By the early architectural work for the system evolved 3GPP, two views on the implementation of mobility with the user plane and control plane protocols were presented.

The first was promoted as the good performance of the GPRS Tunneling Protocol GTP, while the other pushed for the new and new - called "base " other IETF protocols.

Both had good arguments on their side:

- **GTP evolution**: This protocol has proven its usefulness and capabilities to operators, and was very successful in the large scale operations. It was designed exactly to the needs of the mobile networks PS.

- **IETF based protocols**: IETF is the de facto standards body for the internet. Their mobility protocols have evolved from focusing on mobile IP-based network client to "Proxy Mobile IP MP. PMIP was standardized in 3GPP Evolved parallel system. But MobileIPClientbasedusedEPSin conjunction with non 3GPP Access Support.

### EPC for 3GPP access in non-roaming

The functions provided by the reference points and the protocols employed are:

#### LTE-Uu

LTE-Uu is the point of reference for radio interface between EU and eNodeB, encompasses control plane and user plane. The top layer of the control plane is called "Radio Resource Control" RRC. It is stacked on "Packet Data Convergence Protocol" PDCP, Radio Link Control and MAC layers.

#### S1-U

S1-U is the point for user plane traffic between eNodeB and serve GW reference. The main activity via this benchmark is to transfer IP packets encapsulated users arising from traffic or tunnel shape. Encapsulation is needed to realize the virtual IP link between eNodeB and GW service, even during the movement of EU, and thus enable mobility. The protocol used is based on GTP-U.

#### S1-MME

S1-MME is the point for the control plane between eNodeB and MME reference. All control activities are carried out on it, for example, signaling for attachment, detachment, and the establishment of the support of the change, safety procedures, etc. Note that some of this traffic is transparent to the E-UTRAN and is exchanged directly between EU and MS, it is a part called "non-access stratum" N/AS signaling.

#### S5

S5 is the benchmark that includes the control and user plane between GW and PDN GW Service and applies only if both nodes reside in the HPLMN; the corresponding reference point when serving GW is VPLMN is called S8. As explained above, two protocol variants are possible here, an enhanced GPRS Tunneling Protocol GTP and Proxy Mobile IP PMIP.

#### S6a

S6a is the reference point for the exchange of information relating to subscriptions equipment downloading and purging. It corresponds to Gr and D reference point in the existing system, and is based on the DIAMETER protocol.

#### SGi

This is the point of exit for DPR, and corresponds to the Gi reference point GPRS and Wi in I-WLAN. IETF protocols are based here for the user plane i.e. IPv6[DLPE]packetforwarding protocols and control plane as DHCP and radius/diameter for configuring IP address/external network protocol are used.

#### S10

S10 is a reference point for the MME relocation purposes. It is a pure control plane interface and advanced GTP-C protocol is used for this purpose.

#### S11

S11 is a reference point for the existing control plane between MME and GW service. It employs the advanced GTP-C GTP - C2 protocol. The holders of data between eNodeB and serve GW are controlled by the concatenation S1-S11 and MME.

#### S13

S13 is the reference point for Equipment Identity Register EIR and MME, and it is used for identity control e.g. based on "ME, fight". It uses the diameter protocol SCTP.

#### Gx

Gx is the reference point of the QoS policy filtering policy and control the load between PCRF and PDN GW. It is used to provide filters and pricing rules. The protocol used is the DIAMETER.

#### Gxc

Gxc is the reference point that exists in over Gx but is located between GW and PCRF and serves only if PMIP is used on SS or S8.

#### Rx

Rx is defined as an application function 4F, located in NDS and PCRF for the exchange of policy and billing information; it uses the DIAMETER protocol.

### EPC for 3GPP Access in Roaming

Both had good arguments on their side:

- GTP evolution: This protocol has proven its usefulness and capabilities to operators, and was very successful in the large scale operations. It was designed exactly to the needs of the mobile networks PS.

- IETF based protocols: IETF is the de facto standards body for the internet. Their mobility protocols have evolved from focusing on mobile IP-based network client to "Proxy Mobile IP MP. PMIP was standardized in 3GPP Evolved parallel system. But MobileIPClientbasedusedEPSin conjunction with non 3GPP Access Support.
In roaming this case the user plane either:

Extends back to the HPLMN via an interconnection network, which means that all EU user traffic is routed through a PDN GW in the HPLMN, where the DPs are connected; or

For the sake of a more optimal way of traffic, it leaves a PDN GW in the VPLMN to a local PDN.

The first is called "home routed traffic" and the second is called "local breakout:

Note that the concepts of roaming discussed in traffic optimization for home NBS/NodeB, baseband differ in meaning because of the concept of roaming/3GPP, the control plane always involves the HPLMN.

Interworking between EPC and Legacy

From the beginning, it was clear that the 3GPP Evolved system will interoperate seamlessly with existing 2G and 3G systems. 3GPP PS widely deployed or, more precisely, with GERAN and UTRAN

GPRSBased For aspects of interworking with HSS/3GPP System for treatment of optimised voice.

The question of the basic architectural design to 2G/3G in EPS is the location of the GGSN map.

Two versions are available, and both are supported:

- The GW used: It is the normal case where serving the GW ends the user plane
  
  aseemtheneeyzing/GRISnetwork.

  The control plan is completed in the MME, according to the distribution of users and control plane in EPC. S3 and S4 reference points are introduced, and they are based on GTP-U and
  
  GTP-C, correspondingly. S5/S8 is chained to the PDN GW. The advantage is that
  
  interoperability is smooth and optimized. The downside is that for this kind of interoperability
  
  SGSN must be upgraded to Rel. 8 due to the new supporting features on S3 and S4.

- The PDN GW: In this case the unchanged benchmark inheritance Gn when roaming, InwouldGp is reused between SGSN and PDN GW, for both control and user plane. The advantage of this use is that SGSN can be pre-Rel. 8. Furthermore, it carries a certain restriction on IP versions, transfer and S5/S8 protocol.

Interworking with Legacy 3GPP CS System

During the 3GPP Evolved design phase, it became clear that the legacy CS system, with its most important service "voice" communication, could not be ignored by the new system. The operators were simply too related investments in the field, and so very efficient interworking was requested.

Two solutions have been developed:

- Single Radio Voice Call Continuity SRVCC for transferring voice calls from LTE with voice over IMS to the legacy system.

- CS fallback: Enabling a temporary move to the legacy CS before a CS incoming or outgoing activity is performed.

Single Radio Voice Call Continuity SRVCC

In this solution chosen by 3GPP for SRVCC with GERAN/UTRAN, a specially reinforced MSC is connected via a new interface control plane for MME.

Note that the MSC serving the EU can be different than supporting the Sv interface. In the IMS, an application server AS for SRVCC is necessary. Sv is based on GTPv2 and helps prepare resources in the target system access and core network and the interconnection between SnS and Misdomain, while being connected to access the source.

Similarly, with SRVCC CDMA 1xRTT requires interworking 1xRTT Server IVS, which supports the interface and signal relay from / to 1xRTT MSC serving the UE S102 with the same purpose. S102 is a tunnel interface and transmits 1xRTT signaling messages; between MME and UE these are encapsulated.

CS Fallback

Serving GW and PDN GW are not separated S5/8 and VLR is integrated with the MSC server. A new SG interface is introduced between the MSC Server/UR and MME, allowing combined and coordinated procedures. The concept consists of:

- Signal relay to end the CS request incoming calls, handling network triggering of additional services SMS/Legacy from the MSC Server for M5 on SG and vice versa;

- The combined operating procedures between the PS domain and the CS domain.

Interworking with Non-3GPP Access

Interworking with different system of 3GPP access networks called RAN – 3GPP access was an important target for SAE; this should be done under the EPC umbrella. This interoperability can be achieved at different levels and for this, there was an attempt to add 3GPP/SAE to the system – SCELL. But for the generic type of interworking, it seemed necessary to rely on generic mechanisms, so the IP level seemed most appropriate.

In general, complete systems for mobile and fixed networks have an architecture similar to that described above. For the evolved 3GPP system there is normally an access network and a core network. In the interworking architecture, the evolved 3GPP system, other access technologies systems connect to the EPC.

In general, complete mobile network system and fixed network systems have a similar architecture as described outlined in Evolved 3GPP system and normally consist of an access network and a core network.

It was also decided to allow two different types of interoperability, based on the property of the access systems. For networks with non-3GPP access confidence, it is assumed that secure communication between them and the EPC is implemented and also robust data protection is sufficient to guarantee

Processing math: 100%