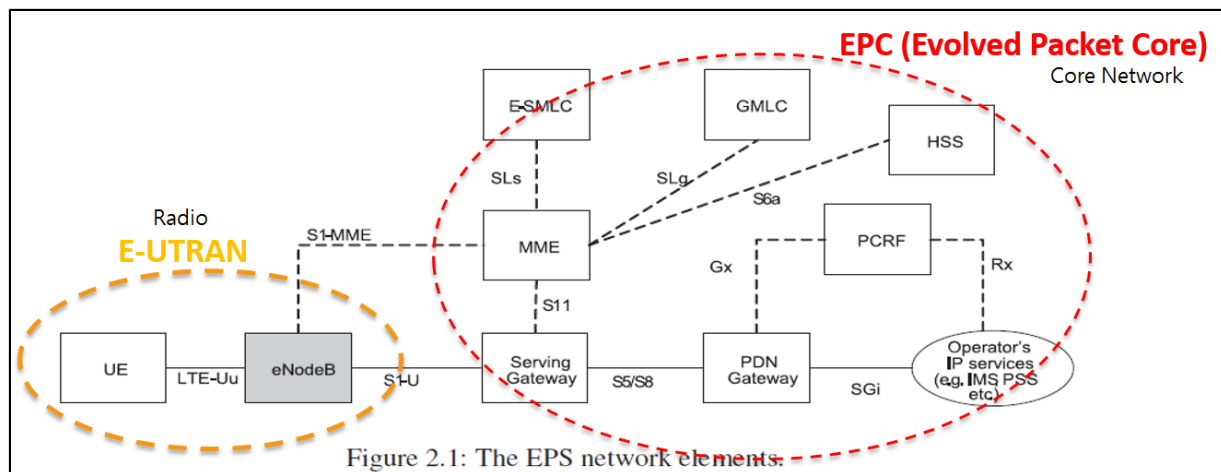


S-GW 是整合所有 3GPP 現有存取技術的資料錨點(Anchoring)，所有 3GPP 的存取技術都可以透過 S-GW 來進行資料傳遞，這樣在進行不同存取技術間的換手服務時較為便利。all user IP packets are transferred through the S-GW

P-GW 以 DHCP IP Allocation 機制派發一個 IP 給用戶端裝置。用戶端裝置在建立完預設承載(Default Bearer)後，會跟 P-GW 建立至少一組 IP(可能是 IPv4 或 IPv6) as well as QoS enforcement (QoS 保證) and flow-based charging according to rules from the Policy Control and Charging Rule Function (PCRF)，根據 PCRF 規則進行基於流量的計費



MME: processes the signaling between the UE and the CN. The protocols running between the UE and the CN are known as NAS protocols. The NAS procedures: EPS Mobility Management (EMM) and EPS Session Management (ESM)

EMM: procedures related to mobility over an E-UTRAN access, authentication and security. It is the equivalent in EPS of MM in GSM and GMM in GPRS

1. EMM common procedures refer to various network-initiated mechanisms.

- GUTI (Global Unique Temporary ID) reallocation
- Authentication
- Security mode control
- Identification
- EMM information

2. EMM specific procedures are UE-initiated.

- These procedures define attach to or detach from EPC mechanisms. UE initiates a Tracking Area Update (TAU) when it detects that it enters into a new Tracking Area. EMM specific procedures also define periodic TAU.

3. EMM connection management procedures (also known as ECM: EPS Connection Management): provide several functions to support the connection of the UE to the network

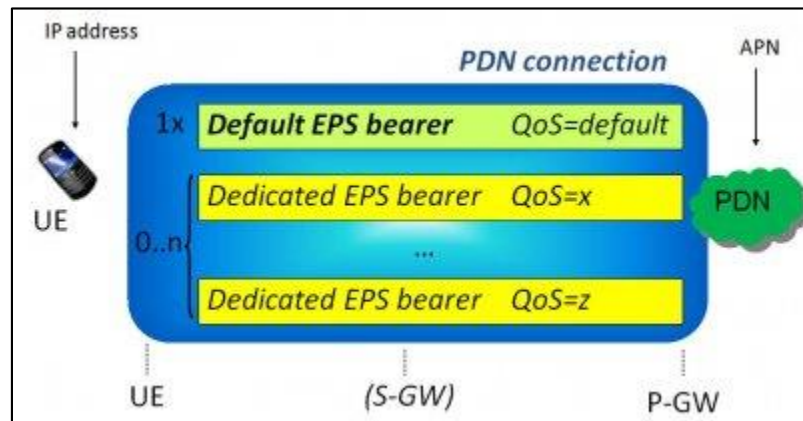
- Service request: initiated by the UE to start the establishment connection to NAS
- Paging: initiated by the network NAS indicate UE to start a service request
- Transport of NAS messages: used for SMS (CS fallback)
- Generic transport of NAS messages: Various other applications (e.g. LCS)

ESM: Bearer modification, release and establishment (support handling of user data) (下圖)

In EPS, (1) PDN connection and (2) EPS bearer define the IP connectivity between a UE and a packet data network (PDN)

PDN connection is composed of a default EPS bearer and possibly additional dedicated EPS bearers

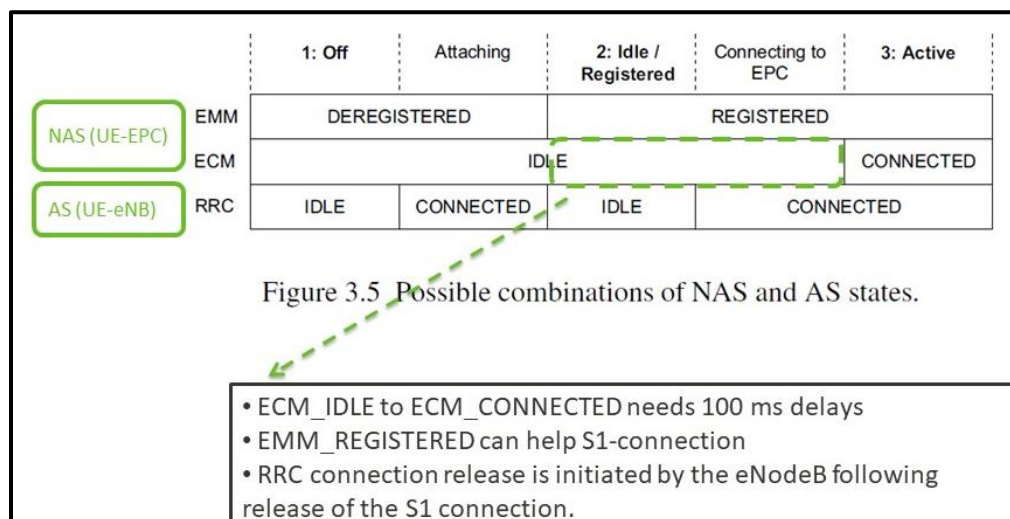
All EPS bearers share a same UE IP address and an APN in the same PDN connection

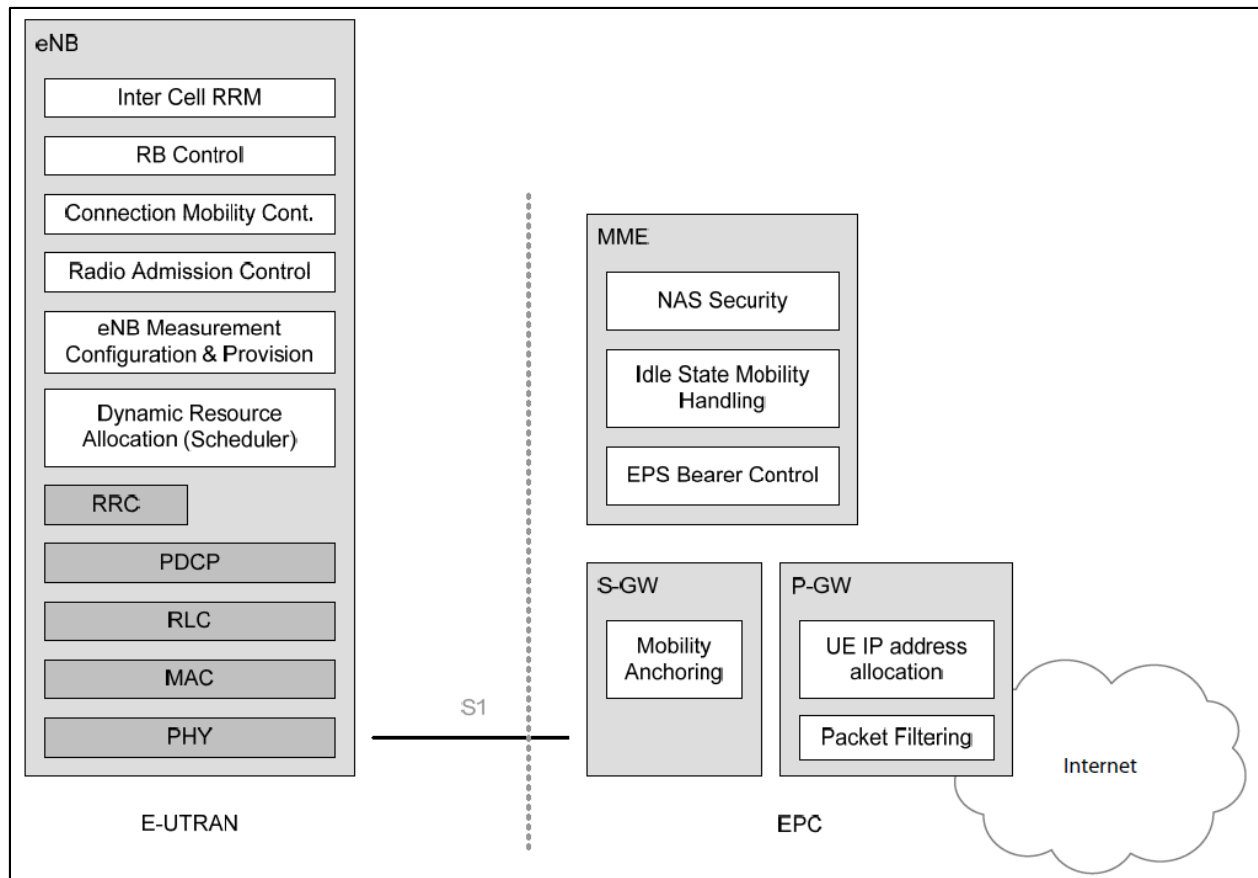


EPS uses the concept of **EPS bearers** to route IP traffic from a gateway in the PDN to the UE.

A bearer is an IP packet flow with a defined QoS between the gateway and the UE. 確保用戶封包資料在 P-GW 經由 S-GW、eNB 到 UE 之間的傳遞能符合 QoS，每一個承載除了對應到一組 QoS 參數外，同時也會對應到一個 Traffic Flow Template (TFT)，TFT 又包含數個 Packet Filter，Gateway 進行收送用戶封包時，該 Gateway 必須能經由正確的 EPS 承載進行隧道封裝，傳遞該用戶的 packet。

Multiple bearers can be established for a user in order to provide different QoS streams or connectivity to different PDNs. For example, a user might be engaged in a VoIP call while at the same time performing web browsing





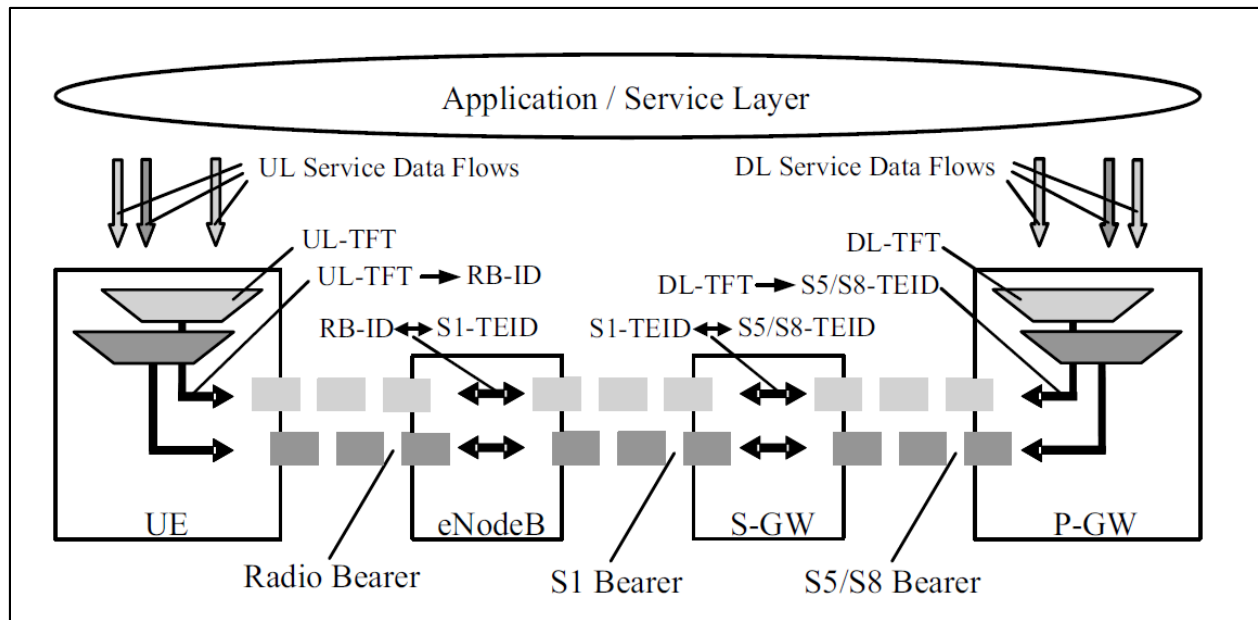
Two kinds of bearers:

Minimum GBR bearers: such as VoIP. Dedicated transmission resources are permanently allocated because of the associated GBR value. Bit rates higher than the GBR may be allowed for a GBR bearer if resources are available. In such cases, a Maximum Bit Rate (MBR) parameter, which can also be associated with a GBR bearer, sets an upper limit on the bit rate which can be expected from a GBR bearer.

Non-GBR bearers: which do not guarantee any particular bit rate. These can be used for applications such as web browsing or FTP transfer. For these bearers, no bandwidth resources are allocated permanently to the bearer.

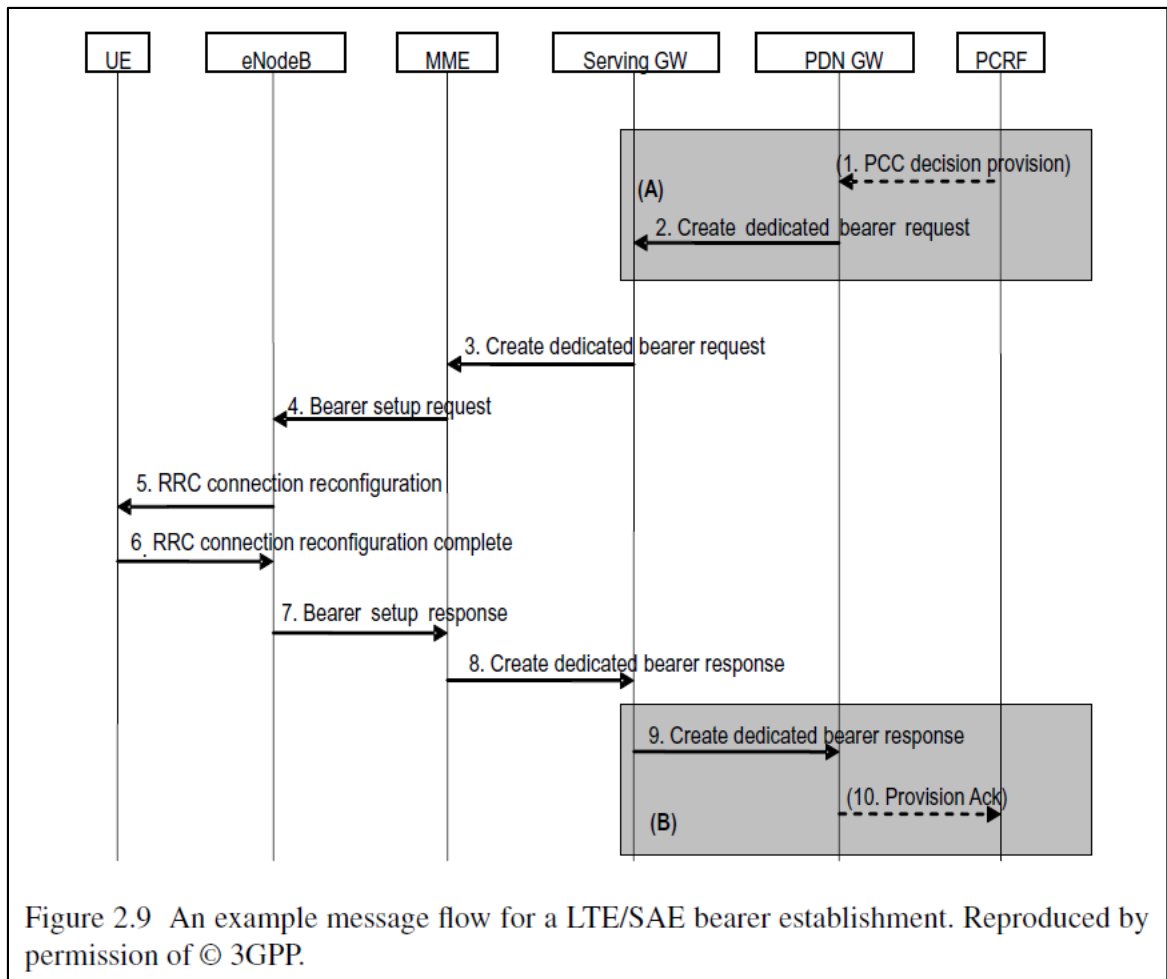
Control plane (S1-MME): Based on SCTP/IP stack, to avoid Head-of-line blocking (多個 connection 同時傳送 frame 而造成的 blocking) and Multi-homing. The individual connections are directly handled at the application layer. Simplified protocol stack with no management protocol

User plane (S1-U): Based on GTP (GPRS Tunneling Protocol)/UDP. Identify tunnel, Support intra-3GPP mobility. A transport bearer is identified by GTP tunnel endpoint, IP address (srcIP, dstIP), Tunnel end ID (src, dstTEID)



上圖中，S-GW 和 P-GW 之間溝通介面(S5/S8 Bearer)是基於 GPRS Tunneling Protocol (GTP)用戶封包傳遞情形。DL 封包過濾由 P-GW 負責，UL 封包過濾則由 UE 控制。封包經由過濾後，得到進行隧道封裝的必要資訊：兩端點 IP、隧道終點辨識符號(Tunnel Endpoint Identifier, TEID)，封裝後的資料則一路映射、隧道封裝傳遞到相對應的兩端點：UE 端或 P-GW 端。DL 流量控制由 P-GW 或 S-GW 負責，UL 流量則由基地台控制。而計費的功能是由 P-GW 或 S-GW 負責，由 Policy and Charging Rules Function (PCRF)統計回報。S5/S8 承載具備封包過濾的功能，但這裡的過濾功能並非將封包濾除掉，而是根據流量樣板(Traffic Flow Template, TFT)進行封包分類，來決定資料封包要從那一條資料承載通道進行傳輸。

Initial Attach時，依照用戶簽約的預設 QoS 等級建立一個 **Default Bearer**，即每一個手機用戶至少存在一個啟動的承載(Active Bearer)，從而保證用戶在開始收送應用服務時具有更短的時延，真正實現了用戶端的永遠連線(Always On Line)。



1. The PCRF sends a Policy Control and Charging (PCC) Decision Provision message indicating the required QoS for the bearer to the P-GW
2. The P-GW uses this QoS policy to assign the bearer-level QoS parameters, then sends a Create Dedicated Bearer Request message including the QoS and UL TFT to be used in the UE to the S-GW.
3. The S-GW forwards the Create Dedicated Bearer Request message (including bearer QoS, UL TFT and S1-bearer ID) to the MME
4. The MME then builds a set of session management configuration information including the UL TFT and the EPS bearer identity, and includes it in the Bearer Setup Request message which it sends to the eNB
5. The session management configuration is NAS information and is therefore sent transparently by the eNodeB to the UE.

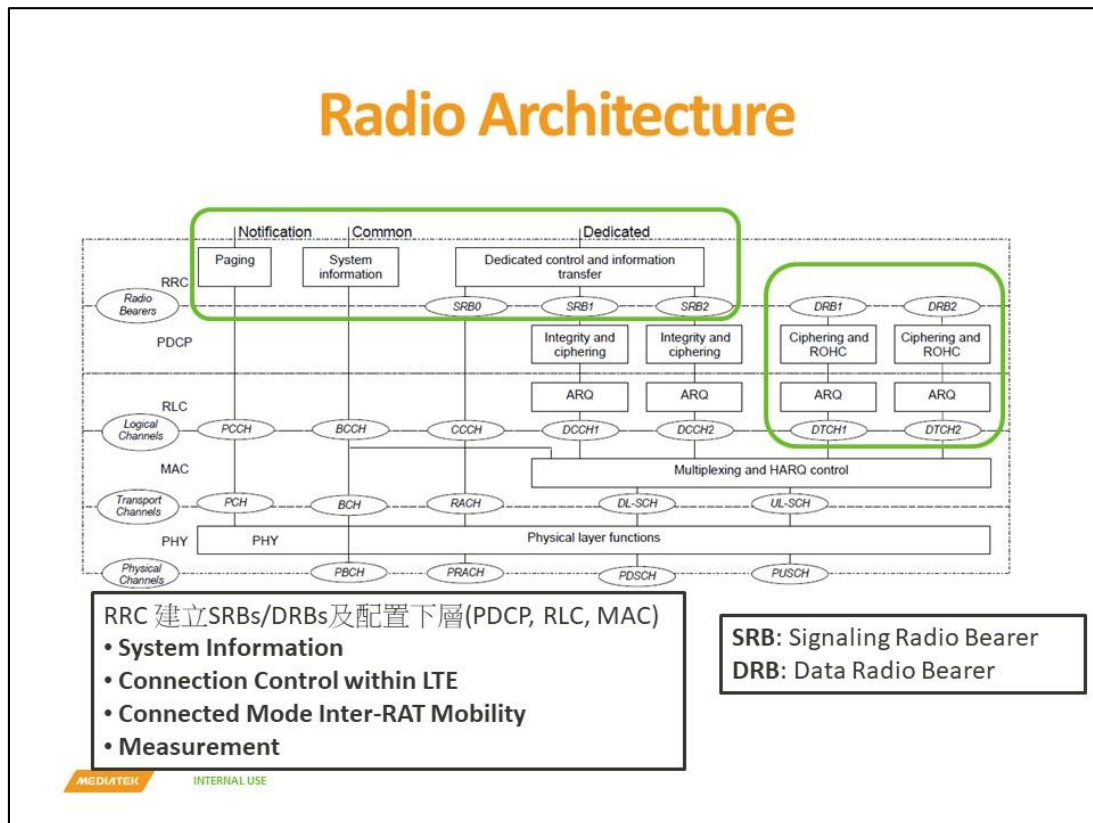
Messages 6 to 10 are the corresponding response messages to confirm that the bearers have been set up correctly.

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RRC (Radio Resource Control): The AS-related procedures largely depend on the UE RRC state

RRC_IDLE: (1) Cell-selection/ re-selection, (2) Monitor paging channel to detect incoming calls, (3) Acquire system information

RRC_CONNECTED: (1) Mobility is controlled by the network, (2) Send unicast data via shared data channels, (3) Monitor PDCCH to get transmission resources, (4) Report cell measurement information, (5) Discontinuous Data Reception (DRX) supported for power saving



SRB: transmit/receive RRC or NAS messages

SRB 0 (UL TM RLC + DL TM RLC): used for RRC message

SRB 1 (UL AM RLC + DL AM RLC): used for RRC message (which may include a piggybacked NAS message) or NAS messages prior to the establishment of SRB2

SRB 2 (UL AM RLC AM RLC): used for NAS message (NAS message is contained in RRC messages) + DL

SRB2 has a lower-priority than SRB1 in MAC and is always configured by E-UTRAN after security activation

DRB: transmit/receive user data