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TECHNICAL REPORT

**Digital cellular telecommunications system (Phase 2+) (GSM);
Feasibility Study on generic access to A/Gb interface
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650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00   Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - APE 7112B
Association à but non lucratif enregistrée à la
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Contents

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Introduction

This document captures the results of the feasibility study of enabling generic access to A/Gb interface using alternate access means such as ADSL, Cable, Bluetooth, etc. Mobile stations obtain services from the GSM core network using such generic access means rather than through the traditional GERAN radio interface. The goal is to ensure no impact to the current A/Gb interface specifications.

1 Scope

This document studies the feasibility of generic access to A/Gb interface. Specific areas of study are:

- Architecture to enable generic access.

- Access interface protocols required to provide connectivity to A/Gb interface and GSM/GPRS services.

- Security mechanisms to support generic access architecture.

- Determining feasibility for support of services currently supported through GERAN.

The focus of the study shall be on establishing the feasibility for supporting generic access in the home network case, while also identifying issues with extending the solution to the roaming scenarios.

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 22.011: "Service accessibility".

[2]   3GPP TS 23.234: "3GPP system to Wireles Local Area Network (WLAN) interworking; System description".

[3]   3GPP TS 26.103: "Speech codec list for GSM and UMTS".

[4]   ITU-T Recommendation V.110: "Support by an ISDN of data terminal equipments with V-Series type interfaces".

[5]   IETF RFC 791: "Internet Protocol".

[6]   IETF RFC 793: "Transmission Control Protocol".

[7]   IETF RFC 2406: "IP Encapsulating Security Payload (ESP)".

[8]   IKEv2

[9]   EAP SIM

[10]   IPSec NAT

[11]   IETF RFC 768: "User Datagram Protocol".

[12]   IETF RFC 3550: "A Transport Protocol for Real-Time Applications".

[13]   3GPP TS 33.234: "3G security; Wireless Local Area Network (WLAN) interworking security".

[14]   IETF RFC 2406: " IP Encapsulating Security Payload (ESP)".

[15]   3GPP TS 23.122: "Non-Access-Stratum functions related to Mobile Station (MS) in idle mode".

3 Definitions, symbols and abbreviations

3.1 Definitions

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

Generic Access Network: an access network providing access to A/Gb interfaces using broadband IP network.

Generic Access Network Controller: the network node that connects to the MSC and SGSN via the A-interface and Gb interface respectively and mimics the functionality of the GERAN BSS.

Roving: the action of re-selection between 3GPP access technology and GAN for a mobile station in idle mode.

Rove in: the mobile station reselects from GERAN/UTRAN to GAN.

Rove out: the mobile station reselects from GAN to GERAN/UTRAN.

Handover: a mobile station engaged in a call moves between GERAN/UTRAN and GAN.

Handover in: the mobile station moves from GERAN/UTRAN to GAN.

Handover out: the mobile station moves from GAN to GERAN/UTRAN.

Seamless: free from noticeable transitions (i.e., no end-user action is required; speech interruptions are short; service interruptions are short; incoming calls are not missed; packet sessions are maintained; services work identically).

3.2 Symbols

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

A	GSM A Interface : the A interface is located between the MSC (Mobile service Switching Centre) and the BSS (Base station system or radio Sub-System).
Gb	GSM Gb Interface : the Gb interface connects the Base Station System (BSS) to the Serving GPRS Support Node (SGSN)
Up	Interface between MS and GAN
Wm	Reference point between a Packet Data Gateway and a 3GPP AAA Server or 3GPP AAA proxy

3.3 Abbreviations

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

A-GPS	Assisted-GPS
AAA	Authentication, Authorisation and Accounting
ADSL	Asymmetric Digital Subscriber Line
ARFCN	Absolute Radio Frequency Channel Number
BCCH	Broadcast Control CHannel
BSIC	Base transceiver Station Identity Code
BSS	Base Station Subsystem
BSSAP	Base Station Subsystem Application Part
BSSGP	Base Station Subsystem GPRS Protocol
BSSMAP	Base Station Subsystem Management Application Part
CBS	Cell Broadcast Service
CC	Call Control
CGI	Cell Global Identity
CI	Cell Identity
CM	Connection Management
CN	Core Network
CS	Circuit Switched
DSL	Digital Subscriber Line
DTAP	Direct Transfer Application Part

DTM	Dual Transfer Mode
ESP	Encapsulating Security Payload
FFS	For Further Study
GAN	Generic Access Network
GANC	Generic Access Network Controller
GERAN	GSM EDGE Radio Access Network
GMM	GPRS Mobility Management
GMMRR	GPRS Mobility Management Radio Resource
GRR	GPRS Radio Resource
HLR	Home Location Register
HO	Handover
HPLMN	Home Public Land Mobile Network
HTTP	Hyper Text Transfer Protocol
IMS	IP Multimedia Subsystem
IMSI	International Mobile Subscriber Identity
IP	Internet Protocol
L1	Layer 1 (physical layer)
LA	Location Area
LA	Location Area Identity
LCS	Location Services
LLC	Logical Link Control
MAC	Medium Access Control (protocol layering context)
MBMS	Multimedia Broadcast and Multicast Service
MM	Man Machine
MMI	Man Machine Interface
MMS	Multimedia Messaging Service
MO	Mobile Originated
MS	Mobile Station
MSC	Mobile Switching Centre
MVNO	Mobile Virtual Network Operator
NACC	Network Assisted Cell Change
NAS	Non-Access Stratum
NC2	Network Control mode 2
OTDOA	Observed Time Difference Of Arrival (positioning method)
PCM	Pulse Code Modulation
PDP	Packet Data Protocol
PDU	Protocol Data Unit
PLMN	Public Land Mobile Network
PS	Packet Switched
RAN	Radio Access Network
RR	Radio Resources
RRC	Radio Resource Control
RTCP	Real-Time Transport Control Protocol
RTP	Real Time Protocol
SAP	Service Access Point
SAPI	Service Access Point Identifier
SCCP	Signalling Connection Control Part
SGW	Security Gateway
SGSN	Serving GPRS Support Node
SID	SIlence Descriptor
SIM	GSM Subscriber Identity Module
SM	Session Management
SMS	Short Message Service
SS	Supplementary Service
SSL	Secure Sockets Layer
TBF	Temporary Block Flow
TCP	Transmission Control Protocol
TFO	Tandem Free Operation
TLLI	Temporary Logical Link Identity
TMSI	Temporary Mobile Subscriber Identity
TrFO	Transcoding Free Operation
UDP	User Datagram Protocol

UNC	Universal Naming Convention
UTRAN	Universal Terrestrial Radio Access Network
VBS	Voice Broadcast Service
VGCS	Voice Group Call Service
VPLMN	Visited Public Land Mobile Network

4 Assumed high level requirements

This clause summarizes the various assumed requirements for the feasibility study, when providing generic access to A/Gb interfaces:

- GAN interfaces to the core network shall use existing standard A interface to the MSC and Gb interface to the SGSN. Non-access stratum (NAS) protocols shall not be impacted.

- GAN shall reuse the existing GERAN identifiers toward the core network.

- GAN should support all telecommunication services supported using the A/Gb interfaces.

- GAN shall be able to operate over existing generic IP access networks (e.g. Cable, DSL, etc.). GAN-specific functionality shall not be required in the generic IP access network.

- Multi-mode terminals shall be able to perform automatic roving between GERAN/UTRAN and GAN, subject to the policies of the operator.

- Multi-mode terminals shall be able to perform seamless handover between GERAN/UTRAN and GAN, subject to the policies of the operator.

- PLMN selection and mechanisms for the avoidance of ping-pong between GERAN/UTRAN and GAN modes shall follow the principles enunciated in 3GPP TS 22.011.

- The home operator providing GAN service shall control access to Generic Access in all scenarios, including roaming.

- GAN shall provide security at least as good as GERAN for all traffic between mobile station and GANC. This includes support of bilateral authentication and encryption of all signalling and user plane traffic between mobile station and GANC.

- GAN should not require any change to existing standards e.g. the behaviour of MS in GERAN. Non-GAN capable MSs shall not be impacted due to GAN deployment.

- GAN shall be easily scaled with increasing users and traffic. It should efficiently use the resources of the generic IP access network.

- Existing charging mechanisms should be used for GAN.

5 Study results

5.1 Architecture

5.1.1 Architecture for generic access interface

5.1.1.1 Functional architecture

An option for the Generic Access Network architecture is illustrated below.
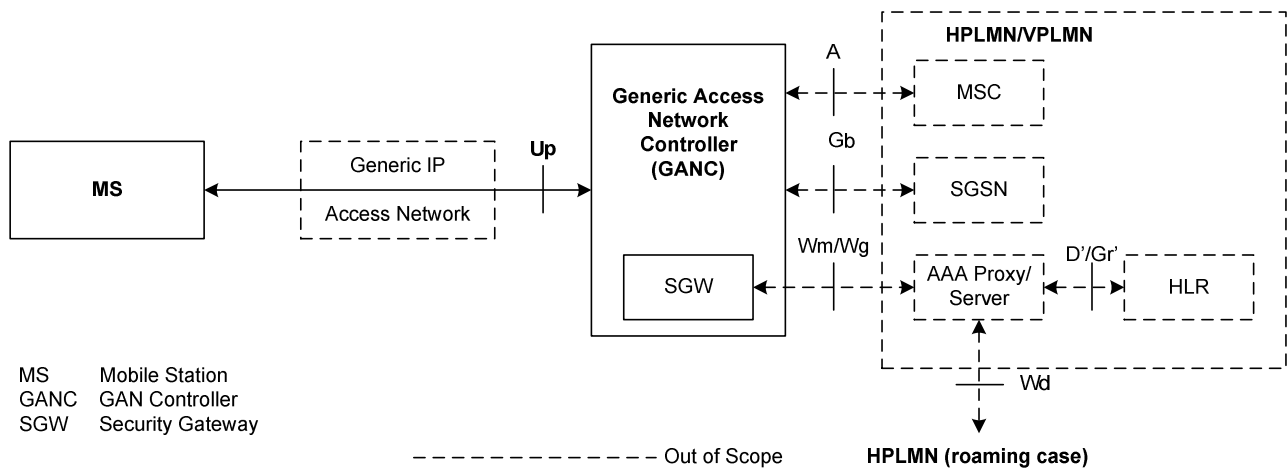
Figure 5.1.1.1.1: GAN Functional Architecture

5.1.1.2   Functional entities

5.1.1.2.1   Mobile Stations (MS)

The MS contains a new functional block to access a generic access network (GAN).

5.1.1.2.2   Generic Access Network Controller (GANC)

The Generic Access Network Controller (GANC) appears to the core network as a GERAN base station subsystem (BSS). This entity mimics the role of the BSC in the GERAN architecure as seen from the perspective of the A/Gb interface. Thus the CN to which the GANC is connected to, is unaware of the different access mechanism being supported by the GANC compared to the BSC. A generic IP access network provides connectivity between the MS and the GANC.

The functionality provided by the GANC includes the following:

- User plane circuit switched services:
  Inter-working circuit switched bearers over Up interface to circuit switched bearers over A-interface, including transcoding voice to/from the MS to PCM voice from/to the MSC (when TFO/TrFO features are not being utilized).

- User plane packet switched services:
  Inter-working data transport channels over Up interface to packet flows over Gb interface

- Control plane functionality

  - Security Gateway (SGW) for the set-up of secure tunnel with MS for mutual authentication, encryption and data integrity

  - Registration for GAN service access and providing system information

  - Set-up of GAN bearer paths for CS and PS services. This includes establishment, management, and teardown of signalling and user plane bearers between the MS and the GANC.

  - GAN functions equivalent to GSM RR and GPRS RLC such as for paging and handovers.

  - Transparent transfer of L3 messages between the MS and core network.

  NOTE: The AAA server is out of scope of the current study. It is used to authenticate the MS when it first sets up a secure tunnel to the GAN, specifically to the SGW.

5.1.1.3 Interfaces

5.1.1.3.1 A/Gb interfaces

The GAN co-exists with the GERAN and interconnects to the core network via the same interfaces used by a standard GERAN BSS network element:

- GSM A-interface for circuit switched services

  No changes are seen necessary to the A interface protocols.

- GPRS Gb-interface for packet services

  No changes are seen necessary to the Gb interface protocols.

5.1.1.3.2 Up interface

A single new interface, the Up interface, is defined between the GANC and the MS.

5.1.1.3.3 Wm interface

The Wm interface is used between the GANC-SGW and AAA server, as defined by 3GPP TS 23.234. The Wm interface is out of scope of the current study.

5.1.1.4 High level description of generic access

The following provides a general outline for how an MS accesses a generic access network which in turn is connected to the core network through the A/Gb interfaces, using the proposed GAN functional architecture:

1. The MS shall first setup a secure tunnel over the new access interface Up, with the GANC-SGW. The identity of the GANC and its SGW, in terms of the IP address or equivalent shall be made known to the MS through any one of various mechanisms, such as provisioning in the terminal, etc. The MS shall be authenticated and authorized using SIM credentials, via the AAA server.

2. The MS shall then setup a signalling connection over the Up with the GANC and register with the GAN. During GAN registration, the MS provides information regarding its identity, location and capabilities. If the GAN accepts the registration, it provides system information to the MS, which is required for obtaining all the supported services and potentially handover functionality. The stored MS identity is used by the GAN, to support unicast paging using the Up signalling connection to the MS and other functions.

3. At this point, the MS can switch from 3GPP mode to GAN mode. Layer 3 messages (MM, CC, CM, SS) are transparently transferred to the core network through the signalling connection over the Up interface. When needed, the GANC and MS set up CS-domain and PS-domain user plane bearers over the GAN. GANC also provides additional functions to support handovers, etc.

NOTE: 3GPP mode refers to the mode wherein the physical layer specification for that mode is part of 3GPP specifications, e.g. GERAN L1 and UTRAN L1.

Identification by the MS of availability of generic access is out of scope of the current study.

5.1.2 Signalling flows

This clause explains how typical functionality such as MO, MT calls, paging, etc may be accomplished for the identified architecture options.

5.1.2.1 Registration for generic access

The GAN Registration procedure is performed between the MS and the GANC. It serves the following functions:

- It informs the GANC that the MS is now connected through a generic IP access network and is available at a particular IP address. The GANC maintains the registration context for the purposes of (for example) mobile-terminated calling.

NOTE: The feasibility study is limited to cases wherein the IP address of the MS remains the same throughout the lifetime of the current registration to the GAN.

- It provides the MS with the operating parameters associated with the GAN service. The "GSM System Information" message content that is applicable to the GAN cell is delivered to the MS during the GAN registration process. This enables the MS to switch to GAN mode, and following the Registration procedure trigger NAS procedures with the core network (such as Location/Routing Area Update, mobile originated calls, mobile terminated calls, etc.).

This procedure is applicable only if the MS is operating in GAN-only, GAN-preferred or GERAN/UTRAN-preferred modes.

In all other cases, the MS will not execute this procedure, and since it will not have successfully registered with a GANC, all subsequent GAN procedures will also not be executed by the MS.

The Registration procedures consist of the following steps:

- Attaching to a generic IP access network

- Registration with a GANC

During the registration process, the MS can be redirected to another GANC, for reasons such as:

- MS provided GERAN cell information. For example, the "appropriate" GANC is the one that is a neighbour of the GERAN cell the MS is currently located in, where " neighbour cells" are defined in clause 5.2.1.

- Load balancing, operator policy, roaming agreements, etc.

The GAN may also reject the MS's request for registration.

If no GSM coverage is available when an MS connects to the GANC, then the GANC may not reliably be able to determine the location of the MS for the purposes of assigning the MS to the appropriate GANC. The GANC functionality should permit the operator to determine the service policy in this case; e.g., the operator could provide GAN service to the user with certain limitations or deny GAN service.

The MS sets up a secure connection to the GANC, and executes the GAN-RR Registration procedures:

- The MS sends a GAN-RR Register Request message that carries the MS identity (IMSI), GERAN cell information (either current camping GSM CGI, or LAI of last cell where the MS successfully registered) and generic IP access network point of attachment.

- The MS additionally provides information about whether there is on-going CS connection in GERAN at the time of registration. This permits the GANC to redirect the MS to an appropriate GANC for enabling seamless handovers.

- If this GANC is the appropriate GANC, it returns a GAN-RR Register Accept message, which contains "System Information" for the cell represented by the GANC, including cell description, LAI and CI. The GANC may also omit information providing the identity of the GAN cell, in order to prohit handovers being triggered from GERAN.

- If this GANC is not the appropriate GANC, it returns a GAN-RR Register Redirect message, using the GERAN cell information provided by the MS to identify the appropriate GANC (FQDN or IP address) and its associated SGW. In this case, the MS will repeat this Registration procedure with the redirected GANC.

- Alternately, the GANC may return a GAN-RR Register Reject message thereby denying GAN service to the MS.

The Registration procedure can support the Access Class functionality by providing the necessary system information in the Registration message to the MS.

The GAN Registration Update procedure allows the MS to update information in the GANC regarding changes in the identity of the overlapping GERAN cell or changes in the generic IP access network point of attachment, by sending a GAN-RR Register Update message to the GANC carrying the updated information. This may result in the MS being redirected to another serving GANC, or being denied service e.g. due to operator policy.

The GAN Registration Update procedure also allows the GANC to update the GAN system information in the MS, if needed, by sending a GAN-RR Register Update message to the MS carrying the updated information.

5.1.2.2 Deregistration

The GAN-RR Deregistration procedure allows the MS to explicitly inform the GANC that it is leaving GAN mode (e.g. when it detaches from the generic IP access network), by sending a GAN-RR Deregister message to the GANC, allowing the GANC to free resources that it assigned to the MS. The GANC also supports "implicit GAN deregistration", when the secure connection to the MS is abruptly lost.

The GANC can also autonomously release the MS registration context, and send a GAN-RR Deregister message to the MS. Alternately, the GANC can implicitly deregister the MS by closing the secure connection with the MS.

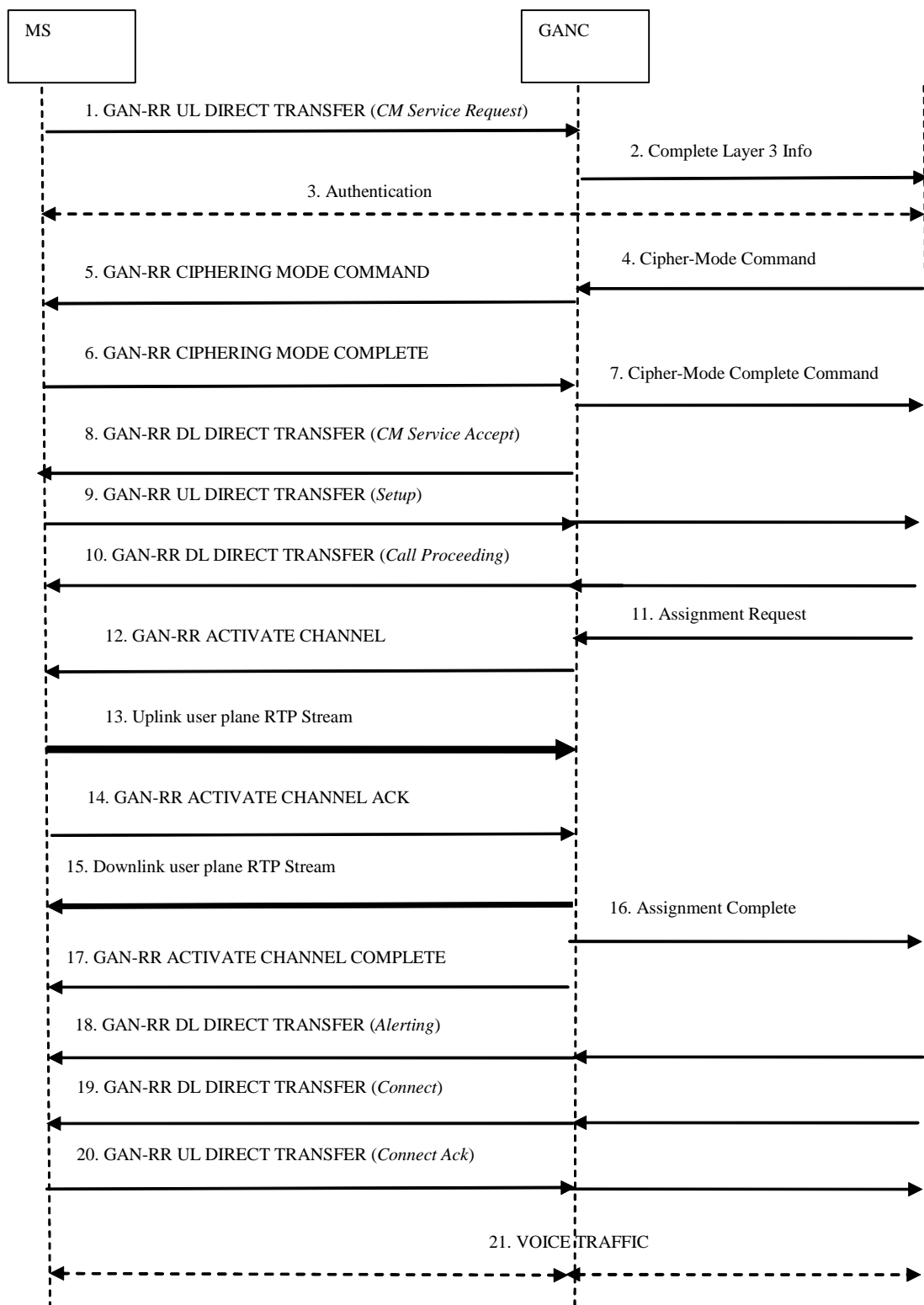## 5.1.3 Mobile originated call flow

Figure 5.1.3.1: Mobile originated speech call

The description of the procedure in this sub-clause assumes the MS is in GAN mode i.e. it has successfully registered with the GANC and GAN-RR is the serving RR entity in the MS.

1) Upon request from the user to originate a call, the MS sends the *CM Service Request* to the GANC in the GAN-RR UL DIRECT TRANSFER.

2) The GANC establishes an SCCP connection to the CN. The GANC then forwards the *CM Service Request* to the CN using the *Complete Layer 3 Information*. Subsequent layer-3 messages between mobile station and core network will be sent between GANC and CN via DTAP.

3) The CN may optionally authenticate the MS using standard GERAN authentication procedures.

4) The CN may optionally update the ciphering parameters in the GANC using the *Cipher-Mode Command*.

5) The GANC signals the permitted ciphering algorithms to the MS using the GAN-RR CIPHERING-MODE COMMAND. These algorithms do not apply for GAN. The MS stores this information for possible future use after a handover to GERAN.

6) The MS signals the selected ciphering algorithm in the GAN-RR CIPHERING-MODE COMPLETE message.

7) The GANC signals the selected ciphering algorithm to the CN using *Cipher-Mode Complete*.

8) The CN sends the *CM service accept* message in the GAN-RR DL DIRECT TRANSFER to the MS.

9) The MS sends the *Setup* message providing details on the call to the CN and its bearer capability and supported codecs. This message is contained within the GAN-RR UL DIRECT TRANSFER.

10) The CN indicates it has received the call setup and it will accept no additional call-establishment information using the GAN-RR DL DIRECT TRANSFER to convey the *Call Proceeding* indication to the MS.

11) The CN requests the GANC to assign call resources using *Assignment Request*.

12) The GANC sends the GAN-RR ACTIVATE CHANNEL to the MS including bearer path setup information such as:

-   channel mode

-   Multi-rate codec configuration

-   the UDP port & the IP address for the uplink stream

-   the voice sample size

-   the cipher mode (for use in case of subsequent handover to GERAN)

13) The MS establishes the RTP path to the GANC. MS optionally sends idle RTP/UDP packets to the GANC but has not connected the user to the audio path.

14) The MS sends the GAN-RR ACTIVATE CHANNEL ACK to the GANC indicating the UDP port and IP address for the downlink stream.

15) The GANC establishes the downlink RTP path between itself and the MS. The GANC may start sending idle RTP/UDP packets to the MS.

16) The GANC signals to the CN that the call resources have been allocated by sending an *Assignment Complete* message.

17) The GANC signals the completion of the bearer path to the MS with the GAN-RR ACTIVATE CHANNEL COMPLETE message. An end-to-end audio path now exists between the MS and the CN. The MS can now connect the user to the audio path.

18) The CN signals that the called subscriber's phone is ringing, via the *Alerting* message. If the MS has not connected the audio path to the user, it shall generate ring back to the calling party. Otherwise, the network-generated ring back will be returned to the calling party.

19) The CN signals that the called party has answered, via the *Connect* message. It connects the user to the audio path. If the mobile station is generating ring back, it stops and connects the user to the audio path.

20) The MS sends the *Connect ACK* in response, and the two parties are connected for the voice call.

21) Bi-directional voice traffic flows between the MS and CN through the GANC.
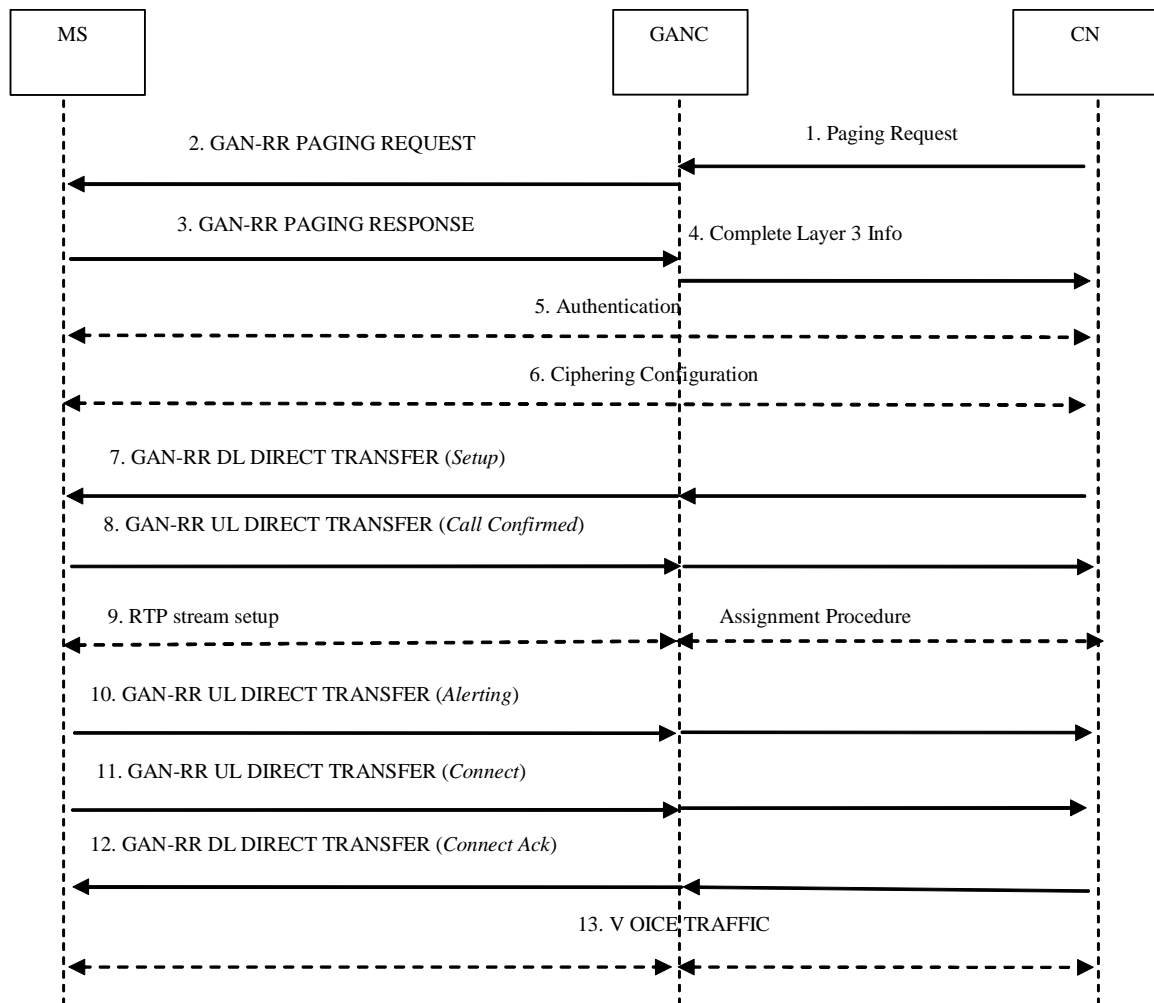
5.1.4 Mobile terminated call flow

Figure 5.1.4.1: Mobile terminated speech call

The description of the procedure in this sub-clause assumes the MS is in GAN mode i.e. it has successfully registered with the GANC and GAN-RR is the serving RR entity in the MS.

1) A mobile-terminated call arrives at the CN. The CN sends a *Paging Request* to the GANC identified through the last *Location Update* received by it and includes the TMSI if available. The IMSI of the mobile being paged is always included in the request.

2) GANC identifies the MS registration context using the IMSI provided by the CN. It then pages the MS using the GAN-RR PAGING REQUEST message. The message includes the TMSI if available in the request from the CN, else it includes only the IMSI of the mobile.

3) The MS responds with a GAN-RR PAGING RESPONSE including the MS Classmark and ciphering key sequence number.

4) The GANC establishes an SCCP connection to the CN. The GANC then forwards the paging response to the CN using the *Complete Layer 3 Information* message.

5) The CN may optionally authenticate the MS using standard GERAN authentication procedures.

6) The CN may optionally update the ciphering configuration in the MS, via the GANC, as described in steps 4-7 of the Mobile Originated calling scenario.

7) The CN initiates call setup using the *Setup* message sent to the MS using the GAN-RR DL DIRECT TRANSFER.

8) The MS responds with *Call Confirmed* using the GAN-RR UL DIRECT TRANSFER after checking it's compatibility with the bearer service requested in the *Setup* and modifying the bearer service as needed. If the *Setup* included the signal information element, the MS alerts the user using the indicated signal, else the MS alerts the user after the successful configuration of the user plane.

9) The CN initiates the assignment procedure with the GANC, which triggers the setup of the RTP stream (voice bearer channel) between the GANC and MS, same as steps 11-17 in MO call scenario.

10) The MS signals that it is alerting the user, via the *Alerting* message. The CN sends a corresponding alerting message to the calling party.

11) The MS signals that the called party has answered, via the *Connect* message. The CN sends a corresponding *Connect* message to the calling party and through connects the audio. The MS connects the user to the audio path.

12) The CN acknowledges via the *Connect Ack* message. The two parties on the call are connected on the audio path.

13) Bi-directional voice traffic flows between the MS and CN through the GANC.

5.1.5 GPRS procedures

5.1.5.1 GAN-GRR user data transport channel

GPRS user data transfer between MS and GANC uses a UDP-based GAN-GRR Transport Channel (identified by the IP address and UPD port at each end). The MS or GANC activates the GAN-GRR Transport Channel only when needed i.e. when the GPRS user data transfer is initiated. A timer is used to deactivate the GAN-GRR Transport Channel when no data is transmitted to or received for some period of time.

5.1.5.2 GPRS user data transport procedures

For uplink data transfer, the MS activates the GAN-GRR Transport Channel if needed. It then encapsulates the uplink LLC PDU within the GAN-GRR UNITDATA message and forwards it to the GANC. The message includes parameters required for Gb interface procedures and TLLI as MS identifier. The GANC forwards the LLC PDU to the Core Network as per standard GPRS.

For downlink data transfer, the Core Network sends the downlink LLC PDU that contains GPRS user data via the Gb interface. The MS is identified with the TLLI. The GANC activates the GAN-GRR Transport Channel if needed, and forwards the LLC PDU to the MS encapsulated in the GAN-GRR UNITDATA message.

5.1.5.3 GPRS signalling and SMS transport procedures

The TCP session used for GAN-RR signalling is also used for GAN-GRR GPRS signalling and SMS transport. This TCP session is available after GAN registration, so there is no need to establish a separate connection for GPRS signalling and SMS transport.

For uplink signalling/SMS, the MS GAN-GRR receives a request from the LLC layer to transfer an uplink GMM/SM signalling message or SMS message; e.g. this could be a GMM attach request or SM PDP context activation message. The GMM/SM signalling messages are identified with LLC SAPI 1 and SMS messages with LLC SAPI 7. The MS GAN-GRR encapsulates the LLC PDU within a GAN-GRR DATA message including the parameters that will be required for Gb interface procedures. Subsequently, the message is forwarded to the GANC, and the GANC forwards the message to the Core Network as per standard GPRS Gb procedure.

For downlink signalling/SMS, the Core Network sends a GMM/SM signalling or SMS message to the GANC via the Gb interface as per standard GPRS; i.e. the LLC PDU may include GMM attach accept or SM PDP context activation accept message. The GANC encapsulates the received LLC PDU within a GAN-GRR DATA message that is forwarded to the MS via the existing signalling TCP connection.

5.1.5.4 Packet paging for GPRS data service

The Core Network sends a PS page for a mobile station that is currently GPRS attached via the GAN. The paging message will include either PTMSI or IMSI as a mobile identifier. The GANC retrieves the MS registration context (based on IMSI) and forwards the corresponding GAN-GRR PS PAGE message to the MS using the TCP signalling

connection. The message includes Mobile Identity IE as per standard GPRS. It will be either PTMSI if available or IMSI.

The mobile station sends any LLC PDU to respond to the page. The uplink LLC PDU is forwarded to the GANC as described in above clauses. The GANC forwards the LLC PDU to the Core Network via the Gb interface as per standard GPRS.

5.1.5.5 Packet paging for CS domain service

The Core Network sends a CS page for a mobile station that is currently GPRS attached via the GAN. The paging message will include either TMSI or IMSI as a mobile identifier. The GANC retrieves the MS registration context (based on IMSI) and forwards the corresponding GAN-RR Paging Request message to the MS using the TCP signalling connection. The message includes Channel Needed and Mobile Identity IEs as per standard GPRS. The Mobile Identity will be either TMSI or IMSI depending on the original BSSGP CS page. The mobile station initiates the standard CS page response procedure via the GAN.

5.1.5.6 GPRS Suspend procedure

While transitioning to dedicated mode and if unable to support simultaneous voice and data services, the mobile station sends a GAN-GRR SUSPEND REQUEST message to the GANC to suspend downlink GPRS traffic. The request is transferred via the TCP signalling connection and includes TLLI and suspension cause parameters as per standard GPRS. The GANC initiates and completes the BSSGP GPRS suspend procedure as per standard GPRS.

5.1.5.7 GPRS Resume procedure

If the GPRS service has been suspended while the mobile station was in the dedicated mode, it needs to be resumed when the mobile station leaves the dedicated mode.

The Core Network sends a Clear Command message to release the resources associated with the dedicated mode procedure. The GANC responds with a Clear Complete message. Optionally, the GANC may initiate the standard BSSGP GPRS resume procedure.

The GANC sends a GAN-RR RR RELEASE message to instruct the MS to release the RR connection. The message includes GPRS resume indication IE as per standard GSM/GPRS to indicate whether the network successfully resumed GPRS service or not. The MS replies with a GAN-RR RR RELEASE COMPLETE message and resumes GPRS service internally. Optionally, if the Core Network indicated unsuccessful resumption, the MS initiates GPRS service resumption as per standard GPRS.

5.2 Protocol aspects

This clause will capture options for any new generic access layer that will be needed to enable generic access to the A/Gb interfaces.

5.2.1 New Generic Layer

5.2.1.1 CS domain signalling plane

The Up protocol architecture in support of CS domain signalling, as well as GAN-specific signalling, is illustrated below.
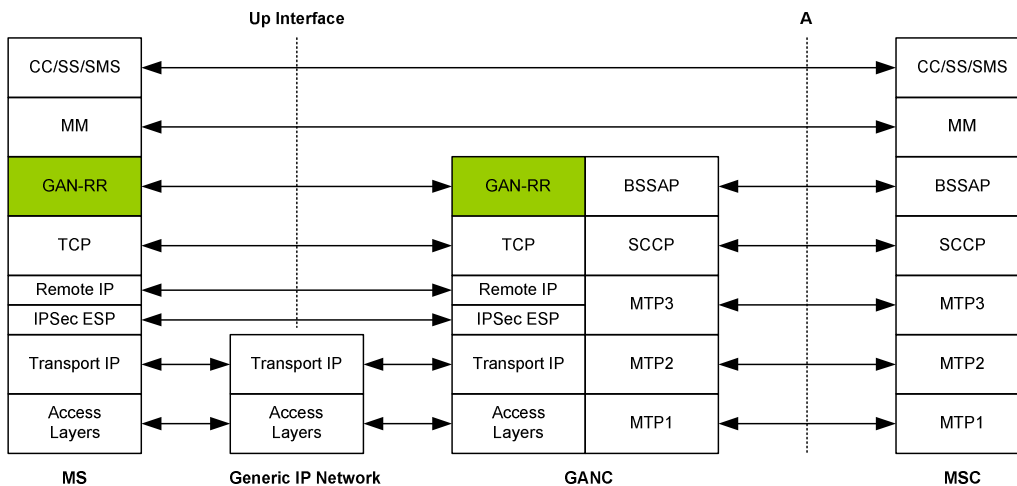
Figure 5.2.1.1.1: Up CS domain signalling protocol architecture

The salient features of this part of the Up interface, with respect to the CS domain, are as follows:

- GSM protocols, MM and above, are carried transparently between the MS and MSC. This allows the MS to obtain all GSM services that it receives through a GSM BSS, through the GAN.

- GSM-RR protocol is replaced with a GAN-RR protocol. The generic IP access network presents different characteristics from that of the GSM radio link, so the GAN-RR protocol is designed to adapt to these characteristics.

- GAN-RR is transported over TCP between MS and GANC, which provides reliable transport of signalling messages. The underlying IPSec layer provides mutual authentication, encryption and data integrity.

- The GANC, acting like a BSC, terminates the GAN-RR protocol and inter-works it to the A-interface using BSSAP messaging.

One potential realization of this architecture in the MS is illustrated in more detail below:
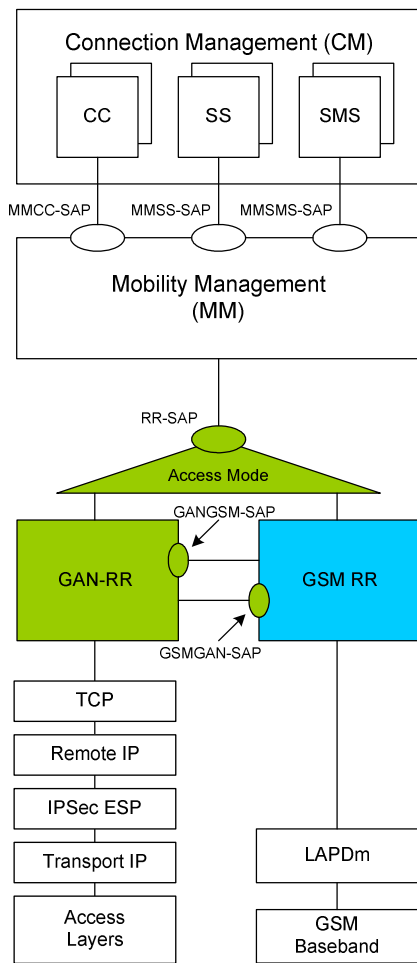
Figure 5.2.1.1.2: MS CS domain signalling architecture

The figure above illustrates the salient features of the MS architecture which are as follows:

- The RR-SAP interface to the GSM-MM layer is preserved identically for both GSM and GAN access

- An access mode switch is provided to switch between GSM and GAN modes

- GAN-RR peers with GSM-RR to provide coordination for roving and handover

5.2.1.2   CS domain user plane

The Up protocol architecture in support of CS domain user plan is below.
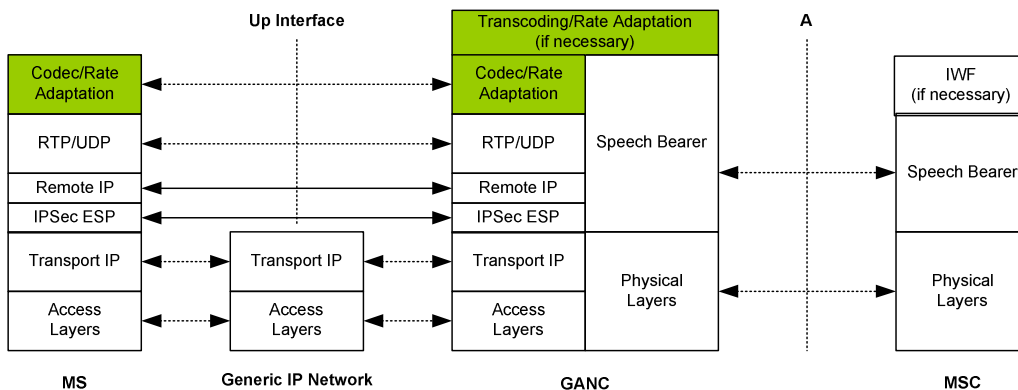
Figure 5.2.1.2.1: Up CS domain user plane protocol architecture

The salient features of the CS domain user plane of the Up interface are as follows:

- CS domain user plane is transported over RTP/UDP between MS and GANC. The underlying IPSec layer provides mutual authentication, encryption and data integrity.

- Voice codecs are supported as per [TS 26.103] for those codecs that have IETF-defined RTP framing formats.

- CS-data is transported over RTP/UDP, by defining a new frame format to carry the TAF-TRAU (V.110-like) frames over RTP..

- TTY is transported using CTM over GSM codec over RTP/UDP.

- The GANC, acting like a BSC, terminates the CS domain user plane over RTP/UDP and inter-works it to speech bearers over the A-interface.

5.2.1.3 PS domain signalling plane

The Up protocol architecture in support of PS domain signalling is illustrated below.
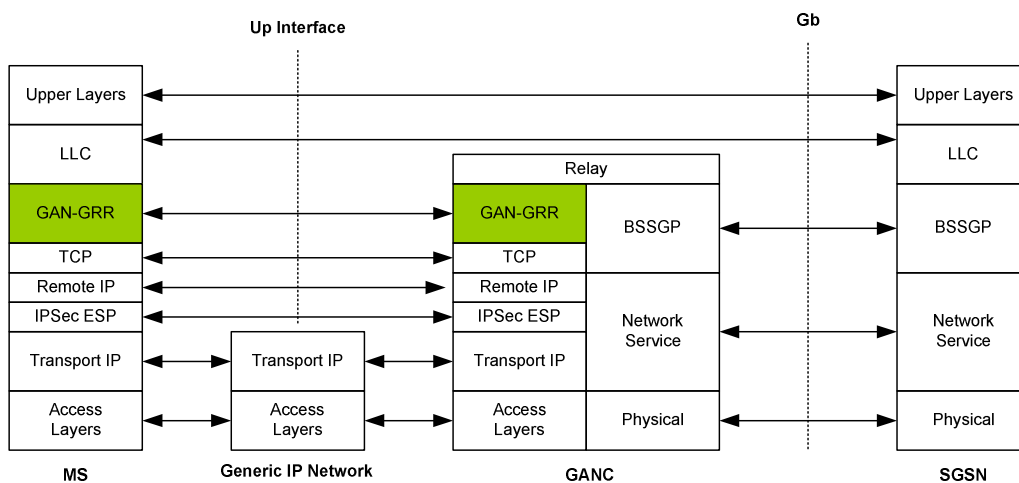
Figure 5.2.1.3.1: Up PS Domain Signalling Protocol Architecture

The salient features of this part of the Up interface are as follows:

- GPRS LLC PDUs for signalling and SMS are carried transparently between the MS and SGSN. This allows the MS to obtain all GPRS services in the same way as if it were connected to a GERAN BSS.

- GPRS-RLC protocol is replaced with a GAN-GRR protocol. Given the IP packet transport characteristics over Up interface, the GPRS Temporary Block Flow (TBF) abstraction is not applicable. Instead GAN-GRR provides mechanisms to establish and teardown IP packet transport channel between MS and UNC. Therefore GAN-GRR is significantly lighter than GPRS-RLC.

- GAN-GRR is transported over TCP between MS and GANC, which provides reliable transport of signalling & SMS messages. The underlying IPSec layer provides mutual authentication, encryption and data integrity.

- The GANC, acting like a BSC, terminates the GAN-GRR protocol and inter-works it to the Gb-interface using BSSGP.

One potential realization of this architecture in the MS is illustrated in more detail below:
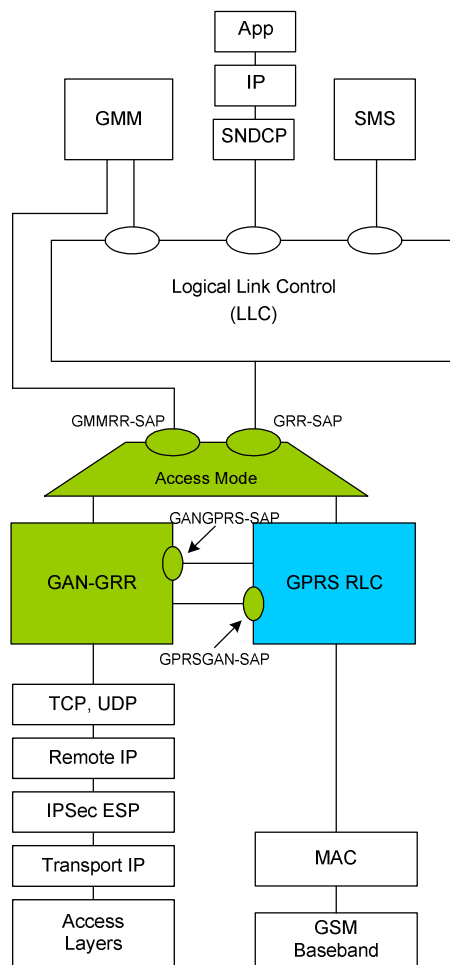
Figure 5.2.1.3.2: MS PS domain protocol architecture

The figure illustrates the salient features of the MS architecture which are as follows:

- The GRR-SAP interface to the GPRS-LLC layer and GMMRR-SAP interface to the GPRS-GMM layer are preserved identically for both GPRS and GAN access

- An access mode switch is provided to switch between GPRS and GAN modes

- GAN-GRR peers with GPRS-RLC to provide coordination for roving and handover

5.2.1.4   PS domain user plane

The Up PS domain dser plane protocol architecture is illustrated below.
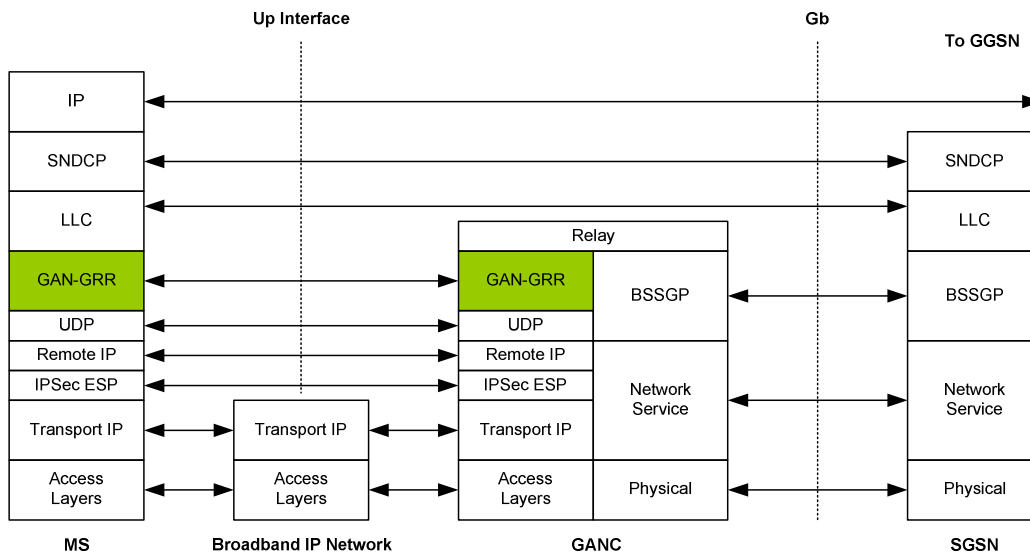
Figure 5.2.1.4.1: Up GPRS user plane protocol architecture

The salient features of the PS domain user plane of the Up interface are as follows:

- GPRS LLC PDUs carrying data, and higher layer protocols, are carried transparently between the MS and SGSN. This allows the MS to derive all GPRS services the same as if it were in a GERAN BSS. All existing GPRS applications and MMI in the MS are unchanged.

- LLC PDUs are carried over GAN-GRR from the MS to the GANC. GAN-GRR runs over UDP. The underlying IPSec layer provides mutual authentication, encryption and data integrity. GAN-GRR does not emulate the reliable transmission characteristics of GPRS RLC since it can be assumed that errors in wireless access layers (below IP) are addressed by lower layer retransmissions on a hop-by-hop basis, UDP provides a suitable transport that matches a wide range of application layer transport requirements.

- The GANC, acting like a BSC, terminates the GAN-GRR protocol and inter-works it to the Gb-interface using BSSGP.

5.2.2 Existing protocols

5.2.2.1 Standard 3GPP protocols

In case of option 1, the GAN can be designed such that the following standard 3GPP protocols are used without any modifications:

- GSM MM, CM and higher layer protocols are used without any changes in the MS or the MSC;

- GSM voice encoding carried over IP between the MS and GANC;

- GPRS LLC and higher layer protocols are used without any changes on the MS and SGSN;

- A-interface protocols are used, without any changes, between the MSC and GANC;

- Gb-interface protocols are used, without any changes, between the SGSN and GANC;

- Wm interface protocols are used without any change between the GANC and the AAA server.

Further, all GSM and GPRS protocols on the MS should be unaffected when they are operating over the GERAN BSS.

5.2.2.1.1 Short Message Service

GAN provides support for both circuit switched (GSM based) and packet switched (GPRS based) SMS services. GAN-attached and GPRS enabled mobile stations will be able to send and receive GSM and GPRS SMS messages via the

GAN, regardless of the GPRS class (B or C) with the restriction that the type C mobiles support only GPRS SMS messages.

5.2.2.1.2 GSM SMS services

The GAN GSM SMS support is based on the same mechanism that is utilized for GSM mobility management and call control. On the MS side, the SMS layers (including the supporting CM sub layer functions) utilize the services of the MM layer to transfer SMS messages per standard circuit switched GSM implementation. The SM-CP protocol is effectively tunneled between the MS and the MSC, using GAN-RR messages to the GANC which interworks it to BSSAP messages.

As with GSM mobility management and call control procedures, the secure IPSec tunnel and TCP session are used to provide secure and reliable SMS delivery over the IP network.

5.2.2.1.3 GPRS SMS services

GPRS SMS message transfer is based on the same mechanism as the transfer of the GPRS MM/SM signalling messages. On the MS side, the SMS layers (including the supporting CM sub layer functions) utilize the services of the LLC layer to transfer SMS messages per standard packet switched GPRS implementation.

GPRS SMS service employs the unacknowledged mode of LLC frame transfer, using SAPI=7 for the transfer of SMS messages. This SAPI identifies the SMS Logical Link Entity within the LLC layer. The CM-sub-layer entity retransmits the CP-DATA message if CP-DATA-ACK is not received. The SM-CP protocol is effectively tunneled between the MS and the SGSN, using GAN-GRR messages to the GANC which inter-works it to LLC-PDU relay functions.

As with GPRS signalling, the secure IPSec tunnel and TCP session is used to provide secure and reliable GPRS SMS delivery over the IP network.

5.2.2.1.4 Supplementary services

GSM has standardized a large number of supplementary services. These supplementary services involve procedures that operate end-to-end between the MS and the MSC. The DTAP messages used for the supplementary service are relayed between the MS and MSC in the same manner as in the other call control and mobility management scenarios described in this document.

5.2.2.2 Standard IP-based protocols

The GAN can be designed such that the following standard IP-based protocols are used without any modifications:

-   IP over standard lower layers [RFC 791],

-   TCP to provide a tunnel for GSM/GPRS signalling and SMS [RFC 793],

-   IPsec ESP to provide a secure tunnel for GERAN user and control plane traffic [RFC 2406],

-   IKEv2 [IKEv2] and EAP-SIM [EAP SIM] for authentication and establishing and maintaining a security association between MS and GANC,

-   UDP [RFC 768]for IPsec NAT traversal [IPSec NAT],

-   UDP for GPRS data transfer,

-   RTP/UDP [RFC 3550] for transfer of circuit switched speech and user data over IP transport.- RTCP [RFC 3550] for control of RTP frames

5.3 Security mechanisms

5.3.1 Security levels

GAN supports security mechanisms at different levels and interfaces as depicted below:
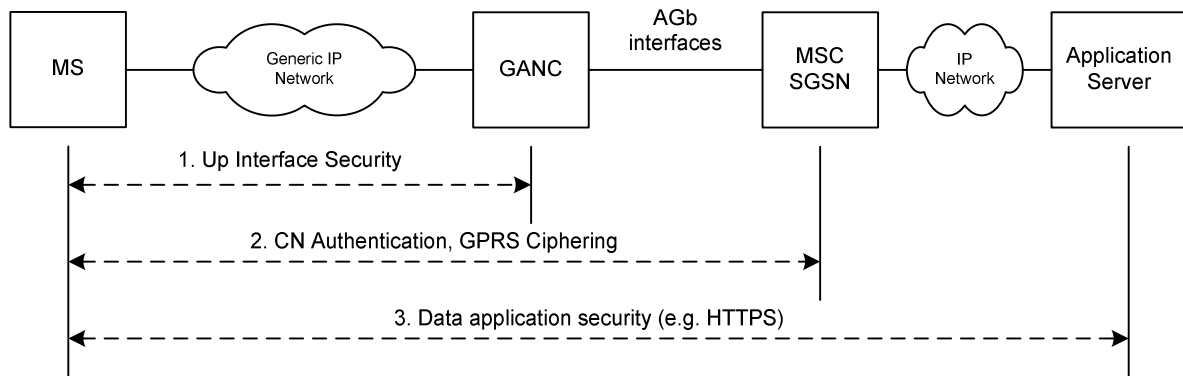
Figure 5.3.1.1: GAN security mechanisms

1. The **security mechanisms over the Up interface** protect signalling, voice and data traffic flows between the MS and the GANC from unauthorized use, data manipulation and eavesdropping; i.e., authentication, encryption and data integrity mechanisms are supported.

2. A**uthentication** of the subscriber by the core network occurs between the MSC/VLR or SGSN and the MS and is transparent to the GANC – however, there will be a cryptographic binding between the MS-CN authentication and the MS-GANC authentication to prevent man in the middle attacks. **GPRS ciphering** is the standard LLC layer ciphering that operates between the MS and the SGSN. These mechanisms are out of scope of the present document.

3. Additional **application level security mechanisms** may be employed to secure the end-to-end communication between the MS and the application server. For example, the MS may run the HTTP protocol over an SSL session for secure web access. These mechanisms are out of scope of the present document.

5.3.2   Up interface security

All signalling traffic and user-plane traffic sent between MS and GANC over the Up interface is protected by an IPsec tunnel between the MS and SGW, that provides mutual authentication (using SIM credentials), encryption and data integrity using the same mechanisms as specified in [TS 33.234]. Specifically:

- Authentication:

  - The MS and the SGW use IKEv2, as specified in [IKEv2], in order to establish IPSec security associations.

  - Public key signature based authentication with certificates, as specified in [IKEv2], is used to authenticate the SGW.

  - EAP-SIM within IKEv2, as specified in [IKEv2, sub-clause 2.16], is used to authenticate the MS.

  - A profile for IKEv2 is defined in [TS 33.234, sub-clause 6.5].

- Confidentiality & data integrity:

  - The confidentiality and data integrity of IP packets sent through the tunnel between the MS and the SGW, if required, is protected by IPSec ESP (RFC 2406). A profile for IPSec ESP is defined in [TS 33.234, sub-clause 6.6].

NOTE: The above option detailed in sub-clause 5.3.2 is essentially an adoption of the solution investigated and adopted by 3GPP TSG SA WG3 for the WLAN Inter-working feature in Rel-6. The aim of the current study is to forward the results of the feasibility study to SA WG3, for detailed analysis and comments on the viability of adoption of the WLAN Inter-working solution for Generic Access, following completion of the feasibility study in TSG GERAN.

5.4   Multi-mode terminal operation

This clause will deal with the procedures for enabling selection and re-selection of generic access to A/Gb interface as opposed to traditional GERAN access.

## 5.4.1	Mechanism of mode selection in multi-mode terminals

The physical layer of a Generic Access capable terminal may support any of a multiple of IP access technologies in addition to the GERAN radio interface, in support of multi-mode operation. The generic access terminal contains an "RR" entity with functionality specific to generic access, namely the GAN RR. The GAN RR entity serves the upper layers in identical fashion to the GSM RR entity, thereby ensuring that there is no change in functionality in the upper layers of the protocol stack. Mode selection relates to which of the RR entities is serving the upper layers i.e. MM at any given time. At any given time, the MS is therefore in one of two operating RR modes:

- 3GPP mode:
  In this mode of operation, the GSM RR or UTRAN RRC entity in the MS serves the upper layers over the Um interface.

- GAN mode:
  In this mode of operation, the GAN RR entity serves the upper layers over the Up interface.

The user can configure the terminal to operate in one of the above two modes at any given time. There can be however a default mode of operation that can be configured by the operator through various mechanisms, including terminal configuration. The operator may additionally be able to set the mode configuration of a terminal through the registration to GAN procedure.

On power up, the MS always starts in 3GPP mode and executes the normal power-up sequence as specified in 3GPP TS 23.122. Following this, the MS may switch into GAN mode based on mode selection preference determined by user preferences or operator configuration.

The various preferences for the MS that are possible through operator configuration are as follows:

- GERAN/UTRAN-only:

  The MS RR entity remains in 3GPP mode and does not switch to GAN mode.

- GERAN/UTRAN-preferred:

  The MS RR entity is configured in 3GPP mode as long as there is a GSM PLMN available through GERAN. If no GSM PLMN is available through GERAN, and MS has successfully registered with a GAN over the generic IP access network, then the MS switches to GAN mode. When a GSM PLMN becomes available over GERAN, or the MS has de-registered or loses connectivity with the GAN over the generic IP access network, the MS returns to 3GPP mode.

- GAN-preferred:

  When the MS has successfully registered with the GAN over the generic IP access network, the MS switches to GAN mode and stays in this mode as long as the GAN is available. When the MS deregisters, or otherwise loses connectivity, with the GAN over the generic IP access network, the MS switches to 3GPP mode.

- GAN-only:

  The MS switches to GAN mode (after initial power up sequence in 3GPP mode) and does not switch to 3GPP mode.

Mechanisms to avoid ping-pong between GERAN and GAN modes of operation are necessary to provide a good user experience.

## 5.4.2	PLMN selection

There is no change in the PLMN selection procedure in the NAS layers (MM and above) in the MS. PLMN selection follows the rules specified in 3GPP TS 23.122.

Currently the BSS can be connected to only one CN node each in the CS and PS domains, both of which are associated with the same PLMN. Hence, it is assumed that one GAN is associated with one PLMN.

The identity of the PLMN associated with the GAN is made known to the MS on successful registration with the GAN. Hence, only the PLMN associated with the successfully registered GAN can be selected. The PLMN associated with the GAN the MS is registered on, is treated as an equivalent PLMN to the HPLMN. As a result, the concept of background

scanning for higher priority PLMNs does not apply in GAN mode. It should be noted that it is the GAN operator of the HPLMN or the GAN operator associated with the HPLMN (in case of MVNO) that assigns the serving GAN to the MS.

Upper layers do not have any visibility to the PLMNs available via GERAN when in GAN mode, since only one RR entity in the MS is connected to the MM at any given time. The RR entity (for e.g. GSM RR in GAN mode) that is not connected to the MM does not provide information to the MM through the connected RR entity (e.g. GAN RR in GAN mode).

The above mechanisms of PLMN selection apply both in automatic and manual PLMN selection modes.

In order to support roaming restrictions, it shall be possible for the GANC to be provisioned with a number of LA identities. Rules for the assignment of a location area identity to a MS based on the information provided by the MS, such as CGI, etc., would then allow the use of normal MM procedures to apply the roaming restrictions.

Roaming network cannot be used for generic access unless the home network supports generic access.

5.4.3 Re-selection between GERAN/UTRAN and GAN modes

5.4.3.1 Rove-in (from GERAN/UTRAN to GAN)

This procedure is applicable only if the MS mode selection is GAN-only, GAN-preferred or GERAN/UTRAN-preferred but no GSM PLMN available. As long as MS is not in NC2 mode, the MS may rove in.

Following successful GAN registration, the MS switches to GAN mode wherein the serving RR entity is GAN-RR. GAN-RR reports the NAS-related system information, as obtained from the GANC, to the NAS. NAS considers the GAN cell as the current serving cell.

While in GAN mode, GSM-RR (and UTRAN RRC) is detached from the RR-SAP in the MS i.e.

- it does not inform NAS about any GERAN/UTRAN cell re-selection and/or the change of system information of the current camping cell;

- it does not inform NAS about any newly found PLMN over GERAN (or UTRAN);

- it does not act on any paging request message received over GERAN (or UTRAN).

5.4.3.2 Rove-out (from GAN to GERAN/UTRAN)

This procedure is applicable when MS detaches from the generic IP access network, and its mode selection is GAN-preferred or GERAN/UTRAN-preferred.

When the MS detaches from the generic IP access network, depending on prevailing circumstances the MS may be able to deregister first with the GANC.

For the GAN-preferred and GERAN/UTRAN-preferred mode selections, the MS detaches GAN-RR from NAS and re-attaches GSM-RR to NAS and restores normal GSM-RR functionality.

For the GAN-only mode selection, GAN-RR (or UTRAN RRC) remains attached to NAS and the MS stays in GAN mode (in "No Service" condition).

5.4.3.3 Ping-pong avoidance between GAN and GERAN/UTRAN

In order to support the requirements in 3GPP TS 22.011 one potential example of the mechanism to be supported by the MS is described below.

Two timers are defined and provided to the MS at the time of registration to the GAN. In addition a counter N keeps track of the number of re-selections between GAN and 3GPP modes the MS has performed.

On switch on, N is set to 1 and when the GAN RR entity is connected to MM, timer $T_{ping-pong-slowdown}$ is started with a value of $N*Y + X$. If the MS switches mode before the expiry of $T_{ping-pong-slowdown}$, timer $T_{ping-pong-avoid}$ is started with value $N*Y$. N is incremented by 1. $T_{ping-pong-slowdown}$ is restarted with value $N*Y + X$. The MS is now prohibited from switching modes until the $T_{ping-pong-avoid}$ timer expires. This mechanism ensures that the MS is forced to stay within a mode for a linearly increasing length of time if consecutive mode switches occur prior to the expiry of the $T_{ping-pong-}$

slowdown timer. If mode switch occurs post- $T_{ping-pong-slowdown}$ expiry, N is reset to 1 and at the next mode switch $T_{ping-pong-avoid}$ and $T_{ping-pong-slowdown}$ are reset. $T_{ping-pong-slowdown}$ timer thereby acts as a penalty timer for the setting and re-setting of $T_{ping-pong-slowdown}$.

5.4.4 Handovers between GAN and GERAN

5.4.4.1 Cell identifiers in generic access

In GAN, as in GERAN, a cell is identified by a Cell Global Identity (CGI) which is the concatenation of a Location Area Identity (LAI) and Cell Identity (CI).

5.4.4.1.1 GAN cell id for Location Services & billing

Cell identities (CGI) are often used to route the call to location dependent services such as emergency calling, operators, announcements and freephone numbers. Cell identities can also used by the core network to identify the location of the call for billing purposes. To meet these requirements, the GANC provides a CGI to the core network indicating the GAN cell that the call originated from.

5.4.4.1.1.1 Assigning GAN cell id based on GSM location

In the GAN architecture, the MS has a direct, IP-based connection to the GANC, so the notion of a "cell" is defined by some logical grouping of MSs being served by a GANC. Since the GAN coverage area overlaps the GERAN coverage area, the simplest grouping of MSs is based on the overlapping GSM cell that the MS is located in. This can be done at various location resolutions, such as:

- a GAN cell for each GSM cell, or

- a GAN cell for each GSM location area, or

- a GAN cell for some other mapping of GSM cells into GAN cells

The mapping of GSM cells into GAN cells is defined in the GANC. A single GANC could represent one or more cells (CGI) in one or more location areas (LAI) for location services.

This mechanism allows the operator to leverage any existing location infrastructure for GSM cell sites, and provides MS location to the resolution of existing GSM cell sites.

5.4.4.1.1.2 Assigning GAN cell id based on other information

The GANC can use other information provided by the MS, such as the identity or location of the generic access network point of attachment, or GPS co-ordinates, to identify the geographic location of the MS, and map it to a corresponding GAN cell id, based on operator configuration.

5.4.4.1.1.3 Determining GAN cell id during GAN registration

During GAN registration, if the MS is in GERAN coverage, it indicates to the GANC the cell id of the overlapping GERAN cell. The GANC then maps this information to a corresponding GAN cell id and stores it in the registration context of that MS. This GAN cell id is also provided to the MS in the system information during GAN registration, so the MS can do a location update with the core network, if required.

During GAN registration, if the MS is not in GSM coverage, then the cell id of the overlapping GERAN cell (and corresponding GAN cell id) may not be determined reliably. In this case, the GANC allows the operator to apply a service policy – either deny GAN service, or allow it with an explicit indication to the MS that its location is unknown. In the latter case, the GANC will assign a default GAN cell id for this MS registration context, and also indicate that to the MS in the system information.

When the MS places a call (including an emergency call) over GAN, the GANC passes to the core network the GAN cell id (CGI) value stored in the MS registration context. The core network must be configured with the new GAN cell id values; however, the GERAN cell id and corresponding GAN cell id can share the same location information e.g. cell site address, location co-ordinates, serving Emergency Centre, etc. If the GAN cell id corresponds to the "no GSM coverage" case, the core network will need a special configuration for that cell id (e.g. to route an emergency call to a default Emergency Centre, no automatic location identification, etc.).

5.4.4.1.1.4 GAN cell id for roaming scenario

If an MS reports a GERAN cell id to the GANC that indicates the MS is in a location that is not served by this GANC (e.g. because the MS is roaming in a foreign country or another PLMN), the GANC can map the MS to one of several distinct GAN cell ids (configured in the GANC according to operator policy).

This GAN cell id is sent to the MS in system information during GAN registration (and is subsequently used by MS for core network registration). Therefore, it can be used to implement roaming restrictions, using existing mechanisms (e.g. in the SIM or in the HLR).

5.4.4.1.2 GAN cell id for handover-to-GAN

The GAN cell id used for location and billing can be independent from the GAN cell id used for handover.

A single GANC represents a single GAN cell for the purpose of handover-to-GAN. This "handover-GAN-CGI" is not visible to the GANC or the MS, and is only used in the source RAN and the core network for identifying a target cell for handover to GAN.

To enable handover-to-GAN, the GANC is also assigned a single ARFCN; in fact, all GANCs in a given operator domain can share the same ARFCN value. This ARFCN is indicated to the MS by the GANC during GAN registration.

The "handover-GAN-CGI" assigned to the GANC is configured as the target handover cell in all neighbouring source RAN cells (in their ARFCN/BSIC-to-CGI mapping table). Neighbouring source RAN cells are those whose service area "overlaps" the GANC service area, for the purpose of handover. For example, neighbour cells are:

- All source RAN cells attached to the same MSC as the GANC

- All source RAN cells attached to a different MSC but that can handover to the MSC to which the GANC is attached.

When the MS reports measurements to the source RAN BSS on the GAN cell identified by its ARFCN, then the source RAN BSS maps the ARFCN to the "handover-GAN-CGI" through its mapping table, and is thus able to identify the target cell (GANC) for handover-to-GAN.
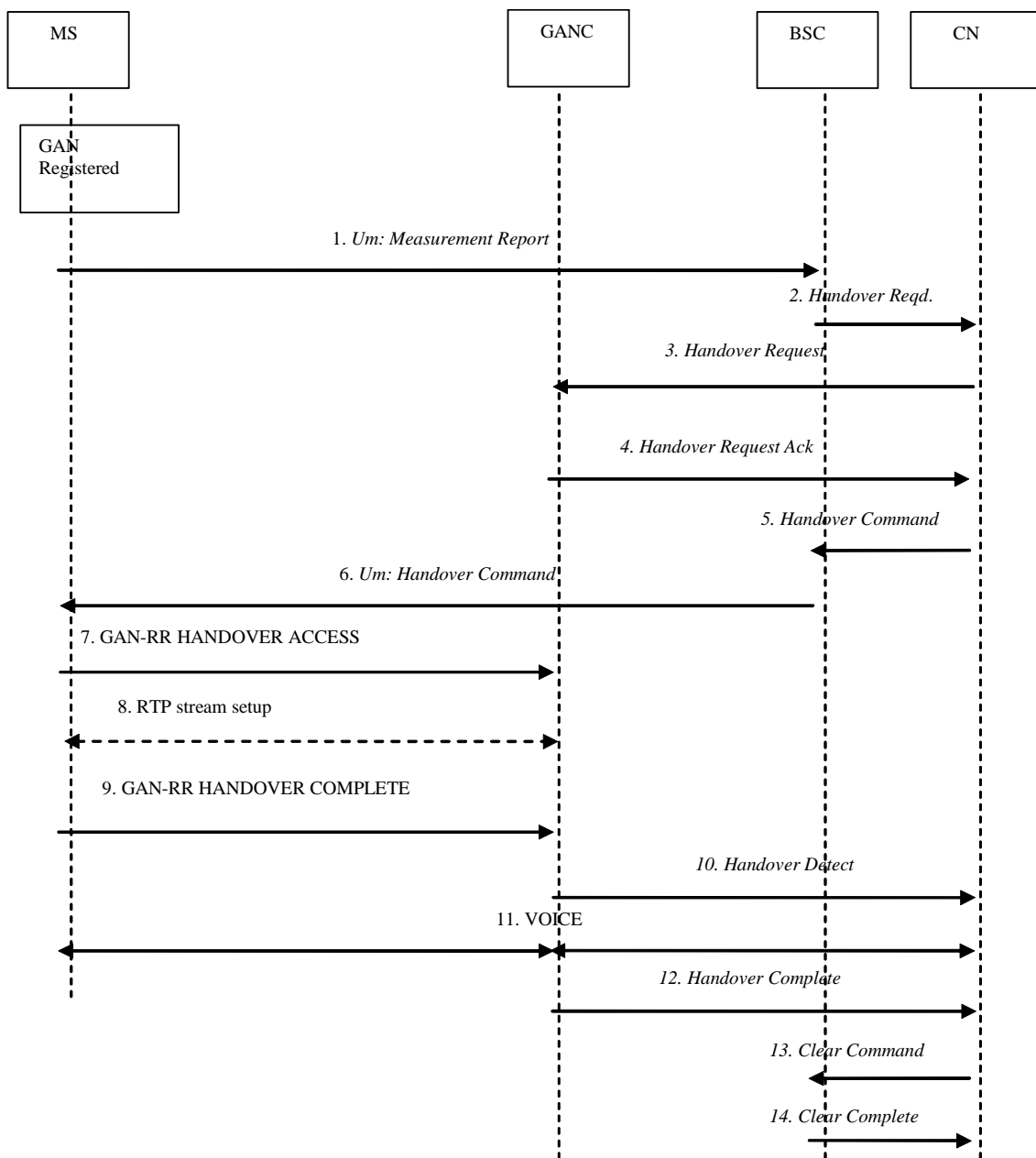
5.4.4.2 Handover to GAN

Figure 5.4.4.2.1: Handover to GAN

The description of the handover procedure assumes the following:

- the MS is on an active call on the GERAN, and

- its mode selection is GAN-preferred, or if GERAN/UTRAN-preferred the RxLev from the current serving cell drops below a defined threshold, RxLev_access_min + X dB (this threshold can be specified as a fixed value, or provided by the GERAN BSS to the MS in dedicated mode), and

- the MS has successfully registered with a GANC, allowing the MS to obtain GAN system information, and

- the GERAN provides information on neighbouring cells such that one of the {ARFCN, BSIC} in the neighbour list matches the {ARFCN, BSIC} associated with the GANC, as provided in the AS-related component of the system information obtained from GANC.

1) The MS now begins to include GAN cell information in the *Measurement Report* to the GERAN. The MS reports the highest signal level for the GAN cell {ARFCN, BSIC}. This is not the actual measured signal level on GAN, rather a "faked" value.

2) Based on MS measurement reports and other internal algorithms, GERAN decides to handover to the GAN cell, using an internal mapping of {ARFCN, BSIC} to CGI. The GERAN starts the handover preparation by sending a *Handover Required* message to the CN, identifying the target (GAN) cell.

3) The CN requests the target GANC to allocate resources for the handover, using *Handover Request*.

4) The target GANC acknowledges the handover request, using *Handover Request Acknowledge*, indicating it can support the requested handover, and provides a *Handover Command* that indicates the radio channel to which the mobile station should be directed.

5) The CN forwards the *Handover Command* to the GERAN, completing the handover preparation.

6) GERAN sends *Handover Command* to the MS to initiate handover to GAN. The *Handover Command* includes among other parameters information about the target GAN such as BCCH ARFCN, PLMN color code and BSIC. The MS does not switch its audio path from GERAN to GAN until handover completion, i.e., until it sends the GAN-RR HANDOVER COMPLETE, to keep the audio interruption short.

7) The MS accesses the GANC using the GAN-RR HANDOVER ACCESS message, and provides the entire *Handover Command* received from GERAN. The handover reference in the handover command allows the GANC to correlate the handover to the *Handover Request Acknowledge* message earlier sent to the CN and identify the successful completion of the handover.

8) The GANC sets up the bearer path with the MS, using the same steps as in steps 11-17 of Mobile Originated calling scenario (with the exception that no *Assignment* or *Assignment Complete* message is exchanged with the CN).

9) The MS transmits the GAN-RR HANDOVER COMPLETE to indicate the completion of the handover procedure at its end. It switches the user from the GERAN user plane to the GAN user plane.

10) The GANC indicates to the CN that it has detected the MS, using *Handover Detect* message. The CN can optionally now switch the user plane from the source GERAN to the target GAN.

11) Bi-directional voice traffic is now flowing between the MS and CN, via GANC.

12) The target GANC indicates the handover is complete, using the *Handover Complete* message. If it had not done so before, the CN now switches the user plane from source GERAN to target GAN.

13) Finally, the CN tears down the connection to the source GERAN, using *Clear Command.*

14) The source GERAN confirms the release of GERAN resources allocated for this call, using *Clear Complete*.
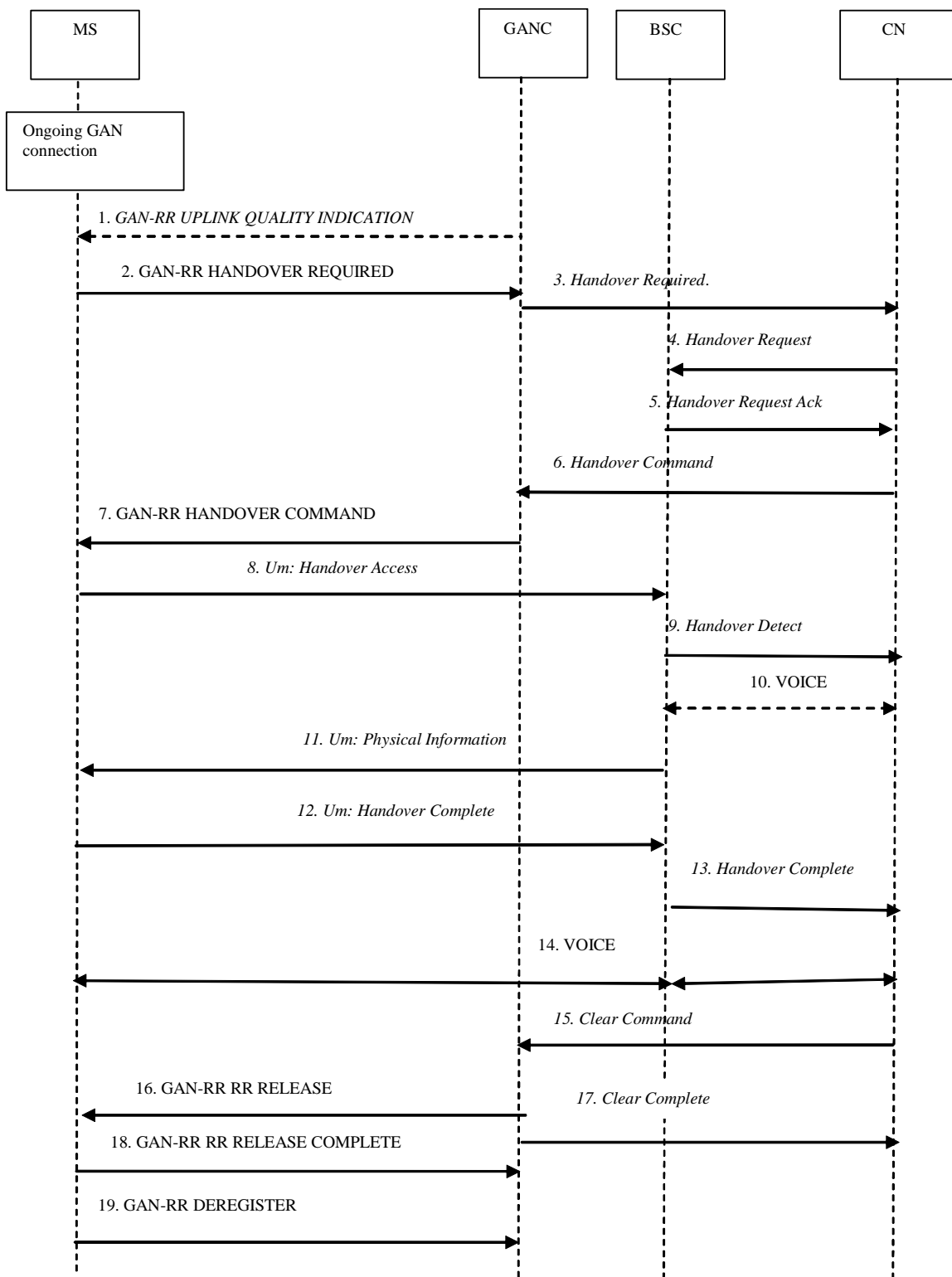
5.4.4.3 Handover to GERAN

Figure 5.4.4.3.1: Handover to GERAN

The procedure description in this sub-clause assumes the following:

- the MS is on an active call on the GAN, and

- the MS mode selection is GAN-preferred or GERAN/UTRAN-preferred, and

- the MS begins to leave GAN coverage, based on its local measurements, received RTCP reports, as well as any uplink quality indications received from the GANC

The handover from GAN to GERAN procedure is always triggered by the MS.

1) The GANC may send a GAN-RR UPLINK QUALITY INDCATION if there is a problem with the uplink quality for the ongoing call. Whenever the MS receives an indication of bad quality, it should start the handover procedure, as described in the next step. Alternately, MS can use RTCP to measure uplink and downlink quality, to initiate the handover procedure.

2) The MS sends the GAN-RR HANDOVER REQUIRED message to the GANC indicating the Channel Mode and a list of GERAN cells, identified by CGI, in order of preference (e.g. ranked by C1 path loss parameter) for handover. This list is the most recent information available from the GSM RR subsystem.

3) The GANC starts the handover preparation by signalling to the CN the need for handover, using *Handover Required,* and including the GERAN cell list provided by the MS.

4) The CN selects a target GERAN cell and requests it to allocate the necessary resources, using *Handover Request*.

5) The target GERAN builds a *Handover Command* message providing information on the channel allocated and sends it to the CN through the *Handover Request Acknowledge* message.

6) The CN signals the GANC to handover the MS to the GERAN, using *Handover Command* message, ending the handover preparation phase.

7) GANC transmits the GAN-RR HANDOVER COMMAND to the MS including the details sent by the GERAN on the target resource allocation.

8) The MS transmits the *Um: Handover Access* containing the handover reference element to allow the target GERAN to correlate this handover access with the *Handover Command* message transmitted earlier to the CN in response to the *Handover Required*.

9) The target GERAN confirms the detection of the handover to the CN, using the *Handover Detect* message.

10) The CN may at this point switch the user plane to the target BSS.

11) The GERAN provides *Physical Information* to the MS i.e. *Timing Advance*, to allow the MS to synchronize with the GERAN.

12) The MS signals to the GERAN that the handover is completed, using *Handover Complete*.

13) The GERAN confirms to the CN the completion of the handover, via *Handover Complete* message.

14) Bi-directional voice traffic is now flowing between the MS and CN, via the GERAN.

15) On receiving the confirmation of the completion of the handover, the CN indicates to the GANC to release any resources allocated to the MS, via the *Clear Command*.

16) GANC commands the MS to release resources, using the GAN-RR RR RELEASE message.

17) GANC confirms resource release to CN using the *Clear Complete* message.

18) The MS confirms resource release to the GANC using the GAN-RR RR RELEASE COMPLETE message.

19) The MS may finally deregister from the GANC, using GAN-RR DEREGISTER message.

5.4.4.4 Other handover considerations

The current mechanisms and definition for handover failure should continue to hold.

Operator methods for setting thresholds to trigger HO from GAN are not seen as being possible due to the generic nature of access.

Handover to and from UTRAN should be possible in a manner identical to the case for handovers between UTRAN and GERAN.

5.4.5   Cell Change Order between GAN and GERAN

While in GERAN, a mobile station may be ordered to perform a cell reselection to GAN, by using the Cell Change Order procedures used in GERAN, with no modifications.

While the mobile station is involved in a PS session in the GAN, the GANC may decide to force the mobile station to perform a cell reselection to GERAN. To achieve this, the GANC may send a GAN GRR MEASUREMENT ORDER to the mobile station. Upon receipt of a GAN GRR MEASUREMENT REPORT, containing a list of GERAN cells, the GANC may send a GAN GRR CELL CHANGE ORDER to the mobile station.

Given the inherent ability of a multi-mode terminal of simultaneous reception by GSM RR and GAN RR, it is not necessary to provide support for NACC.

5.5   Emergency call support in GAN

The GANC can indicate an operator preference for the access network for emergency calls placement in the registration accept message. Based on operator preference, and if a GSM PLMN is available, the MS should switch from GAN mode to 3GPP mode and place the emergency call over GERAN/UTRAN, to leverage the location determination infrastructure in GERAN/UTRAN. During the emergency call, the MS should not attempt to handover the call to GAN. After the emergency call is completed, the MS performs normal rove-in procedures, if GAN coverage is still available, to re-enter GAN mode. Alternately there may be a penalty timer configured to ensure that the MS remains in GERAN/UTRAN for call-back purposes. On expiry of the penalty timer the MS performs normal rove-in procedures, if GAN coverage is still available, to re-enter GAN mode.

Based on operator preference, or if a GSM PLMN is not available, the MS places the emergency call over GAN. In GAN, the emergency call is handled just like a GSM emergency call origination. The CGI associated with the GANC provides an indication of the location of the MS. Additional, more accurate location information may be obtained by the GANC either directly from the MS (e.g. using AGPS) or from the generic IP access network point of attachment (e.g. using a database of IP or MAC addresses). If available, the GANC can pass this location information through BSSMAP to the core network, when requested. However, location services based on mechanisms using the GERAN physical layer cannot be applied.

Mechanisms to deregister the MS if the location accuracy is not deemed sufficient for emergency calls in GAN mode by the operator can be supported.

5.6   Feasibility for support of services available through GERAN while in GAN mode

The complete support of LCS through Generic Access is FFS. However it was determined that a certain level of LCS support can be obtained through

-    appropriate assignment of CGIs for GAN cells,

-    use of A-GPS

Location services that rely on the physical layer of GERAN cannot be applied in the case of generic access, e.g. OTDOA.It is seen feasible to support all services requiring support of CC, MM, GMM, LLC and SS as well as SMS since support for the transfer of upper layer NAS messages is provided in an identical fashion as in GERAN. However, services such as VGCS, VBS and CBS cannot be provided in a generic fashion. Such services require specific support from the concerned generic access technology. CBS is a service provided by GERAN and if needed in GAN then it needs to be supported in the GANC through functionality such as IP multicast.

It is seen feasible to support MBMS through Point-to-point means using current mechanisms of support through GPRS bearers. In case of point-to-multipoint MBMS service, notification of service and how the service area can be mapped to the GAN cell identity and location area are issues that need to be resolved. Point-to-multipoint MBMS support requires access network specific support.

5.7   Other considerations

1) It is noted that there is a need to define the frequency of SID and Idle-frame transmission to provide support to the GAN in the determination of uplink quality.

2) It is noted that architecture studied in the feasibility study requires that in case of handover in a roaming scenario, the MS needs to have first registered on the GAN by first contacting the home operator. The visiting network cannot direct the MS to establish GAN connectivity.

3) It is noted that with the ability to connect to the home operator through generic access while roaming fro a GERAN perspective, proper MMI indication will be needed to inform the user of the need for appropriate dialling of digits (e.g. addition of "+"-country code when roving out of GAN coverage into the visiting network. Currently it is not typical, except in border regions, for the MS in the same geographical area to dial the called number differently.

4) The ability to have the SGW functionality in a physically separate node from the other GANC functionality implies the need for a trusted relationship between the two nodes, i.e. secure links between the GANC and the SGW.

5) The support of priority services needs to be studied further.

6) It was seen possible to have the MS continue to support its Class A/B/C of operation as in GERAN. It was also seen possible to provide support for DTM mode of operation.

7) For the case of Handovers in PS Domain that is currently being worked on in GERAN, it was seen possible to re-use the concept of mimicking the GERAN procedure by using a similar CGI identity mechanism for the GAN cell as in the case of CS domain handovers.

6   Potential impacts on current specifications

No impact on the current GERAN specifications was identified.

7   Summary and conclusion

It has been concluded that it is feasible to support generic access to the A/Gb interface, wherein an MS capable of generic access can obtain services provided by the core network, using alternate access methods such as through a generic IP based broadband connection. The generic broadband connection provides connectivity between the MS and the core network and may be obtained through any means or any combination of means such as ADSL, Cable, alternate wireless access, etc. The MS connects to a network node that interfaces with the core network through the standard A/Gb interfaces. A new interface that connects the MS to a generic access network needs to be defined. A new protocol that mimics the functionality as seen by the MM layer would need to be defined.

It was determined that an MS supporting generic access to the A/Gb interface can support all the service requirements defined for the 3GPP system including support for SMS, MMS and IMS services that can be supported by GERAN. Due to the generic nature of the access network, services provided by the radio network in GERAN such as CBS, VGCS and VBS cannot be supported in a generic manner. However, support for such features is possible through access specific mechanisms such as multiple IP unicast in case of support of CBS. Emergency calls support was seen feasible in GAN mode with the limitations that location services relying on GERAN physical layer based mechanisms cannot be used. However, alternate mechanisms are possible.

Given the current state of specifications and the on-going status of the work, it was not possible to conclude on the feasibility for support of MBMS. It was seen possible to support handovers in PS domain with the understanding that the current CS domain handover trigger mechanisms would continue to be used in this case as well thereby allowing the use of the mechanisms seen possible for CS domain handovers.

Annex A:
Change history

Change history							
Date	**TSG #**	**TSG Doc.**	**CR**	**Rev**	**Subject/Comment**	**Old**	**New**
2004-08	GERAN#21	GP-042290			Approved at GERAN#21		6.0.0
2007-08	GERAN#35				Version for Release 7	6.0.0	7.0.0
2008-12	GERAN#40				Version for Release 8	7.0.0	8.0.0
2009-12	GERAN#44				Version for Release 9	8.0.0	9.0.0
2011-03	GERAN#49				Version for Release 10	9.0.0	10.0.0
2011-04					Correction to previous entry in history table	10.0.0	10.0.1
2012-01					Correction to Symbols and Abbreviations	10.0.1	10.0.2
2012-09	GERAN#55				Version for Release 11	10.0.2	11.0.0
2014-09	GERAN#63				Version for Release 12 (frozen at SP-65)	11.0.0	12.0.0
2015-12	GERAN#68				Version for Release 13 (frozen at SP-70)	12.0.0	13.0.0

Change history							
Date	**TSG #**	**TSG Doc.**	**CR**	**Rev**	**Cat**	**Subject/Comment**	**New**
2017-03	RP-75					Release 14 version (frozen at TSG-75)	14.0.0
2018-06	RP-80					Release 15 version (frozen at TSG-80)	15.0.0
2020-07	RP-88e	-	-	-	-	Upgrade to Rel-16 version without technical change	16.0.0
2022-03	RP-95e	-	-	-	-	Upgrade to Rel-17 version without technical change	17.0.0

History

Document history		
V17.0.0	May 2022	Publication