Mobile IPv6 deployment opportunities in next generation 3GPP networks

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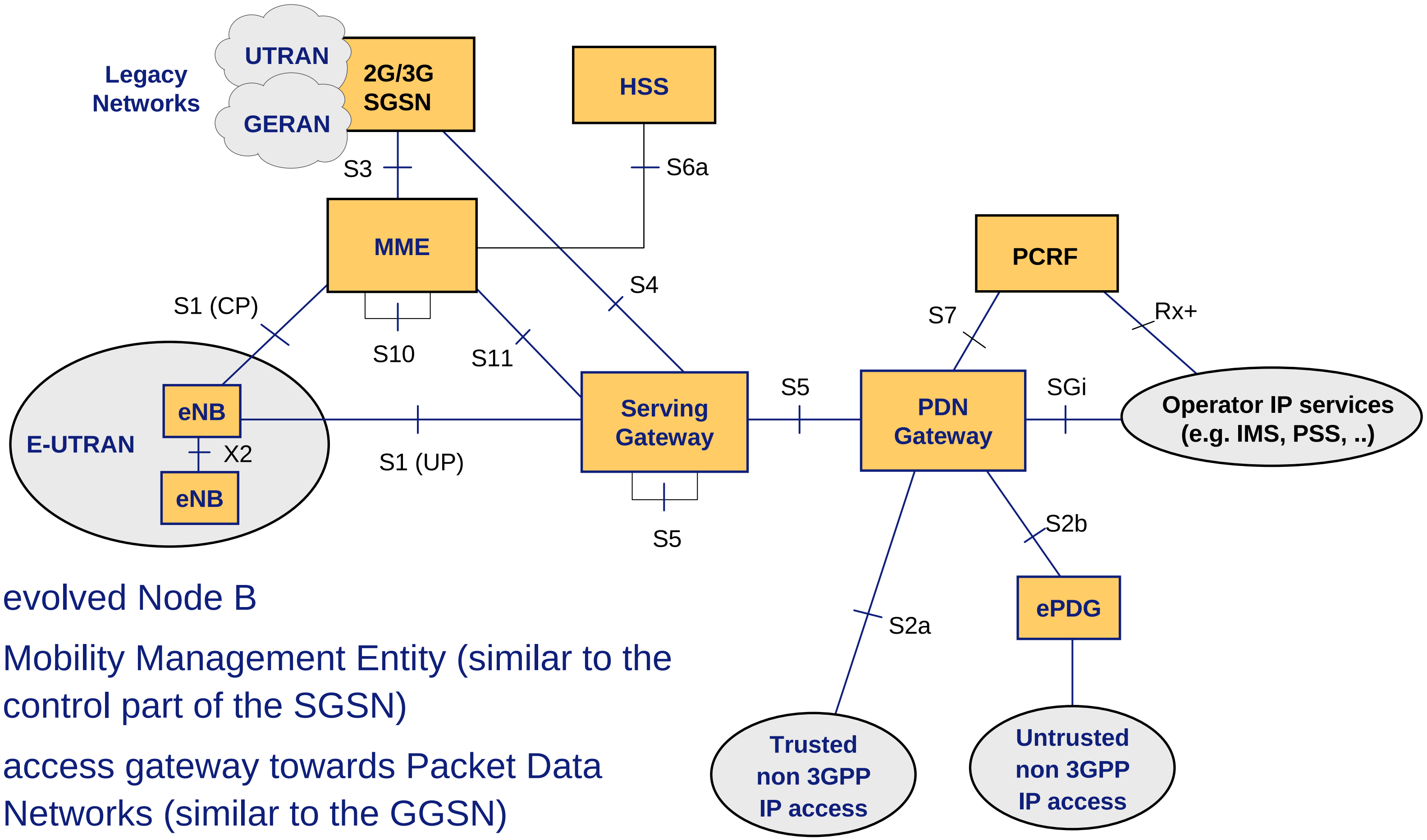
Overview of SAE/LTE

- Terminology
  - SAE (System Architecture Evolution): core network/system aspects
  - LTE (Long Term Evolution): new radio access (E-UTRAN)
- Main system characteristics
  - support for packet services only
  - OFDM radio technology
  - peak throughput per user : 100 Mbps DL and 50 Mbps UL (with a 20 MHz channel width)
  - multi-access core network: GERAN, UTRAN, E-UTRAN and non-3GPP
- Specifications to be completed by 2008

Logical architecture: non roaming



eNB: evolved Node B

MME: Mobility Management Entity (similar to the control part of the SGSN)

PDN GW: access gateway towards Packet Data Networks (similar to the GGSN)

SGi: interface towards Internet/Intranet (equivalent to Gi interface in GPRS)

Interworking with non 3GPP accesses (I)

- SAE supports both host-based and network-based mobility management solutions
  - Dual-Stack MIPv6 (host-based)
  - Proxy MIPv6 and MIPv4 in Foreign Agent mode (network-based)
- PDN GW works as MIP/PMIP Home Agent
  - when connected to a 3GPP access the UE can be assumed to be at home in MIP sense
    - ❑ mobility within 3GPP accesses (E-UTRAN, UTRAN and GERAN) is managed in a network-based fashion using 3GPP-specific protocols
  - service continuity is guaranteed in case the UE moves from a 3GPP access to a non 3GPP access (or vice versa)
    - ❑ the UE communicates using the same IP address independently of the access network it is attached to

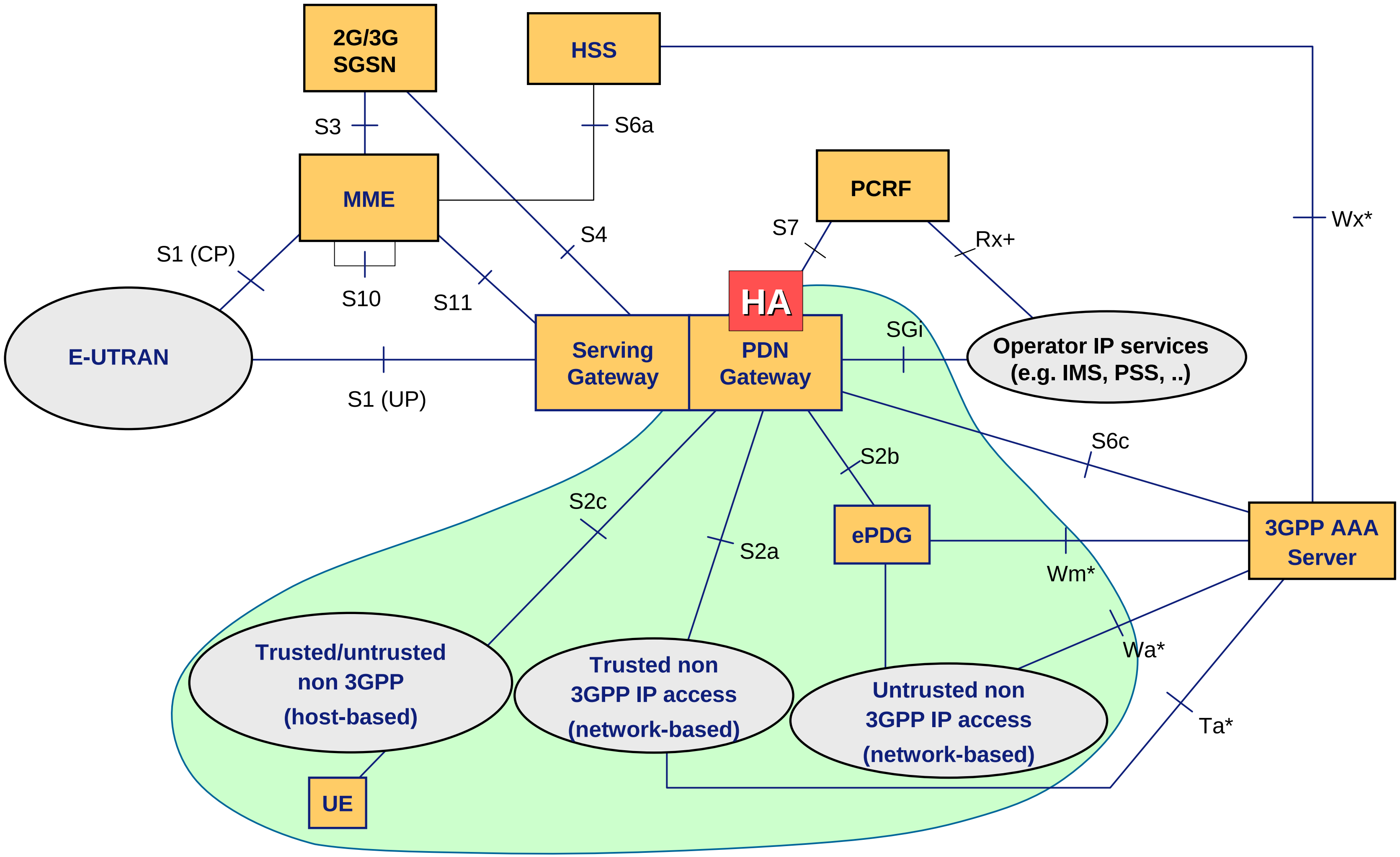
Interworking with non 3GPP accesses (II)

- SAE distinguishes between “trusted” and “untrusted” non 3GPP accesses
- It is up to the operator to decide if a non 3GPP access is trusted or untrusted
  - the decision is not based just on the access network technology but may depend also on business considerations
- Interworking with an untrusted access is performed via an evolved PDG (ePDG)
  - the ePDG is similar to a VPN concentrator
  - the UE has to establish an IPsec tunnel with the ePDG to access operator’s services
  - the ePDG may implement IP mobility protocols (e.g. PMIPv6)

Interworking with non 3GPP accesses (III)

- Interworking with a trusted access is performed using a more lightweight procedure
  - the UE does not need to establish an IPsec tunnel with the ePDG in advance
  - MIP or PMIP protocols can be used directly between the non 3GPP access network and the SAE core network
    - ❑ the non 3GPP access gateway (e.g. ASN GW in case of mobile WiMAX) can run PMIPv6

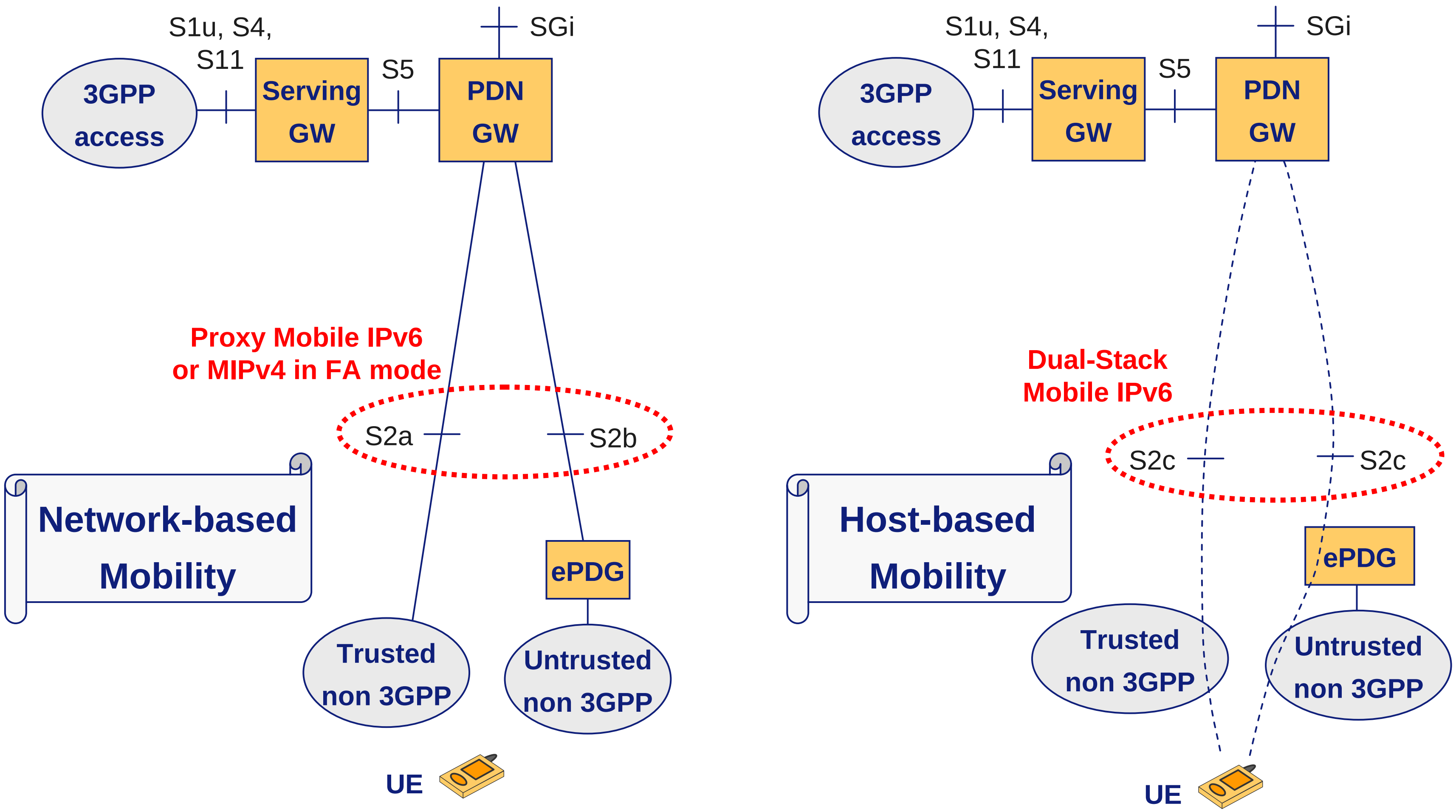
Interworking with non 3GPP accesses (IV)



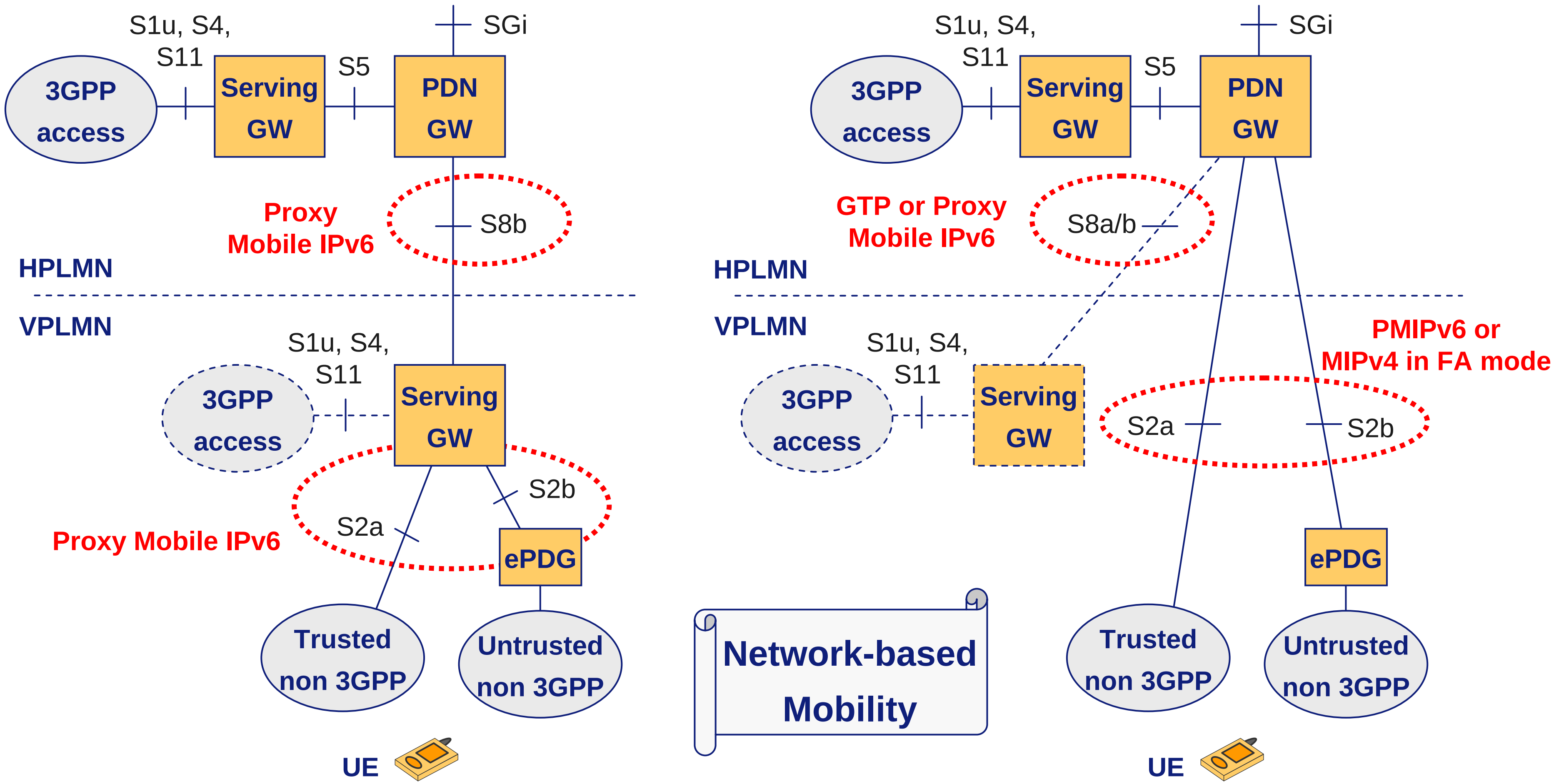
Protocols on non 3GPP interfaces

- The protocols that have been selected for mobility between 3GPP and non 3GPP accesses are
  - S2a reference point (trusted non 3GPP accesses): Proxy Mobile IPv6 and Mobile IPv4 in Foreign Agent mode
    - ❑ Mobile IPv4 in FA mode was requested by CDMA2000 operators (e.g. Verizon), that want to re-use their already deployed Mobile IPv4 infrastructure
  - S2b reference point (untrusted non 3GPP accesses): Proxy Mobile IPv6 with dual-stack extensions
  - S2c reference point (host-based mobility on trusted/untrusted accesses): Dual-Stack Mobile IPv6 (DSMIPv6)
    - ❑ the usage of Mobile IPv4 in co-located mode is still under consideration

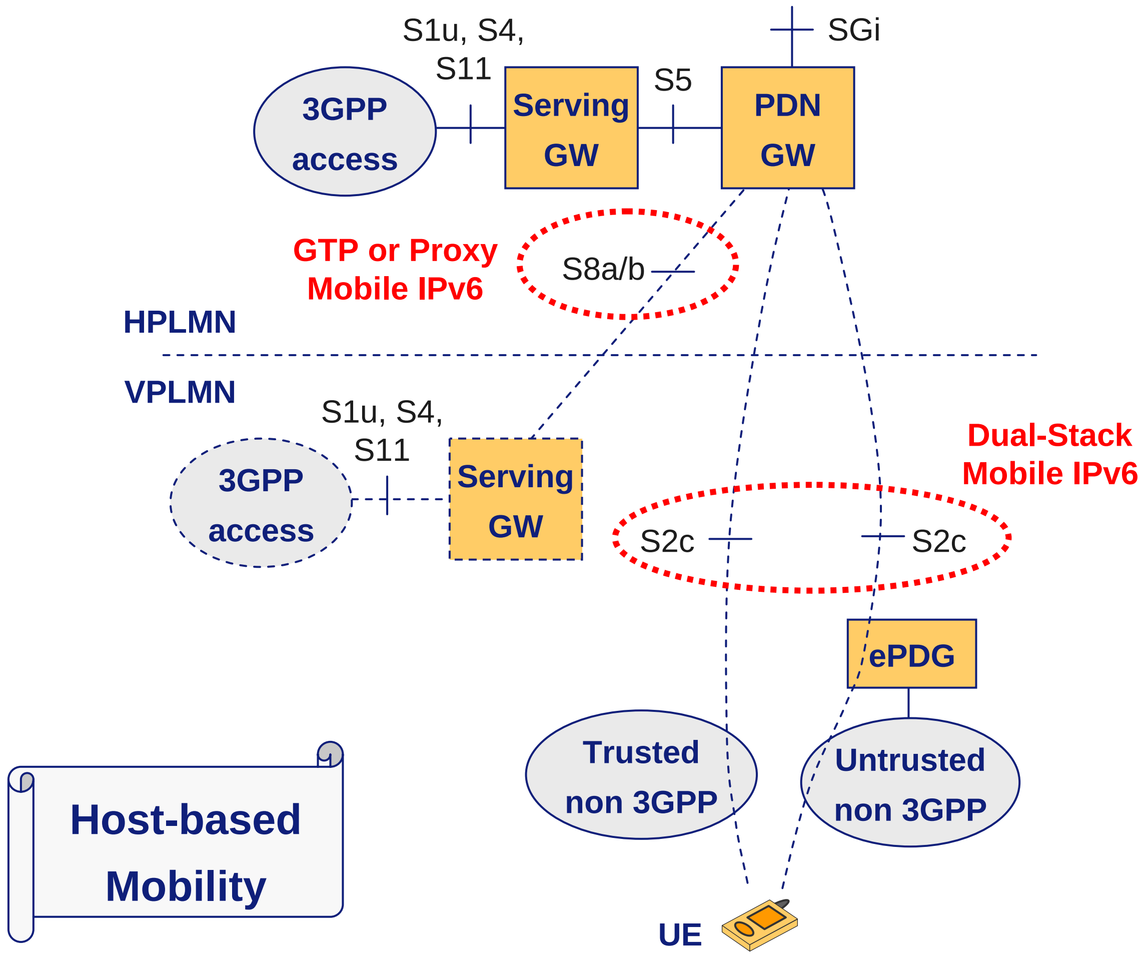
Interworking scenarios: non roaming



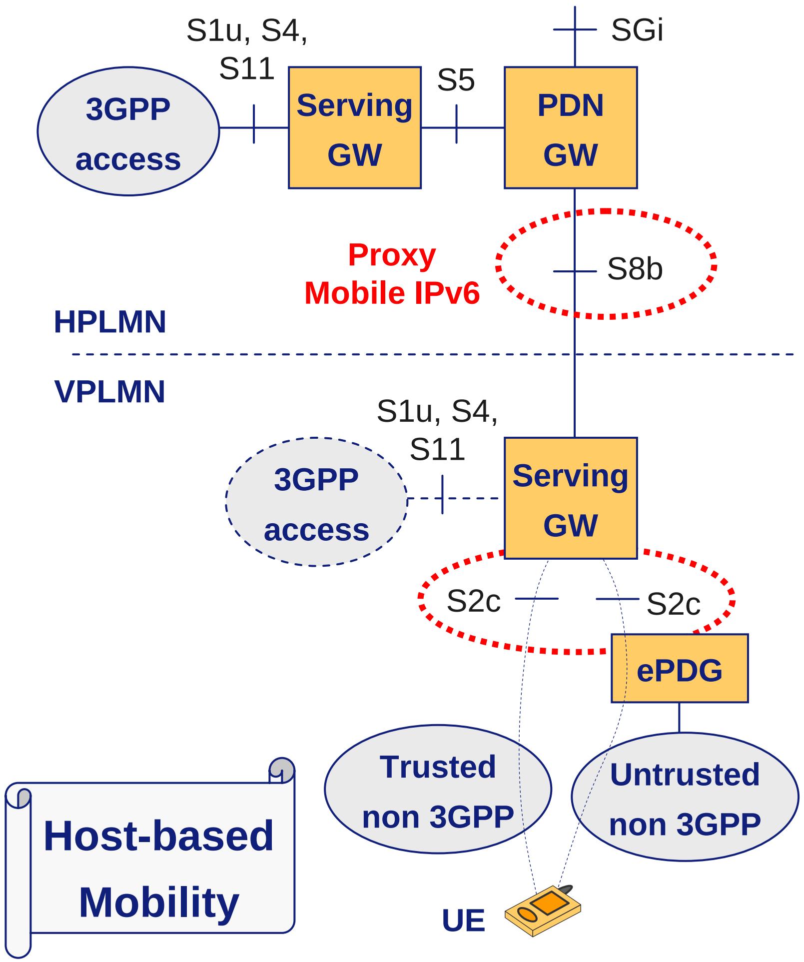
Interworking scenarios: roaming (I)



Interworking scenarios: roaming (II)

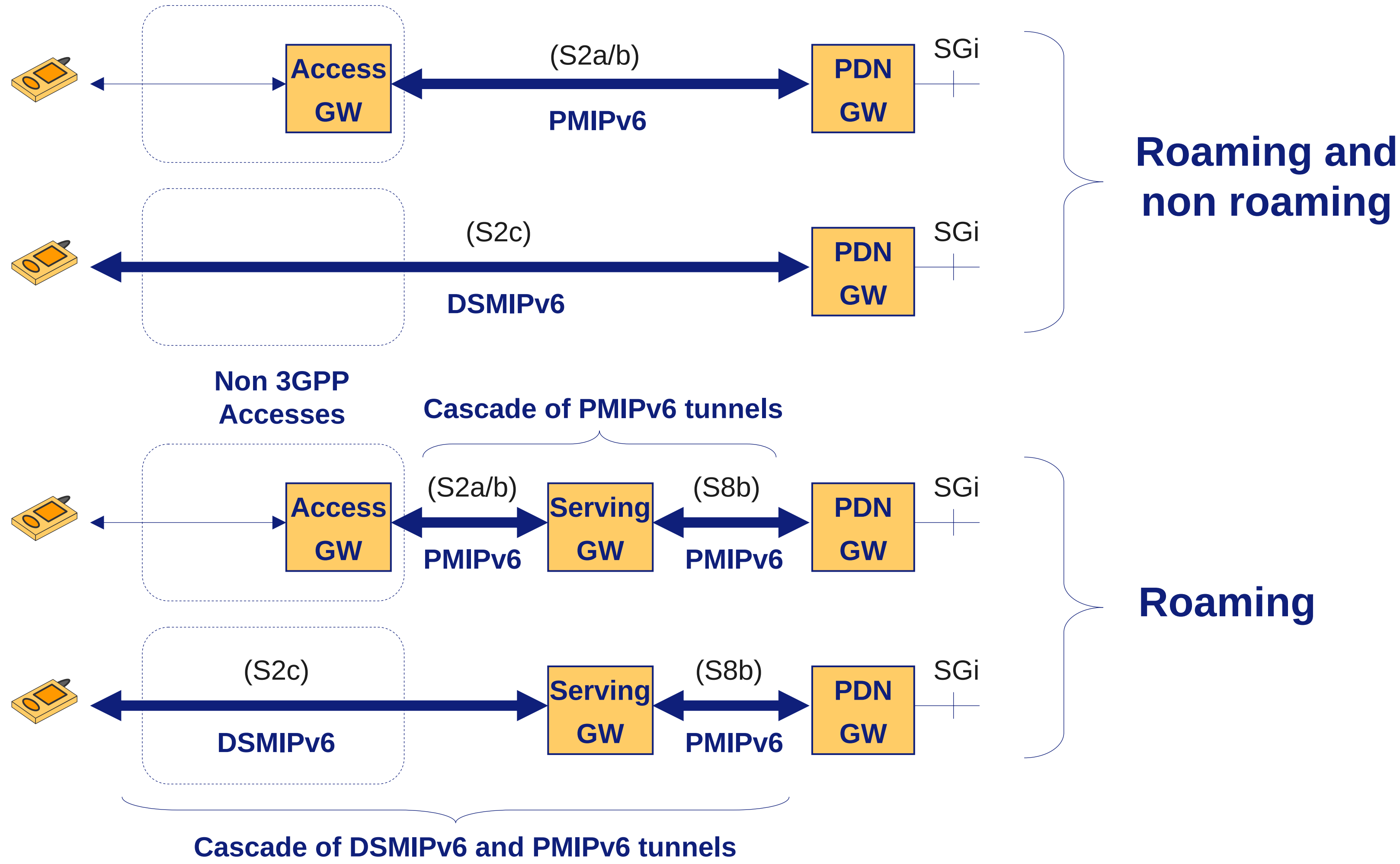


Interworking scenarios: roaming (III)



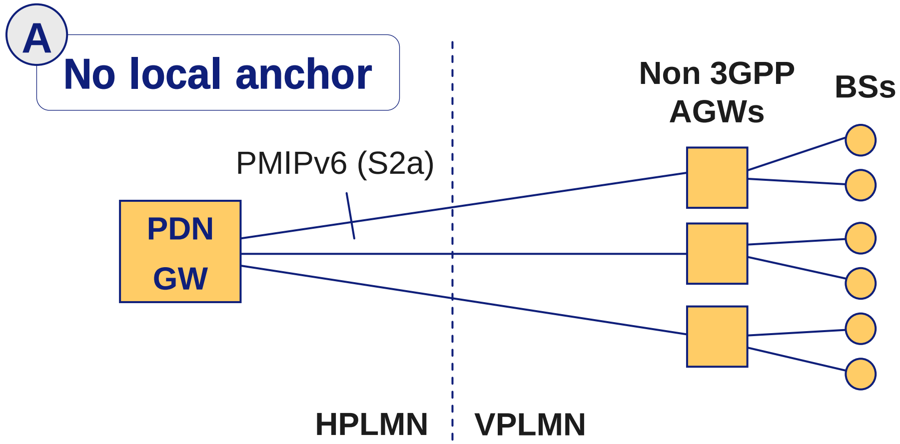
- This scenario has not been officially accepted yet
  - the Serving GW works as a local mobility anchor and runs PMIPv6 with the PDN GW
    - ❑ the home address is provided by the PDN GW (i.e. the real HA)
    - ❑ data traffic is anchored on the PDN GW
    - ❑ the Serving GW handles local mobility through DSMIPv6
    - ❑ the visited operator can use the Serving GW to enforce policies (e.g. charging)
  - not clear how to handle Serving GW relocation when the UE moves across VPLMNs

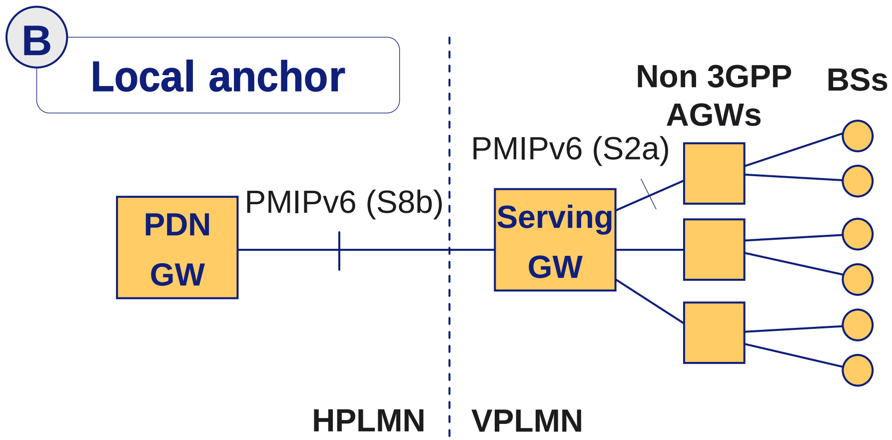
PMIPv6/MIPv6: summary of usage scenarios



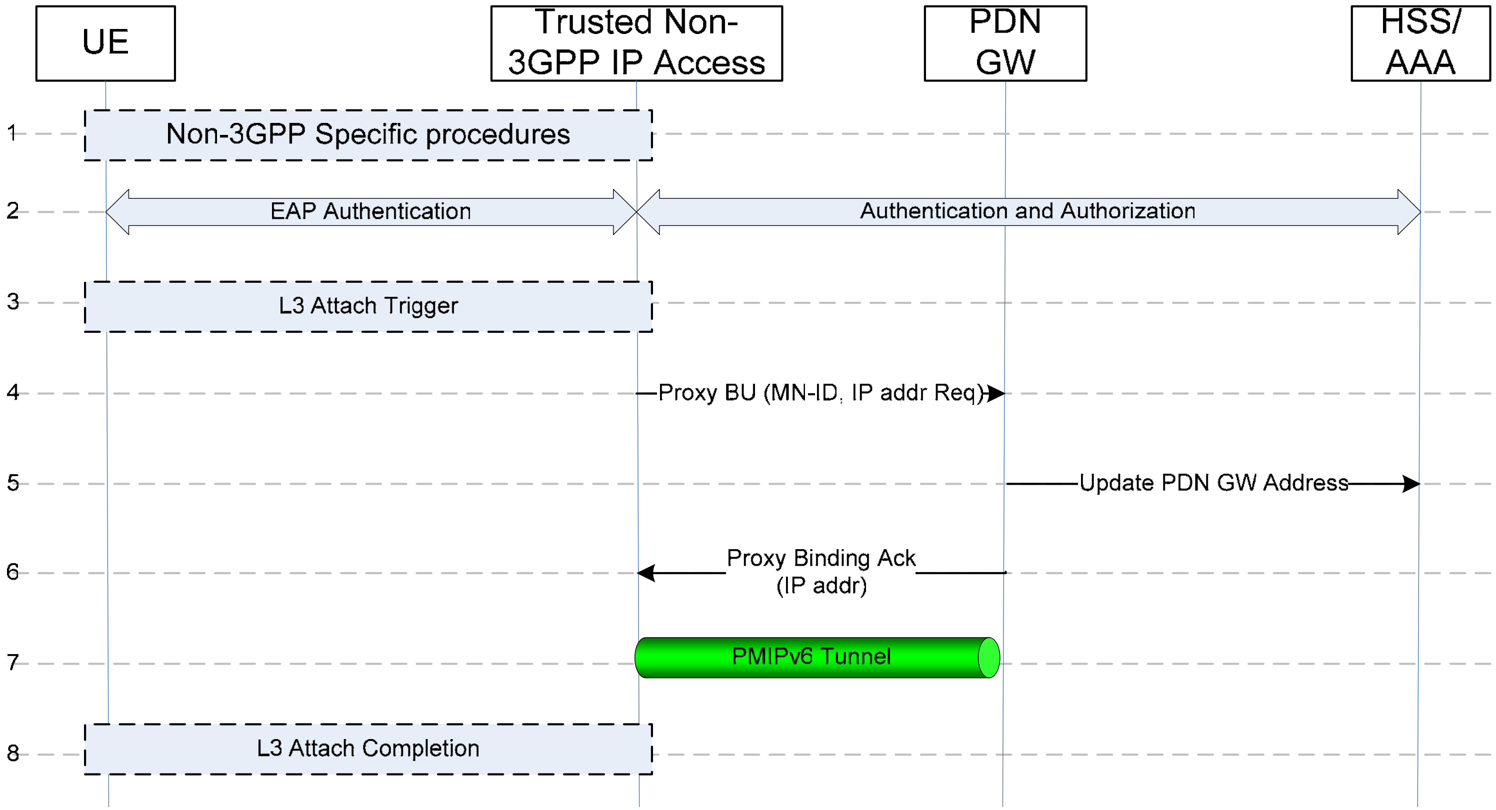
Roaming with or without local anchor

- Option A: no local anchor
  - HPLMN has to interface via PMIPv6 with all non 3GPP AGWs in VPLMN
  - complicates the establishment and maintenance of roaming agreements
- Option B: local anchor
  - PDN GW in HPLMN needs to interface via PMIPv6 just with the anchor point in VPLMN
  - simplifies the establishment of roaming agreements
  - the visited operator can exploit the local anchor to enforce policies on UE's data traffic





Attach over S2a: trusted non 3GPP access (I)



Attach over S2a: trusted non 3GPP access (II)

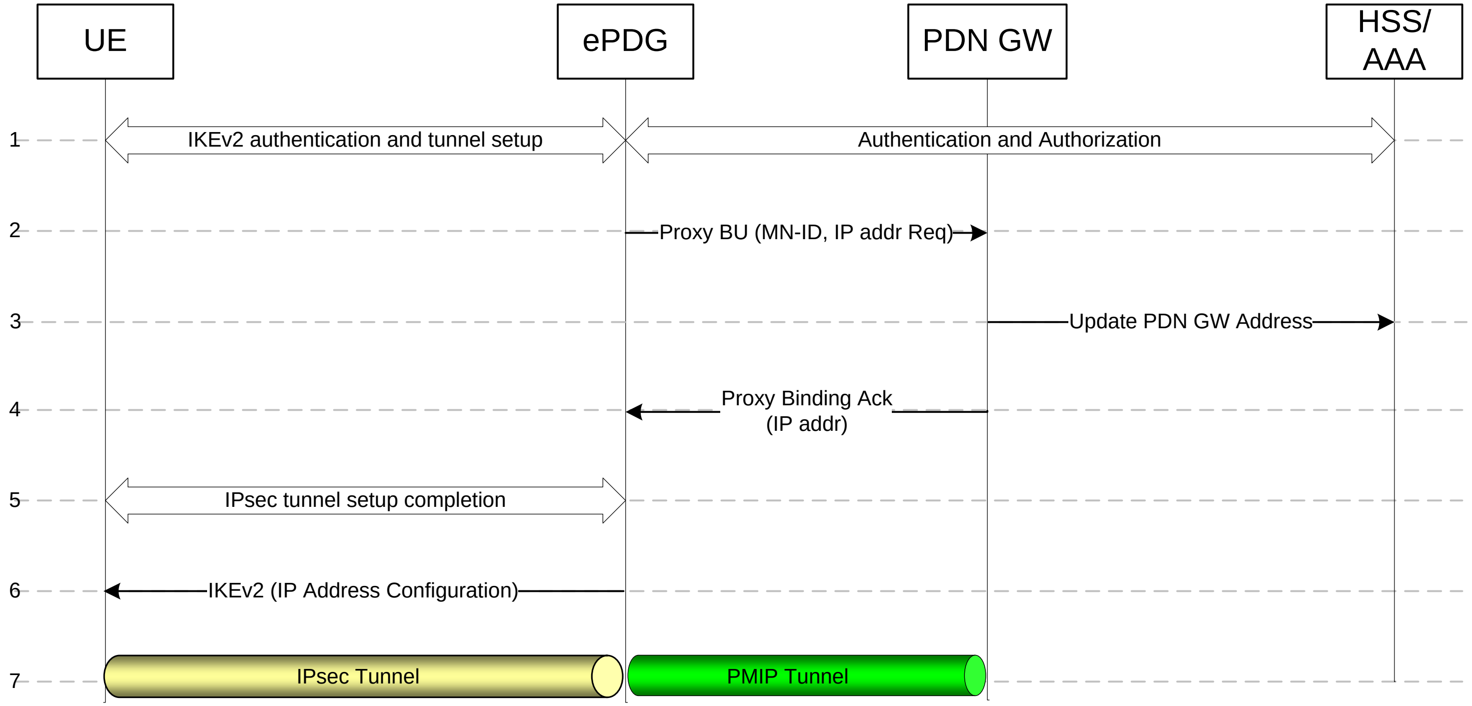
- Step by step description of the procedure
  1. The initial Non-3GPP access specific L2 procedures are performed
  2. The EAP authentication procedure for network access is performed involving the UE, trusted non-3GPP IP Access and the 3GPP AAA Server. In the roaming case, there may be several AAA proxies involved. The PDN GW information is returned as part of the reply from the 3GPP AAA Server to the MAG in the trusted non-3GPP access
  3. After successful authentication and authorization, the L3 attach procedure is triggered
  4. MAG function of Trusted Non-3GPP IP Access sends Proxy Binding Update message to PDN GW
  5. The selected PDN GW informs the 3GPP AAA Server of its address

Attach over S2a: trusted non 3GPP access (III)

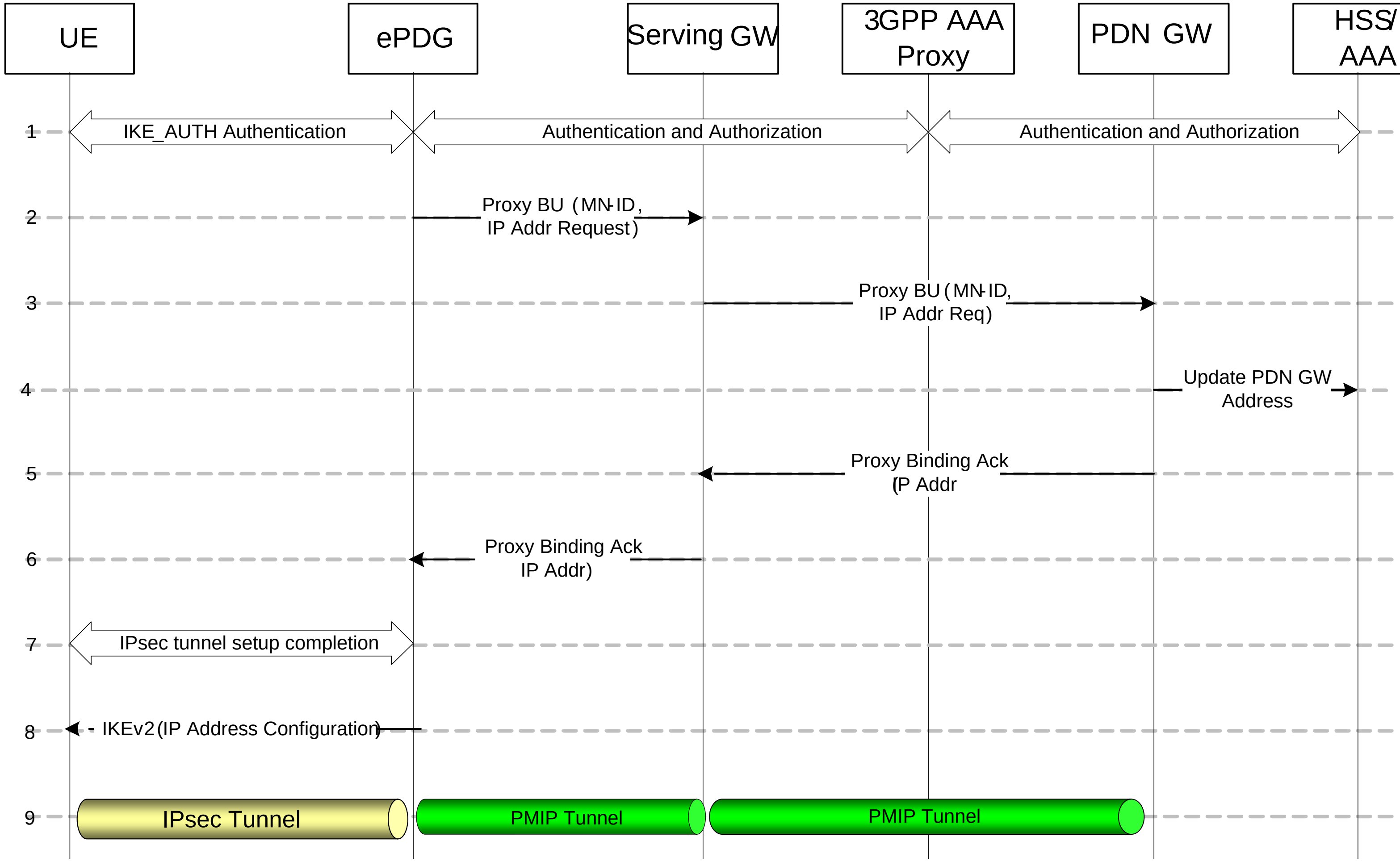
- Step by step description of the procedure (cont'ed)

6. The PDN GW processes the proxy binding update and creates a binding cache entry for the UE. The PDN GW allocates IP address for the UE. The PDN GW then sends a proxy binding acknowledgement to the MAG function in Trusted Non-3GPP IP Access, including the IP address(es) allocated for the UE
7. The PMIPv6 tunnel is set up between the Trusted Non-3GPP IP Access and the PDN GW
8. L3 attach procedure is completed. IP connectivity between the UE and the PDN GW is set for uplink and downlink directions

Attach over S2b: untrusted non 3GPP access



Attach over S2b/S8b: cascade of tunnels (I)



Attach over S2b/S8b: cascade of tunnels (II)

- Step by step description of the procedure
  1. The IKEv2 tunnel establishment procedure is started by the UE. The ePDG IP address to which the UE needs to form IPsec tunnel is discovered via DNS query. The PDN GW information is returned as part of the reply from the 3GPP AAA Proxy to the ePDG. This may entail an additional name resolution step, issuing a request to a DNS Server
  2. The ePDG sends the PBU message to the Serving GW
  3. The visited Serving GW processes the proxy binding update and creates a binding cache entry for the UE. Then the visited Serving GW sends the PBU message to the PDN GW using its own address as the MAG address. Note that the binding cache entry on the Serving GW does not yet have the UE's IP address information. This information will be added to the binding cache entry after step 4

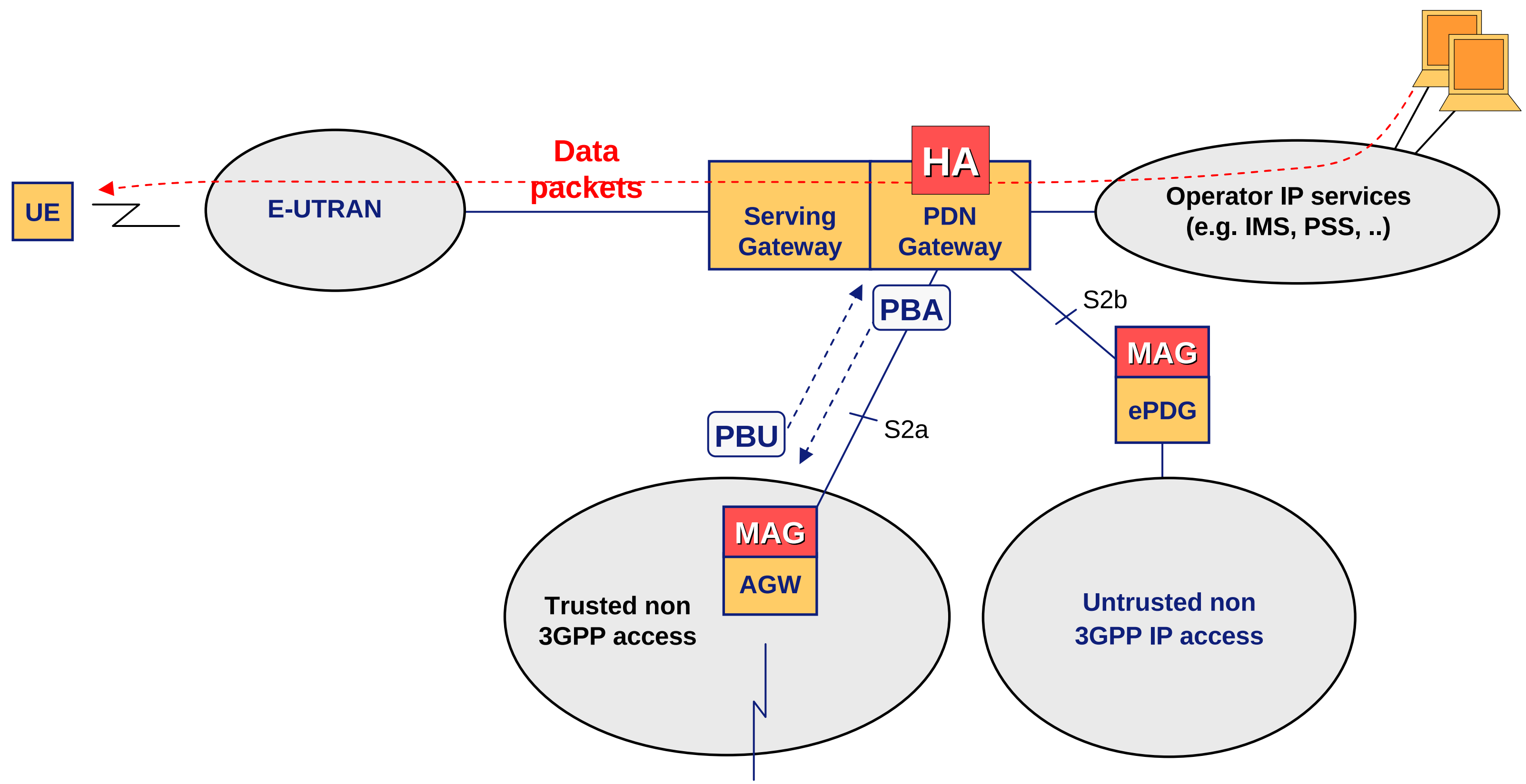
Attach over S2b/S8b: cascade of tunnels (III)

- Step by step description of the procedure (cont'ed)
  4. The selected PDN GW informs the 3GPP AAA Server of its address
  5. The PDN GW processes the proxy binding update and creates a binding cache entry for the UE. The PDN GW allocates an IP address for the UE. The PDN GW then sends a proxy binding ack to the Serving GW, including the IP address allocated for the UE. Once the Serving GW processes the proxy Binding Ack, it stores the UE's IP address information in the binding cache entry
  6. After the Proxy BU/Proxy BAck is successful, there is a PMIPv6 tunnel setup between the Serving GW and the PDN GW
  7. The ePDG continues with the IKE_AUTH exchange

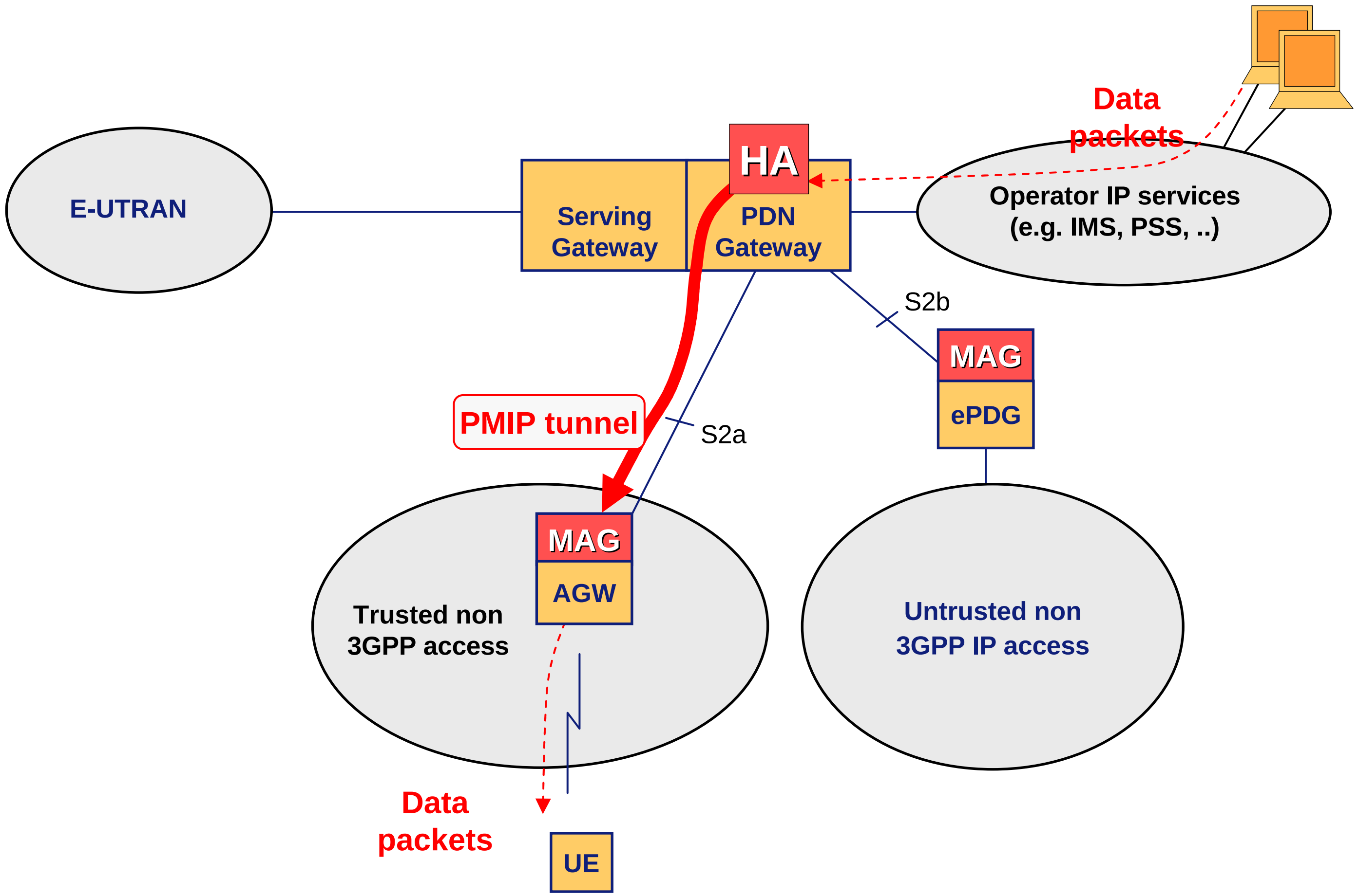
Attach over S2b/S8b: cascade of tunnels (IV)

- Step by step description of the procedure (cont'ed)
  8. The ePDG sends the final IKEv2 message with the IP address in IKEv2 Configuration payloads. The IP address sent in the IKEv2 configuration payload is the same address that the ePDG received in the Proxy Binding Ack message
  9. IP connectivity from the UE to the PDN GW is now setup
     - any packet in the uplink direction is tunneled to the ePDG by the UE using the IPSec tunnel. The ePDG then tunnels the packet to the visited Serving GW. The visited Serving GW then tunnels the packet to the PDN GW. From the PDN GW normal IP based routing takes place
     - In the downlink direction, the packet for UE (HoA) arrives at the PDN GW. The PDN GW tunnels the packet based on the binding cache entry to the visited Serving GW. The visited Serving GW tunnels the packet based on the binding cache entry to the ePDG. The ePDG then tunnels the packet to the UE via proper IPsec tunnel

PMIPv6: an example scenario (I)



PMIPv6: an example scenario (II)



PMIPv6 in 3GPP vs. PMIPv6 in IETF

- The PMIPv6 usage scenarios foreseen for 3GPP SAE/LTE present some differences with respect to those in the scope of the IETF MIP6 WG
  - PMIPv6 is used for inter-system handovers (i.e. handovers between 3GPP and non 3GPP accesses)
    - ❑ PMIPv6 is used as a global mobility protocol
  - PMIPv6 may be used in roaming scenarios, which means that the HA and the Proxy Mobility Agent may be located in different administrative domains
  - in the roaming case there is the possibility to have a cascade of PMIPv6 tunnels (AGW – Serving GW, Serving GW – PDN GW)
    - ❑ in this way there is a local anchor point in the visited domain, that can be used by the visited operator to enforce policies on UE's traffic
    - ❑ the local anchor also simplifies the establishment of roaming agreements

Conclusions

- IETF protocols will be extensively used for 3GPP-non-3GPP mobility in UMTS Rel8
  - PMIPv6, DSMIPv6 and MIPv4 in FA mode
- Some open issues still need to be resolved/clarified
  - mobility mode selection (PMIPv6, DSMIPv6 and MIPv4 in FA mode)
  - multihoming (i.e. multiple interface) management
  - simultaneous usage of multiple access technologies for load-sharing or performance optimization
  - combined usage of PMIPv6 and DSMIPv6 in case the UE moves into an access network that does not support any mobility feature (e.g. domestic/public WiFi access)
  - handover optimizations for tight interworking with mobile WiMAX and/or CDMA2000