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Service Architecture Evolution – State of Standardization

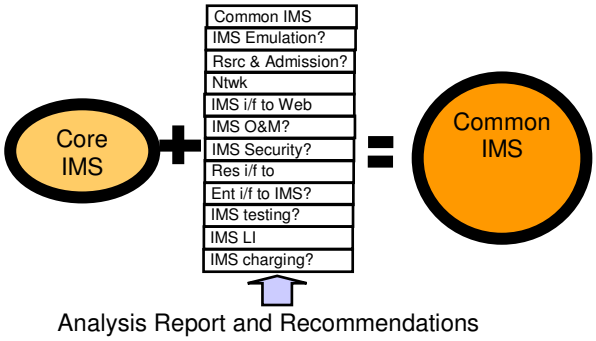
Authors: Mirko Naumann, Eiko Seidel

3GPP Project coordination

IMS Adhoc Group

- After an IMS workshop, the PCG#16 meeting last year triggered the establishment of a 3GPP OP Ad Hoc Group on IMS to join IMS forces within 3GPP and to avoid market fragmentation and duplication of work. Dr Satoh (ARIB) appointed as Convenor. Among others the IMS Forum were accepted as a Market Representation Partner in 3GPP.
- It was basically agreed to expand the scope of 3GPP. In the March meeting the following recommendations were agreed:
  - The scope of 3GPP should be expanded to encompass "common IMS"
  - Pursuit of a common single core IMS architecture
  - OPs encourage their members to contribute to the common set of Technical Specifications and Technical Reports
  - Some modification of the 3GPP Partnership Project Agreement needed
  - Recognition of results by the ITU
- "Common IMS" is not a new IMS, but is the current IMS plus added functionality
- Figure from the Convenor of Common IMS Subgroup:

Goal of Contents Group



- It seems participation and and decision making will be done based on 3GPP rules. Some concerns by CableLabs who are afraid that their requirements are not accepted.
- Common IMS report V 2.0.0 provided (not published yet)

GERAN Work

- GERAN Evolution is progressing as well. Main work items are:
  - Dual carrier in the Downlink
  - MS receive diversity
  - Latency Reductions
  - Higher Uplink Performance for GERAN Evolution
  - Reduced symbol Duration, Higher Order modulation and Turbo coding
- GERAN-LTE handover requirement suggest a maximum service interruption of 300ms

Details on Release 8

- Stage 1 Freeze date tentatively set to Dec 2007
- New Work Items (since SA#33)
  - Notification XML Schema
  - Support of Customized Alerting Tone Service
  - LCS for 3GPP I-WLAN
  - Support of Service-Level Interworking for Messaging Services
  - WLAN NSP
  - Various Cablelabs related improvements to IMS
  - Lawful interception for Rel 8
  - Online Charging Correlation
- New Studies Started (normative work would be Rel 8 earliest)
  - Management of LTE and SAE
  - Value Added Services for SMS
  - Non-3GPP Access NSP
  - Requirements for Seamless Roaming and Service Continuity between Mobile and WLAN Networks

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- Study of Mobility between I-WLAN and 3GPP Systems
- Study on Charging Aspects of SAE

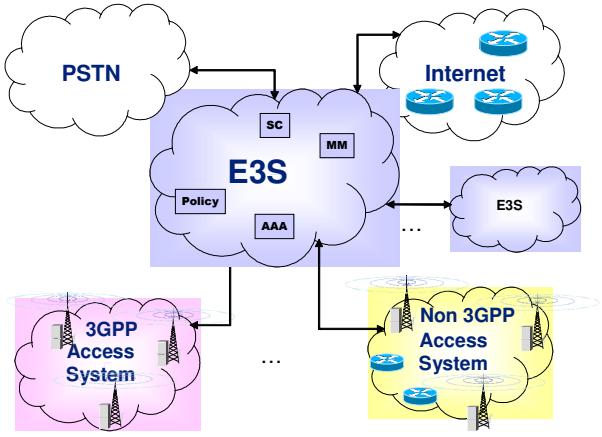
System Architecture Evolution

Baseline

Requirements

- The service requirements for the evolution of the 3GPP system in TS 22.278 describing the evolved 3GPP system as characterized by:
  - Reduced latency
  - Higher user data rates equating to broadband performance
  - Improved system capacity and coverage
  - Lower operational costs
  - packet optimized system supporting multiple RATs
  - SAE + E-UTRA and E-UTRAN
  - Service continuity

- Evolved 3GPP System (E3S) is a heterogeneous access system supporting mobility between 3GPP Access Systems and non 3GPP Access Systems including Fixed Access systems:



Specifications:

- 3GPP TR 23.882v190: "3GPP system architecture evolution (SAE): Report on technical options and conclusions" containing updates agreed by SA WG2 in Warsaw
- 3GPP TS 23.401v041: "3GPP System Architecture Evolution: GPRS enhancements for E-UTRAN access" containing updates agreed by SA2 in Warsaw and proposed vocabulary changes and alignment plus other editorial changes.
- 3GPP TS 23.402v040: 3GPP System Architecture Evolution: Architecture Enhancements for non-3GPP accesses" containing updates for terminology change (SAE deleted) and edits to protocol stack figures.

Interworking

- For SAE there will be separate specifications for 3GPP and non-3GPP access
- Liaison statements are being sent to 3GPP2 and WiMax to start dialog on interworking scenarios
- Workshop on generic handover mechanism for 3GPP radio technologies to non 3GPP radio technologies will take place on May 28th in Busan (host Samsung)

3GPP TR 23.882

Requirements

The evolved 3GPP system shall meet or exceed the following performance criteria:

- The radio access network shall be capable of supporting instantaneous peak packet data rates of 100 Mbps on the radio access bearer downlink to the UE and 50 Mbps on the uplink.
- The evolved 3GPP system shall be capable of providing lower user and control plane latency when compared to existing 3GPP access networks. The maximum delay should be comparable to that for fixed

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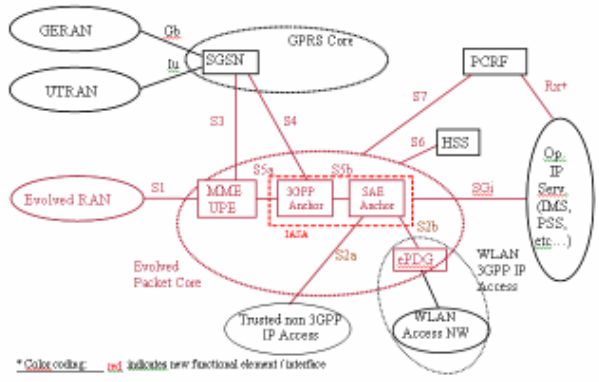
broadband Internet access technologies. [e.g. less than 5ms in ideal conditions]

- The system shall be capable of supporting large volumes of mixed e.g. voice, data and multimedia traffic. Enhanced load balancing and steering of roaming methods should be used to minimise cell congestion.
- The level of system complexity and mobility management signalling shall be optimised to reduce infrastructure and operating costs. UE power consumption shall also be minimised accordingly.
- 3GPP TS 22.258 (AIPN) is treated as overall requirement list

Key Issues

- Policy Control and Charging
- Roaming with Local Breakout
- Tracking Area
- Radio Access Network – Core Network Functional Split
- Inter 3GPP Access System Mobility in Idle State
- Limiting signalling due to idle mode mobility between E-UTRA and UTRA/GSM
- Intra LTE-Access-System Mobility in LTE_IDLE State
- Inter access system handover
- Default IP Access Service
- basic "always-on" IP packet bearer service
- for user data that do not require any service specific policies or charging rules
- supports mobility
- IP connectivity with multiple PDNs
- Functions in the evolved packet core
- List of functions to be supported by EPC
- QoS concepts
- SAE bearers: GBR SAE bearer or Non-GBR SAE bearer
- SAE QoS profile: Label, GBR (UL + DL), MBR (UL + DL), ARP
- SAE QoS profile is associated with an SAE Bearer
- SAE QoS profile is only signalled from the MME/UPE to the eNB across S1 in the control plane at SAE bearer establishment / modification

Overview SAE System Architecture



In the following the different entities and interfaces will be introduced. The full figure can be found in the annex figure 2.

Entities

- **PDN SAE GW** terminates the SGi interface towards the PDN. For each UE associated with SAE system, there may be several PDN SAE GW's to support multiple PDNs (if deemed required). PDN SAE GW functions include: Policy Enforcement, Per-user based packet filtering (by e.g. deep packet inspection), Charging Support, User plane anchor for mobility between 3GPP access and non-3GPP access, LI
- **Serving SAE GW** is the SAE gateway which terminates the interface towards EUTRAN. For each UE associated with SAE system, at a given point of time, there is always a single Serving SAE GW Serving SAE GW functions include: the local Mobility Anchor point for inter-eNB handover, Mobility anchoring for inter-3GPP mobility (terminating S4 and relaying the traffic between 2G/3G and PDN SAE GW), LI

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- **Mobility Management Entity (MME):** manages and stores UE context (for idle state: UE/user identities, UE mobility state, user security parameters). It generates temporary identities and allocates them to UEs. It checks the authorization whether the UE may camp on the TA or on the PLMN. It also authenticates the user.
- **User Plane Entity (UPE):** terminates for idle state Ues the downlink data path and triggers/initiates paging when downlink data arrive for the UE. It manages and stores UE contexts, e.g. parameters of the IP bearer service or network internal routing information. It performs replication of the user traffic in case of interception. It is FFS whether Charging Information for inter-operator accounting is in UPE or in another functional block.
- **3GPP Anchor:** The 3GPP Anchor is a functional entity that anchors the user plane for mobility between the 2G/3G access system and the LTE access system.
- **SAE Anchor:** The SAE Anchor is a functional entity that anchors the user plane for mobility between 3GPP access systems and non-3GPP access systems.
- **ePDG (evolved PDG):** It comprises the functionality of a PDG (3GPP–WLAN Interworking System) according to 3GPP TS 23.234. It basically provides bearer services allowing a 3GPP subscriber to use a WLAN to access 3GPP PS based services.

→ Currently there are ongoing discussions to eliminate the UPE. Most of the original functionality has been moved to eNodeB.
→ Functional split of PDN SAE GW and serving SAE GW shall be the same regardless of IETF or GTP based protocols
→ The PDN SAE GW and the Serving SAE GW may be implemented in one physical node or separated physical nodes

→ The Serving SAE GW and the MME may be implemented in one physical node or separated physical nodes.
→ PDCP and user plane ciphering is in eNodeB

Reference points

S1: It provides access to Evolved RAN radio resources for the transport of user plane and control plane traffic. The S1 reference point shall enable MME and UPE separation and also deployments of a combined MME and UPE solution. (S1-MME, S1-U)

S2a: It provides the user plane with related control and mobility support between trusted non 3GPP IP access and the SAE Anchor.

S2b: It provides the user plane with related control and mobility support between ePDG and the SAE Anchor.

S3: It enables user and bearer information exchange for inter 3GPP access system mobility in idle and/or active state. It is based on Gn reference point as defined between SGSNs.
User data forwarding for inter 3GPP access system mobility in active state (FFS).

S4: It provides the user plane with related control and mobility support between GPRS Core and the 3GPP Anchor and is based on Gn reference point as defined between SGSN and GGSN.

S5a: It provides the user plane with related control and mobility support between MME/UPE and 3GPP anchor. It is FFS whether a standardized S5a exists or whether MME/UPE and 3GPP anchor are combined into one entity.

S5b: It provides the user plane with related control and mobility support between 3GPP anchor and SAE anchor. It is FFS whether a standardized S5b exists or whether 3GPP anchor and SAE anchor are combined into one entity.

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S6: It enables transfer of subscription and authentication data for authenticating/authorizing user access to the evolved system (AAA interface).

S7: It provides transfer of (QoS) policy and charging rules from PCRF to Policy and Charging Enforcement Point (PCEP). The allocation of the PCEP is FFS.

Sgi: It is the reference point between the Inter AS Anchor and the packet data network. Packet data network may be an operator external public or private packet data network or an intra operator packet data network, e.g. for provision of IMS services. This reference point corresponds to Gi and Wi functionalities and supports any 3GPP and non-3GPP access systems.

Additional reference points for roaming scenarios:

S8: indicates the roaming variant of S5 reference point when the Inter AS Anchor is located in the HPLMN.

S9: indicates the roaming variant of the S7 reference point for the enforcement in the VPLMN of dynamic control policies from the HPLMN.

S10: Reference point between MMEs for MME relocation and MME to MME information transfer.

S11: Reference point between MME and Serving GW

Protocol assumptions

- The interfaces between the SGSN in 2G/3G Core Network and the Evolved Packet Core (EPC) shall be based on GTP protocol.
- The interfaces between the SAE MME/UPE and the 2G/3G Core Network shall be based on GTP protocol.
- S1: GTP-U for user plane
- S2a/b: Client and Network based mobility (IETF Based)
- S3, S4: GTP
- S5, S8: GTP and IETF based mobility protocol

Architectural principles

- Standardized interface between MME and Serving SAE GW
- PDCP and user plane ciphering in eNodeB
- S5 interface between two different SAE GWs with different roles
- Chaining of S5 & S8a/b in roaming scenarios is not required.
- QoS model leaves as TR 23.882
- NAS Signalling security terminates in MME
- Functional allocation between MME and CN UP Node shall be standardised
- Idle Mode Termination is above eNB

Logical base line architecture

- Annex Figure 1 shows the overall architecture
- Annex Figure 2 shows logical high level architecture for the evolved system in non-roaming case
- Annex Figure 3 shows logical high level architecture for the evolved system in roaming case with a evolved packet core in the home network and home routed traffic
- Annex Figure 4 shows logical high level architecture for the evolved system in roaming case with a evolved packet core in the home network and local break out

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Latest SA2 meetings

#56c AH (Warsaw, 26.-30.03.2007)

- Several documents have been provided dealing with the common high level functions for all accesses. Contributions from Motorola (High Level Functions and their allocation to network elements in SAE) and Qualcomm Europe (High Level SAE Session Management Functions) are agreed to be added to the TS.
- SAE-GW Selection and IP Address Allocation: it was agreed that all services will be accessible via IPv4 and IPv6, terminals shall support both IPv4 and IPv6
- Several contributions SAE GW and MME selection principles have been posted. Most of them have been noted but no final conclusion was made
- Functional allocation between MME - SAE GW: Idle Mode termination, currently exist a majority for termination in SAE GW – 17:5 pro termination in SAE GW. Supporters: VdF, Alcatel-Lucent, Qualcomm, Motorola
- QoS aspects: several contributions for Label Characteristics:
  - eNB delay budget
  - Relative Priority
- Clarification that meaning of labels is a equivalent to QCI
- Labels will point to characteristics which need to be mapped to mechanisms which are specific to the underlying network
- S5/S8 bearer models: No common agreements could be made with the divergence of proposals for the bearer model. It was decided to have an off-line meeting to try to come to some common decision
- Roaming scenarios for non-3GPP accesses have been discussed (see architecture pictures in annex)
- Several contributions on protocols options (mobility management protocols) and protocols stacks on the S2 interface
- Contributions on Non-3GPP Identities (from Intel and Ericsson) have been discussed, no final conclusion
- It was commented that this is also a good time to rationalise the Reference point naming as they have become complicated (e.g. S2a, S2b, S2c, etc.) and delegates were asked to consider the renaming of the reference points. "X" reference points were suggested as TSG RAN have only used X1 and X2 and the "S" points could be used with the same range for consistency of the related system

#57 (Beijing, 23.-27.04.2007)

- The proposal from #56c meeting to change the terminology for the SAE feature in the TSs and TRs to Evolved Packet Core (EPC) was accepted.
- GW and MME and ePDG selection: several contributions were discussed. The SA WG2 Chairman suggested that in order to make progress the proposals need to be analysed and reduced down to the main different proposals (ideally 1, or maximum 2 options). An informal poll was taken on the issues under discussion: Initial PDN Gateway Selection in MME: 12 supporters, Initial PDN Gateway Selection in Serving Gateway: 6 supporters
- Idle Mode termination: informal poll: Buffering idle-mode termination on eNodeB: 1, Buffering idle-mode termination on MME: 7, Buffering idle-mode termination on Serving GW: 19 → It was therefore agreed as a working assumption that the buffering for idle-mode termination will be placed in the

Serving Gateway. This decision will be recorded in the draft TS

- There was some discussion on security issues between the eNodeB and the UE. It was argued that integrity protection is used for the signalling flows. There was some reluctance to allow two options as this would be against the working assumptions made by SA WG2. It was commented that the hop-by-hop integrity protection was vulnerable if an eNodeB is compromised and end-to-end protection will provide better security. It was commented that alternative 2 would not work if there is a signalling problem on S11
- It was asked whether the non-3GPP access identities will not be in Network Access Identifier (NAI) format like defined in IETF. It was clarified that the format employed by non-3GPP accesses are out of the scope of 3GPP and can be in any format. In order to connect to the 3GPP Evolved Packet Core a 3GPP compliant identity will be needed. Local access in the non-3GPP network may therefore be possible without an NAI, but access to the 3GPP Evolved Core will require an NAI compliant identity
- Single Radio VCC: topic is closely related to IMS and the topic of IMS centralized services, most proposals have been postponed as they are too early for the current state of architecture and principles which have been agreed up to now

The next newsletter ...

We will, besides others, look at:

- Completion of SA4 Release 7 Work Items on 3G Services
  - Multimedia Telephony over IMS
  - Enhanced Packet Switched Streaming
  - Enhanced MBMS User Services
  - Etc.
- Updates on RAN Long Term Evolution

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Annex

Figure 1: Logical base line architecture from TR 23.882

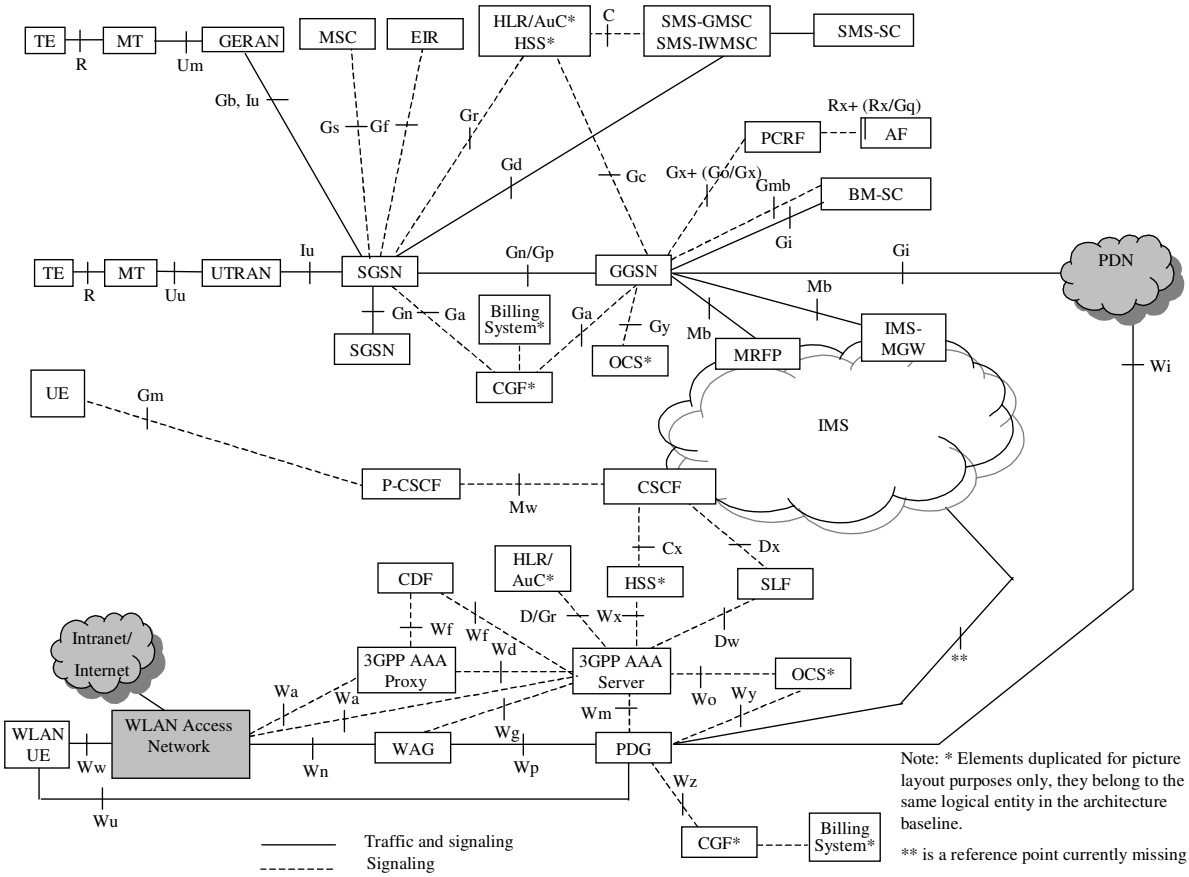

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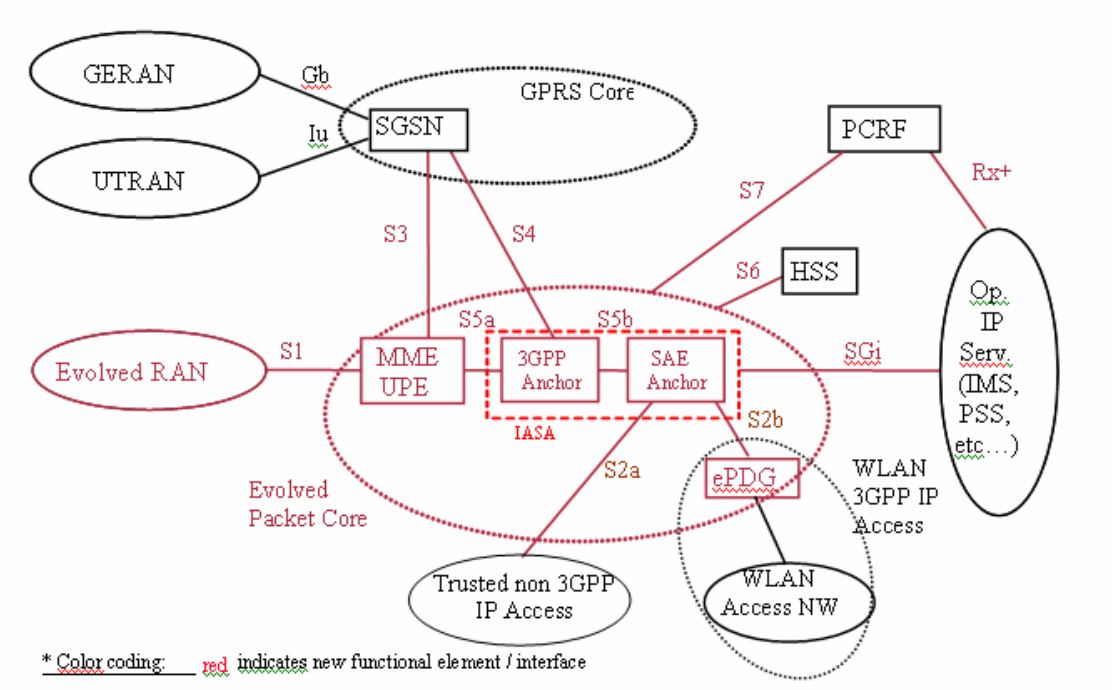
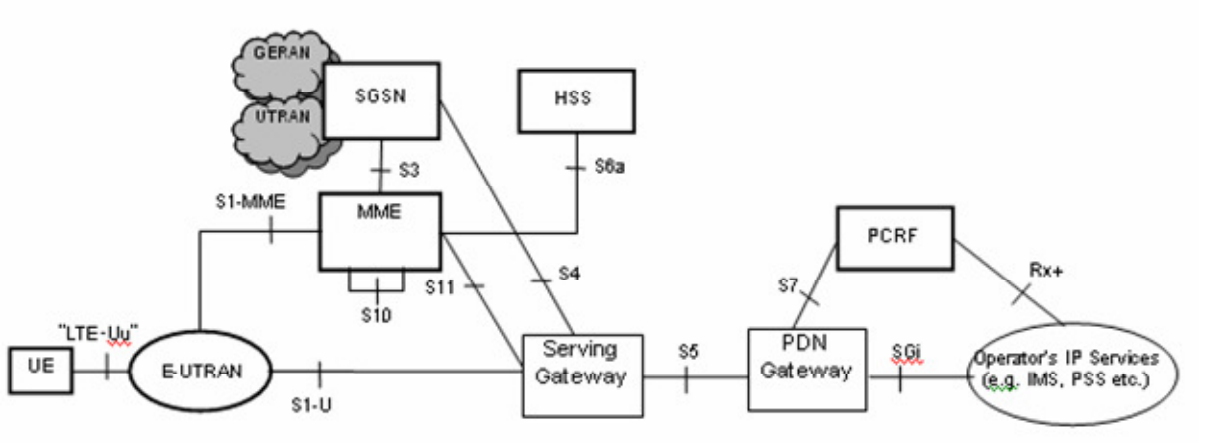
Figure 2: Logical high level architecture for the evolved system in non-roaming case



Architecture regarding TR 23.882



Architecture regarding TS 23.401

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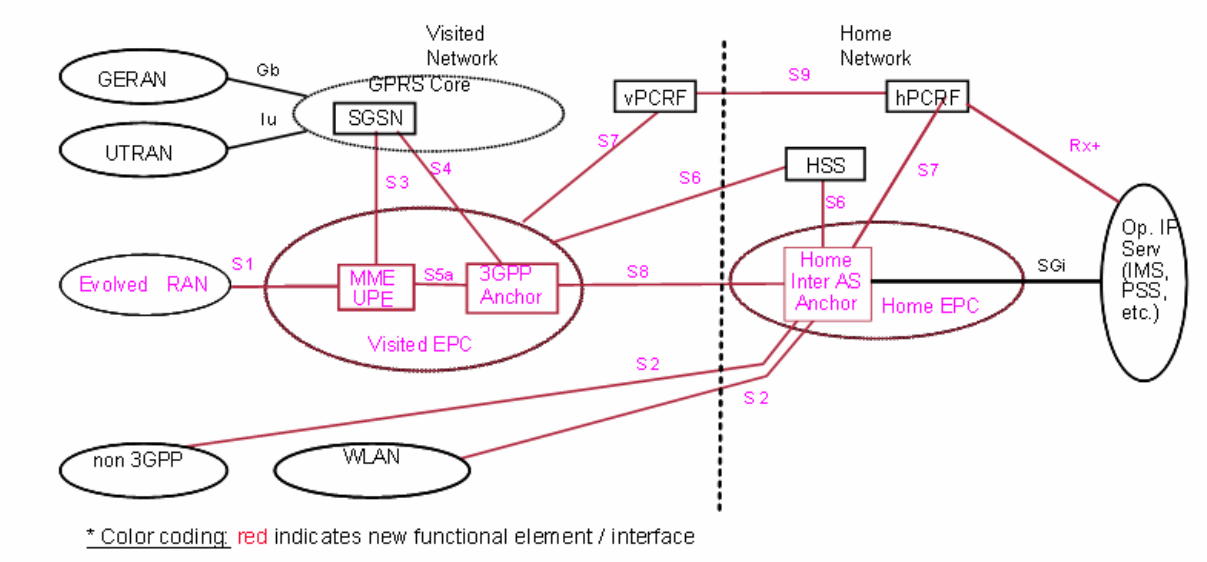
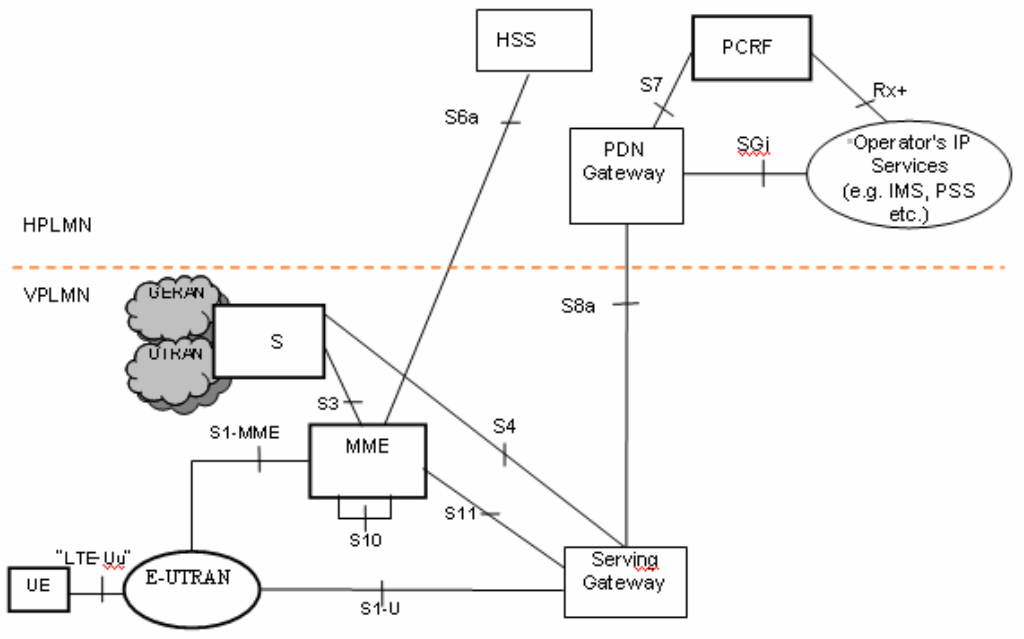
Figure 3: SAE roaming architecture – Home routed traffic



Architecture regarding TR 23.882



Architecture regarding TS 23.401

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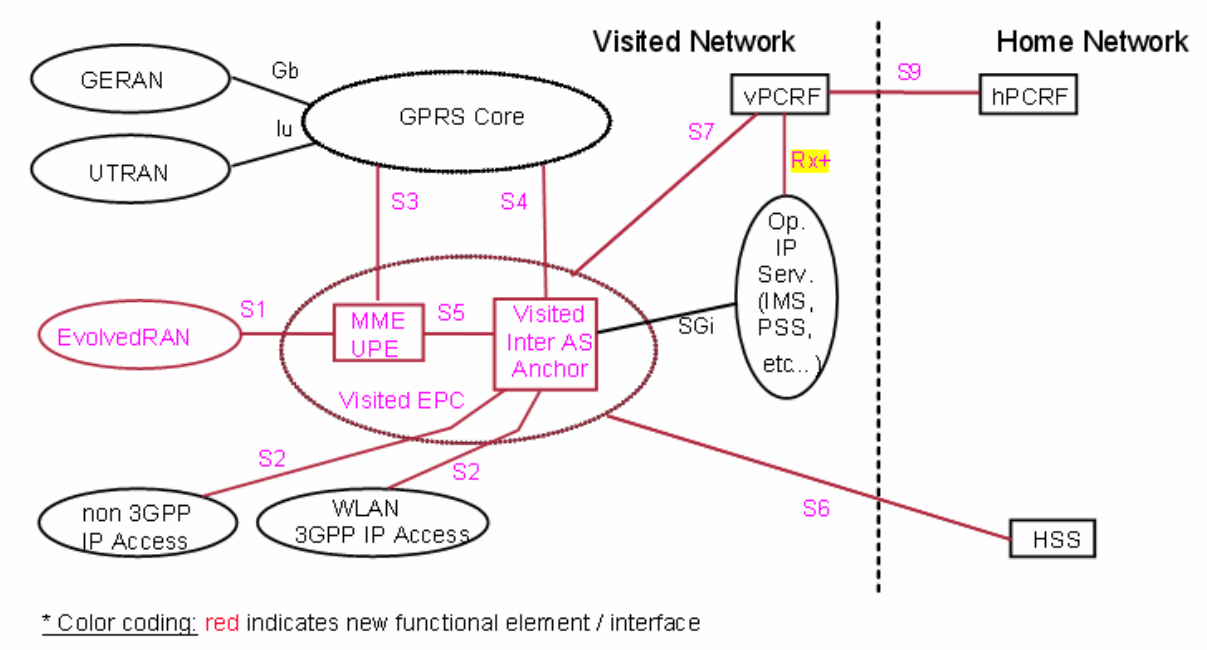
Figure 4: SAE Roaming architecture – Local Breakout



Architecture regarding TR 23.882