3GPP: Evolution of Air Interface and IP Network for IMT-Advanced

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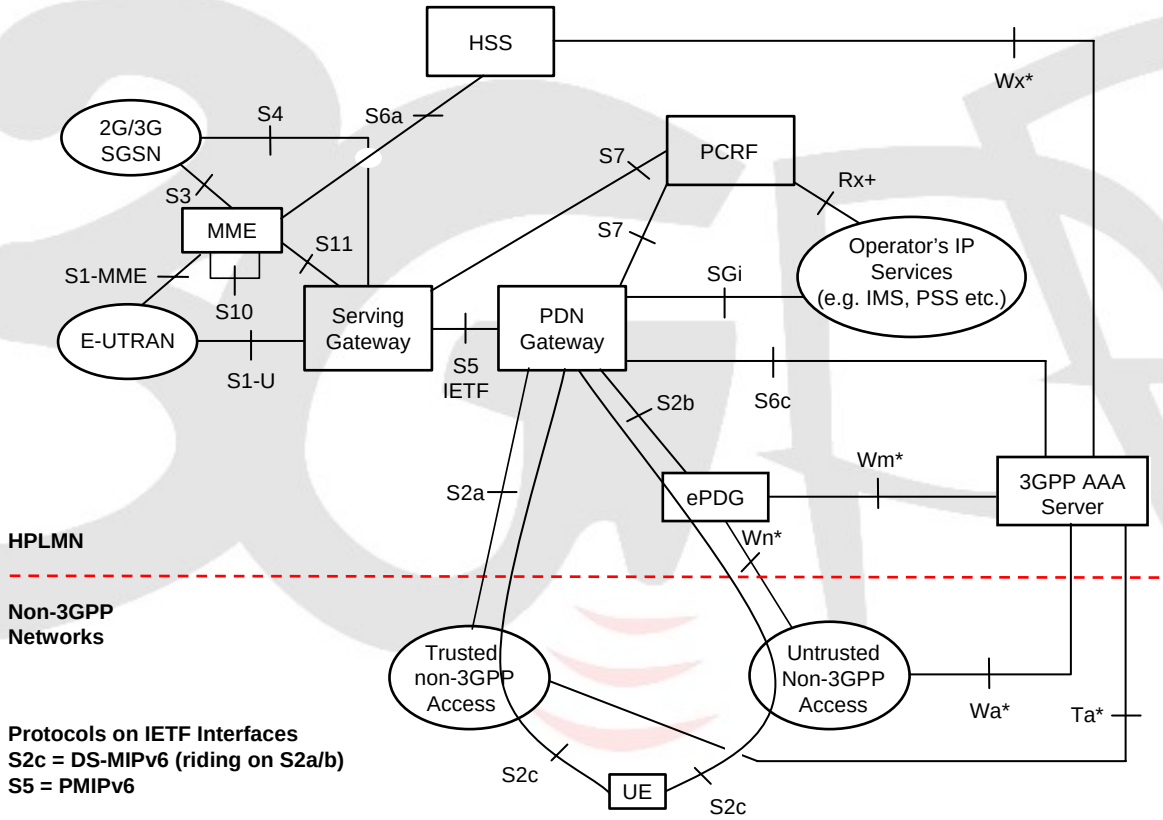
Introduction

- **Reminder of LTE SAE Requirement**
- **Key architecture of SAE and its impact**
- **Key architecture of LTE and its impact**
- **Transport network within SAE/LTE**
- **Conclusion**

Reminder of the objective of SAE/LTE

- **LTE focus is on:**
  - **enhancement of the Universal Terrestrial Radio Access (UTRA)**
  - **optimisation of the UTRAN architecture**
- **SAE focus is on:**
  - **enhancement of Packet Switched technology to cope with rapid growth in IP traffic**
    - **higher data rates**
    - **lower latency**
    - **packet optimised system**
  - **through**
    - **fully IP network**
    - **simplified network architecture**
    - **distributed control**

SAE


HSS
Wx*
2G/3G SGSN
S4
S6a
S7
PCRF
Rx+
S3
MME
S11
S7
Operator's IP Services (e.g. IMS, PSS etc.)
S1-MME
S10
SGi
E-UTRAN
Serving Gateway
PDN Gateway
S1-U
S5 IETF
S2b
S6c
Wm*
S2a
ePDG
3GPP AAA Server
Wn*
HPLMN
Non-3GPP Networks
Trusted non-3GPP Access
Untrusted Non-3GPP Access
Wa*
Ta*
Protocols on IETF Interfaces
S2c = DS-MIPv6 (riding on S2a/b)
S5 = PMIPv6
S2c
UE
S2c

Reminder of the requirements for 3G LTE and SAE

- **LTE requirements**
  - Reduced cost per bit
    - Improve spectrum efficiency (e.g. 2-4 x Rel6)
    - Reduce cost of backhaul (transmission in UTRAN)
  - Increased service provisioning – more services at lower cost with better user experience
  - Focus on delivery of services utilising ”IP”
  - Reduce setup time and round trip time
  - Increase the support of QoS for the various types of services (e.g. Voice over IP)
  - Increase “cell edge bit rate” whilst maintaining same site locations as deployed today
  - Increase peak bit rate (e.g. above 100Mbps DL and above 50Mbps UL)
  - Enhance the bit rate for MBMS (e.g. 1-3 Mbps)

Reminder of the requirements for 3G LTE and SAE

- **LTE Requirements 2/3**
  - **Flexibility of use of existing and new frequency bands**
  - **Allow to deploy in wider and smaller bandwidths than 5 MHz (e.g. ranging from 1.25 to 20MHz)**
  - **Allow variable duplex technology within bands as well as between bands**
  - **Non-contiguous spectrum allocations to one UE should not be precluded**
  - **Should consider FDD/TDD convergence?**
  - **Architecture and mobility**
    - **Need to consider UTRAN Evolution and UTRA Evolution at the same time aiming at simplifying the current architecture**

Reminder of the requirements for 3G LTE and SAE

- **LTE Requirements 3/3**
  - **Architecture and Mobility (Continued)**
    - **Shall provide open interfaces to support Multi-vendor deployments**
    - **Consider robustness – no single point of failure**
    - **Support multi-RAT with resources controlled from the network**
    - **Support of seamless mobility to legacy systems as well as to other emerging systems including inter RAT Handovers and Service based RAT Selection**
    - **Maintain appropriate level of security**
  - **Allow for reasonable terminal power consumption**

LTE Key elements

- 2 main issues have been investigated:
  - The physical layer
  - The access network internal architecture
- Physical layer
  - Downlink based on OFDMA
    - OFDMA offers improved spectral efficiency, capacity etc
  - Uplink based on SC-FDMA
    - SC-FDMA is technically similar to OFDMA but is better suited for uplink from hand-held devices
    - (battery power considerations)
  - For both FDD and TDD modes (User Equipment to support both)
    - With Similar framing + an option for TD SCDMA framing also
- Access Network consideration
  - For the access network it was agreed to get rid of the RNC which minimized the number of nodes

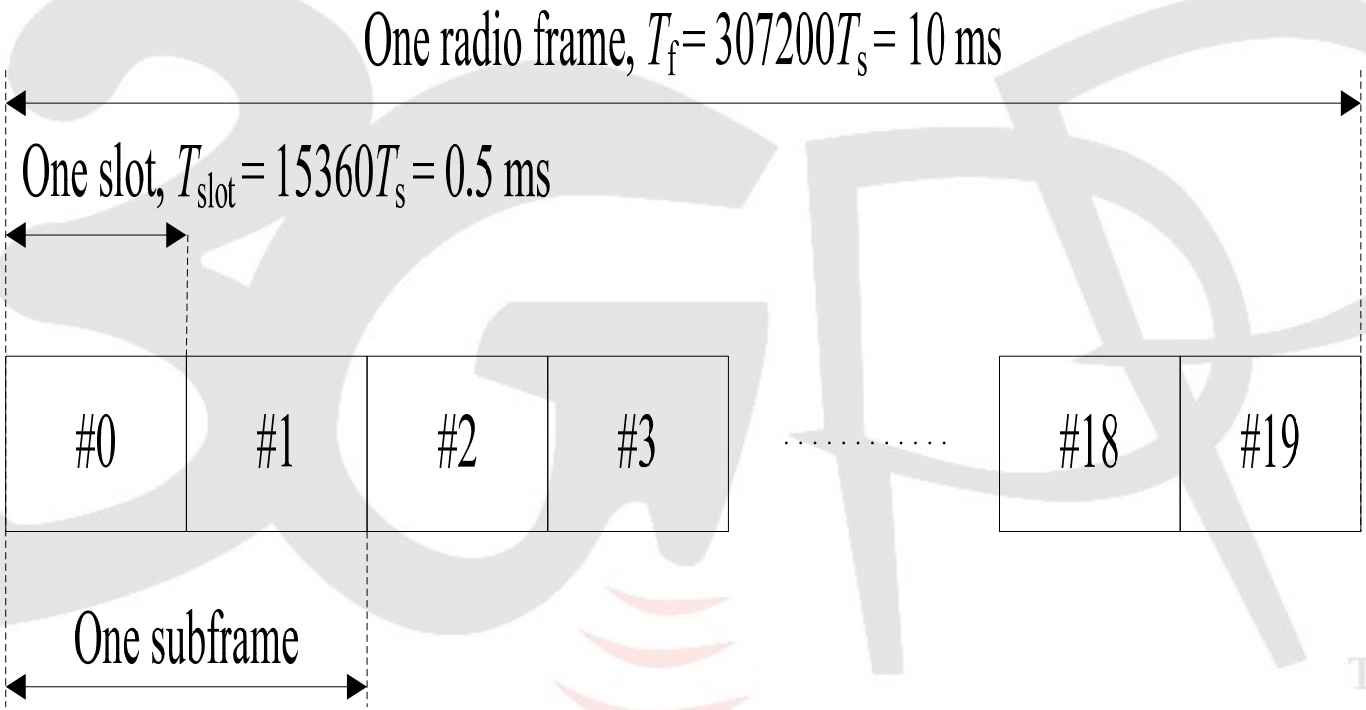
LTE Key elements

- On the UTRAN Architecture the following working assumptions were agreed in TSG RAN:
  - RRC Terminates in the eNode B
  - Outer ARQ terminates also in the eNode B
  - Currently Ciphering and integrity for signaling is inside the eNode B while Ciphering for the User plane is in the AGW
  - New Frame Structure 2 approved last week ensuring convergence of the TDD and FDD

Frame Structure 1

- Frame structure type 1 is applicable to both full duplex and half duplex FDD and to TDD. Each radio frame is long and consists of 20 slots of length , numbered from 0 to 19. A subframe is defined as two consecutive slots where subframe consists of slots and .
- For FDD, 10 subframes are available for downlink transmission and 10 subframes are available for uplink transmissions in each 10 ms interval. Uplink and downlink transmissions are separated in the frequency domain.
- For TDD, a subframe is either allocated to downlink or uplink transmission. Subframe 0 and subframe 5 are always allocated for downlink transmission.

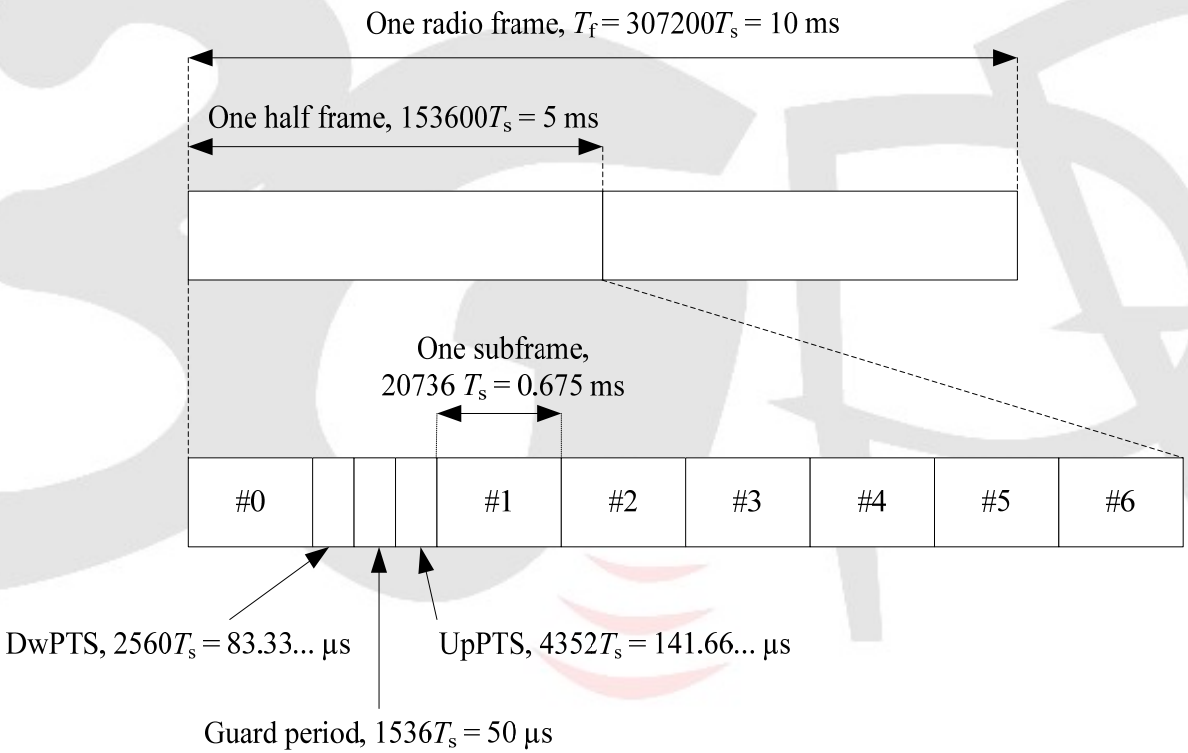
Frame Structure 1



Frame Structure 2

- Frame structure type 2 is only applicable to TDD. Each radio frame consists of two half-frames of length each. The structure of each half-frame in a radio frame is identical. Each half-frame consists of seven slots, numbered from 0 to 6, and three special fields, DwPTS, GP, and UpPTS. A subframe is defined as one slot where subframe consists of slot .
- Subframe 0 and DwPTS are always reserved for downlink transmission. UpPTS and subframe 1 are always reserved for uplink transmission.

Frame Structure 2



LTE Key elements

- Requirements satisfaction
  - The LTE concept has the potential to fulfil both the system capacity and user throughput targets
  - Evaluated uplink peak data rate is a bit smaller than the requirements, however, it is expected that the peak data rate can be increased by some optimisations, e.g. higher TTI values and/or by reducing the amount of control signalling information.
  - It was confirmed that the requirements of C-plane and U-plane latency can be satisfied.
  - Fulfilments without any issues are identified for requirements on deployment scenarios, spectrum flexibility, interworking, mobility, E-UTRAN architecture and RRM.

LTE Key elements

- Regarding system and device cost and complexity work needs to continue in the future. As evolved UTRA and UTRAN system will provide significantly higher data rates than Release 6 WCDMA and, as a consequence hereof, the physical layer complexity will increase accordingly compared to lower-rate systems. This complexity is not seen as evolved UTRA and UTRAN specific, but is similar to the complexity experienced in any high data rate system.
- According to these evaluation results, it can be concluded that system concepts captured in this TR are feasible for evolved UTRA and UTRAN.
- For Broadcast/Multicast services it is assume that network synchronization will improve greatly the performance

LTE Key elements

- To support a Multimedia Broadcast and Multicast Service (MBMS), LTE offers the possibility to transmit Multicast/Broadcast over a Single Frequency Network (MBSFN), where a time-synchronized common waveform is transmitted from multiple cells for a given duration. MBSFN transmission enables highly efficient MBMS, allowing for over-the-air combining of multi-cell transmissions in the UE, where the cyclic prefix is utilized to cover the difference in the propagation delays, which makes the MBSFN transmission appear to the UE as a transmission from a single large cell. Transmission on a dedicated carrier for MBSFN with the possibility to use a longer CP with a sub-carrier bandwidth of 7.5kHz is supported as well as transmission of MBSFN on a carrier with both MBMS transmissions and point-to-point transmissions using time division multiplexing.
- Transmission with multiple input and multiple output antennas (MIMO) are supported with configurations in the downlink with two or four transmit antennas and two or four receive antennas, which allow for multi-layer transmissions with up to four streams. Multi-user MIMO i.e. allocation of different streams to different users is supported in both UL and DL.

LTE Key elements

- **Status**
  - **Radio Interface**
    - **Layer 1 around 90% complete**
    - **Layer 2 and 3 (MAC, RRC, RLC) 80% complete**
  - **Interfaces inside the network**
    - **Around 80 %**
  - **Most of these specification have been put under change control**

Reminder of the requirements for 3G LTE and SAE

- **SAE Main requirement**
  - **The main requirement for SAE is to minimized end to end delay**

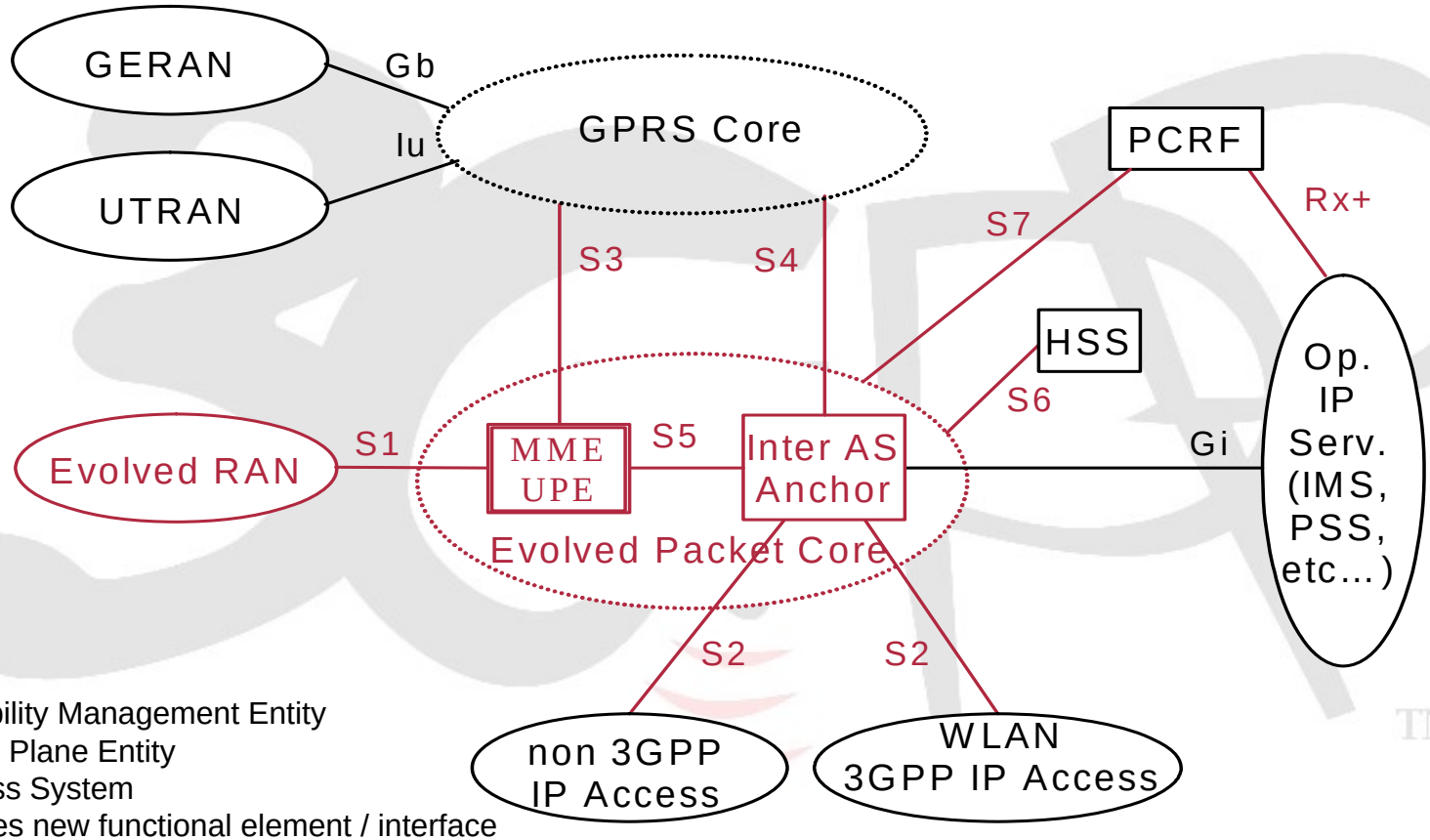
SAE key elements

- **The key to minimize the delay is to reduced the number of nodes involved for the packet delivery inside the core network.**
- **Based on service offering per IMS the main elements that be considered are the core network nodes and hence GGSN and SGSN as demonstrated on the next slide this is what 3GPP has already agreed.**

SAE Key elements

- **Some big issues still to address…**
  - **Achieving mobility within the Evolved Access System**
  - **Implications of using the evolved access system on existing and new frequency bands**
  - **Will the Evolved RAN need to be connected to the legacy PS core?**
  - **Adding support for non-3GPP access systems**
  - **Inter-system Mobility with the Evolved Access System**
  - **Roaming issues, including identifying the roaming interfaces**
  - **Inter-access-system mobility**
  - **Policy Control & Charging**
  - **How does User Equipment discover Access Systems and corresponding radio cells? Implications of various solutions on User Equipment, e.g. on battery life**
  - **Implications for seamless coverage with diverse Access Systems**

Current views on SAE architecture



MME – Mobility Management Entity
UPE – User Plane Entity
AS – Access System
Red indicates new functional element / interface

Conclusion

- Work is going well from an LTE radio interface
- Work on IMT Advance will start next year by promoting LTE+ still to be identified
  - Approval of the SI in March 2008 based on the ITU-R Circular letter to be provided in February 2008
  - A workshop to identify the full list of requirements on April 2008
  - Approval of the list of the requirements by June 2008
  - Time frame for approval of LTE advanced specifications according to ITU-R WP5D

THANKS FOR YOUR ATTENTION

ANY QUESTIONS?