SMS Evolution
Version 4.0
27 Nov 2025

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1 Introduction

1.1 Overview

The scope of this document is to analyse the SMS evolution, specifically related to 4G, IMS, 5G, and MIoT introduction, this also includes the impact on roaming and the interconnection domain.

One of the key questions is: are there opportunities to move from MAP to Diameter protocol for different networks (4/5G and IMS) at home, roaming or interconnection context?

1.2 Abbreviations

Term	Description
A2P	Application to Person
AMF	Access Management Function
EC-GSM-IoT	Extended Coverage GSM Internet of Things
e-MTC	Enhanced Machine Type Communication
EPS	Evolved Packet Core
CS	Circuit Switched
GMSC	Gateway Mobile Switching Centre
GT	Global Title
GW	Gateway
HLR	Home Location Register
HPMN	Home Public Mobile Network
HSS	Home Subscriber Server
iFC	Initial Filter Criteria
IMS	IP Multimedia Subsystem
IMSI	International Mobile Subscriber Identity
IP	Internet Protocol
IPX	IP Packet exchange
IWF	Interworking Functionality
IWMSC	Inter Working Mobile Switching Centre
LTE	Long Term Evolution

LTE-M	LTE Machine Type Communication
LPWA	Low Power Wide Area
M2M	Machine to Machine
MAP	Mobile Application Part
MCC	Mobile Country Code
MIoT	Mobile Internet of Things
MME	Mobility Management Entity
MNC	Mobile Network Code
MNP	Mobile Number Portability
MNO	Mobile Network Operator
MO	Mobile Originated
MSISDN	Mobile Station International Subscriber Directory Number
MSC	Mobile Switching Centre
MT	Mobile Terminated
MTC	Machine Type Communication
MTC-IWF	MTC InterWorking Function
MTC/MioT	Machine Type Communication/Mobile IoT
NAS	Non Access Stratum
NB-IoT	Narrow Band IoT
NNI	Network-to-Network Interface
NP	Number Portability
OC-SMS	Open Connectivity SMS
ODB	Operator Determined Barring
OFA	Forward ShortMessage Operation
OTA	Over the Air
P2P	Person to Person
PDU	Protocol Data Unit
PGW	Packet Data Network Gateway
PS	Packet Switched

S8HR	S8 Home Routing
SCEF	Service Capability Exposure Function
SCCP	Signaling Connection Control Part
SCTP	Simple Control Transmission Protocol
SG	Signalling Gateway
SGSN	Service GPRS Support Node
SIM	Subscriber Identify Module
SM	Short Message
SME	Short Message Entity
SMS	Short Message Service (MO: Mobile Originating / MT: Mobile Terminating)
SMS-C	Short Message Service Centre
SMSF	SMS Function (5G)
SMS-MO	SMS Mobile Originating
SMS-MT	SMS Mobile Terminating
SIGTRAN	Signalling Transport
SIP	Session Initialization Protocol
SS7	Signalling System 7
TCP	Transmission Control Protocol
TFA	TransFer Allowed
TFR	TransFer Restricted
UAC	User Agent Client
UAS	User Agent Server
UDM	Unified Data Management
UE	User Equipment
USIM	Universal Subscriber Identify Module
VLR	Visitor Location Register
VPMN	Visited Public Mobile Network

1.3 Definitions

Term	Description
MIoT	Mobile Internet of Things is a GSMA term which refers to the 3GPP standardised LPWA (Low Power Wide Area) technologies using the licenced band (LTE-M (LTE-Mobile), NB-IoT (Narrow Band IoT) and EC-GSM-IoT (Extended Coverage GSMA Internet of Things)). From 3GPP Release 13 onwards, the Category of UEs (User Equipment) that support power consumption optimisation, extended coverage and lower complexity are part of Mobile IoT, MIoT (CAT M1, CAT NB1 from Release 13 and CAT M2, CAT NB2 from Release 14). As this particular term is widely used throughout GSMA, it is utilized also in this document. Not to be confused with the term “mIoT” which means 5G massive IoT in 3GPP terminology.
MTC	Machine Type Communications is a 3GPP term referring to pre-Rel-13 enhancements for M2M (Machine to Machine) applications over 3GPP technologies. 3GPP further developed the features for Machine Type Communications in Release 13 and later Releases, and the term enhanced MTC (eMTC) is used. The term eMTC is known as LTE-M at GSMA
NAS	The Non Access Stratum (NAS) is a set of protocols in the Evolved Packet System. The NAS is used to convey non radio signalling between UE and MME for LTE/E UTRAN.

1.4 Document Cross-References

ref	Document Number	Title
1	3GPP TS 23.040	Technical realization of the Short Message Service (SMS)
2	3GPP TS 29.002	Mobile application Part (MAP) specifications
3	3GPP TS 23.272	Circuit Switched (CS) fallback in Evolved Packet System (EPS)
4	3GPP TS 29.118	Mobility Management Entity (MME) - Visitor Location Register (VLR) SGs interface specification
5	3GPP TS 29.338	Diameter based protocols to support Short Message Service (SMS) capable Mobile Management Entities (MMEs)
6	3GPP TS 23.204	Support of Short Message Service (SMS) over generic 3GPP Internet Protocol (IP) access
7	3GPP TS 23.501	System Architecture for the 5G System (including SMS requirement)
8	3GPP TS 29.891	5G System (SMS section 9.1)
9	3GPP TS 23.682	Architecture enhancements to facilitate communications with packet data networks and applications
10	3GPP TS 24.301	Non-Access-Stratum (NAS) protocol for Evolved Packet System (EPS)
11	3GPP 24.341	Support of SMS over IP networks; Stage 3
12	GSMA PRD IR.70	SMS SS7 Fraud
13	GSMA PRD IR.71	SMS SS7 Fraud prevention
14	GSMA PRD IR.75	Open Connectivity SMS Hubbing Architecture

15	GSMA PRD IR.92	IMS profile for voice and SMS
16	GSMA PRD NG.108	IMS Profile for Voice and SMS for UE category M1
17	GSMA PRD BA.64	SMS and MMS Interworking
18	GSMA PRD AA.19	Addendum to the International GSM Roaming Agreement: SMS Interworking Agreement
19	RFC 6733	Diameter Base Protocol
20	GSMA PRD CLP.28	NB-IoT Deployment Guide to Basic Feature Set Requirements v2.0 (April18) https://infocentre2.gsma.com/gp/pr/IoT/MIoT/NBIoTF/OfficialDocuments/CLP.28%20NB-IoT%20Deployment%20Guide%20to%20Basic%20Feature%20set%20Requirements%20v2.0%20(Current)/CLP.28%20v2.0.pdf
21	GSMA PRD CLP.29	LTE-M Deployment Guide to Basic Feature Set Requirements v2.0 (April18)
22	3GPP TS 29.305	InterWorking Function (IWF) between MAP based and Diameter based interfaces.
23	3GPP TS 29.573	5G System; Public Land Mobile Network (PLMN) Interconnection
24	3GPP TS 23.540	5G System: Technical realization of Service Based Short Message Service; Stage 2
25	3GPP TS 29.578	5G System; Mobile Number Portability Services
26	3GPP TR 29.829	Service-based support for SMS in 5GC
27	GSMA PRD NG.113	5GS Roaming Guidelines
28	GSMA 5GMRR Doc 37_09	SMS Roaming and Hubbing with SBI support (II)

2 SMS Requirements

2.1 SMS service

SMS (Short Message Service) consists of two steps:

1. Message submission.
2. Message delivery, which also includes a delivery report.

Optionally, SMS can also include a delivery report (steps 3 and 4 in the figure)

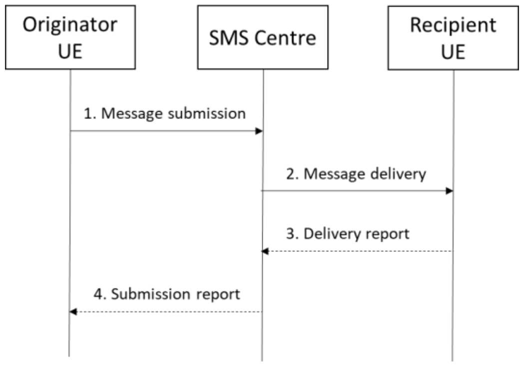


Figure 1 - SMS service overview

The SMS serves various use cases:

- Person-to-Person (P2P)
- Application-to-Person (A2P). Very popular for generating significant wholesale interconnection revenues and also applicable to MIoT (Mobile Internet of Things)
- Technical enabler: OTA (Over the Air) messaging for (U)SIM (Universal Subscriber Identify Module) provisioning, IP (Internet Protocol) session wake-up.

2.1.1 SMS Mobile Originating (SMS-MO, Mobile Originated)

SMS are routed to a Short Message Service Centre (SMSC) which is essentially an electronic message store. If the SMS-C receives the SMS successfully, the SMSC sends an acknowledgement to the originating handset which is often displayed to the sender as "message sent" (this does not mean that the recipient has received the text message). If there was a problem in sending the SMS: the sending handset may display a "message sending failure indication" to the sender.

2.1.2 SMS Terminating (SMS-MT, Mobile Terminated)

If the SMS reached the SMS-C successfully, the SMSC will then attempt to deliver the SMS to the receiving handset. If the receiving handset is switched on and registered on the mobile network, then the SMS will be delivered. If the receiving phone is switched off or not registered, the SMSC will keep the SMS and try to deliver it at a later stage. The SMS-C may receive notification when the receiving mobile becomes available to receive the SMS. These operations are referred to as retry mechanism and alerting mechanism respectively.

The sender of the SMS will only know if the recipient has received the SMS if the sender of the Text Message selected the "delivery confirmation" option.

It should be noted that the Short Message (SM originator) will always use SMSC on its home network. This SMSC will also be responsible to deliver the Short Message to the recipient (including the case where the recipient is roaming or recipient is a subscriber of a different PMN than the originator).

2.2 SMS for MTC/MIoT

In the case of Machine Type Communication and Mobile IoT (MTC, MIoT) the SMS could be a key technical enabler to enable the following functionality:

- Wake-up for IP session: an SMS is sent to the object in order to wake-up an IP session. The solution is based on the MTC InterWorking Function (MTC-IWF). The SMS message includes an indicator allowing the UE and the network to distinguish an MT message carrying device triggering information from any other type of message. In addition, a parameter called Trigger payload may be inserted in the SMS message to identify this type of SMS.
- SMS without CS (Circuit Switch) minimizes the usage of the MSC (Mobile Switching Centre), especially in the case of a massive deployment of objects.

Note: Today, the use of the functionality described above is not widely adopted by the NB-IOT and LTE-M (Long Term Evolution Mobile) communities. In fact, the results of recent surveys lead to conclude that: “Operators do not yet have consistent deployment plans. Therefore, the SMS is not a key feature for the short term deployment, and no related recommendation can be provided”. NB-IoT community clarified that MNOs do not yet have consistent deployment plans for SMS.

The survey document references can be found in section 1.4 of [18] and [19].

LTE-M status has been updated following a later survey, to clarify that “SMS will be deployed for global LTE-M deployments”. Therefore, this will have dependency on networks supporting SMS without combined attached, or “consistent attached, or “consistent with the MNO’s existing implementation of SMS over legacy Long Term Evolution, LTE networks”.

2.3 SMS security

SMS is generally considered a trusted enabler from the end user perspective, and from the wholesale perspective, however, the SMS is facing a some security issues that are described in GSMA PRD IR.71 [11]. Other problem areas not strictly related to security include:

- SMS Spamming: unsolicited SMS received by a subscriber. There are no specific technical remedies to prevent this issue at network level since the spam messages are sent following the standard procedure.
- SMS Flooding: very large number of messages are sent to one or more destinations.

Other threats which instead involve protocol manipulation to send messages bypassing the normal procedure for message sending such as

- **SMS Faking**: is a specific case where SCCP (Signalling Connection Control Part) or the MAP (Mobile Application Part) originator addresses are manipulated and replaced wrongly or stolen from a valid originator. The objective of this manipulation is to deliver the SMS for free (impossible for the receiver network to invoice the correct originator).

- **SMS Spoofing**: is related to an illegal use of the HPMN SMSC by a third party. To do that, the A-MSISDN (A- Mobile Station International Subscriber Directory Number) that originates the SMS is manipulated to be able to use the HPMN SMSC. Therefore, the SMS could be sent for free by the sending customer.
- **Global Title GT scanning**: is sending a SM-MO to ALL GTs of one network to detect SMSC and especially SMS-C not controlling the A-number. The final objective is to be able to send the SMS for free.
- **Open SMSC**: is SMS-C not controlling the A-number. The SMSC can be used by illegal customers (not part of HPMN).
- **Phishing (Smishing)**: Attackers send fraudulent messages pretending to be from reputable sources to trick users into revealing personal information, such as passwords or credit card numbers.
- **Malware Distribution**: SMS can be used to send links to malicious websites or to download malware directly onto a user's device.
- **SIM Swapping**: Attackers trick mobile carriers into transferring a victim's phone number to a new SIM card, allowing them to intercept SMS messages, including those used for two-factor authentication (2FA).
- **Denial of Service (DoS) Attacks**: Flooding a device with SMS messages can overwhelm it, causing it to crash or become unusable.
- **Premium Rate SMS Fraud**: Users are tricked into sending messages to premium-rate numbers, resulting in unexpected charges on their phone bills.

Even though taking countermeasures to avoid these issues (via SMS control solution), the SMS is no longer considered as a trusted solution to exchange a message of the identified user. This is critical since SMS is largely used, for example, to identify the user when a login/password must be reset and for user authentication owing to SMS being a “universal technology” (SMS is support by all devices; network natively)

The reason for this is that after Signalling System 7, SS7 vulnerability audits, the SMS as a trusted solution has been challenged and other technologies are slowly replacing the SMS, example, RCS.

While actions have been taken already to avoid SS7 vulnerability (SS7 Control solution), it is important to also take actions to avoid direct vulnerability for new protocols (Diameter, SIP, Session Initialization Protocol) and continue to make the SMS a universal trusted technology especially when used to authenticate the customer.

2.4 SMS and Number Portability

While the management of MNP (Mobile Number Portability) for SMS delivery in a national context is fully controlled and efficient, this is not always the case in the international interconnection context.

Problems may occur with terminating a SMS to a ported number is when the recipient network does not have signalling connectivity with the SMS Sender Network or the SMS Hub provider.

When signalling message Routing Based on MSISDN is used, the message will be routed to the number range holder network. If the terminating number is ported out, the messages will be forwarded to the recipient network.

However, if the recipient network does not have signalling open with the SMS Sender network or the SMS hub then the SMS MT procedure could not be completed.

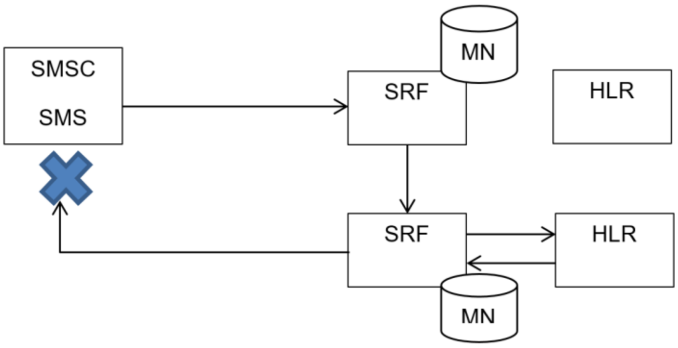


Figure 2 - SMS Number Portability fails – Case 1

To complete the picture, we have to take into account the case where signalling connectivity between the SMS hub used by the Recipient Network and the SMSC of the SMS Sender Network is not present.

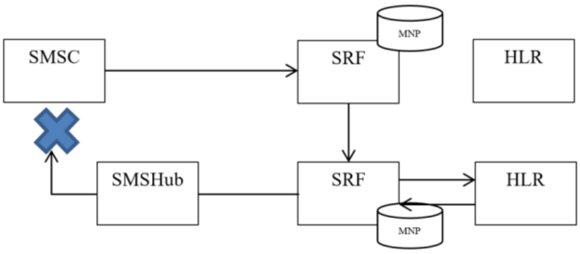


Figure 3 - SMS Number Portability fails – Case 2

This issue has been largely demonstrated on the current deployment based on MAP but a solution has not been provided to solve this issue.

The correct way to manage Mobile Number portability delivering SMS to any customer on any network in any country is to have connectivity with ALL operators in that country. This connectivity can be completed via bilateral agreement between operators or more simply through an SMS hub connectivity.

3 SMS uses cases and architectures

This section details the architecture and different protocols used to transport SMS to the core network.

Introduction

Currently, the architecture for transporting SMS, notably SMSoNAS and SMSoIP, between the UE and the core network, is depicted in Figure 4 below and is handled as follows:

- **SMS over Non-Access Stratum (SMSoNAS):**
  This method uses the signaling channel to transport SMS. It is natively supported by User Equipment (UE), including IoT devices.
- **SMS over IP (SMSoIP):**
  In this approach, SMS is transported over a data session. However, it is only available if the UE includes a Session Initiation Protocol (SIP) client.

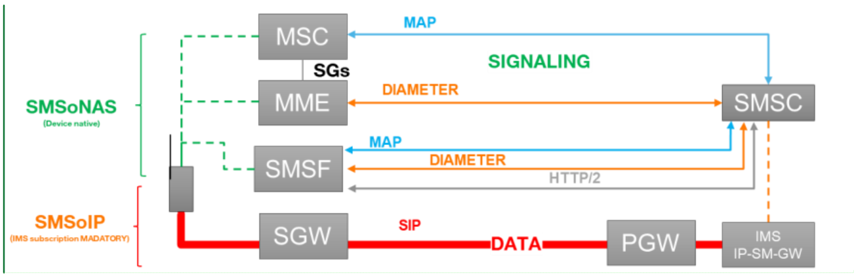


Figure 4 - SMSoNAS versus SMSoIP

3.1 <2G/3G> SMS over MAP

Three MAP interfaces have been defined to support the Short Message Service:

1. H interface between HLR (Home Location Register) and the SMS C (SMS-GMSC, Gateway Mobile Switching Centre)
2. E interface between MSC and the SMS-C (SMS-GMSC, SMS-IWMSC, Inter Working Mobile Switching Centre)
3. Gd interface between SGSN (Service GPRS Support Node) and the SMS-C (SMS-GMSC, SMS-IWMSC)

MAP interface is built on top of SS7 (TDM or SIGTRAN, Signalling Transport) using the following layers (TCAP, SCCP and MTP).

Commented [KL1]: For the interface between the SMSF and SMSC, the supported protocols are MAP/Diameter/HTTP/2. SMS over SBI is defined in 23.540 but 23.501 continues to support the legacy protocols for the SMSF (as you've also described in the later sections in this document).

Commented [EG2R1]: Figure Updated

Commented [KL3R1]: Thanks. Please fix also the PGW instead of PWG

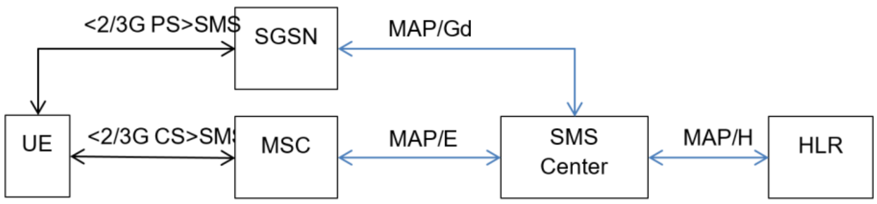


Figure 5 - SMS over MAP interfaces

For M2M applications/devices that only require Packet Switched, (PS) data, avoiding attaching to the CS domain is trivial. However, for other applications/devices, attachment to the CS domain can be avoided only when the following conditions are satisfied:

1. The UE only needs PS domain services and SMS.
2. The SGSN supports SMS.
3. The HLR/HSS (Home Subscriber Server) supports SMS via SGSN.
4. For roaming cases, the roaming agreement allows SMS via SGSN

3.2 <4G> SMS over SGsAP and MAP

To enable the delivery of SMS in 4G networks without using IMS (IP Multimedia Subsystem, 3GPP specified SMS over SGs (see TS 29.118 [4]). SMS over the SGs (evolved Gs interface) is a hybrid approach that allows the transmission of SMS in the native CS domain over the LTE radio network.

As shown in Figure 6, the SGs interface (based on Gs) is used to coordinate mobility management and paging procedures between the EPS (Evolved Packet System) and CS domain and can be used to transport both mobile originating and terminating SMS.

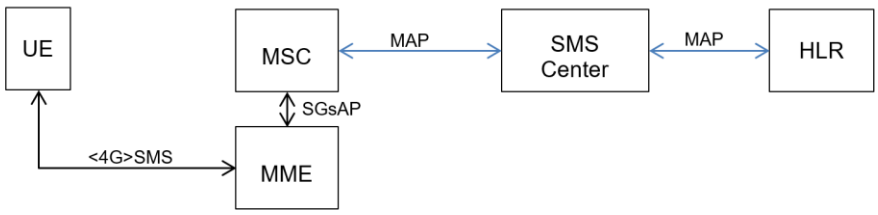


Figure 6 - SMS over SGsAP and MAP interfaces

3.3 <4G> SMS over Diameter

As well as SMS over SGs, the Diameter interface can also be used in 4G to transport SMS between MME (Mobility Management Entity) and SMS-C. Diameter solution could also apply to some SGSN supporting EPS interfaces.

SMS in MME enables support of MO and MT SMS over LTE without requiring any involvement of any MSCs. Instead of delivering MT-SMS via the MSC (which would require the UE to be registered in the CS domain), the Short Messages pass directly between the MME and the SMS-C using a new Diameter-based interface SGd.

The following Diameter interfaces have been defined to support Short Message service.

- S6c interface between HSS and the central SMS function (SMS-GMSC, SMS Router);
- SGd interface between MME, the SMS-IWMSC, the SMS-GMSC and the SMS Router;
- Gdd interface between the SGSN, the SMS-IWMSC, the SMS-GMSC and the SMS Router

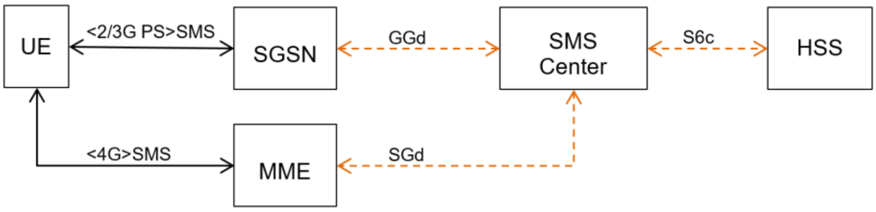


Figure 7 - SMS over Diameter interfaces

Note: In the <4G> context and as specified in 3GPP TS 24.301 [10], the Non Access Stratum Protocol (NAS) transport message procedures is used to carry the encapsulated SMS messages between the UE and MME. The SMS messages CP-DATA, CP-ACK and CP-ERROR are carried in the NAS Message Container IE in the Uplink or Downlink NAS Transport message within the NAS PDU (Non Access Stratum Protocol Data Unit).

3.4 <IMS> SMS over MAP/Diameter

With the IMS introduction, VoLTE network could also support the SMS sent over SIP. IP-SM-GW, placed between the IMS and the legacy domain, provides the possibility for the users to register and deregister and to enable or disable the possibilities to send/receive SMSs over IP.

The IP-SM-GW is connected to the HLR/HSS and is able to communicate with it both with MAP and Diameter:

<u>MAP is used between IP-SM-GW and HLR/HSS</u>

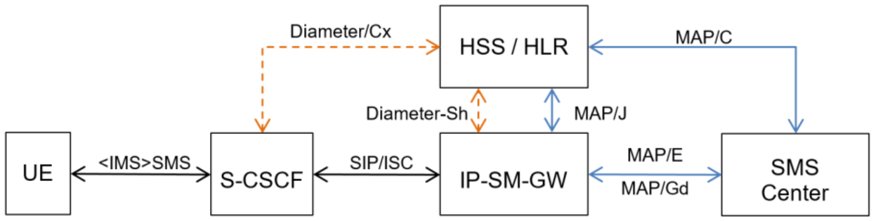


Figure 8 - SMS over IMS interfaces (MAP)

Diameter is used between IP-SM-GW and HLR/HSS

(Standardized in release 14 of 3GPP in TS 23.204 [6])

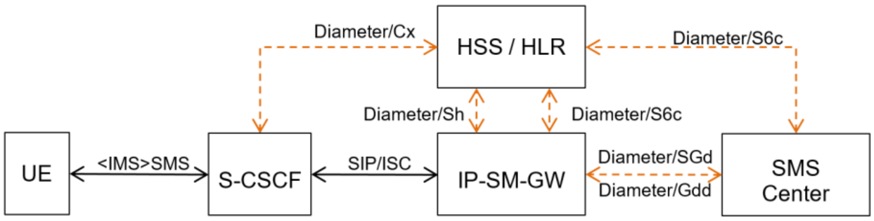


Figure 9 - SMS over IMS interfaces (Diameter)

3.5 <5G> SMS in MAP-Diameter-HTTP/2

SMS support in 5G is required as (see 3GPP 23.501 [7] [section 4.4.2]).

The SMS architecture is defined in 3GPPTS 23.501 7] [section 9.1].

MAP and Diameter are supported in 5G between SMS-C-UDM and SMSF-SMS-C respectively.

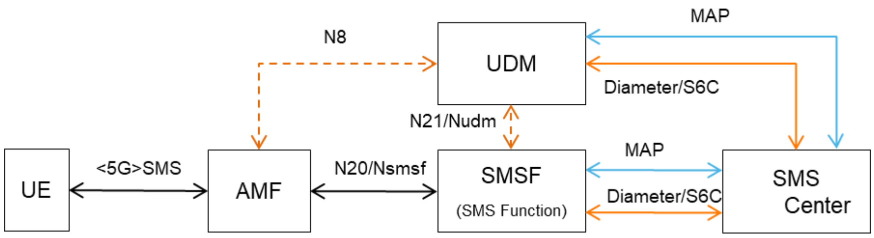


Figure 10 - SMS over 5G interfaces (MAP/Diameter)

HTTP/2 is also supported in 5G between SMS-C-UDM and SMS-C-SMSF as defined in the 3GPP Release 17 version of TS 23.540 [25].

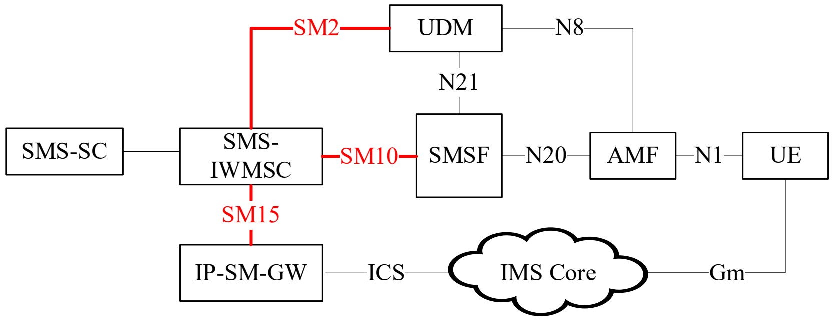


Figure 11 - Non-roaming System Architecture for SBI-based SMS in reference point representation (extract from 3GPP TS 23.540 [25])

3.6 <MTC/MIoT>

SMS will also be used for IoT in the following scenarios:

- Wake-up IP session: using MTC-IWF environment (defined in 3GPP TS 23.682 [9]), SMS will be delivered using <2/3G> or <4G> SMS use cases. The global ecosystem around this is Diameter oriented (T4, T6, T7 Diameter interface)

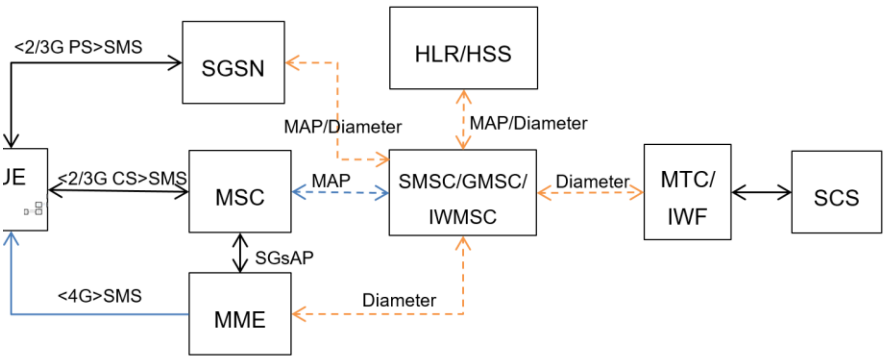


Figure 12 - MTC/MIoT via MAP or Diameter for Wake-up IP session

- SMS delivery without CS usage in order to avoid combined attach (CS/PS); 2 cases are foreseen:

1. 2G/3G: PS only, using SMS via SGSN
2. 4G: “SMS transfer without combined attach” allows an NB-IoT UE to request SMS service by launching an EPS Attach procedure instead of a combined attach procedure. The MME shall request to be registered for SMS by indicating its MME Number for MT SMS in the Location Update Request to the HSS, including the SMS-Register-Request AVP (SMS in MME Required, SMS in MME not Preferred, No Preference for SMS in MME)

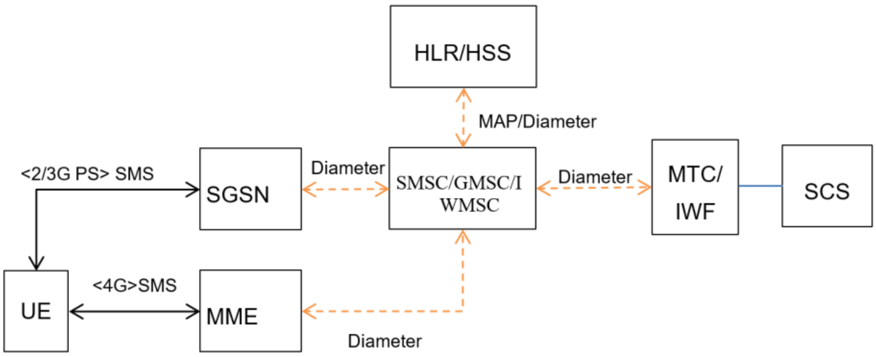


Figure 13 - MTC/MIoT via Diameter for without CS usage

- SMS using CIoT EPS optimisation: As part of the MTC evolution, 3GPP Release13 introduced a new work item called Cellular IoT (CIoT) with EPS optimisation to allow infrequent small data transport. There are two ways for SMS/Data transfer using Control-plane or User-plane CIoT EPS optimisation, depending on configuration. The UE can be registered with the EPS network without activating a PDN connection and using Control Plane optimization. The device can now exchange SMS data. SMS transfer can therefore be supported without the need for a combined attach for CIoT devices. Both Control Plane NAS PDU via S11-U between S-GW and MME or User Plane via S1-U between SGW and eNB can be used for SMS/Data transfer. Also note that SMS service can be used simultaneously with both IP data (terminated at the PGW Packet Data Network Gateway) and non-IP data (terminated at the PGW or at the SCEF) using Control Plane CIoT EPS optimisation.

4 SMS protocols

This section will detail the various protocols used to transport SMS over the core network.

4.1 2/3G SMS over MAP

Three MAP interfaces have been defined to support the Short Message Service:

1. H interface between HLR and the SMS C (SMS-GMSC)
2. E interface between MSC and the SMS-C (SMS-GMSC, SMS-IWMSC)
3. Gd interface between SGSN and the SMS-C (SMS-GMSC, SMS-IWMSC)

MAP interface is built on top of SS7 (TDM or SIGTRAN) using the following layers (TCAP, SCCP and MTP)

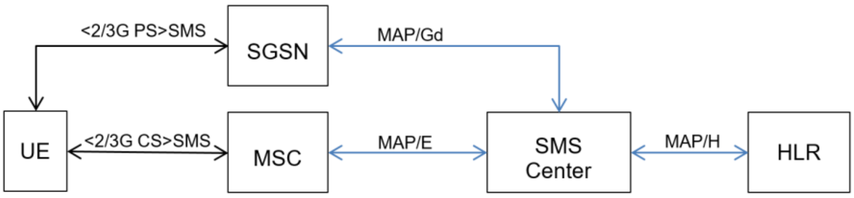


Figure 14 - SMS over MAP interfaces

4.2 4G SMS over SGsAP

With 4G introduction, an intermediate environment (without IMS) was specified. This is called SMS over SGs (evolved Gs interface). A hybrid approach that allows the transmission of native SMS form CS infrastructure over the LTE radio network. SMS over SGs was specified in 3GPP TS 29.118 [4] (running on top of SCTP).

The SGs based on Gs is used to handle mobility management and paging procedures between EPS and CS domain, and, for SMS, to deliver both mobile originating and mobile terminating SMS.

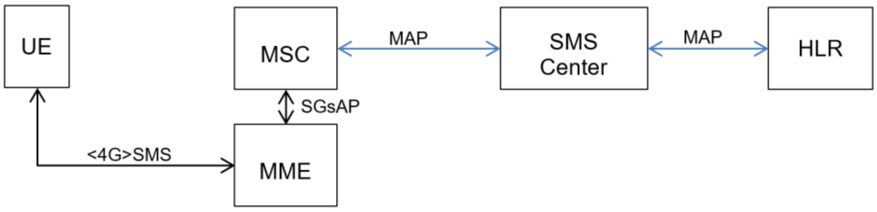


Figure 15- SMS over SGsAP interfaces

4.3 4G SMS over Diameter

Diameter protocol was introduced with 4G, in order to transport SMS between MME and SMS-C, and could also apply on some SGSN supporting EPS interfaces.

The following Diameter interfaces have been defined to support Short Message services.

- S6c interface between HSS and the central SMS function (SMS-GMSC, SMS Router);
- SGd interface between MME, the SMS-IWMSC, the SMS-GMSC and the SMS Router;
- GGd interface between the SGSN, the SMS-IWMSC, the SMS-GMSC and the SMS Router

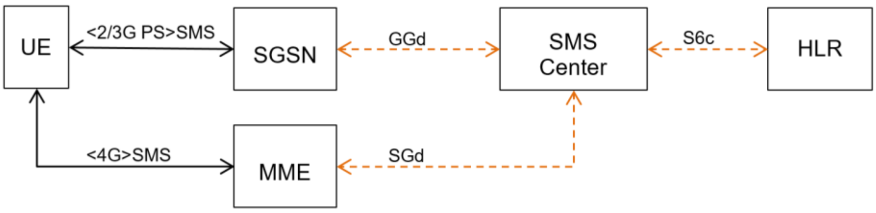


Figure 16- SMS over Diameter interfaces

4.4 IMS SMS over MAP/Diameter

With IMS introduction, IMS network could also support the SMS sent over SIP. IP-SM-GW, placed between the IMS core and the legacy domain, provides the possibility for the users to register and deregister, in order to enable or disable the possibilities to send/receive SMSs over IP.

It is important to notice that IP-SM-GW is connected to the HLR/HSS and is able to communicate with it both with MAP and Diameter:

4.4.1 MAP is used between IP-SM-GW and HLR/HSS

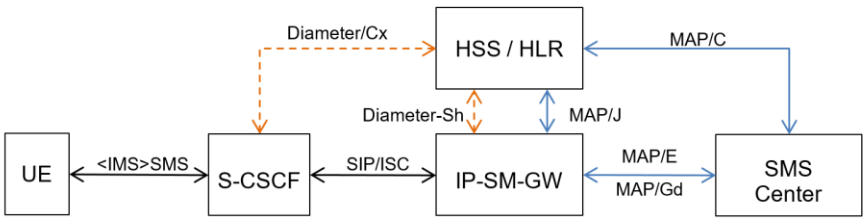


Figure 17- SMS over IMS interfaces (MAP)

4.4.2 Diameter is used between IP-SM-GW and HLR/HSS

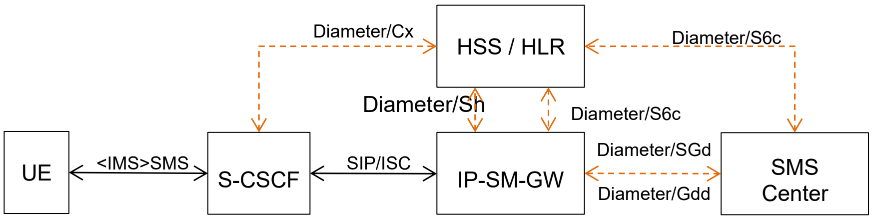


Figure 18 - SMS over IMS interfaces (Diameter)

4.5 5G SMS in MAP-Diameter-HTTP/2

- SMS is defined in 5G as a clear requirement in 3GPP 23.501 [7] [section 4.4.2].
- SMS architecture is defined in 3GPP 29.891[8] [section 9.1].
- MAP and Diameter are supported in 5G between SMSF and SMS-C.

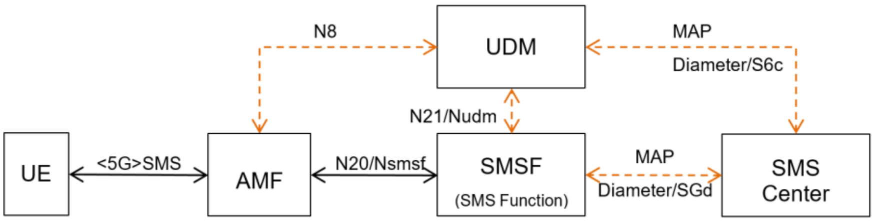


Figure 19 - SMS over 5G interfaces (MAP/Diameter)

Therefore, the 3GPP group responsible for protocols definition, CT4 has decided that network protocols should be used for SBA. It will be HTTP/2 on top of TCP, Transmission Control Protocol (no longer SCTP).

5G signalling (based on HTTP/2-JSON) shall apply in the 5G Core Network. The SMSF also supports legacy SMS-C interworking via the MAP or Diameter interface. So the SMS evolution towards 5G will see the potential support for legacy MAP/Diameter signalling for SMS.

HTTP/2 is also supported in 5G between SMS-C and UDM and SMS-C and SMSF as defined in 3GPP Release 17 version TS 23.540 [25].

- The protocol used on ref point (SM2) could be based on HTTP/2 as specified for Nudm service-based interface.
- The protocol used on ref point (SM10) could be based on HTTP/2 as specified for Niwmsc (for SMS-MO) or Nsmsf (for SMS-MT) service-based interface.

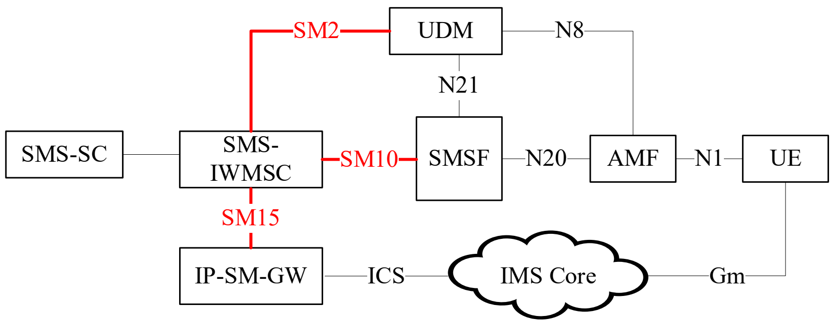


Figure 20 - Non-roaming System Architecture for SBI-based SMS in reference point representation (extract from 3GPP TS 23.540 [25])

5 SMS home architecture

Different architectures are foreseen in the future to transport SMS, taken into account 4G (using Diameter), IMS (using SIP) and 5G evolution.

This section introduces the Home Network architecture .

5.1 2G-3G-4G SMS Architecture based on SS7

The current core network architecture to transport SMS is based on MAP (2/3G) and SGsAP (4G) protocol, capitalising on SS7 networks.

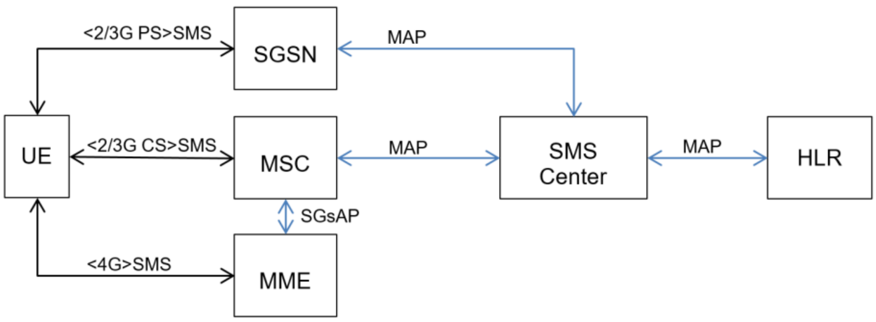


Figure 21 - 2G-3G-4G SMS architecture based on SS7 (MAP/SGsAP)

5.2 2G-3G-4G SMS architecture based on SS7 and IMS

The IMS core network architecture to transport SMS over IP is described in the following diagrams for (i) in combination with the legacy CS network; (ii) standalone EPC network.

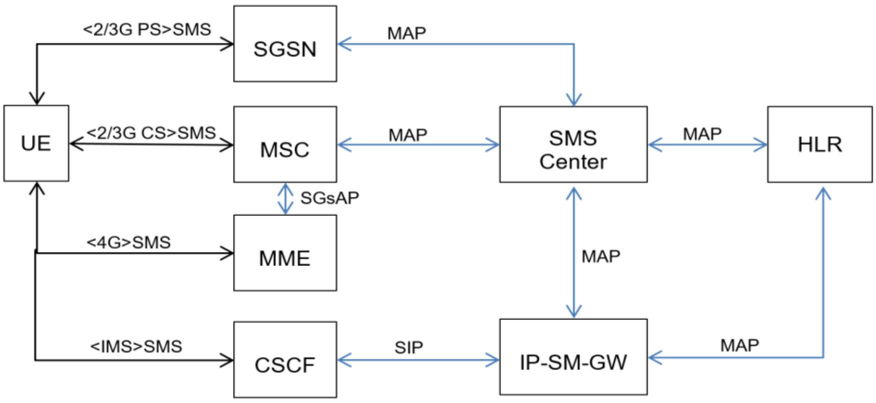


Figure 22- 2G-3G-4G SMS architecture based on SS7 and IMS (MAP/SMSoIP)

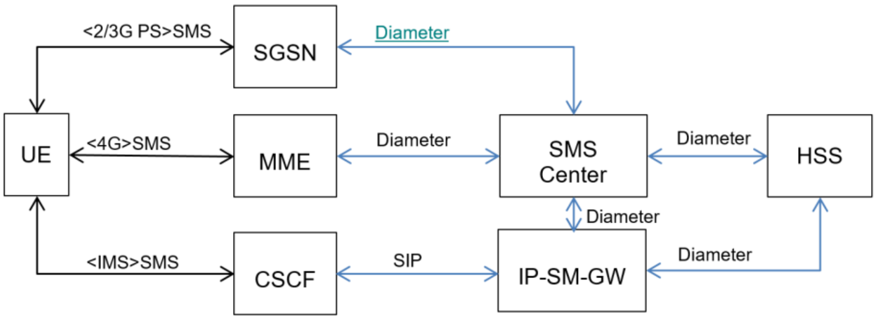


Figure 23 - EPC/IMS SMS architecture (Diameter/SMSoIP)

5.3 2G-3G-4G SMS Architecture based on Diameter – IMS and HTTP/2

Different architectures are foreseen in the future to transport SMS, taken into account 4G (using Diameter), IMS (using SIP) and 5G evolution.

The 4G SMS could be transported by Diameter while IMS/5G SMS could select MAP or Diameter or HTTP/2 in order to interconnect with SMS-C and HLR/HSS/UDM.

Commented [KL4]: Also to add the HTTP/2 interface support for the IP-SM-GW, as defined in 23.540

Commented [EG5R4]: Figure Updated

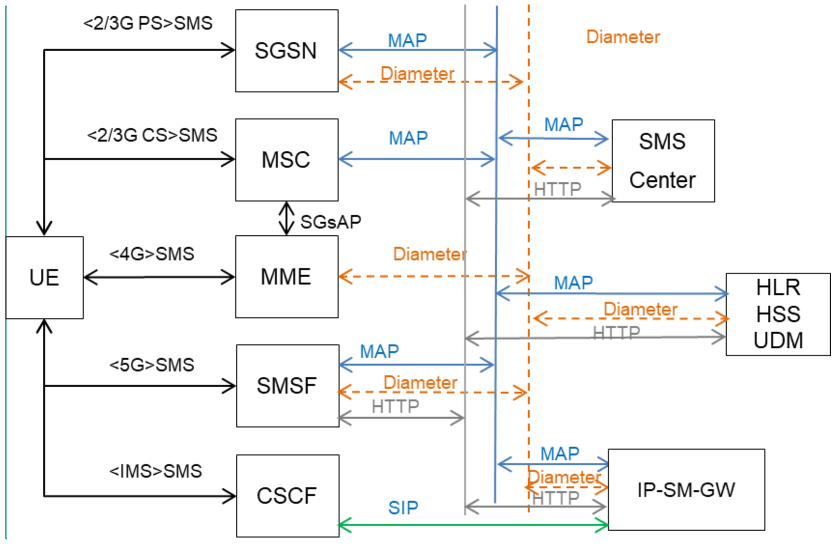


Figure 24 - Future SMS architecture (4G/IMS/5G)

Note: For 4G SMS, and at this stage, no recommendation whether to use Diameter or SGsAP can be done.

Note: For 5G, is it better to reuse MAP, or to implement Diameter or to move directly to HTTP/2

5.4 Pro/Cons SMS home architectures

The following table provides an in-depth comparison of the pros and cons associated with various SMS home architecture protocols, including SS7 (MAP), Diameter, HTTP/2, and SIP. Each architecture demonstrates distinct advantages and limitations, which influence its suitability for specific network generations, from legacy 2G and 3G systems to advanced 5G networks.

SMS home architecture	Pros	Cons
based on SS7 (MAP)	MAP is a common transport mechanism for 2/3/4(SGs)/5G	Need to have MSC involved
based on Diameter	Diameter is a common protocol for 4G and IMS Bypass MSC (no longer needs to be attached on CS, especially important for objects) Enable IP wake-up	Migration from MAP to Diameter

based on HTTP/2	HTTP/2 is the common 5G protocol Assure 5G security improvement	Migration needed to HTTP/2
based on SIP	Common protocol for VoLTE Bypass MSC (no longer need to be attached on CS)	Requires IMS infrastructure, which may not be available in all regions or networks.

Table 1 Protocols Pros Vs Cons

6 SMS roaming architecture

This section will analyse the current and potential future of the roaming architecture.

Background

SMS roaming refers to the ability of a mobile phone user to send and receive SMS (Short Message Service) messages while they are outside their home mobile network coverage area, typically when traveling abroad.

SS7-signaling based roaming. The current roaming architecture is based on SS7 network connecting the VPMN, and HPMN.

All roaming SMS are routed via the SS7 network: 4G SMS are anchored to the MSC.

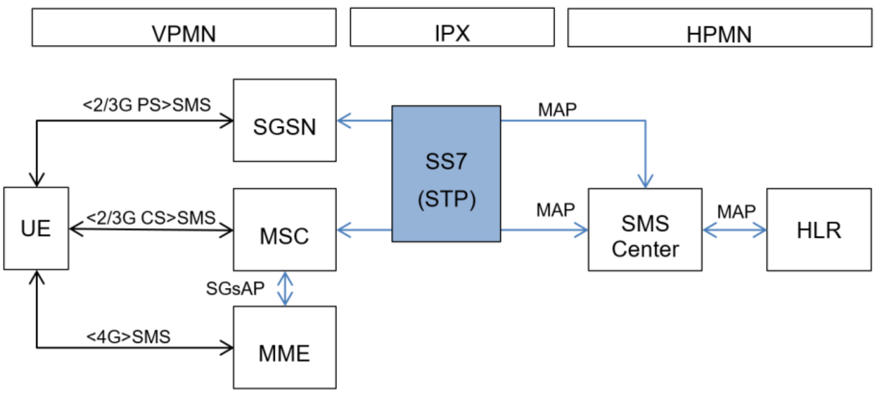


Figure 25 - Current roaming SMSMO architecture (SS7)

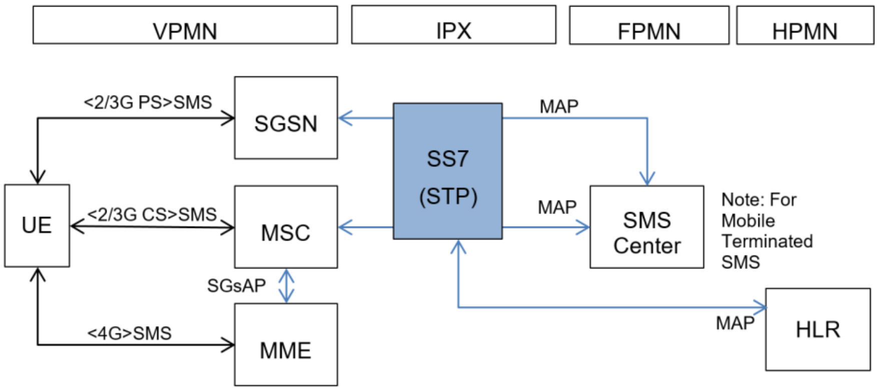


Figure 26 - Current roaming SMSMT architecture (SS7)

6.1 Evolved roaming SMS architecture

6.1.1 Diameter based roaming architecture

For roaming, the key issue is related to 4G (and 5G evolution) for the usage of Diameter to replace MAP protocol. For IMS, the choice between MAP and Diameter is a HPMN internal issue, because IMS SMS roaming is always anchored to the home IP-SM-GW (S8HR, S8 Home Routing scenario).

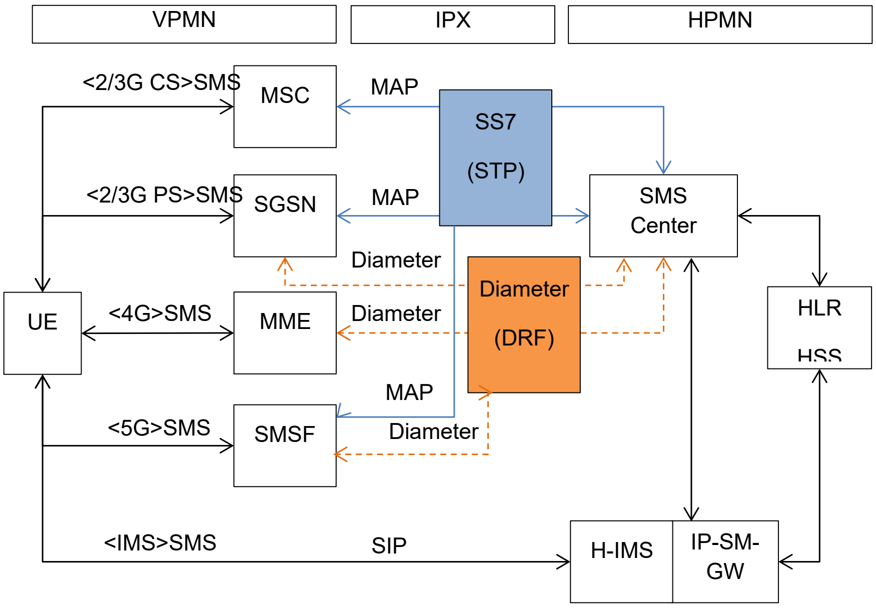


Figure 27- Future roaming SMS architecture (Diameter)

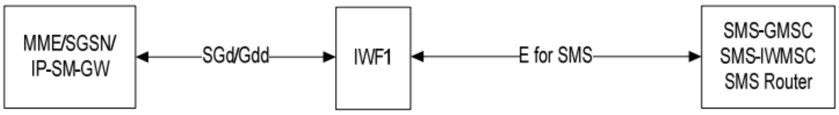
Note: SGSN could also use Diameter for Location Update procedures (instead of MAP)

6.1.2 Roaming in VPLMN with no serving MSC and using InterWorking Function

With 2G/3G network closure (including MSC capabilities. Otherwise, the SGs interface connecting MME and MSC will still be utilized for SMS communication), mobile operators need to maintain SMSoNAS mobile originating and mobile terminating capability without SGs interface.

In this case, it is mandatory to move from MAP to DIAMETER and deploy SGd interface between MME and Home SMS-C of ALL roaming partners which has MAJOR impact for them.

To avoid impacts on roaming partners, visited network shutting down its MSCs could deploy an InterWorking Function (IWF) as defined in 3GPP TS 29.305 [23]. Using an IWF makes it possible for Home Network roaming partners to continue to use MAP E interface while visited networks move to Diameter SGd/Gdd interfaces. This InterWorking Function (IWK) could be deployed in the visited network (Closing MAP interfaces) or in IPX by International Carrier.



Extract from 3GPP TS 29.305

Figure 28- Interworking MAP/Diameter

IMPORTANT Prerequisite:

To make possible SMS_MT using IWF, Home SMS-C need to retrieve MME customer location via MAP C HLR query or via S6c HSS query as illustrated in Figure below.

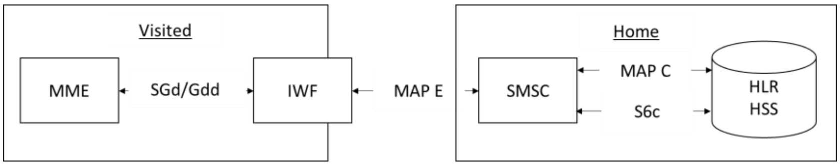


Figure 29- Interworking MAP/Diameter (mapping on networks)

Two options are possible to enable a successful HLR/HSS query:

- Option 1: No support for S6c in HSS in the Home Network
  MAP C interface can contain MME related information if the S6c interface is not supported in HSS or SMS-C (as defined in 3GPP TS 23.272 [2] annex C for the SMS in MME architecture). Subscription data management in HLR/HSS related to SMS in MME and handling of the corresponding information over MAP C

interface is not defined by 3GPP and is implementation specific (and may not be supported by all HLR/HSS providers).

- Option 2: S6sc need to be supported in HSS in the home Network.
  This enables support for SRR to collect information related to the visited MME for SMSoNAS_MT routing.

  Note: Mobility Management Entities (MMEs) are unable to produce SMS Call Detail Records (CDRs) that are essential for wholesale billing in roaming scenarios. To address this issue, it is suggested that Interworking Functions (IWFs) are capable of generating CDRs to compensate for the absence of MMEs.

6.1.3 SBA based SMS architecture (HTTP/2)

Service Based Short Message service is defined in 3GPP TS 23.540 [25].

Commented [KL6]: SMS over SBI is specified in 23.540. TR 29.829 is a technical report to study SMS over SBI.

Reusing N32 for SMS transport in roaming cases has significant benefits, including making operation easier (because of the unique N32 interface) and providing the same degree of security as 5G design for all control-plane messages sent and received between two mobile operators while roaming and also for national and international SMS interconnections.

The following picture introduces high level architecture related to SMS-MO and SMS-MT using N32 interface in the Roaming context. Detailed call flow is described in annex G1.

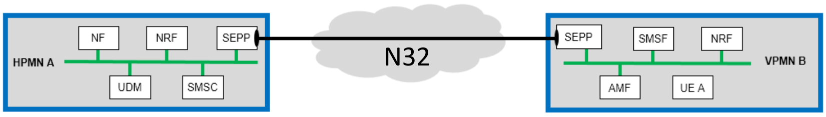


Figure 30 - SBA SMS architecture (HTTP/2)

However, MAP and the SS7 network will gradually disappear in favour of the 5G-proposed N32 connection. Usage of N32 imposes mobile operators and international carriers to migrate SMS traffic from MAP to HTTP/2 as illustrated in the next pictures.

6.1.4 Overall roaming SMS architecture

The next figure proposes a complete picture of the roaming SMS architecture.

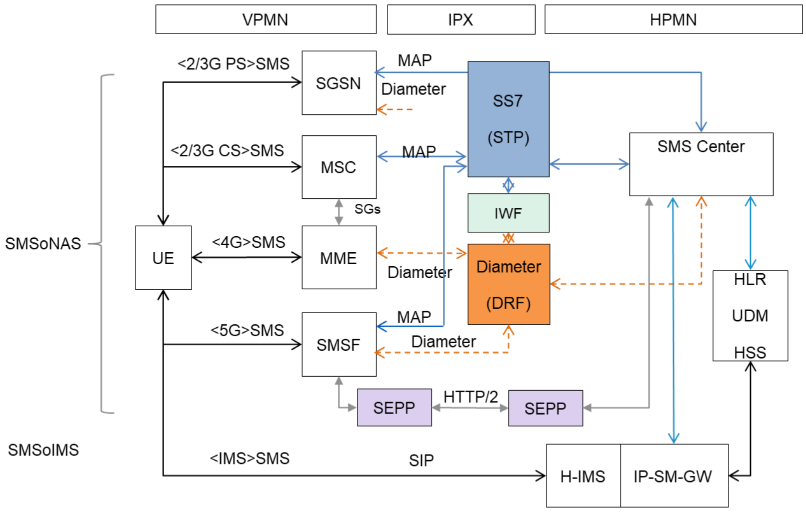


Figure 31- Evolved roaming SMS architecture (summary)

6.2 Pro/Cons for SMS roaming architectures

SMS roaming architecture	Pros	Cons
Based on SS7 (MAP)	MAP is a common transport mechanism for 2/3/4G	Continued potential support in 5G although concerns for SS7 security will need to be addressed especially on the roaming interface.
Based on Diameter	Reduce SS7 investment for MNO and Carriers Bypass MSC (no longer need to be attached to CS), especially for MIoT Enable IP wake-up Future proof for 5G?	New interface for roaming Diameter vulnerability could be an issue (today) or an advantage (using signed AVP), specially to protect networks against SMS-MO spoofing
Using IWK (MAP/Diameter)	Avoid need for home network to deploy Diameter SGd and Gdd interface after Visited network closing MAP E interface.	Limited to Home network being able to provide MME customer location after HLR or HSS interrogation.
SBA Architecture (HTTP/2)	Unique Roaming Interface – N32 same degree of security as 5G design	New interface for SMS roaming

Commented [KL7]: Please note also that 23.540 has specified only the SMS NON-ROAMING architecture. I have yet to find the roaming architecture for SMS over SBI as specified by 3GPP.

Commented [EG8R7]: What is your proposal? Add a note?

Commented [KL9R7]: I think we're fine within the context of this table. 23.540 may still be evolving so if we put a note on this, we may end up needing to amend this note if 3GPP defines the SMS roaming architecture.

Commented [EG10R7]: OK. We keep the current proposal

7 SMS interconnection architecture

This section will analyse the current and potential future interconnection architecture for national and international environment.

Background

SMS interconnection is the process by which SMS messages are transmitted and received across different mobile networks, enabling users on one network to send text messages to users on another network.

7.1 Bilateral SS7- based architecture

All interconnection SMS are routed via the SS7 network: 4G SMS are anchored to the MSC.

In the receiver network, an SMS Firewall (FW) is responsible to Home Route all incoming SMS, especially in order to protect receiver network (signalling vulnerability).

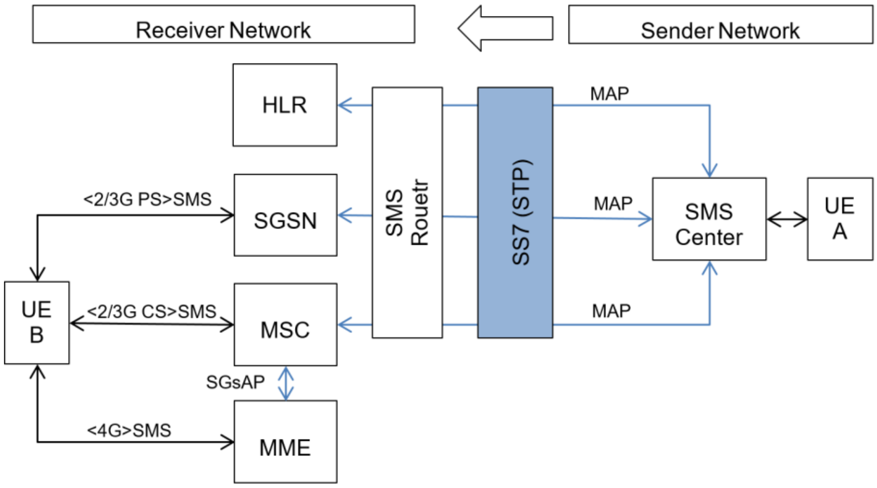


Figure 32 - Current interconnection SMS architecture (SS7)

Note: SMS Router is highly recommended in order to protect the network against signalling vulnerabilities.

7.2 Evolved bilateral architecture

7.2.1 Impact of evolved access network on SMS interconnection

The interconnection could be affected by the evolution of the access network technology, moving to 4G, IMS and 5G.

The figure hereafter describes the evolution based on a MAP NNI (Network-to-Network Interface) between the Sending and the Receiving Networks: the SMS firewall, implementing the Home routing policy, will be able to deliver the SMS over various access technologies, using MAP or Diameter. Typically, this function is supported by the MAP IWF as described in 29.305.

The SMS home Routing policy is also mandatory in order to hide the access technology to the Sender network.

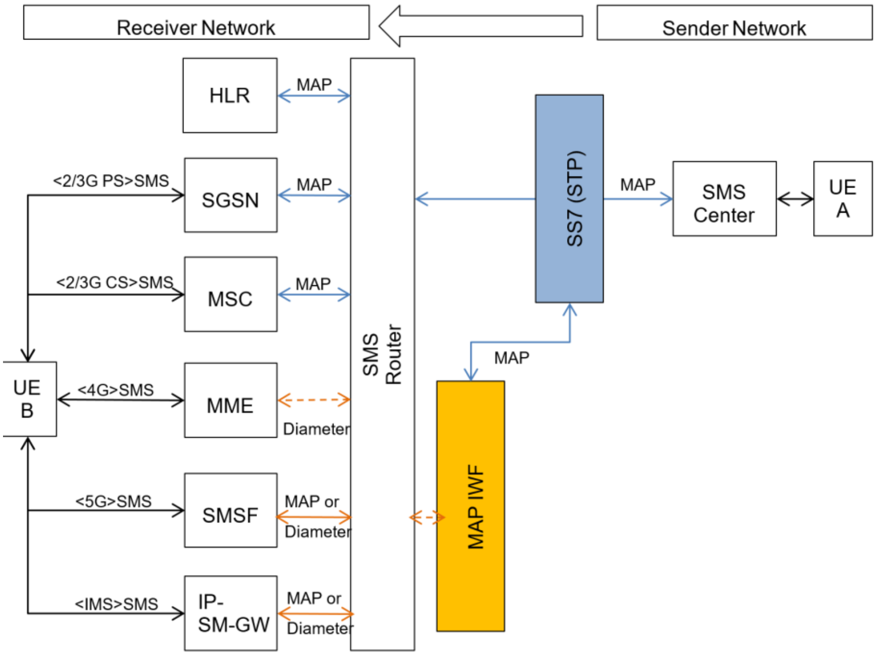


Figure 33 - Future interconnection SMS architecture (Access network evolution)

7.2.2 Evolution of SMS interconnection NNI

The NNI could also evolve from MAP to Diameter or HTTP/2 for SMS interconnection. Call flow for SMS interconnection with SBI is described in annex G2.

The requirement to control number portability to guarantee SMS delivery to the appropriate operator supporting the target user will slow down the migration of SMS interconnection on DIAMETER or HTTP/2.

Commented [KL11]: Please add HTTP/2 support for IP-SM-GW

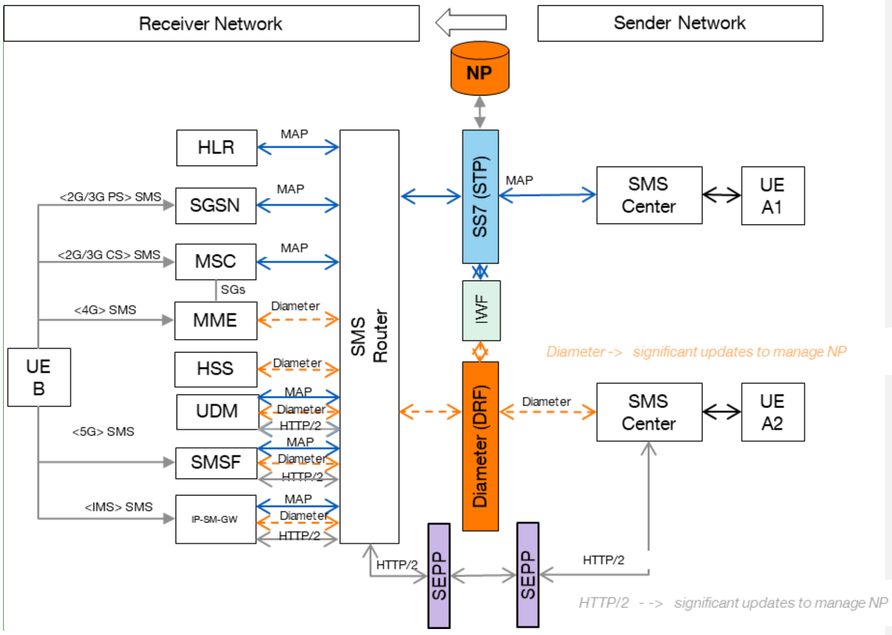


Figure 34 - Future interconnection SMS architecture (NNI evolution)

The MAP protocol is used to manage Mobile Number Portability (MNP) at the level of interconnection. To ensure MNP administration based on DIAMETER (4G) or HTTP/2 (5G), significant changes are required.

7.2.3 Pro/Cons for SMS interconnection architectures

SMS interconnection architecture	Pros	Cons
based on SS7 (MAP)	MAP is a common transport mechanism for 2/3/4G Number portability resolution	Continued potential support in 5G although with some concerns for SS7 security that will need to be addressed especially on the interconnect interface.

based on Diameter	Reduce SS7 investment for MNO and Carriers Future proof for 5G?	New interface for interconnection Diameter vulnerability could be an issue (today) or an advantage (using signed AVP), specially to protect networks against SMS-MT faking Number portability resolution to be re-build
based on HTTP/2	Unique interface for 5G interconnect	New interface for SMS interconnection Number portability resolution to be fully re-build

Table 2 Interconnection Pros Vs Cons

7.3 SMS Hubbing Architecture-based on SS7

SMS Hubbing is a telecommunications solution designed to streamline the exchange of SMS messages among mobile network operators (MNOs) worldwide. Rather than relying on direct connections between operators, SMS hubbing leverages a centralized hub or intermediary to route messages efficiently. This approach is especially beneficial for managing international SMS traffic.

Currently, client operators have the flexibility to connect with the OC-SMS Hubbing Solution provider using either an SS7 MAP-based interface or an IP-based SMPP interface, as outlined in the GSMA IR75 Open Connectivity SMS Hubbing specifications

Note: To simplify, the SMS Router in the receiver network is not represented but can exist.

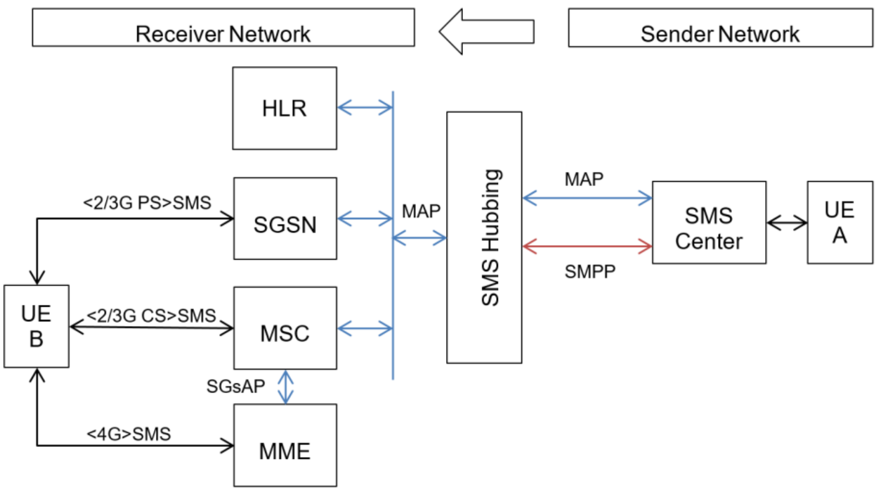
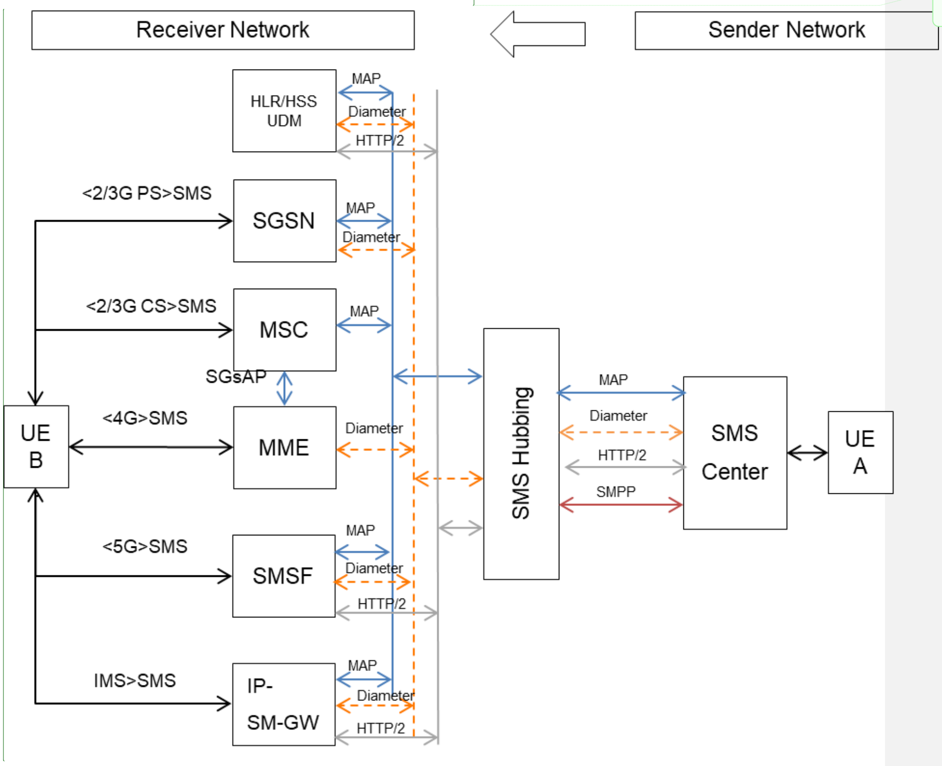


Figure 34 - Current SMS Hubbing architecture (SS7/SMPP)

7.4 Evolved SMS Hubbing architecture.

The client operator connection could be affected by the evolution of the network access technology, moving to 4G, IMS and 5G.

With 4G, the SMS Hubbing solution provider could propose the client operator a new Diameter interface to connect SMS Hubbing solution.



Commented [KL12]: Please add support for HTTP/2 for the IP-SM-GW, and HLR/HSS/UDM with HTTP/2 as well.

Figure 35 - Future SMS Hubbing architecture (SS7-SMPP-Diameter-HTTP/2)

Note: Diameter - HTTP/2 are currently not defined as possible interfaces to connect the client operator to SMS Hubbing solution in GSMA PRD IR.75 Open Connectivity SMS Hubbing v.2.0.

7.5 Pro/Cons for SMS Hubbing architecture

Pro/Cons are similar to Pro/Cons for NNI interconnection.

SMS Hubbing Architecture	Pros	Cons
based on SS7 (MAP)	MAP is a common transport mechanism for 2/3/4G Number portability resolution	Continued potential support in 5G although with some concerns for SS7 security that will need to be addressed especially on the interconnect interface.
based on Diameter	Reduce SS7 investment for MNO and Carriers Future proof for 5G?	New interface for interconnection Diameter vulnerability could be an issue (today) or an advantage (using signed AVP), specially to protect networks against SMS-MT faking NP portability resolution to be re-build
based on HTTP/2	Unique interface for 5G interconnect Benefit of 5G security mechanisms	New interface for SMS interconnection Number portability resolution to be fully re-build

Table 3 SMS Hubbing Pros Vs Cons

Commented [KL13]: Please note that SMS Hubbing over SBI may be impacted by the MNOs' choice of N32 security interworking model e.g. PRINS, TLS. Essentially SMS Hubbing over SBI fits the TLS hop-by-hop model.

Commented [EG14R13]: Looi - do you agree with note proposed (I re-use you rcomment)

Commented [KL15R13]: Please see my proposed amendment.

Note : SMS Hubbing over SBI may be impacted by the MNOs' choice of N32 security interworking model e.g. PRINS, TLS as described in NG.113 [28].

8 Ways to move forward

The results of the SMS survey carried out in 20xx provide a very interesting overview on the SMS evolution and the possible introduction of new protocols to support SMS.

The responses of different operators who participated in this survey clearly indicate a change in the SMS according to the type of user and not an overall trend for any type of users.

Three categories of users could be identified:

1. Legacy users - there are no drivers to justify a change of technology for the SMS transport for legacy users.
2. IMS User - for IMS users, the SMS migration to IP using SIP is no longer in doubt, benefiting from VoLTE convergence and capabilities to offer SMS service under Wi-Fi coverage. This <IMS> SMS technology can also be considered in a roaming situation (SMS-MO and SMS-MT).

Objects - as the survey showed, operators consider SMS to be a very important technical enabler in the context of MIoT. The most frequently use cases are the "Wake Up IP session" and OTA, besides standard MO and MT-SMS. But in the particular context of MIoT, the SMS service must be considered without a double attachment on the circuit switch and packet switch networks. Objects should only be attached on packet switch in order to minimise non futureproof capacity extension on the legacy network. With MIoT, SMS service migration on diameter seems recommended and also in line with Diameter eco-system to connect SCEF.

Note: not all roaming partners will be prepared to use SMSoDiameter and will continue to use SMSoMAP. The mobile operator closing 2G/3G (radio and core network) must apply an interworking function between Diameter and MAP, as outlined in section 6.2.2, to ensure SMSoNAS service continuation with all roaming partners.

The figure below illustrates the trend resulting from the analysis of this document and shows a differentiated evolution of the support of the SMS service according to the type of user: Legacy, IMS or Object.

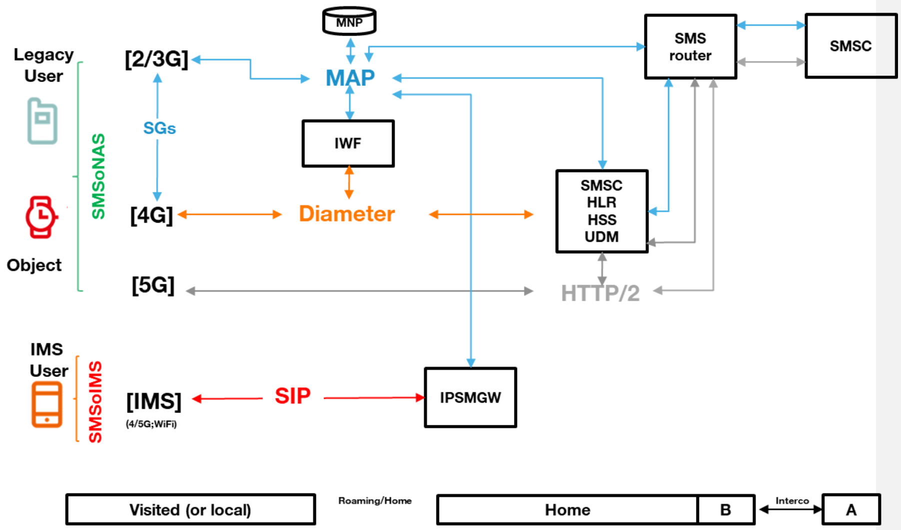


Figure 36 - SMS Evolution by User type

The technology that will be used to support the SMS will therefore depend on the type of user as already mentioned but also according to the use case: Home, Roaming or Interco.

Roaming evolution

Legacy and Object: MAP will be utilized for 2G, 3G, and 4G. Diameter will be utilized on 4G after MAP (2G/3G radio and core network closure) is closed, although IWF (supplied by an international carrier) will be required to ensure that short message service continues with roaming partners that are not Diameter capable. Short messages can be sent both at home and while roaming with 5G partners using the 5G-defined HTTP/2 protocol.

IMS users (many smartphone users) SIP will be utilized for 4G, 5G.

<u>Interconnection evolution</u>

Legacy and IMS: SMS connectivity requires mobile operators to control mobile number portability to guarantee short message delivery. Using a protocol other than MAP will necessitate a major update in order to manage NP. For HTTP/2, 3GPP TS 29.578 [26] describes the MNPF network function and associated APIs. How these APIs are used in interconnect scenarios has not been defined.
MAP will therefore continue to be utilized for SMS connections. Transition to HTTP/2 could not be considered before the number portability management process on HTTP/2 is available.

Object: Not applicable

As a conclusion, we can say that the evolution of the SMS technology will not be uniform for all users but will depend on the specific needs of the three major classes of users identified: Legacy, Object and IMS

The table below allows a clear visual of the evolution of the technology supporting the SMS service according to the type of user and the use case.

	Home	Roaming	Interco
Legacy User (SMSoNAS)	Diameter (4G) or HTTP/2 (5G)	Diameter (+ IWF) (4G) or HTTP/2 (5G)	MAP or HTTP/2
Object (SMSoNAS)	Diameter (4G) or HTTP/2 (5G)	Diameter (+ IWF) (4G) or HTTP/2 (5G)	NA
IMS User (<IMS> SMS)	SIP	SIP	MAP or HTTP/2

Table 4 Evolution of Technology

Annex A <2/3G> SMS over MAP

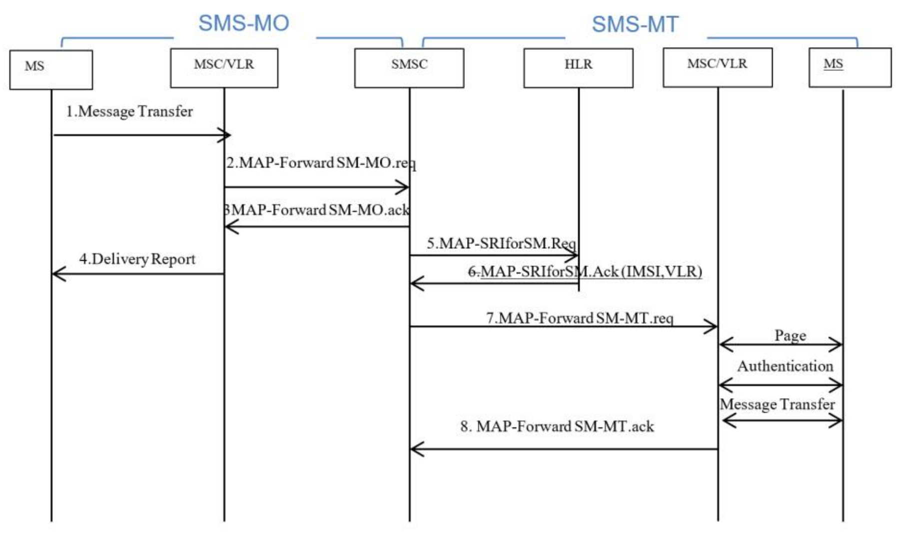


Figure 37 - SMS Over Map Signaling flow

1. The MS transfers the SM to the MSC. The MSC interrogates the VLR (Visitor Location Register) to verify that the message transfer does not violate the supplementary services invoked or the restrictions imposed.
2. The MSC sends the short message to the SMS-C using the forwardShortMessage operation.
3. The SMS-C acknowledges the MSC the successful outcome of the forwardShortMessage operation.
4. The MSC returns the MS outcome of the MO-SM operation.
5. After completing its internal processing, the SMS-C interrogates the HLR and receives the routing information for the mobile subscriber.
6. The SMS-C sends the short message to the MSC using the forwardShortMessage operation. The MSC retrieves the subscriber information from the VLR. This operation may include an authentication procedure.
7. The MSC transfers the short message to MS.
8. The MSC returns the SMS-C the outcome of the forwardShortMessage operation. If requested by the SME (Short Message Entity), the SMS-C returns a status report indicating delivery of the short message.

Annex B   <4G> SMS over SGsAP and MAP

B.1   Introduction

SMS over SGs is independent from Circuit Switched Fall Back. As no fallback takes place, SMS over SGs does not require overlapped coverage of LTE and legacy technologies.

Supporting SMS over SGs requires some slight modifications to the EPS attach procedure, which is based on the combined EPS/IMSI (International Mobile Subscriber Identity) Attach procedure. Compared to the conventional attach, additional information about CS domain capabilities is exchanged. The EPS Attach Type in the ATTACH REQUEST message indicates that the UE requests a combined EPS/IMSI attach and informs the network whether the UE requests “SMS only” services (“SMS only” – included in the ATTACH REQUEST only if no CSFB is required).

During the Attach, the SGs association between MME and MSC/VLR entities is created.

B.2   4G SMS over SGs Mobile originated case.

The following pictures are taken from 3GPP TS 23.272 [3] technical specification [section 8 other CS Services].

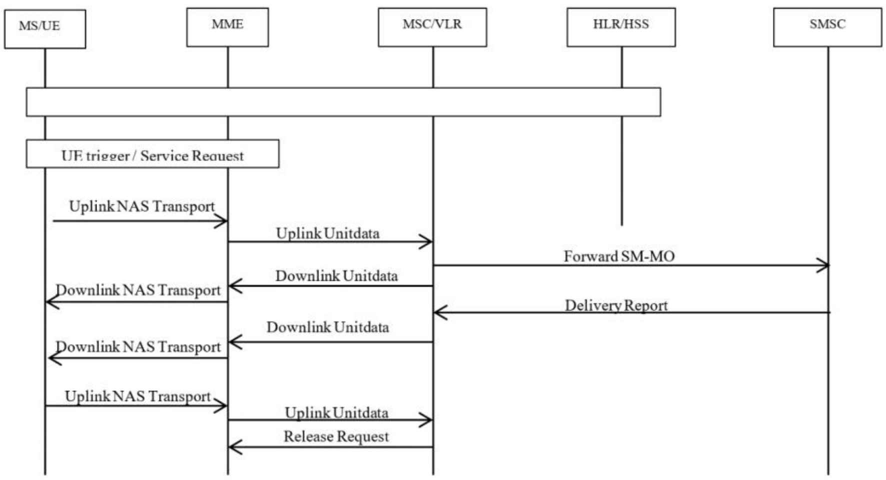


Figure 38 - SMSO over SG flow

After the EPS/IMSI Attach, the UE triggers a service request to initiate a mobile originating SMS procedure. The SMS is encapsulated in a NAS message and sent to the MME, which forwards the SMS to the MSC/VLR that acknowledges the reception of the SMS to the UE. The SMS is forwarded to the SMS-C that returns a Delivery Report message. The Delivery Report is forwarded back to the UE. The UE acknowledges the reception of the Delivery Report to the MSC/VLR and the MSC/VLR indicates to the MME that no more NAS messages that need to be tunnelled.

B.3 4G SMS over SGs mobile terminated case.

The following pictures are taken from 3GPP TS 23.272 [3] technical specification [section 8 other CS Services].

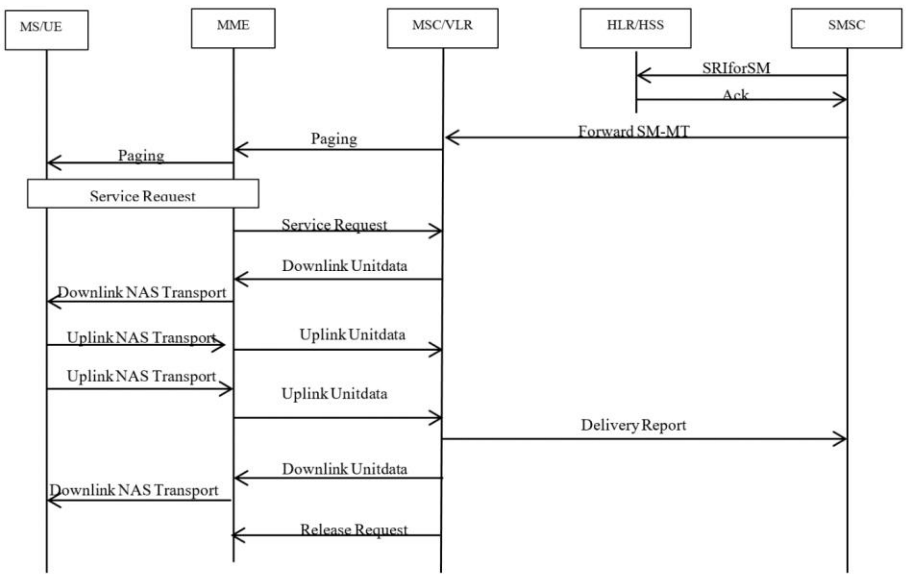


Figure 39 - SMST over SG flow

The service Center initiates the transfer of the SMS. The HLR is requested for the routing information for the SMS services and the SMS is forwarded to the right MSC/VLR where the UE is attached.

The MSC/VLR issues a paging to the MME, and the MME initiates a paging to each LTE base station with cells in the tracking area(s) in which the UE is registered. Upon successful paging, the UE sends a Service Request message to the MME who issues a Service Request to the MSC/VLR. The MSC/VLR builds the SMS and forwards it to the MME which encapsulates the SMS in a NAS message to the UE. The UE acknowledges the reception of the SMS to the MSC/VLR and Issues a delivery report (if initially requested). The Delivery Report is forwarded to the SMS-C. The MSC/VLR acknowledges the reception of the Delivery Report to the UE and indicates to the MME that no more NAS messages need to be tunnelled.

Annex C <4G> SMS over Diameter

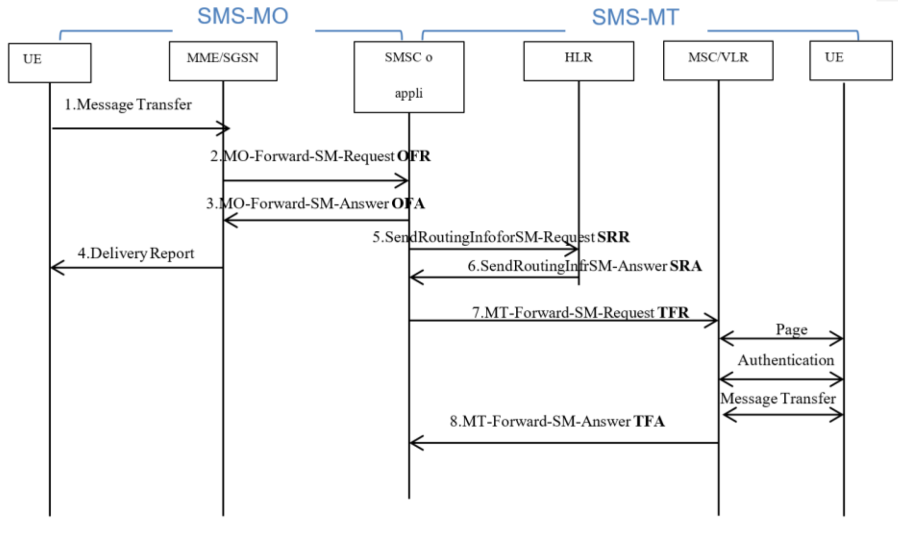


Figure 40 - SMS over Diameter flow

1. The UE transfers the SM to the MME/SGSN. The MME/SGSN shall check if the SMS related subscription data (e.g. ODB, Operator Determined Barring data and Call Baring) allows the forwarding of the short message.
2. The MME/SGSN sends the short message to the SMS-C using the forwardShortMessage operation (**OFR)**.
3. The SMS-C acknowledges to the MME/SGSN the successful outcome of the forwardShortMessage operation (**OFA)**.
4. The MME/SGSN returns to the MS outcome of the MO-SM operation.
5. After completing its internal processing, the SMSC interrogates the HSS and receives the routing information needed for routing the short message to the serving MME/SGSN.
6. The SMS-C sends the short message to the serving MME/SGSN using the forwardShortMessage operation (**TFR**). The MME/SGSN checks if the IMSI is known. Then the MME/SGSN attempts to deliver the short message to the UE is, if successful, the MME/SGSN returns a Result Code set to Diameter_Success. In any other case, the relevant error is returned.
7. The MME/SGSN transfers the short message to MS.
8. The MME/SGSN returns to the SMS-C the outcome of the forwardShortMessage operation (**TFA**). If requested by the SME, the SMS-C returns a status report indicating the delivery of the short message.

C.1 Introduction

As described in GSMA IR.92 [13], VoLTE network has to support the SMS sent over SIP. The VoLTE phone will receive a common (binary) SMS and the native client will display this message as any other. The only difference is that this time the SMS is sent from an IMS network over SIP protocol. The purpose is not just to support common text messages, but (more importantly) to support OTA messaging for (U)SIM provisioning, SMS 'non-text' applications or Message Waiting Indication for Voice Mail.

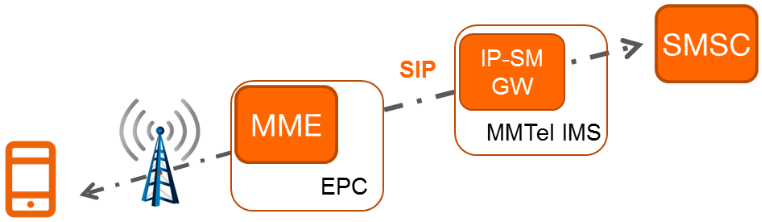


Figure 41 - SMS over IMS interfaces

IMS allows the sending of messages of 200 bytes with acknowledgement. The messages are sent between users in real-time. The service provides a fast enough exchange of messages for an interactive conversation to take place.

In IMS there are two types of messages: page-mode message and session-mode message: for SMS, only page mode will be used.

A page-mode message is very similar to an SMS. It is a SIP MESSAGE. It is not related to any previously sent message and requires no answer. It can be a test sent between two subscribers, or a notification. The User Agent Client (UAC) sends the SIP MESSAGE to the proxy, and the proxy forwards it to the User Agent Server (UAS), which responds with a 200 OK message.

Example

```
MESSAGE sip:bob@example.org SIP/2.0
Via: SIP/2.0/TCP alicepc.example.com;branch=z9hG4bK776sgd43d
Max-Forwards: 70
From: Alice sip:bob@example.org
Call-ID: a3d3hdj5ws223ns61k8djds
Cseq: 1 MESSAGE
Content-Type: text/plain
Content-Length: 31

Hi, what is going today,
```

The general form of SIP MESSAGE is presented above. The first line defines the message type, followed by a number of headers used for the routing of the message and the control of the session. At the bottom we find the message body, this is an actual case of text sent by the subscriber

Annex D <IMS> SMS over MAP/Diameter

D.1 IPSMGW Functionalities

The network functionality which provides messaging service in the IMS network is called IP-SM Gateway (IP-SM-GW) and from the IMS point of view it is an Application Server.

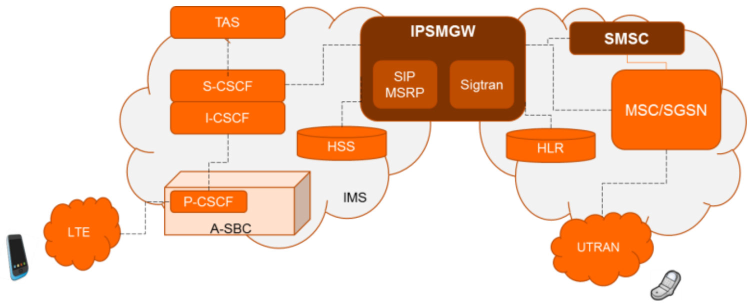


Figure 42 - IPSMGW architecture

From the picture above we can see that the IP-SM-GW is a bridge between 2/3G networks and IMS. We have two types of IP-SM-GWs defined in 3GPP TS 23.204 [6] (and some OMA enhancements in 3GPP TR 23.824). Firstly, it is a Service Level Interworking (SLI) which can work with Session or Pager Mode Messaging. Then it is a Transport Level Interworking (TLI) which can work with SMS over IP only (SMoIP). This time we will focus on the TLI. The specification of the TLI is the 3GPP 24.341. If not familiar with the SMS flow, the SMS in 2G/3G first can be studied.

3GPP 23.204 [6] has identified the following function to be supported by IP-SM-GW:

- Identify the domain where the short message must be delivered (CS, DS or IMS).
- Assures the transmission to the legacy network Seamless:
    - The SMS-GMSC sees it as if it where MSC or SGSN connecting to it via MAP;
    - The SMS-IW-MSC sees it as if it where MSC or SGSN, connecting to via MAP.

- Responds with its own address to the Routing Information for Short Message MAP requests received from the HSS
- When sending a message to the legacy domain, it must connect via the HSS to find the address of the MSC/SGSN concerned
- Keep the data correlation between the MSIDN/IMSI and the address of the associated S-CSCF
- In case the Short Message is sent from IMS towards legacy domain, it must check that the sender and receiver addresses are correct in the SIP headers
- For messages sent from legacy domain towards IP based domain, a translation from the MSIDN/IMSI to TEL URI or to SIP URI (only possible if IMSI information is available), must be done
- Act as an Application Server for the IMS core
- To read from the HSS and interpret the available flags for the SMS receiver.

The introduction of the IP-SM-Gateway has an impact on the function to be supported by HSS. These “complementary” functions are also described in the 3GPP 23.204 [6].

- To now for each subscriber the address of its corresponding IP-SM-GW
- Have flags for each subscription (terminal) which indicate its registration to an IP-SM-GW
- To respond with the address of the MSC/SGSN to the Routing Information for Short Message requests received form the IP-SM-GW
- To forward to the IP-SM-GW the Routing Information for Short message query. It also must respond with the IMSI and the associated MSC/SGSN address
- When the terminal is not available to receive of the message, the HSS stores the address of the SC in the Message Waiting Data file. It must then inform the SC when the terminal becomes available for receiving the message through the IP-SM-GW
- Send a notification to the IP-SM-GW when the user becomes available after a delivery failure
- Accept delivery status reports from IP-SM-GWs instead of SMS-GMSC.

D.2 SMS transfer successfully sent from IMS

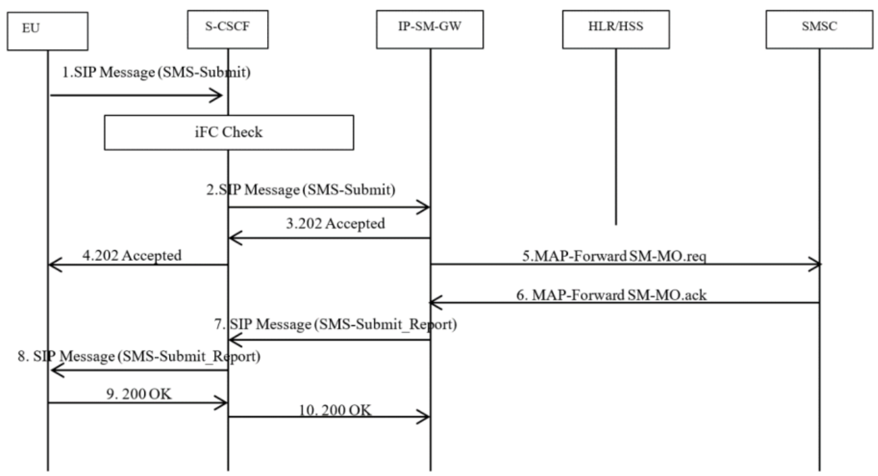


Figure 43 - SMS transfer via IMS flow

1. UE submits the SMS message (SMS-Submit, SC Address) to the S-CSCF using the SIP Message method.
2. S-CSCF forwards the Message to IP-SM-GW based on the stored iFC (Initial Filter Criteria). iFC is a service mark in the service profile of the SMS originator (if the sender has no subscription to SMS service, iFC is provided with SMS filtering/blocking).
3. IP-SM-GW acknowledges the SIP message with 202meaning; this means the message has been received but not yet delivered to the destination user.
4. SIP message acknowledges that is forwarded by S-CSCF to UE.
5. IP-SM-GW performs service authorization based on the stored subscriber data. IP-SM-GW shall check whether the subscriber is authorised to use the short message service (e.g. Operator Determinating Barring), similar to the

authorization performed by MSC/SGSN when SMS is delivered via CS or PS; Moreover, the IP-SM-GW will check if the user is authorised to receive IMS encapsulated Short Message delivery procedure. If the user is not authorised, IP-SM-GW will not forward the message to SMS-C but will return the appropriated error information to the UE in a failure report. Otherwise, the IP-SM-GW extracts the SMS message (SMS-Submit) and forwards it to the SMS-C (SC Address) using a standard MAP message.

6. SMS-C sends a MAP message acknowledgement to IP-SM-GW
7. IP-SM-GW sends a SUBMIT-REPORT to S-CSCF, using the SIP message method.
8. S-CSCF sends the SUBMIT-REPORT.
9. UE acknowledge the SUBMIT-REPORT
10. Acknowledgement of the SUBMIT-REPORT is forwarded by S-CSCF to IP-SM-GW.

D.3 Successful SMS reception via IMS.

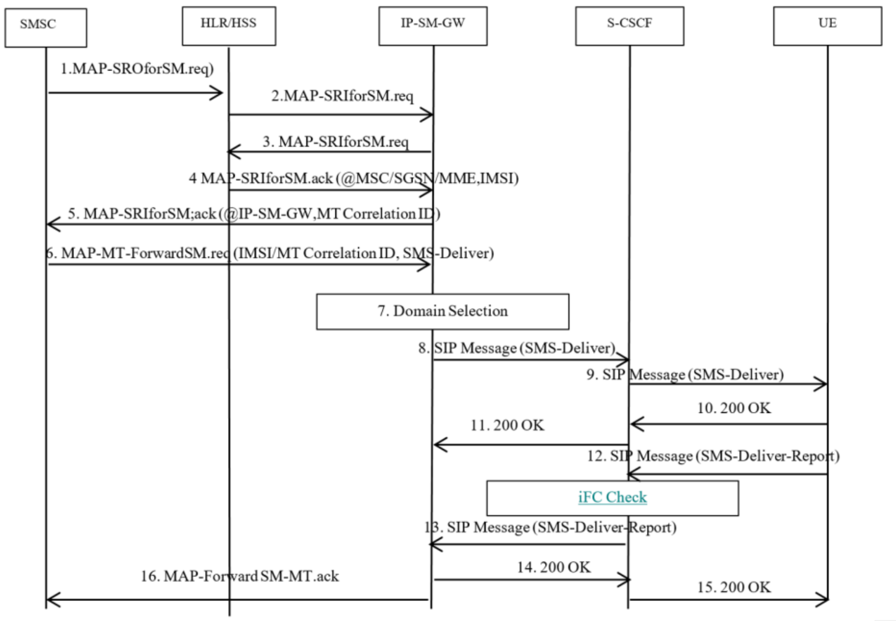


Figure 44 - SMS reception via IMS

1. The SMS-C interrogates the HSS to retrieve routeing information.
2. Based on the pre-configured IP-SM-GW address for the user, the HSS forwards the request to the corresponding IP_SM-GW.
3. The IP-SM-GW queries the HLR/HSS to obtain the IMS and the address(es) of the current MSC, SGSN and/or MME
4. The HLR/HSS returns the IMSI and the address(es) of the current MSC, SGSN and/or MME to the IP-SM-GW for the delivery of the SM in CS/PS domain.
5. The IP-SM-GW creates a MT Correlation ID as defined in TS 23.540, which associates the Routing Info retrieval with the subsequent Forward Short Message message(s), and stores this along with the IMSI oft he received subscriber. The IP-SM_GW returns to the SMS-C its own address along with the MT Correlation ID in the IMSI field, as routing information.
6. The SMS-GMSC delivers the Short Message to the IP-SM-GW in the same manner that it delivers the Short Message to an MSC, SGSN or MME, including the MT correlation ID received from the P-SM-GW, in place of the IMSI.
7. The IP-SM-GW performs domain selection.
8. The IP-SM-GW knows that the UE is registered with the IMS domain. It translates the received MAP message into a SIP Message method and sends it to the S-CSCF of the UE.
9. The S-CSCF routes it to the UE.
10. The UE acknowledgements it by a 200 OK.

11. 200 OK is forwarded by the S-CSCF
12. The UE returns a SMS-DELIVER-REPORT within a SIP MESSAGE request to S-CSCF.
13. S-CSCF forwards it to IP-SM-GW.
14. IP-SM-GW acknowledges the SIP MESSAGE request by 200 OK.
15. S-CSCF forwards the 200 OK to UE.
16. The IP-SM-GW sends an acknowledgement of SMS delivery to the SMS-C using the MAP protocol.

Annex E <5G> SMS over MAP/Diameter

The 5G SMS architecture is defined in the following documents:

- SMS is defined in 5G as a clear requirement and its functional architecture is provided in 3GPP TS 23.501 [section 4.4.2].
- SMS architecture is defined in 3GPP 29.891[8] [section 9.1].

The SMS in 5G will be delivered by AMF and SMSF functions, relaying the SMS to the SMS-C (defined on 3GPP TS 23.501 [section 4.4.2])

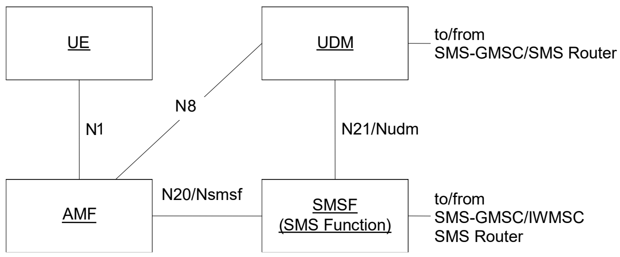


Figure 45 - SMS over MAP/Diameter Architecture

SMS Function (SMSF) may be connected to the SMS-GMSC/IWMSC/SMS Router via one of the standardized interfaces as shown in TS 23.040 [1].

UDM may be connected to the SMS-GMSC/SMS Router via one of the standardized interfaces as shown in TS 23.040 [51].

Each UE is associated with only one SMS Function.

When the serving AMF is relocated for a given UE, the SMS function for a given UE does not need to change. Thus the source AMF includes SMSF identifier as part of UE context transfer during AMF relocation to target AMF

Figure hereafter shows the roaming architecture to support SMS over NAS.

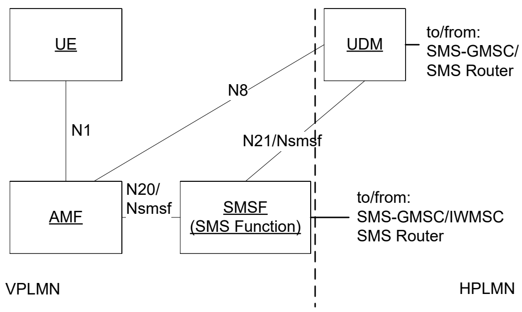


Figure 46 - SMS over NAS Architecture

Reference point to support SMS over NAS

- N1: Reference point for SMS transfer between UE and AMF via NAS.
- N8: Reference point for SMS function address retrieval between AMF and UDM.
- N20: Reference point for SMS transfer between AMF and SMS Function.
- N21: Reference point for SMS subscription retrieval and SMS notification procedure between SMS Function and UDM.

Service based interface to support SMS over NAS

- Nsmsf: Service-based interface exhibited by SMSF.

For SMS over NAS support, the UDM may be connected to the SMS-GMSC/SMS-Router via one of the standardized interfaces as shown in 3GPP TS 23.040 [1] (which is MAP or Diameter S6c). In addition, the SMSF may be connected to the SMS-GMSC/IWMSC/SMS-Router via one of the standardized interfaces as shown in 3GPP TS 23.040 [1] (which is MAP or Diameter SGd).

Figure hereafter provides an architecture overview with focus on the SMSF.

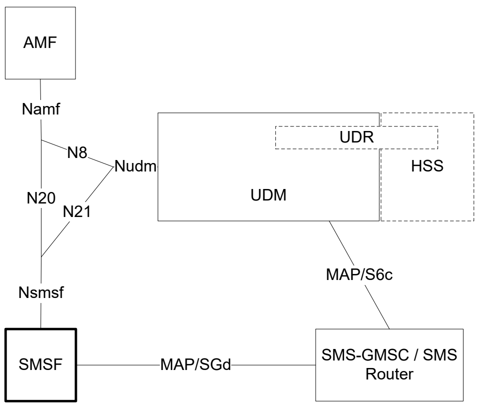


Figure 47 - SMSF role in SMS over NAS

Annex F   <MTC/MIoT> SMS

Extract from 3GPP TS 23.682 [9]

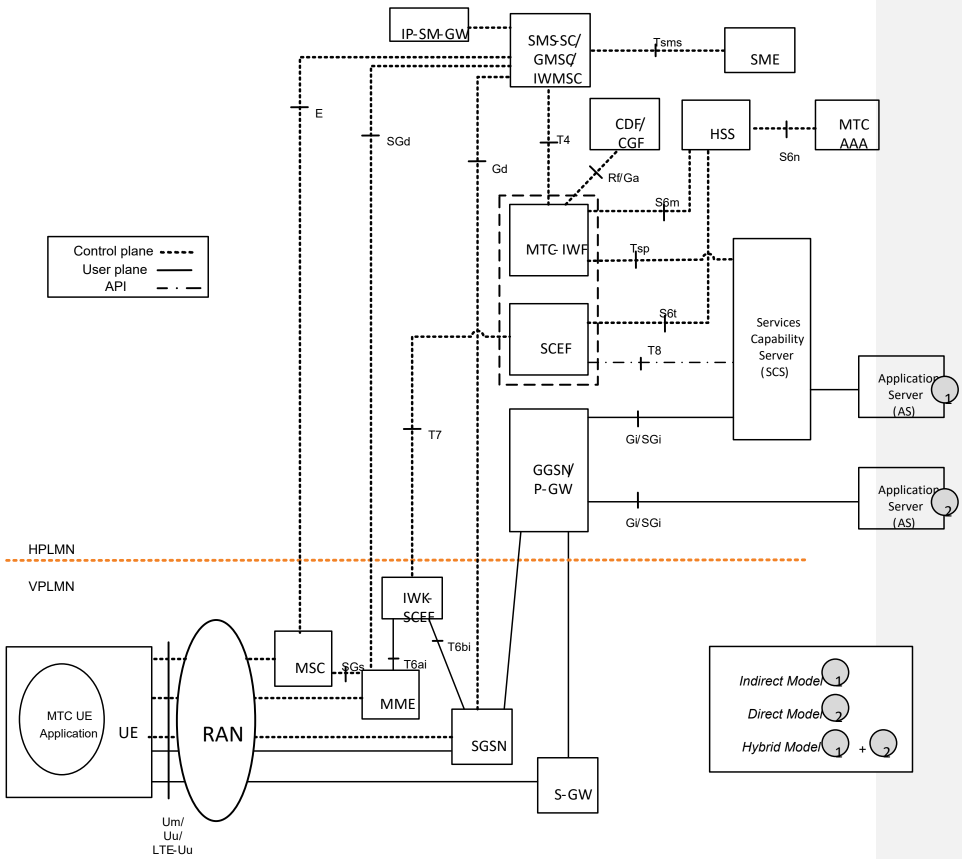


Figure 48 - MTC/MIoT SMS Architecture

Annex G <5G> SMS – Based N32

G.1 SMS roaming – based N32

SMS roaming based on the N32 interface is not currently defined by 3GPP. However, as outlined in Section 6.1.3 and based on extensions to the non-roaming architecture described in 3GPP TS 23.540 [25], preliminary call flows for SBI-based SMS roaming (both MO-SMS and MT-SMS) are proposed in the next sections. These flows provide a foundation for a more detailed format description to be included in a future 3GPP document.

G.1.1 MO-SMS from roaming subscriber

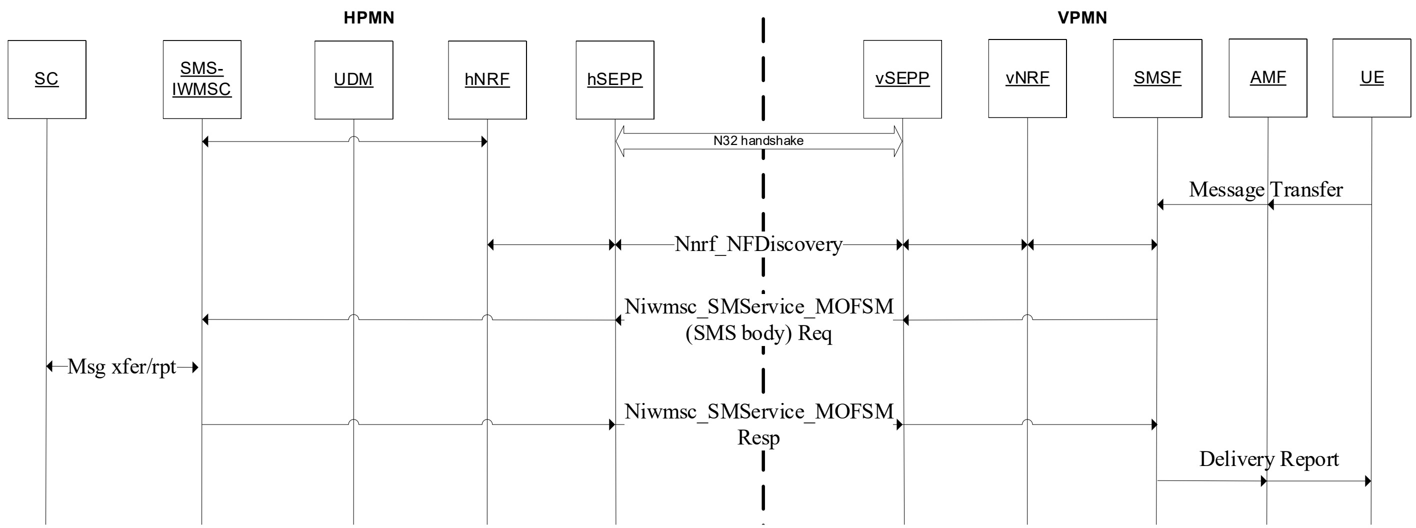


Figure 49 - Call-flow MO-SMS Roaming in 5G (extract from 5GMRR Doc 37_09 [29])

The same principles for SBI-based MO-SMS as described in 3GPP TS 23.540 [25] Section 5.2 is assumed to apply for the roaming subscriber.

The MO-SMS is submitted by the outbound roamer on his/her UE to the serving SMSF via the AMF in the VPMN. The serving SMSF invokes the Nnrf_NFDiscovery through the roaming connections to discover the roaming subscriber's home SMSC (SMS-IWMSC) based on the subscriber's information such as the home SMS-C address. Following the successful discovery, the serving SMSF forwards the MO-SMS in the Niwmsc_SMService_MoForwardSm request to the home SMS-IWMSC through the roaming connections. Subsequently, the home SMS-IWMSC replies with the Niwmsc_SMService_MoForwardSm response through the roaming connections, to deliver the MO-SMS delivery report to the serving SMSF and the roaming subscriber's UE.

Commented [KL16]: This caption may be removed if there's no diagram.

G.1.2 MT-SMS from HPMN to roaming subscriber

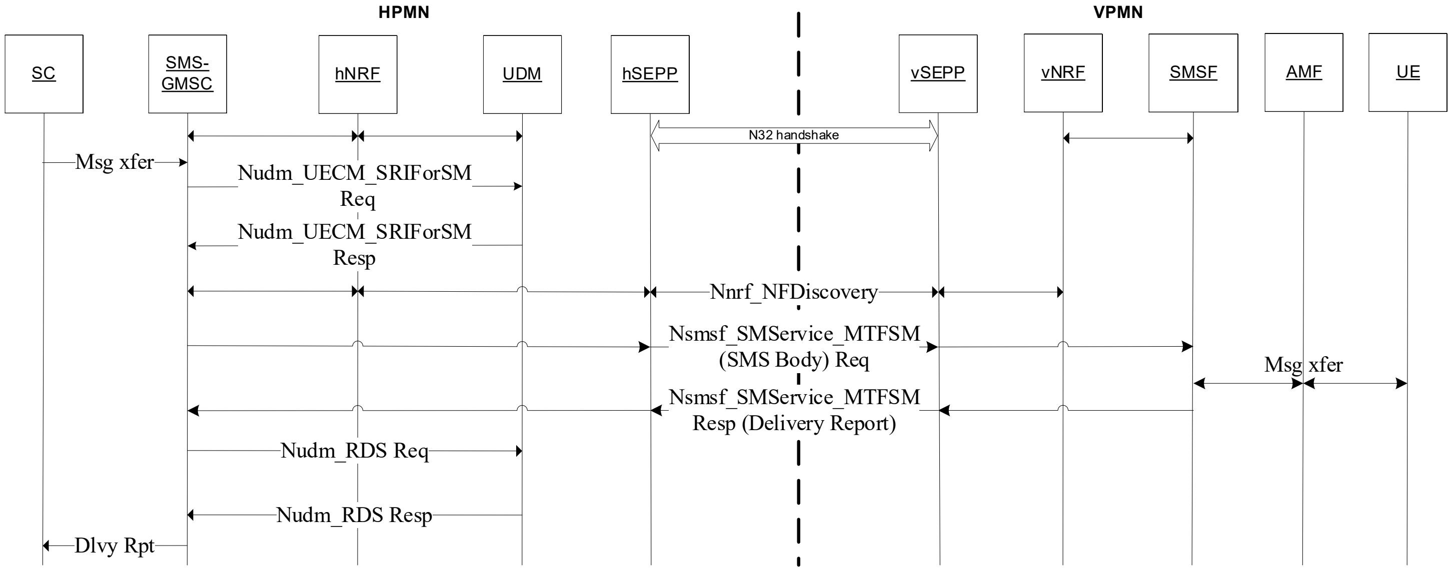


Figure 50 - Call-flow MT-SMS Roaming in 5G (extract from 5GMRR Doc 37_09 [29])

The same principles for SBI-based MT-SMS as described in 3GPP TS 23.540 [25] Section 5.1 is assumed to apply for the roaming subscriber.

The home SMS-C (SMS-GMSC) invokes the Nudm_UECM_SendRoutingInfoForSM to query the UDM for the routing information of the nodes available for MT-SMS delivery to the destination subscriber based on his/her GPSI. Based on the Nudm_UECM_SendRoutingInfoForSM response, the destination subscriber is found to be roaming in the VPMN, served by the VPMN SMSF. The home SMS-GMSC invokes the Nnrf_NFDiscovery through the roaming connections to discover the VPMN serving SMSF. Following the successful discovery, the home SMS-GMSC forwards the MT-SMS in the Nsmsf_SMService_MtForwardSm request to the VPMN serving SMSF through the roaming connections.

The VPMN serving SMSF then delivers the MT-SMS to the roaming subscriber’s UE via the AMF. Subsequently, the VPMN serving SMSF replies with the Nsmsf_SMService_MtForwardSm response through the roaming connections, to deliver the MT-SMS delivery report to the home SMS-GMSC. The home SMS-GMSC updates the UDM on the delivery status with the Nudm_SMReportStatus operation.

G.2 SMS interconnection – based N32

SMS interconnection based on the N32 interface is not currently defined by 3GPP. However, as outlined in Section 7.4 and based on extensions to the non-roaming architecture described in 3GPP TS 23.540 [25], preliminary call flows for SBI-based SMS interconnection are proposed in the next sections. These flows provide a foundation for a more detailed format description to be included in a future 3GPP document.

G.2.1 Inter-PMN P2P SMS Interconnect via Direct Connections

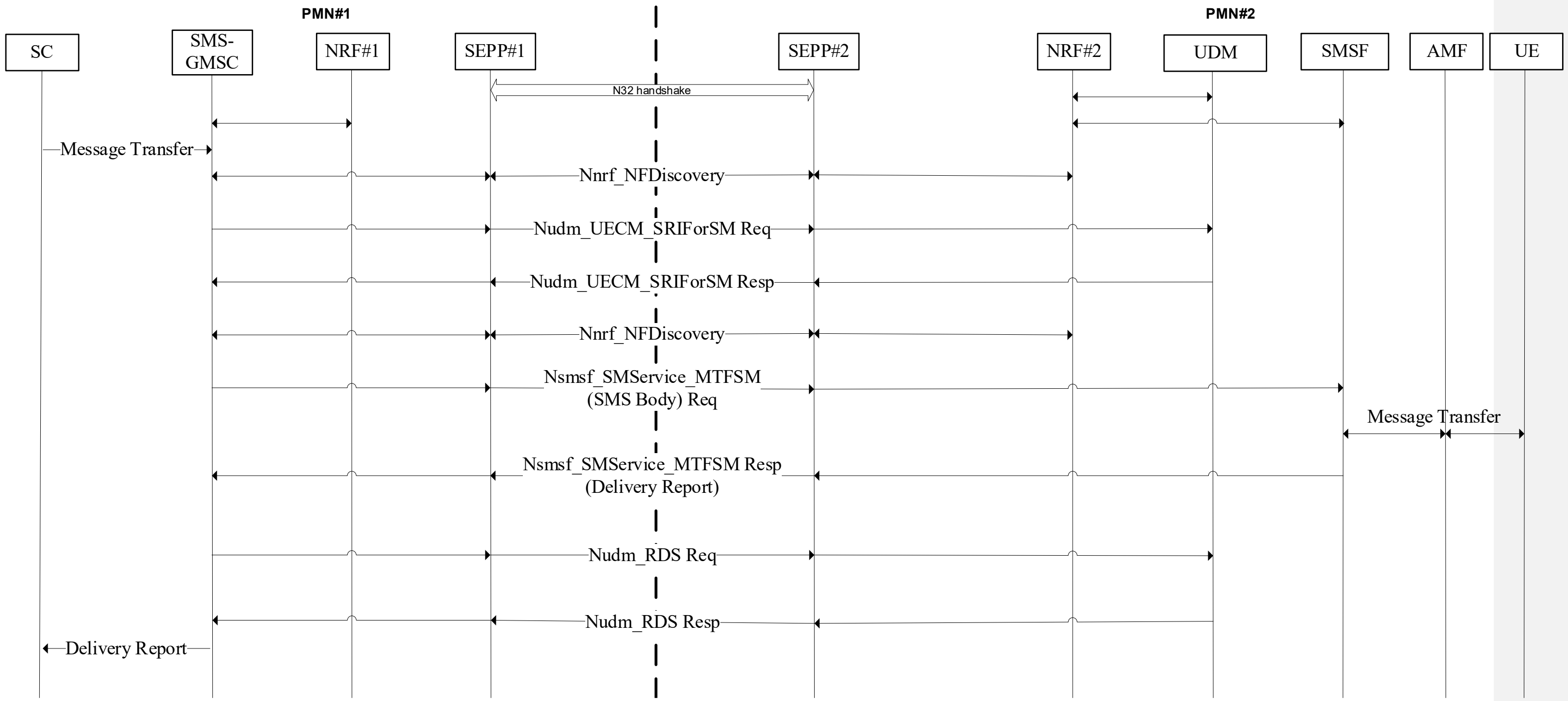


Figure 51 - Call-flow Inter-PMN SMS direct interconnection in 5G (extract from 5GMRR Doc 37_09 [29])

The same principles for SBI-based MT-SMS as described in 3GPP TS 23.540 [25] Section 5.1 is assumed to apply for Inter-PMN SMS interconnect.

The PMN#1 SMS-C (SMS-GMSC) invokes the Nnrf_NFDiscovery through the Inter-PMN SMS interconnections to discover the destination subscriber's UDM based on the subscriber's GPSI. This may be based on Mobile Number Portability (MNP) lookups (not shown in 0). Following the successful discovery, the PMN#1 SMS-GMSC invokes the Nudm_UECM_SendRoutingInfoForSM request through the Inter-PMN SMS interconnections to query the destination subscriber's UDM for the routing information of the nodes available for MT-SMS delivery to the subscriber. Based on the Nudm_UECM_SendRoutingInfoForSM response, the destination subscriber's serving SMSF is returned. The PMN#1 SMS-GMSC invokes the Nnrf_NFDiscovery through the Inter-PMN SMS interconnections to discover the destination subscriber's serving SMSF. Following the successful discovery, the PMN#1 SMS-GMSC forwards the MT-SMS in the Nsmsf_SMService_MtForwardSm request to the destination subscriber's serving SMSF through the Inter-PMN SMS interconnections. The serving SMSF then delivers the MT-SMS to the destination subscriber's UE via the AMF. Subsequently, the serving SMSF replies with the Nsmsf_SMService_MtForwardSm response through the Inter-PMN SMS interconnections, to deliver the MT-SMS delivery report to the PMN#1 SMS-GMSC. The PMN#1 SMS-GMSC updates the UDM on the delivery status with the Nudm_SMReportStatus operation.

G.2.2 Inter-PMN P2P SMS Interconnect via Hub Connections

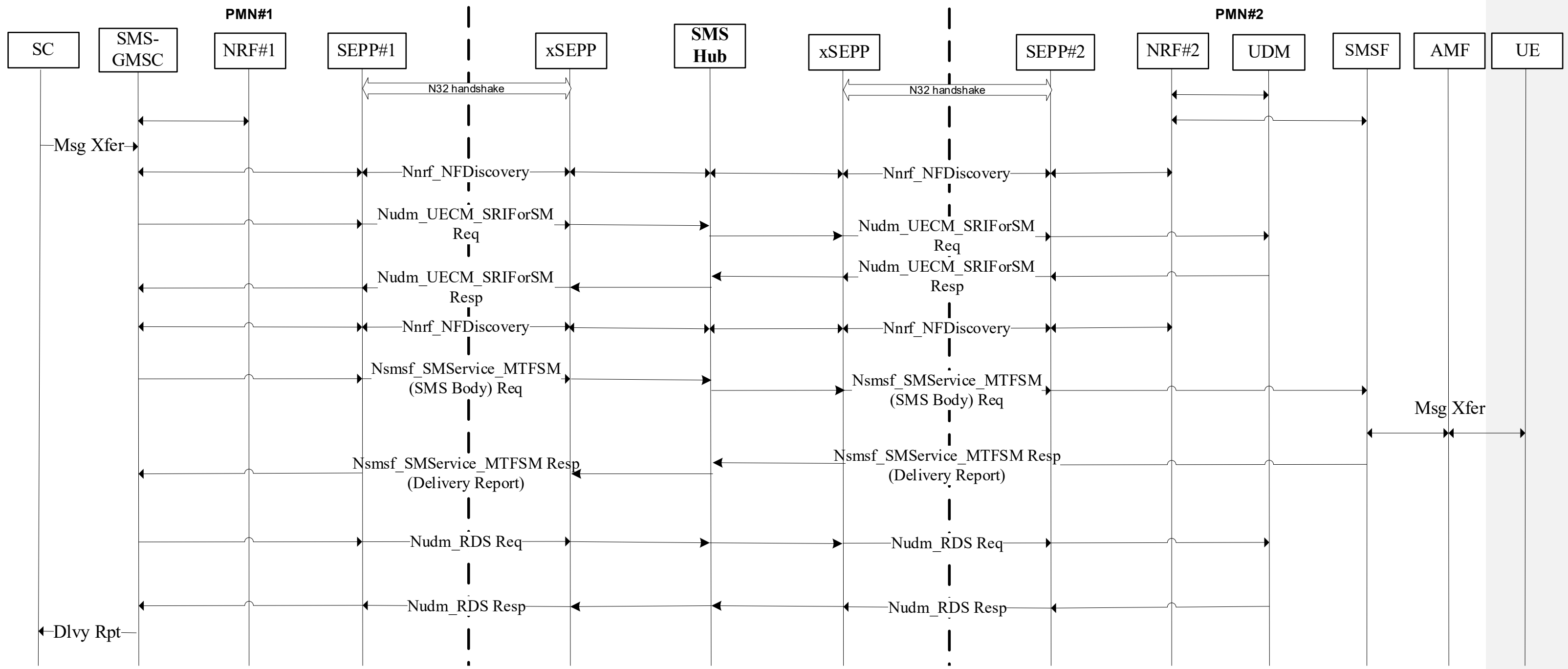


Figure 52 - Call-flow Inter-PMN SMS Hubbing in 5G (extract from 5GMRR Doc 37_09 [29])

The same principles for SBI-based MT-SMS as described in 3GPP TS 23.540 [25] Section 5.1 is assumed to apply for Inter-PMN SMS Hubbing.

The PMN#1 SMS-C (SMS-GMSC) invokes the Nnrf_NFDiscovery through the SMS Hubbing interconnections to discover the serving SMS Hub based on the destination subscriber's GPSI. Correspondingly, the SMS Hub invokes the Nnrf_NFDiscovery to discover the destination subscriber's UDM based on the subscriber's GPSI. This may be based on Mobile Number Portability (MNP) lookups (not shown in 0). Following the successful discovery, the SMS Hub responds to the PMN#1 SMS-GMSC with the SMS Hub's address as the serving UDM.

The PMN#1 SMS-GMSC invokes the Nudm_UECM_SendRoutingInfoForSM request to the SMS Hub to query for the routing information for the MT-SMS delivery to the destination subscriber. Correspondingly, the SMS Hub invokes the Nudm_UECM_SendRoutingInfoForSM request to the destination subscriber's UDM to query for the routing information of the destination subscriber's serving SMSF for the MT-SMS delivery. Based on the Nudm_UECM_SendRoutingInfoForSM response, the destination subscriber's serving SMSF is returned. The SMS Hub then replies to the PMN#1 SMS-GMSC with the Nudm_UECM_SendRoutingInfoForSM response with the SMS Hub as the serving SMSF.

The PMN#1 SMS-GMSC invokes the Nnrf_NFDiscovery to the SMS Hub to discover the serving SMSF. Correspondingly, the SMS Hub invokes the Nnrf_NFDiscovery to discover the destination subscriber's serving SMSF. Following the successful discovery, the SMS Hub responds to the PMN#1 SMS-GMSC with the SMS Hub's address as the serving SMSF.

The PMN#1 SMS-GMSC forwards the MT-SMS in the Nsmsf_SMService_MtForwardSm request to the SMS Hub. Correspondingly, the SMS Hub forwards the MT-SMS in the Nsmsf_SMService_MtForwardSm request to the destination subscriber's serving SMSF. The serving SMSF then delivers the MT-SMS to the destination subscriber's UE via the AMF. Subsequently, the serving SMSF replies with the Nsmsf_SMService_MtForwardSm response to the SMS Hub, to deliver the MT-SMS delivery report. Correspondingly, the SMS Hub replies with the Nsmsf_SMService_MtForwardSm response to the PMN#1 SMS-GMSC to deliver the MT-SMS delivery report.

The PMN#1 SMS-GMSC updates the SMS Hub on the delivery status with the Nudm_SMReportStatus operation. Correspondingly, the SMS Hub updates the destination subscriber's UDM on the delivery status with the Nudm_SMReportStatus operation.

Annex H Global architecture

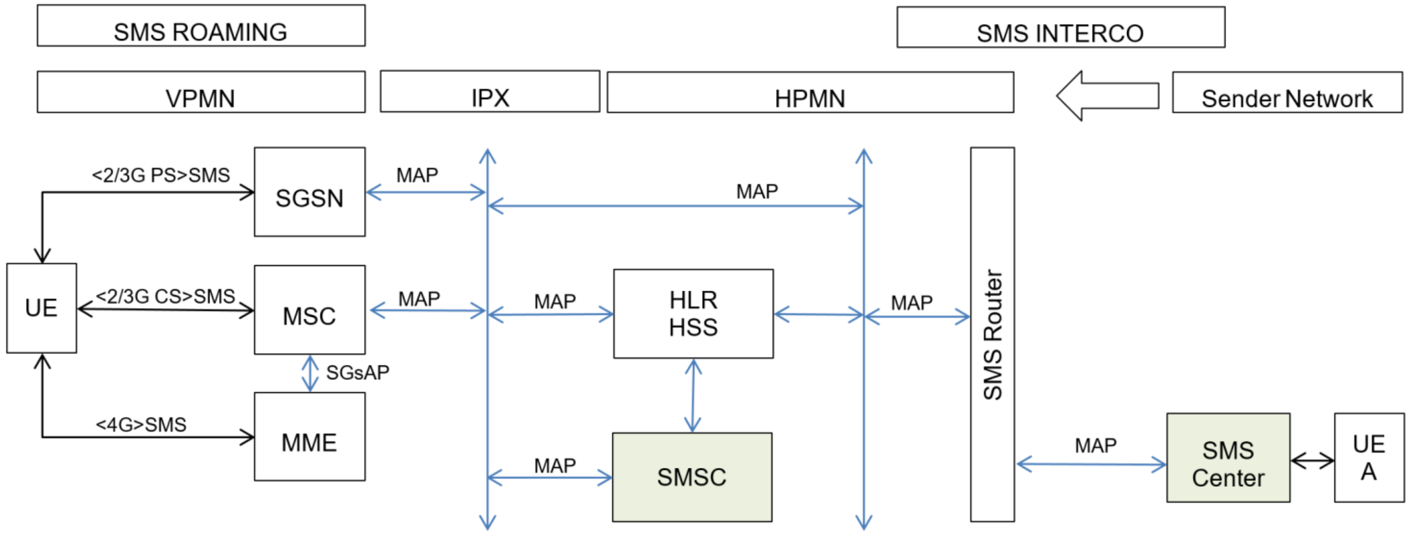


Figure 53 - Global Architecture

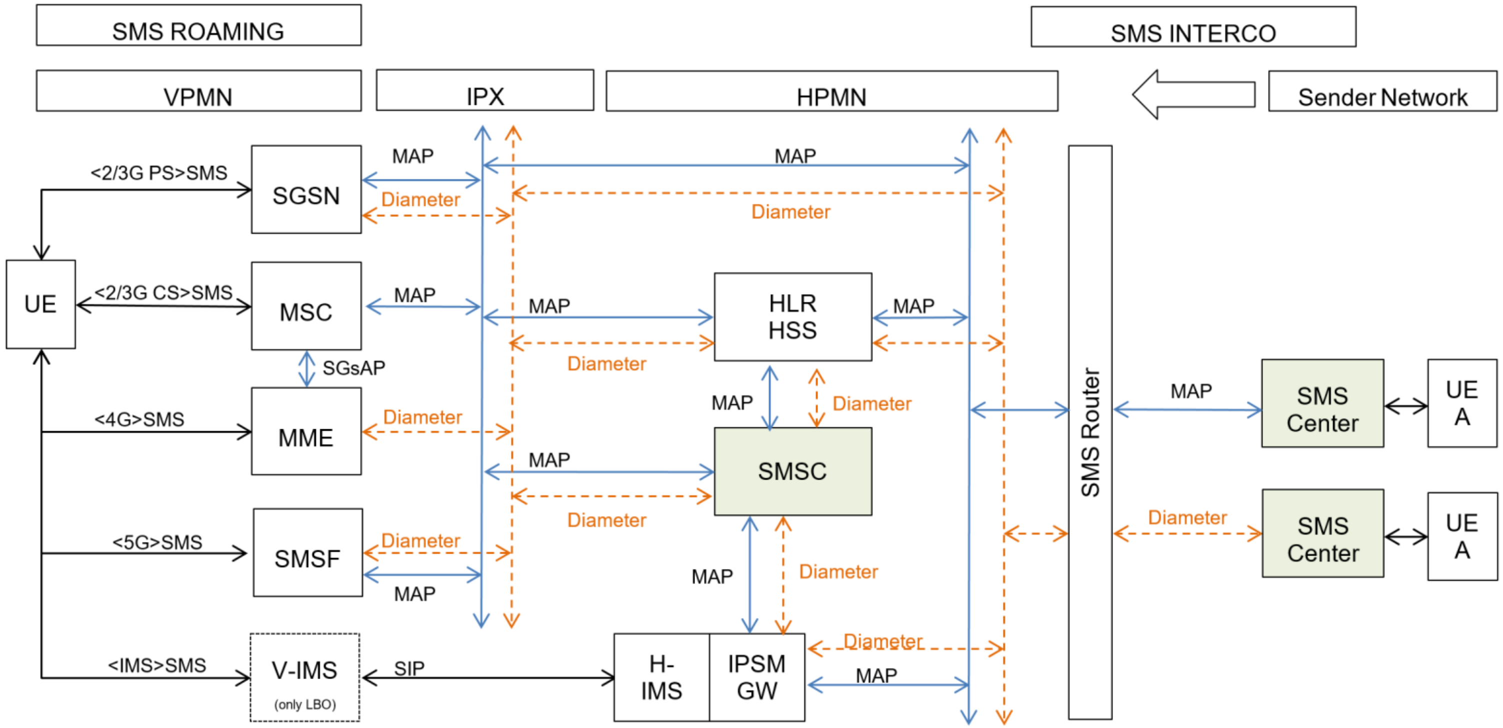
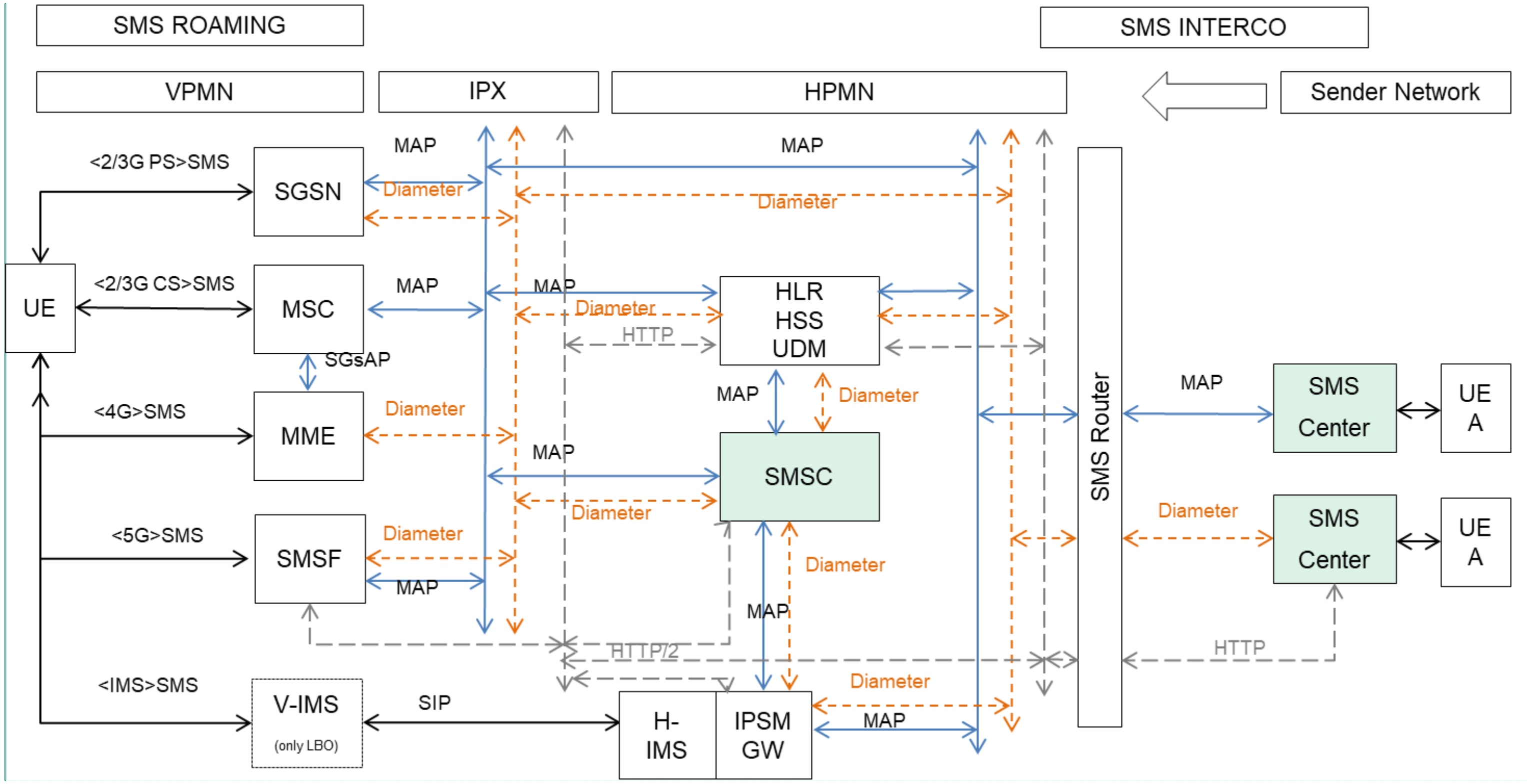


Figure 54 - Global Architecture over Diameter

Commented [KL17]: Suggest to add HTTP/2 support to IP-SM-GW



Commented [EG18R17]: Figure updated

Figure 55 - Global Architecture over HTTP/2

Annex I GSMA_Survey SMS Evolution Result summary

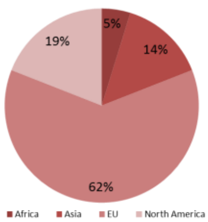
I.1 Survey participation.

- Participants
  - 12 fully completing the survey
  - 6 partially completing the survey
  - 5 operators registering the survey but without providing information

- List of countries (partly/fully answers)

  Africa: Somalia

  - Asia: Japan, Sri Lanka, Turkey, Fiji
  - Europe: Austria, France, Germany, Italy, Netherland, Sweden, Switzerland, UK, Belgium
  - North America: USA, Canada
  - Oceania: Fiji



I.2 Survey result summary

<4G> SMS over Diameter use case (Home).

A small number of operators have already chosen to move SMS on Diameter. The first deployments are limited to SGd however, their intent is to also migrate on Diameter for GGd and S6c interface within the 3 next years.

The picture below summarise responses related to this topic.

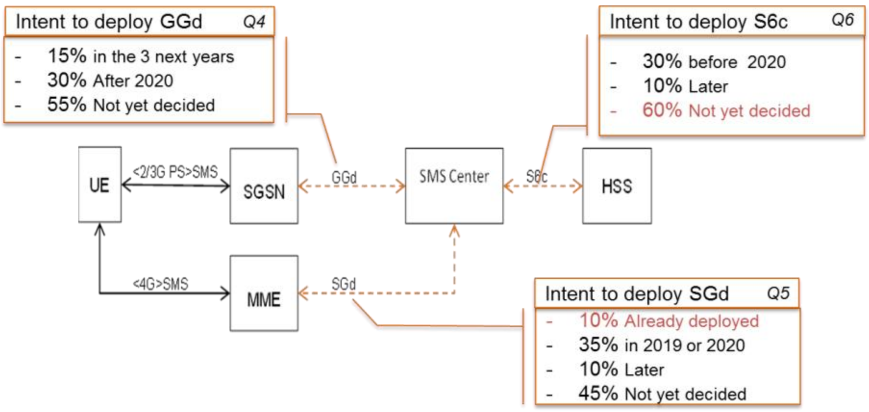


Figure 56 - Survey Responses

Regarding the possibility to use Diameter for roaming and interconnection, it seems too early to plan a migration from SS7 to Diameter. Moreover, usage of Diameter for roaming could not be taking into account before a secure Diameter able to prevent spoofing for example.

<IMS> SMS over SIP use case (Home/Roaming)

SMSoSIP for IMS customers is planned for next year, for a large number of operators on the Home network. Extension to roaming is also planned within the next three years.

It is also important to note that if Diameter can be used between IP-SM-GW and SMS Center, MAP is the preferred option.

The picture below summarise responses related to these topics.

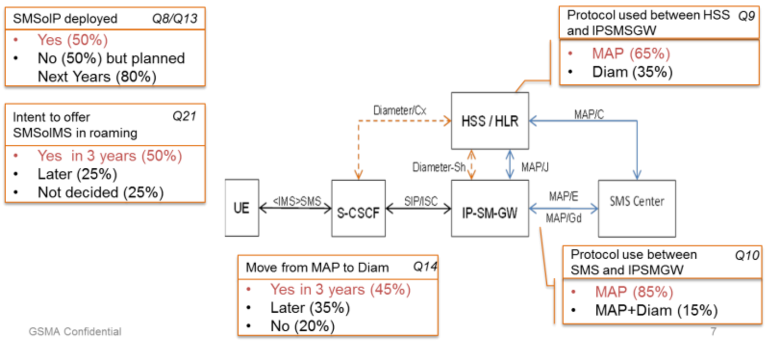


Figure 57 - SMS over SIP responses

<MIoT> SMS MT use case (Home)

SMS is still an important technical enabler in the MIoT context for operators. Two important use cases have been identified in this context: OTA and Wake up IP session.

In this MIoT context, it is also mandatory for operators to be able to deliver SMS to Objects without double attachments on CS and PS. SMS delivery must be done without CS.

The picture below summarise responses related to these topics.

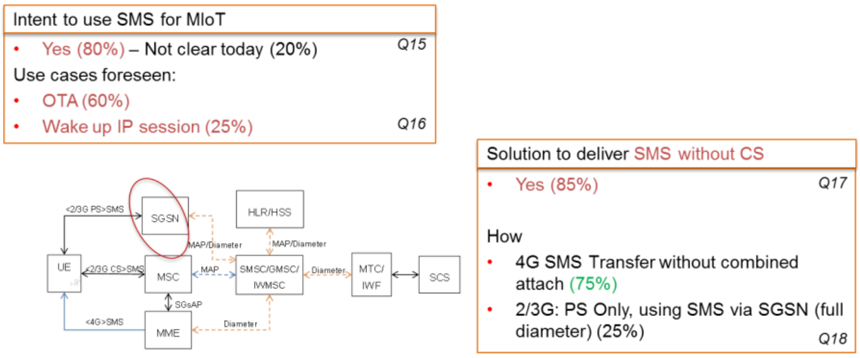


Figure 58 - SMS MT responses

I.3 Conclusions and survey lessons

- SMS is a mandatory technical enabler for MioT (OTA / Wake up IP) and need solution to deliver SMS without CS.
- SMS will move progressively to Diameter. SGd is the first interface.
- <IMS> SMS is a reality on home network and will be opened in roaming soon. Interworking with IP-SMS-GW remains mainly based on MAP.
- It is too early to anticipate the migration of SMS roaming / interconnection to Diameter.
- Diameter vulnerability is still an important concern for operators to move SMS on Diameter.

Document Management

Document History

Version	Date	Brief Description of Change	Approval Authority	Editor/Company
V1.0	05/06/2018	Initial version	SIGNAL/TG	Eddy Goffin(Orange)
V2.0	21/10/2020	CR1002 Remove LBO	NG	Eddy Goffin(Orange)
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