxy

TS 33.222 [4] describes a mechanism where a reverse proxy (called authentication proxy (AP)) is used between the UE and the AS.

The AP is the TLS end point and the UE shall be able to simultaneously connect to different ASs behind one AP. The AP shall be able to authenticate the UE using the means of GAA, and shall send the authenticated UE identity to the AS. If UE authentication is based on a shared secret then the AP acts as the NAF in the GAA architecture and terminology.

Possible advantages of the use of such an AP may include reduced consumption of authentication vectors, minimization of SQN synchronization failures and reduction of number of TLS sessions that a UE needs to set up and maintain.

6.5.2 HTTPS without Authentication Proxy

HTTP based application servers can also be deployed without the use of an authentication proxy. In this case the HTTPS (or TLS) session is between the UE and the AS. In this case the AS shall be able to authenticate the UE using the means of GAA. If UE authentication is based on a shared secret then the AS acts as the NAF in the GAA architecture and terminology.

7 Application guidelines to use GAA

GAA provides different alternatives to an AS or an AP to perform user authentication (i.e. force the UE to run AKA with the BSF as specified in TS 33.220 [2] or use a mechanism based on subscriber certificates). Also under GAA, an AS may understand that the user request is already authenticated by an Authentication Proxy.

GAA as described in this TR has not the intention to impose any one authentication mechanism onto applications . It is rather aimed to be a tool at developers disposal which they can use to their benefit. Application developers may save development time by using GAA instead of designing and implementing application-specific authentication mechanisms. An additional advantage of the mechanisms of GAA is that they can provide global coverage, inherited from the GSM/UMTS coverage.

Depending on network configuration and policies of the operator, an AS or an AP will be able to use any of the alternatives provided by GAA or even any other user authentication mechanisms specified outside of 3GPP if such mechanisms are at their disposal. It is therefore assumed that an AS and an AP should be able to take the decision what parts of GAA shall be used if any.

This section tries to give an overview of arguments that can play a role in the choice of authentication mechanism. The authentication mechanism selected will be dependent on:

1. Requirements/policies relating to the user/server/application/device that needs authentication. This may be in both directions (mutual authentication), but the usual emphasis is user to server authentication.

2. Device and service characteristics, user capabilities and preferences as defined in the user profile.

3. Policies of the network or networks providing the transport service and the service providers of the applications.

Requirements/policies relating to authentication will depend on whether there is a need for:

a) Device authentication: The device is genuine and not a clone i.e. Authentication of a (U)SIM by challenge response.

b) Integrity protection: An example is signalling protection in UTRAN access A weakness in GSM is that it is very easy for a man in the middle to manipulate signalling message e.g. cipher mode command and a way to prevent it being compromised is to use device authentication **and** integrity protection via a keyed MAC (Message Authentication Code) on the specific signalling messages.

c) Application authentication: It will often be necessary to check the authenticity of the application software by checking its digital signature. An example is ETSI ES 202 915-3 V1.2.1: "Open Service Access (OSA) Application Programming Interface (API) Part 3: Framework (Parlay 4)" Application authentication is however out of the scope of GAA. This is more the domain of code signing and will not be further discussed in this section.

d) User authentication:. This refers to authentication of the end user, the person who is using the end user device. One way of doing this is to make the USIM availability to devices/protocols/applications dependent, logically, by user PIN input or physically, by a policy of removal and insertion. The entry of a PIN may also be required before access is allowed to a specific application.

e) Transaction authentication and non-repudiation: For some business transactions that are carried out using the mobile device it is necessary to digitally sign the transaction with a users private key, specifically where there is a need for non repudiation i.e. to prevent:

- the False Denial of the: SENDING of the Message, e.g. "I never sent it!"

- the CONTENT of the Message, e.g. "I said you should sell, not buy!"

- the TIME of the Message, e.g. "I sent it a different time!"

NOTE: Many authentication techniques such as 3GPP AKA are based on a single key which is shared between the network and the user - this is OK for authentication between sender and recipient, but non repudiation provable to a third party may require the use of public key technique where the private key is only held by the sender.

Figure 5 shows how device and service characteristics can impact the choice of a particular technique from the Spectrum of Authentication Mechanisms.

	authentication type		
client (device) charateristics	device (client) auth	server auth	transaction auth
PIN/password	stored PIN/password	signature or password	x
GAA: subscriber certificate	client private key, signature	signature	private key, signature
GAA: GBA at UE	shared secret (GBA), keyd MAC	shared secret (GBA), keyd MAC OR server private key, signature	x

x = client characteristics do not allow authentication requirement to be met.

Figure 5: Authentication characteristics comparison

7.1 Use of shared secrets and GBA

Some examples of where shared secrets from the innovation of GBA can be used are:

- distribution of symmetric ciphering and integrity keys for securing applications running between the UE and a server in he network. Example protocols that can be used to secure an application and that require a shared secret include HTTP Digest, shared secret TLS and IPsec;
- distribution of passwords and PIN for third party applications;
- for protecting the distribution of certificates between the UE and the certificate authority.

7.2 Use of certificates

Some examples of where certificates can be used for authentication are:

- when it is necessary to check the identity of the end user;
- when the application security protocol works smoothly with (public, private) key pair authentication and subscriber certificates are available (e.g. normal TLS);
- where there is a need for non-repudiation and where the user is required to digitally sign the transaction with a user's private key as many authentication techniques such as 3GPP AKA are based on a single key, which is shared between the network and the user. Non-repudiation provable to a third party may require the use of public key technique where the private key is only held by the sender.

Annex A:
Change history

Change history							
Date	**TSG #**	**TSG Doc.**	**CR**	**Rev**	**Subject/Comment**	**Old**	**New**
2003-10	SA3#30				New Draft TR: Generic Authentication Architecture (GAA)		0.1.0
2003-11	SA3#31				Text has been added to the introduction and to sections 1 to 6	0.1.0	0.2.0
2003-12	SP-22	SP-030582	-	-	Presentation to TSG SA#22 for Information	0.2.0	1.0.0
2004-01	SA3#32	-	-	-	Editorial changes plus an additional reference	1.0.0	1.0.1
2004-02	SA3#32	-	-	-	References have been added. An editor's note in section 6.5 has been removed, Figure with explanation has been added and text has been added to sections 6.3, 6.4, 6.5 and 7.	1.0.1	1.2.0
2004-06	SP-24	SP-040365	-	-	Editorial changes for Presentation to TSG SA#24 for information	1.2.0	1.2.1
2004-07	SA3#34	-	-	-	Text has been added to section 7	1.2.1	1.3.0
2004-09	SP-25	SP-040625	-	-	Edited by MCC for presentation to TSG SA #25 for approval	1.3.0	2.0.0
2004-09	-	-	-	-	Updated to v6.0.0 after TSG SA approval	2.0.0	6.0.0
2004-12	SP-26	SP-040861	002	-	Removal of unnecessary editor's notes	6.0.0	6.1.0

History

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