Advanced Signaling Gateway: Roaming Hub and MNO STP SS7, Diameter, GTP, ISUP

The Halys Advanced signaling gateway fulfill all the needs of *Roaming Hub suppliers*(including SMS), *major international carriers* and the *STP functions of the MNOs:* STP, DRA/DEA and GMSC including full redundancy for SS7, Diameter, GTP and ISUP, using two active-active load sharing dual servers for all the functions with the Virtual Machines architecture. For GTP data traffic the sessions are fully maintained in case of total or partial failure of one of the servers.
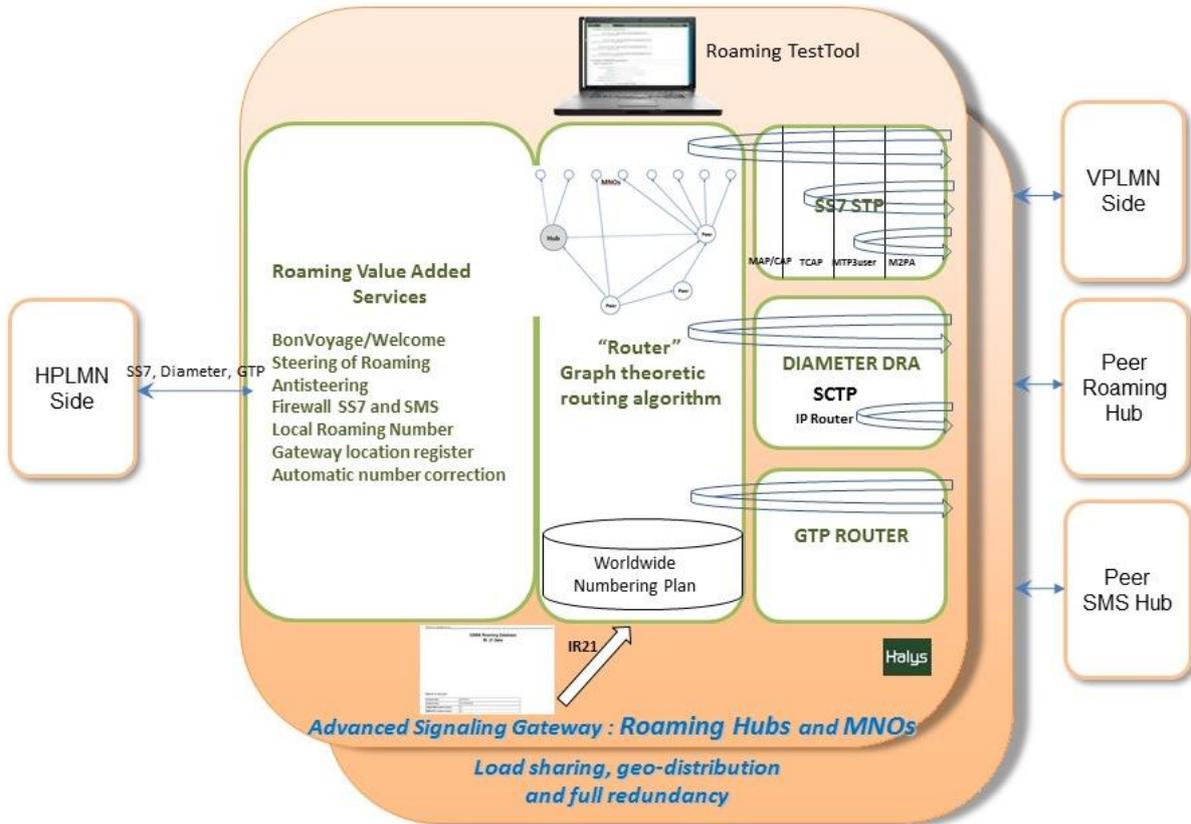

Figure 1: Roaming Hub for SS7, Diameter and GTP

Halys provides a unique high level functional provisioning method: the routes and relationships opening for all flows: SS7, Diameter, GTP is unified with the use of a regularly updated *worldwide numbering plan* provided by Halys which allows to use *network names* only without the burden of GTs, MSISDNs, MCC-MNC, etc.. configurations. The provisioning is done with the Halys single graphical provisioning interface and can be automated with the use of the provisioning XML API. No need any more to have specialized staffs filling the NDC and IP tables.

In addition, the MNOs need the interfacing and conversions *for voice services provided by a GMSC* to handle the ISUP/TDM voice traffic. The Halys GMSC-IWF-IMS (see the more detailed Data Sheet) in a separate server because of the specific HW, has all these functions plus a MGCF (Media Gateway Conversion Function) to convert ISUP<→SIP for VoIP OTT services.
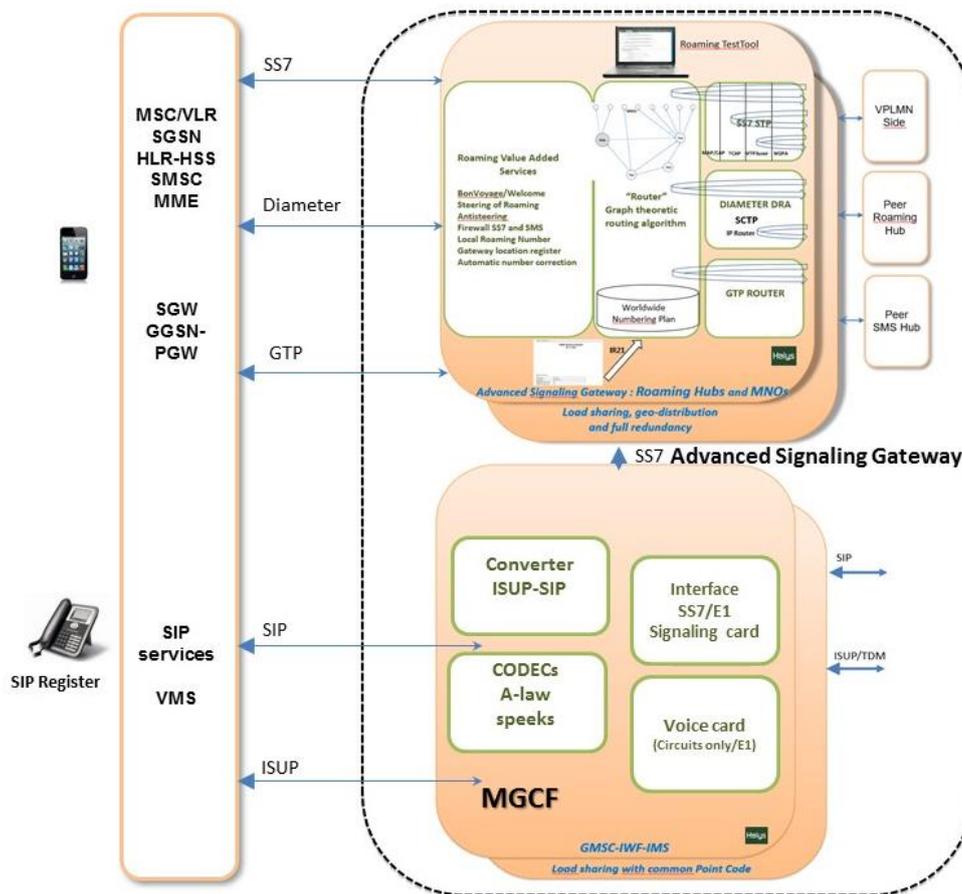
Figure 2: STP for MNO with the signaling and voice handling

1- *Active-Active load sharing redundancy: SS7, Diameter and GTP*

SS7 redundancy uses a single Point Code for the two dual servers, with a TCAP synchronization link to relay transaction segments to the originating system. DRA/DEA redundancy uses SCTP backup routes. For GTP the session creations/update/delete are replicated on the two servers, so that the GTP-U traffic can be handled by any of them. The Architecture is extensible to more than two servers in a "cluster"(see "scalability) for high traffic carriers or MNOs.

In addition, for large world carriers, a *unique networking "geographical distribution"* is available for the GTP data traffic with *clusters in several continents* sharing the *same IPs* to reduce the data transit delay based on the shortest route optimization performed by the BGP routing of GRX between two operators in the same area. The optimized transit time i*mproves the speed of the data service* in roaming situations.

2- *Detailed routing characteristics: SS7, Diameter and GTP*

2.1 SS7 routing, transformations, blocking and filtering

Beyond the GSMA specification that defines a single method which is Alias *GT (mode 2 with Hi.Oi.NNi*), Halys provides 4 other choices including:

-*Alias GT (mode 0 with HubGT)* does not require any setup in the HPLMN if it already has roaming with the Roaming Hub adjacent

-*Alias GT (mode 1 with Hi.GT)* is most convenient for HPLMNs and will work for all MNOs with GT length <= 12 digits if the HI length is 4 digits (total length HI-GT <= 16 digits)

-*Alias GT (mode 3 with Hi.Oi)* is a simplification to method 2: no NNI (Network Node Indicator) of the visited MSC/VLR is included.

Complemented with a direct *MTP mode* and a *TT mode*, it allows to face all participating MNO connection situations. Each hub client network is presented with a virtual view of its accessible peers.

Multi IMSI and Multi GT of different sponsors are supported for roaming and SMS delivery.

The Signaling Gateway is providing the *firewall protection* against signalling threats with its blocking, filtering for SS7 (and also Diameter): All MSUs are thoroughly inspected and evaluated with regards to the communication context.

2.1 Diameter Routing: DRA(Diameter Routing Agent) and DEA(Diameter Edge Agent)

The DRA provides beyond the classical Diameter Routing based on the Destination-Realm, a DEA to assign the Destination-Host (e.g. several HLR-HSS) of a MNO.

It provides a virtual environment for an easy, flexible and fully controlled interconnection: AVP and Diameter Domain aliasing are used and permit the separate management of the 2 legs of each association. End to end transparency and compatibility with standard diameter routing are maintained. The SCTP associations with each partner are set, then the individual 1to1 opening of the relations are performed with the GUI or from files coming from a central provisioning.

When a Request message is received from a connected MNO, the DRA asks the "HALYS graph router" with the Destination Realm as argument (example epc.mnc380.mcc310.3gppnetwork.org for ATT) and obtains the SCTP association number to reach it, which could be another DRA. Then it is routed to this destination.

Multi-IMSI support extends the out-roaming coverage capabilities. The hub plays the role of the HSS for the auxiliary sponsored IMSIs and handles the conversions required to interface with the nominal home HSS. The DRA has advanced capabilities to add and modify AVPs and to interconnect with other DRA peers to reach more destinations.

2.3 GTP routing: GTPv1 and GTPv2 3G-4G

"The GTP Router handles all the GTP traffic between the hub clients, simultaneously for GTP v1 and GTP v2. Compared with other GTP routing solutions, it uses a single virtual IP address (of the GTP Hub provider) for all the destinations of a client MNO. This widely facilitates the configuration on the MNO side, as they only need to authorize one single IP address in their firewalls, instead of all the IP ranges of their roaming partners. The routing decision may be performed by the *standard IP routing tables in the Linux kernel (iptables)* convenient for a platform migration, or by the common *Graph Router* which uses the network IPs from the *Worldwide Numbering Plan* fed with the IR21s.

Some carriers associate each client (being directly connected or through a peer hub) with a separate virtual address, which has the advantage to differentiate easily the traffic based on the destination IP address."

4- Flexible reporting and accounting

Transaction Detailed Records are created for all transactions through the hub and allows the creation of a multiple months history DataBase. A detailed exploitation of the TDRs with the Halys Traceback tool permits a productive trouble shooting. It can be complemented by the recording of detailed "pcap" traces.

type ticket	type msg	error code	msg ref	timestamp	calling party	MAP or MMS version	oa	da
All	All	All						
UL_SUBMIT	GSM		HSS_20171120_235756_856810	20171120_235756_970060	+33970670007	3	+0	
ISD_DELIVER	GSM		HSS_20171120_235756_856810	20171120_235756_969895	+33970670007	3	+0	+208940000001114
ISD_DELIVER	GSM		HSS_20171120_235756_856810	20171120_235756_961895	+33970670007	3	+33757791114	+208940000001114
SRI_SUBMIT	SMS		HSS_20171120_235756_846066	20171120_235756_846076	+33970670007	3		+33757791114
SRI_SUBMIT	SMS		HSS_20171120_235734_382190	20171120_235734_382209	+33970670007	3		+33757791114
UL_SUBMIT	GSM		HSS_20171120_235511_208109	20171120_235511_322008	+33970670007	3	+0	
ISD_DELIVER	GSM		HSS_20171120_235511_208109	20171120_235511_321852	+33970670007	3	+0	+208940000001114
ISD_DELIVER	GSM		HSS_20171120_235511_208109	20171120_235511_313540	+33970670007	3	+33757791114	+208940000001114
SRI_SUBMIT	SMS		HSS_20171120_235511_196705	20171120_235511_196719	+33970670007	3		+33757791114
SRI_SUBMIT	SMS		HSS_20171120_235454_328688	20171120_235454_328695	+33970670007	3		+33757791114

Figure 2: TDRs can be expanded with a click to give the full details

Powerful statistics interactive tools are provided for the management of the traffic. Multiple customizable reports are created and are automatically distributed.
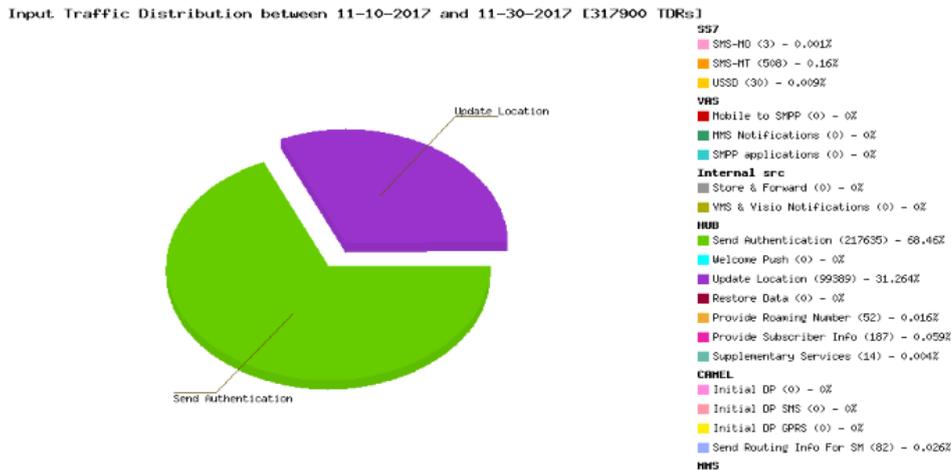

Figure 3: Graphic statistics of the signaling messages

The interface with billing system is made with the accounting of the different recorded billable information or events. It is extended with the capability to force a Camel profile to capture the duration of calls.

The recording of all communication transactions enables the creation of multiple statistics and reports at hub level or participating MNO level that summarize the operations on daily and monthly basis.

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5- Full set of Roaming Value Added Services

As shown in Figure 1, the modularity of the Halys product architecture allows to complement the Signaling Gateway functionalities with a set of value added services for individual networks (in case of a MNO deployment) or for groups of networks (with multi-tenant hosted facilities in case of group of networks or carriers) .

6- Comprehensive TestTool 2-3-4G

The TestTool of figure 1 allows to send test commands and sequences to validate the communication with the other systems. It includes all the MAP, Camel, Diameter (S6a S6b (mobility), S6c SGd (SMS 4G) , Cx Dx Sh (VoLTE/IMS), etc..) and GTPv1 and GTPv2 messages; as well as SIP messages for testing VoIP.

Compliance:

[1]GSMA IR.80 for Roaming Hub

[2] GSMA IR75 for SMS Hub

[3] TS 29.002 MAP, TS 29.272 S6a/Diameter, TS 29.060 GTPv1, TS 29.274 GTPv2, ISUP Q714

[4] Halys European Patent N°073 013 71.6 of 10.06.2009). Halys has GSMA compliant Hubs products (SS7 (including SMS), Diameter, GTP) in production since 2008 at worldwide carriers and groups of operators.

OS, hypervisor and scalability:

Linux OS on independent Intel Servers or Virtual Machines (VMware EXSI). Cores are statically assigned to the various VMs to provide the necessary resources.
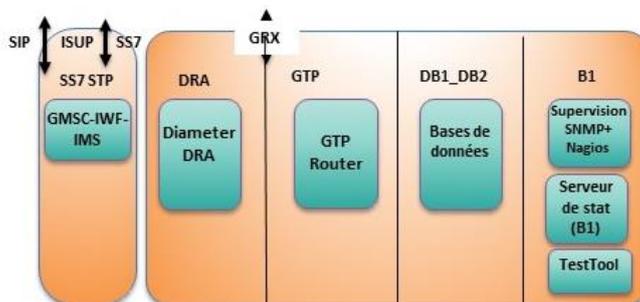

Figure 4: Virtualized Implementation of the Advanced Signaling Gateway

Scalability:

-SS7: 32000 MSU/sec for a 4-system cluster (logical routing by the "router" of Figure 1), 60000 MSU/sec for a SCCP or Point code level routing.

-GTP: 0.4 Gbits/sec / core (10000 bits average packets) assigned to multi-threaded GTP processing. For example 16 Gbits/sec per system need 40 cores and a medium or large blade server for scalability.