3GPP Core Network Evolution & Terminals

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Topics of this presentation

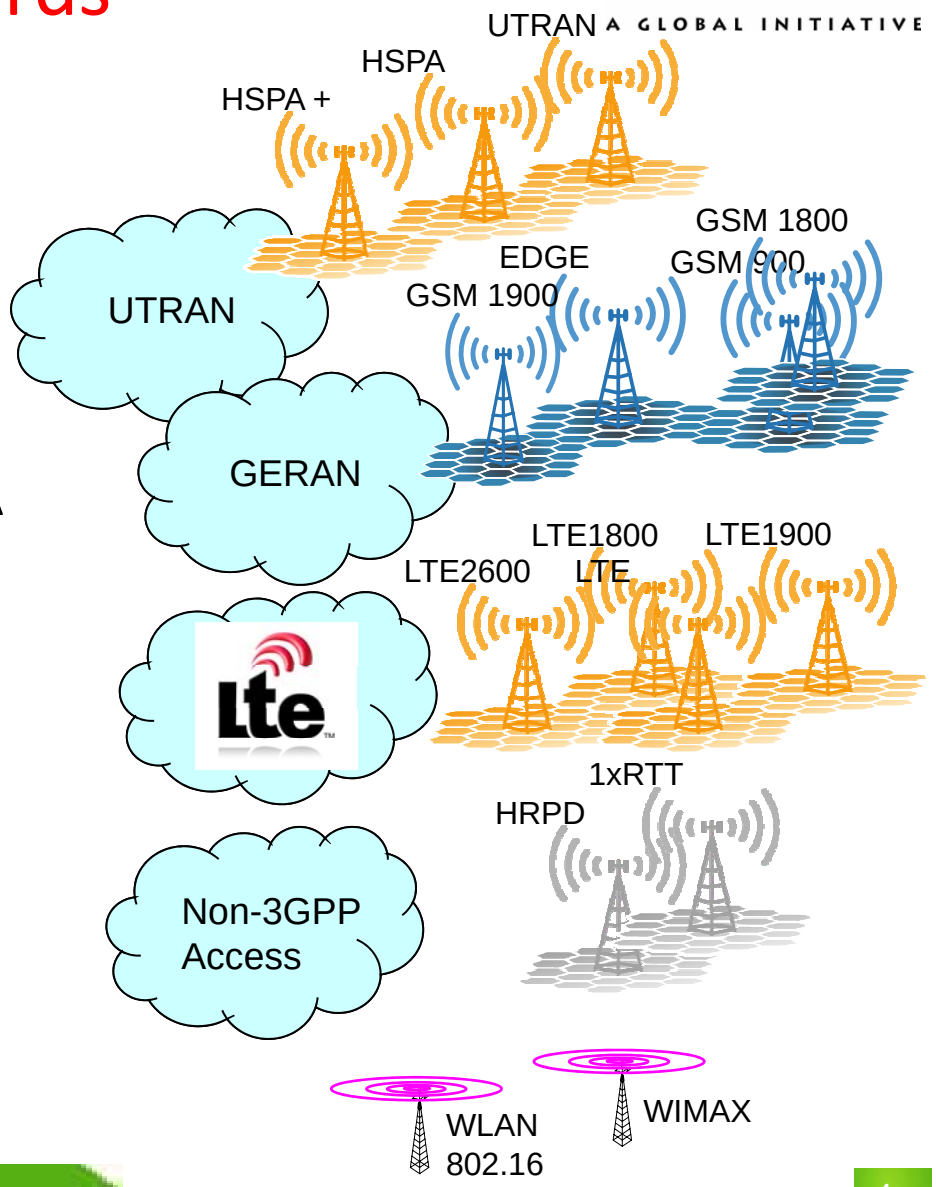
- Key features of EPC
  - EPC keywords
  - Key features
- Core Network Interoperability and 2G/3G integration
  - CS and PS voice service capabilities
  - Emergency calls in LTE
  - Emergency call routing
  - CS Fallback (CSFB)
  - Single Radio Voice Call Continuity (SR-VCC)
  - Dual-Stack IPv4/6 connectivity
  - Home (e)NodeB
  - Public warning system
  - LTE deployment scenarios
- (some) Terminal features in EPC
  - Multi-mode network selection
  - ANDSF
  - Local IP Access (LIPA)
  - Selective IP Traffic Offloading (SIPTO)
  - WLAN offloading
  - Multiple PDN Connections to Same APN (MUPSAP)
- QoS management
  - Terminal initiated QoS
  - Network initiated QoS

Key Features of EPC

- EPC keywords
- Key features

EPC keywords

- Flat PS-only architecture
- Mobility between access technologies
  - Optimised mobility with legacy cellular systems, including CDMA
  - Interoperability with non-3GPP access technologies
- Interoperability
  - Multiple security mechanisms
  - Trusted and untrusted access



Key features

Main features

- End-to-end IP based system
- Dual stack IPv4 and IPv6 support
- Network initiated QoS
- Support of traffic offloading to optimise cost per bit
- Interoperability with legacy cellular systems
- Support of Home (e)NodeB = Femto Cell
- Regulatory grade emergency call support
- Public Warning System

Core Network interoperability and 2G/3G integration

- CS and PS voice service capabilities
- Emergency calls in LTE
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- Dual-Stack IPv4/6 connectivity
- Home (e)NodeB
- Public warning system (PWS)
- LTE deployment scenarios

CS and PS voice service capabilities

device has multiple capabilities CSFB, IMS, VoIP, SR-VCC, etc. **Can VoIP be used now?**

Operator delivers its preferences to device (CS or IMS or both)

Network decides whether to offer incoming call via PS or CS

Network

UE signals its capabilities to the network during LTE attach

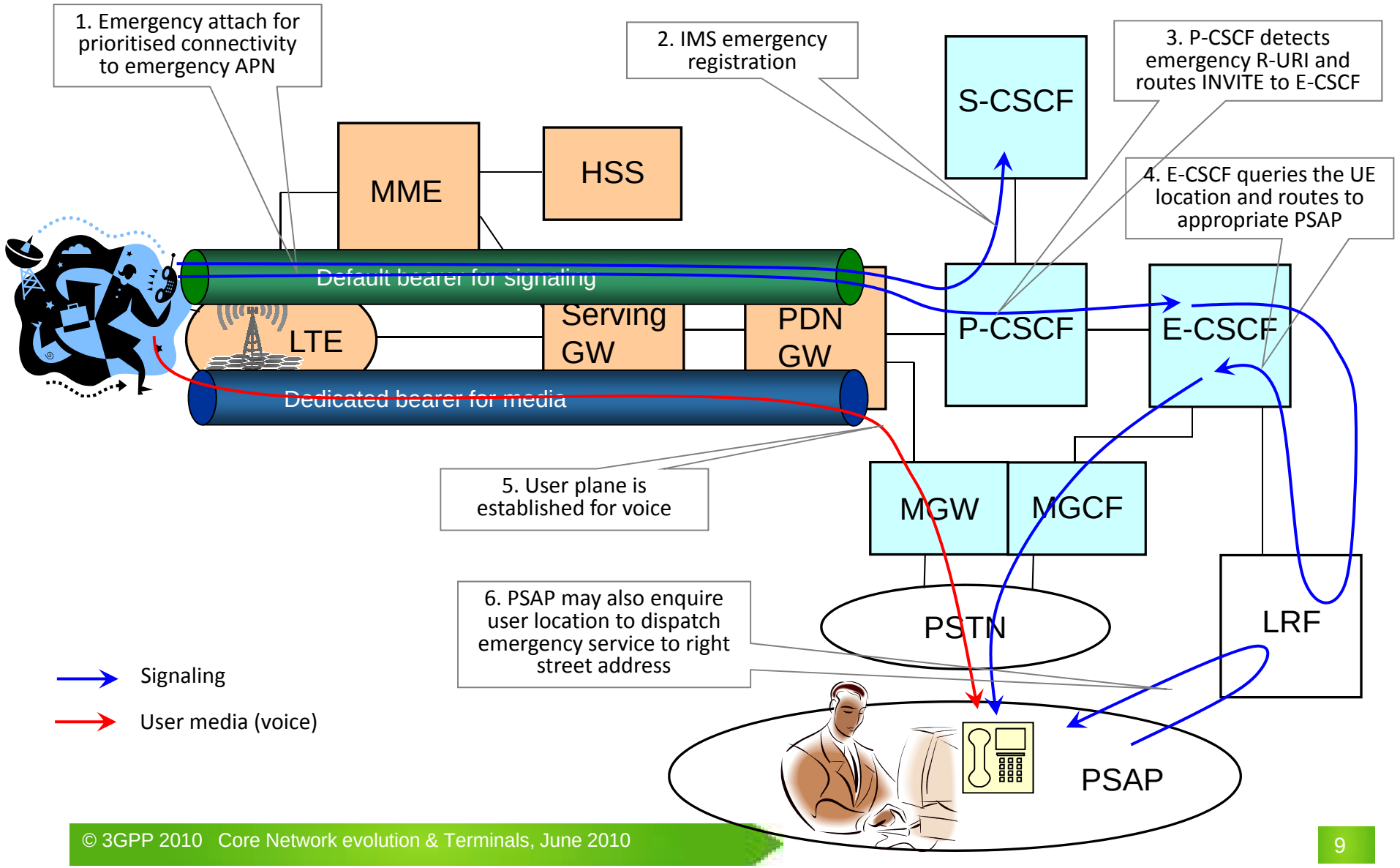
Based on all received information the UE makes decision to use either CS or IMS for voice

Network analyses received UE information, it's own technical cabilities and policies and informs the UE on VoIP support

Emergency calls in LTE

- Regulatory emergency call requirements are supported in Rel-9 in PS domain
  - Detection of emergency numbers in UE
  - Indication and prioritisation of emergency calls
  - Location services, both for routing and user location data for PSAP
  - Callback is possible, but processed as normal call
- UE matches digits dialled by the user with list of known emergency numbers
  - Emergency number list in the UE is common for CS and PS domain use
  - Default 112 and 911 (+ local configuration via USIM pre-configuration + download)
  - In case of match, the UE shall initiate the call as an emergency call
- UE translates dialed number into emergency service request
  - Service URN with a top-level service type of "sos" as specified in RFC 5031
  - Emergency category can indicate emergency service if known (fire, ambulance, police,..)
- Network can detect emergency call if UE is not aware of local emergency number
  - UE does not have full information of all local emergency call numbers and initiates a normal call
  - From EPC perspective, it will be a normal PDN connection
- Benefit of location information
  - P-CSCF discovers the correct regional PSAP to take the emergency call
  - PSAP gets information on the precise user location

Emergency call routing

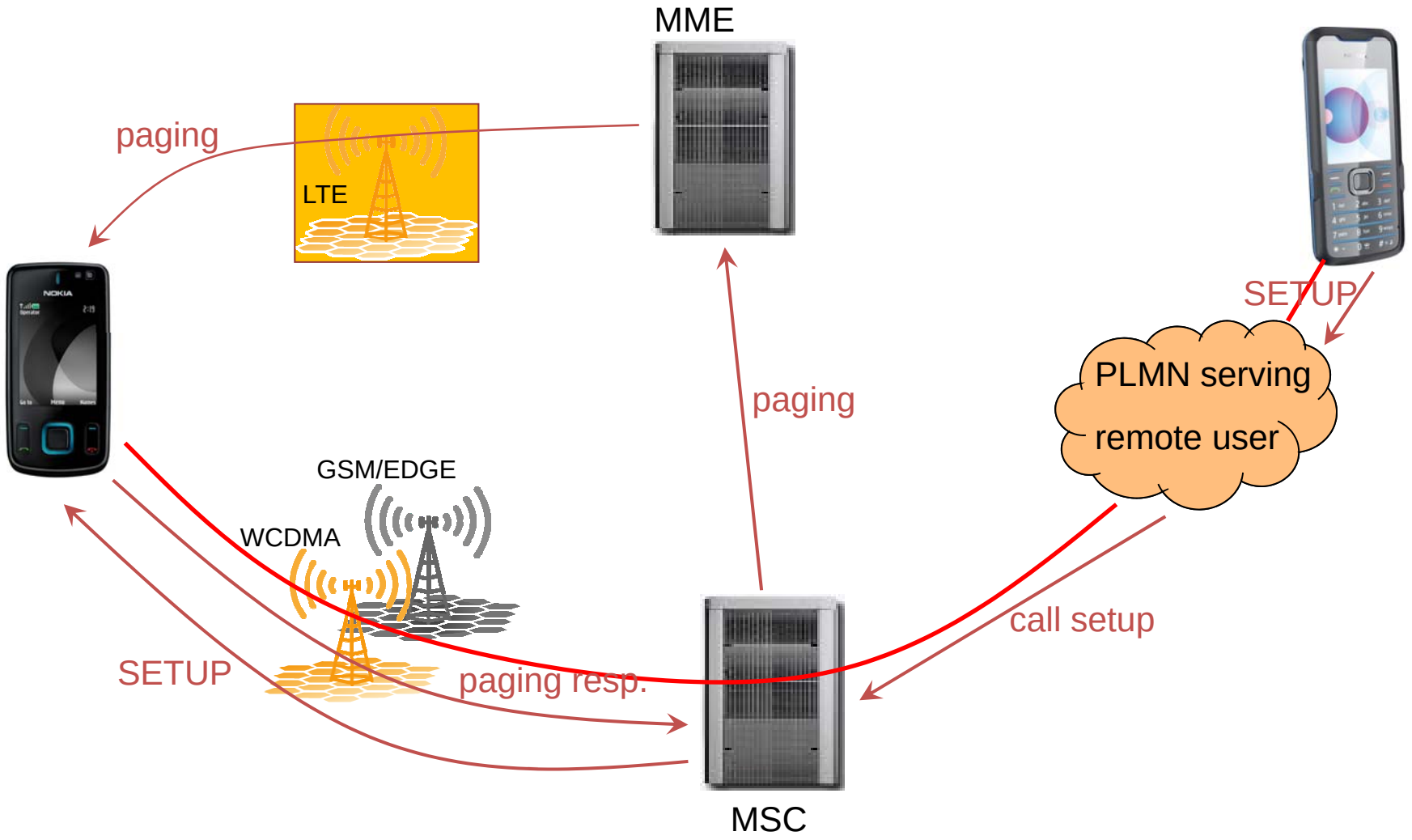


CS Fallback (CSFB)

- CS FallBack from EPS to CS domain
- CSFB reuses voice and other CS-domain services provided by legacy CS infrastructure
- EPS redirects the UE to CS Domain for CS services
  - SMS can be delivered to the UE without redirecting to CS Domain
  - After CS service the UE can return to LTE depending on coverage and policy
- User can decide whether to accept CSFB request or not
- Application of CSFB:
  - CS capable device camping on LTE cell can establish/receive CS services
  - Reuse of existing CS infrastructure for voice service until IMS VoIP is deployed
  - Provide voice roaming support with LTE
  - Support E911 using existing CS infrastructure
    - Rel-9 IMS provides full emergency call support
  - Requires overlapping CS domain coverage
  - CSFB applies between LTE - GSM, WCDMA and 1xRTT

CSFB procedure

- Directing the UE from LTE to 2G/3G for CS service

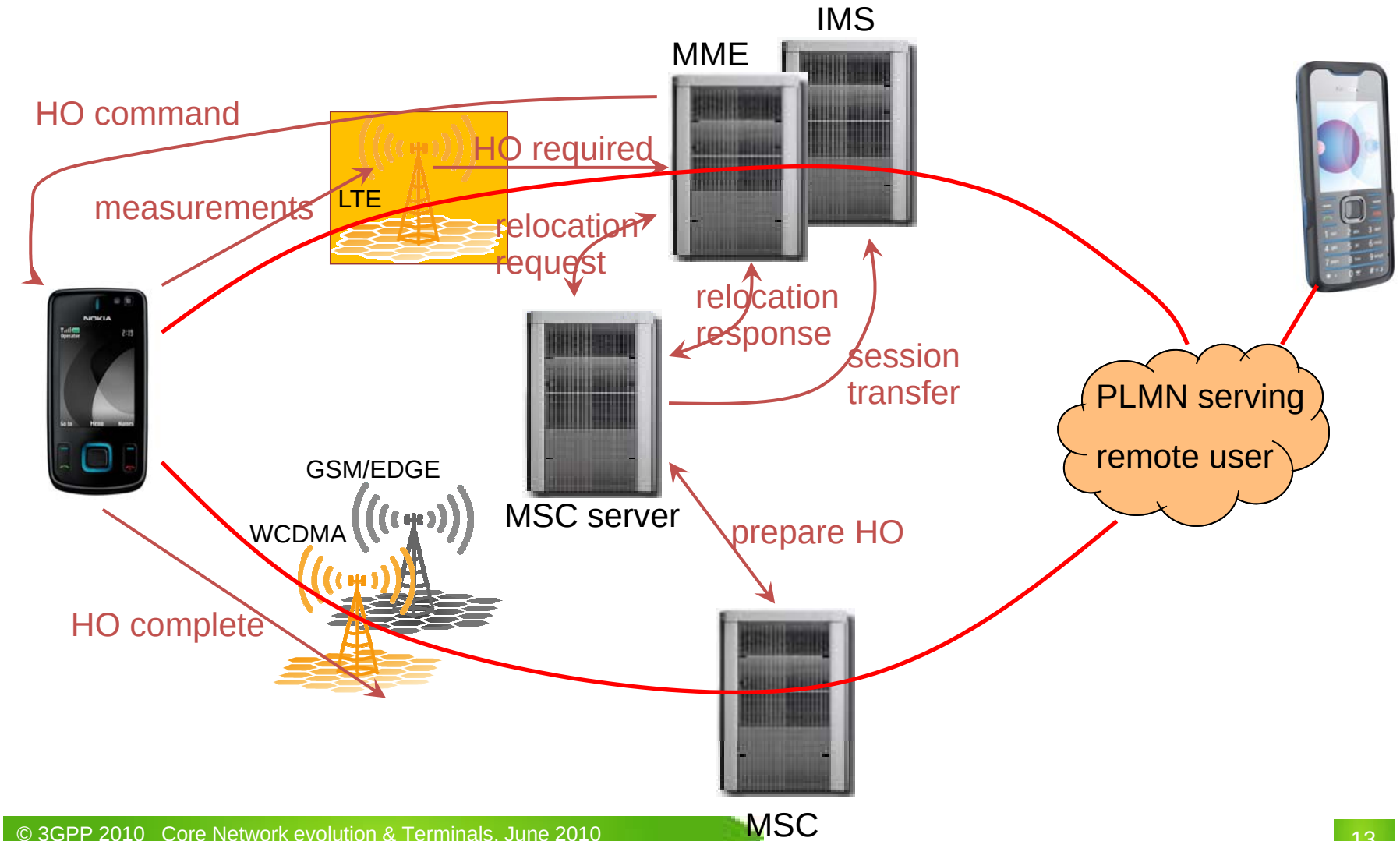


Single Radio Voice Call Continuity (SR-VCC)

- SR-VCC use case
  - IMS call can continue is CS domain outside of LTE coverage area
  - SR-VCC to CS domain is invoked if VoIP call cannot continue via PS-PS HO
  - Only HO of a single voice bearer from PS to CS is specified
  - Requires overlapping with 1xRTT/GSM/WCDMA coverage
- SR-VCC voice calls are anchored in IMS
  - One-way HO from PS to CS systems (LTE to GSM/UMTS or to 1xRTT)
  - No simultaneous operation of different radio transceivers is needed
- Rel-9 SR-VCC improvements
  - IMS support of mid call services (e.g., HOLD, MPTY)
  - SR-VCC support for emergency calls
- Video calls, reverse direction from CS call to IMS and optimisations are being studied in Rel-10

SR-VCC procedure

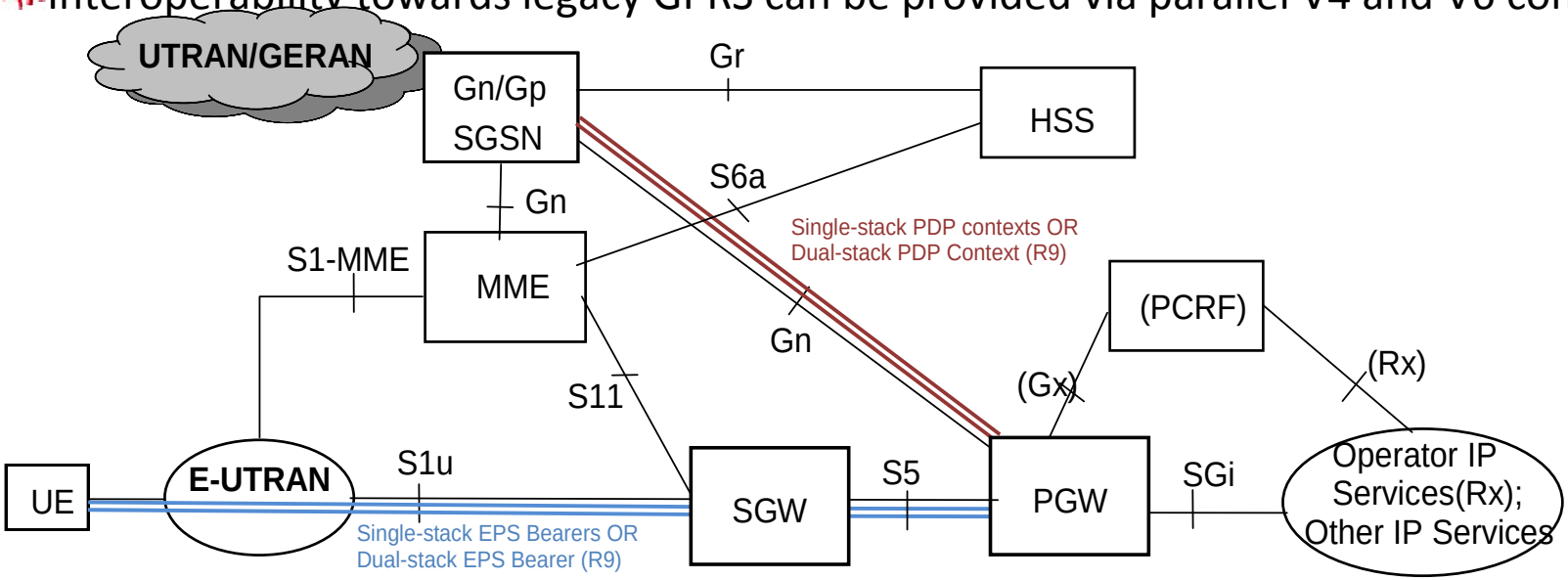
- Transfer from LTE to 2G/3G with active call (not all entities shown)



Dual-stack IPv4/6 connectivity,

GPRS and EPS

- Two parallel PDP contexts (IPv4 and V6) towards single APN in Pre-release 8 GPRS
- DS v4v6 PDP contexts is added to GPRS UE in Rel-8 and for SGSN and GGSN in Rel-9
- Migration to IPv6 is studied in 3GPP TR 23.975 in Rel-10
  - Current EPS and GPRS specifications already support DS connectivity
  - Tools for IPv4 and IPv6 co-existence and subsequent transition to IPv6 are already provided
  - DS connectivity may require the use of private IPv4 addressing within the network
- EPS network provides IPv4 and IPv6 coexistence based on DS connectivity
- Interoperability towards legacy GPRS can be provided via parallel V4 and V6 contexts



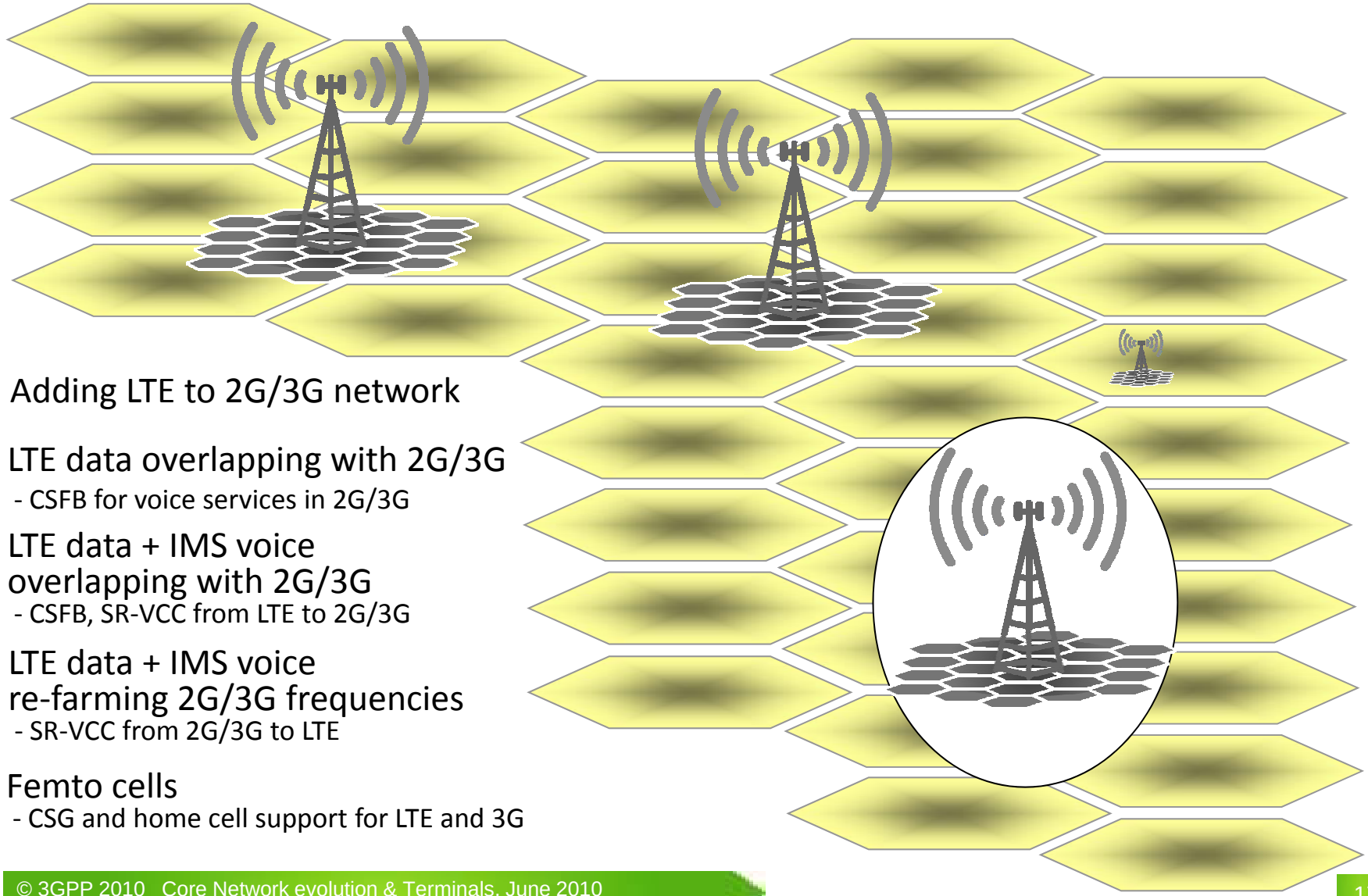
Home (e)NodeB

- Femto Cell in 3GPP is realized via Home NodeB
- Enhanced access control for home Cell
  - Automatic access control in UE via Closed Subscriber Group
    - Allowed CSG list is pre-configured by the operator or by the user
    - Automatic cell (re-)selection to allowed home cells when available
  - Ad-hoc visitors can also find the home cell
    - Access is subject to access control
- Applicable on 3G (HNodeB) and LTE (HeNodeB)
  - Legacy 3G mobiles detect home cell, but consider it normal cell
    - Access control via normal MM procedures
- Local Breakout is possible

Public Warning System

- PWS is global public alerting system
  - Current applications are US CMAS and Japanese ETWS
  - The mechanism is extendable (EU-Alert is under consideration)
- Broadcast warnings to all users in the affected area
  - Notification provider outside the operator network
  - Both HPLMN and roaming subscribers are covered
  - Different languages
  - Different alert categories
- Alert message comprises
  - Event description
  - Affected area
  - Recommended action
  - Expiration time
  - Sending agency

LTE deployment scenarios



Adding LTE to 2G/3G network

LTE data overlapping with 2G/3G
- CSFB for voice services in 2G/3G

LTE data + IMS voice overlapping with 2G/3G
- CSFB, SR-VCC from LTE to 2G/3G

LTE data + IMS voice re-farming 2G/3G frequencies
- SR-VCC from 2G/3G to LTE

Femto cells
- CSG and home cell support for LTE and 3G

(some) Terminal features in 3GPP EPC

- Multi-mode network selection
- ANDSF
- Local IP Access (LIPA)
- Selective IP Traffic Offloading (SIPTO)
- WLAN offloading
- Multiple PDN Connections to Same APN (MUPSAP)

(Some of these are under remote control of the operator)

Multi-mode network selection

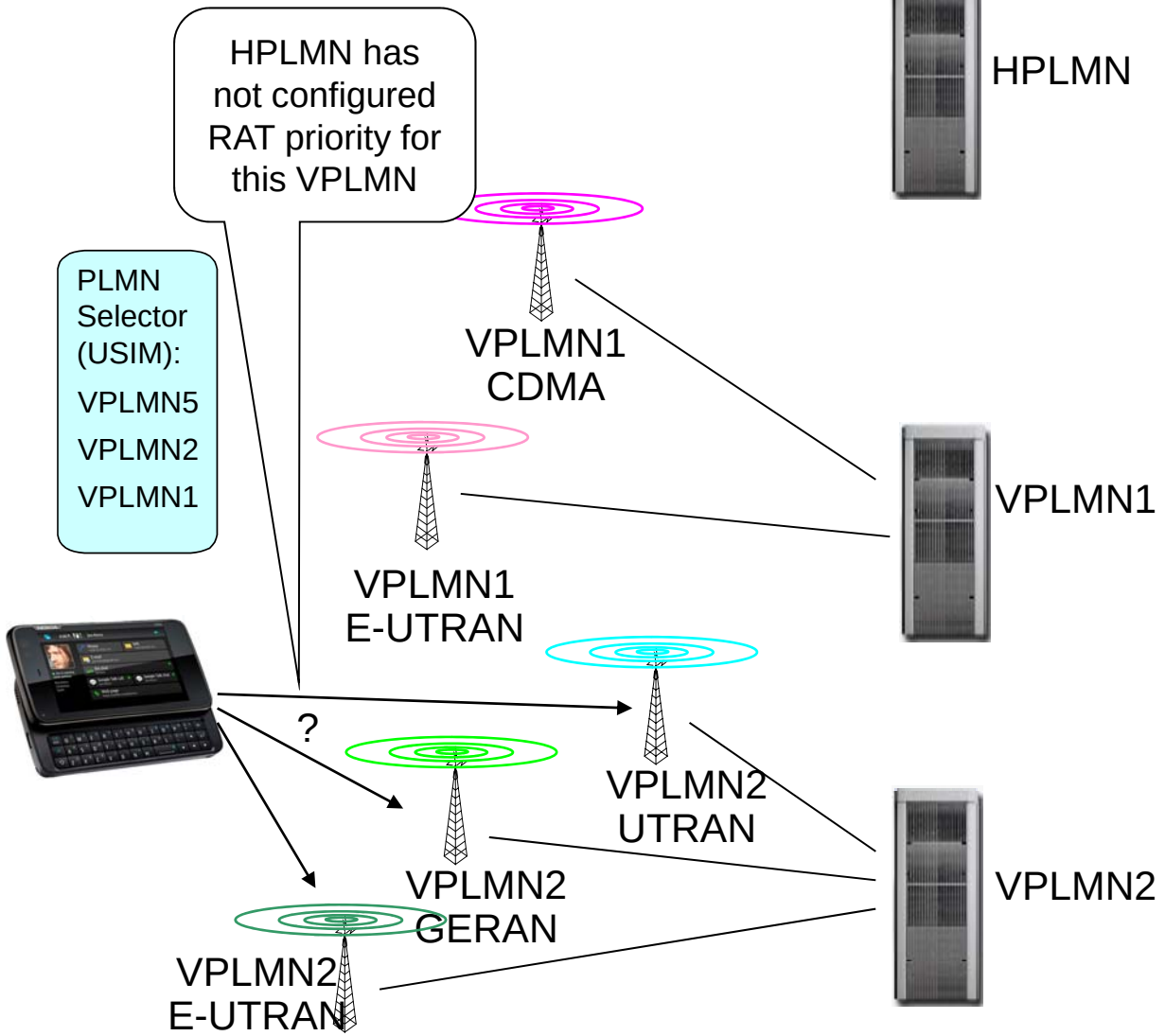
- Network selection comprises two parts
  - Network operator (PLMN) selection
    - The goal, based on commercial agreements
    - Home operator determines the preferred visited operators
  - Access technology selection
    - The means, based on technical criteria
    - Serving visited operator determines access technology, frequency band and cell
- 3GPP PLMN selection is extendable
  - PLMN selection is based on ITU-T defined Mobile Country Code (MCC) and Mobile Network Code (MNC) and it can be extended to any system supporting MCC+MNC
  - 3GPP2 access technologies are already supported
- Common network selection rules are a strength of 3GPP system
  - Economies of scale via common UE logic to adapt to different network configurations
  - Automatic roaming to the best available operator (based on subscription to HPLMN)
  - Automatic roaming to the best available RAT (based on serving operators configuration)
    - Selection of non-3GPP AN can be optimised via ANDSF policy

Network selection,

Outbound roaming example

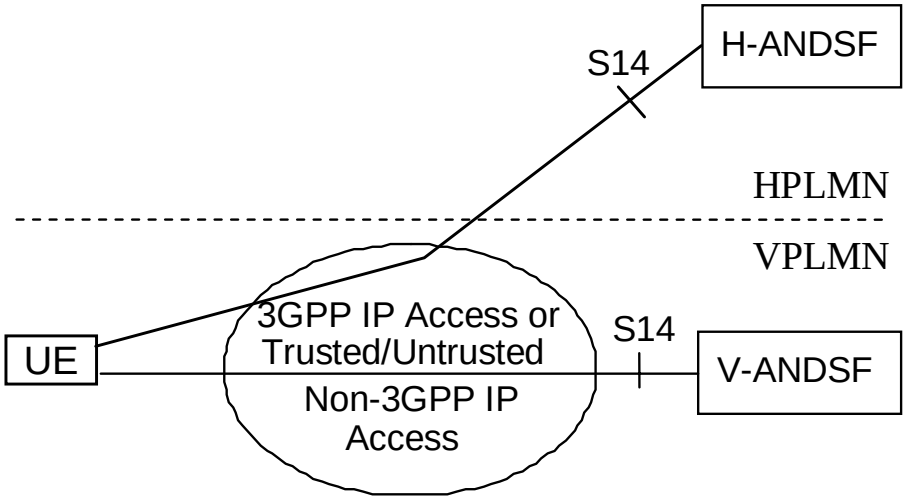
- HPLMN is not available
- Prioritized VPLMNs are listed with no associated RAT in PLMN selector with access technology:
  - VPLMN5 is not available
  - VPLMN1 is available
  - VPLMN2 is available
- VPLMN2 is selected via 2G, 3G or E-UTRAN
  - USIM configured RAT preference possible
- After PLMN selection normal idle mode is resumed
  - Cell & RAT may change within the selected PLMN
  - Inter-RAT priority
  - Background scan for higher priority network

RAT = Radio Access Technology,
PLMN = Public Land Mobile Network

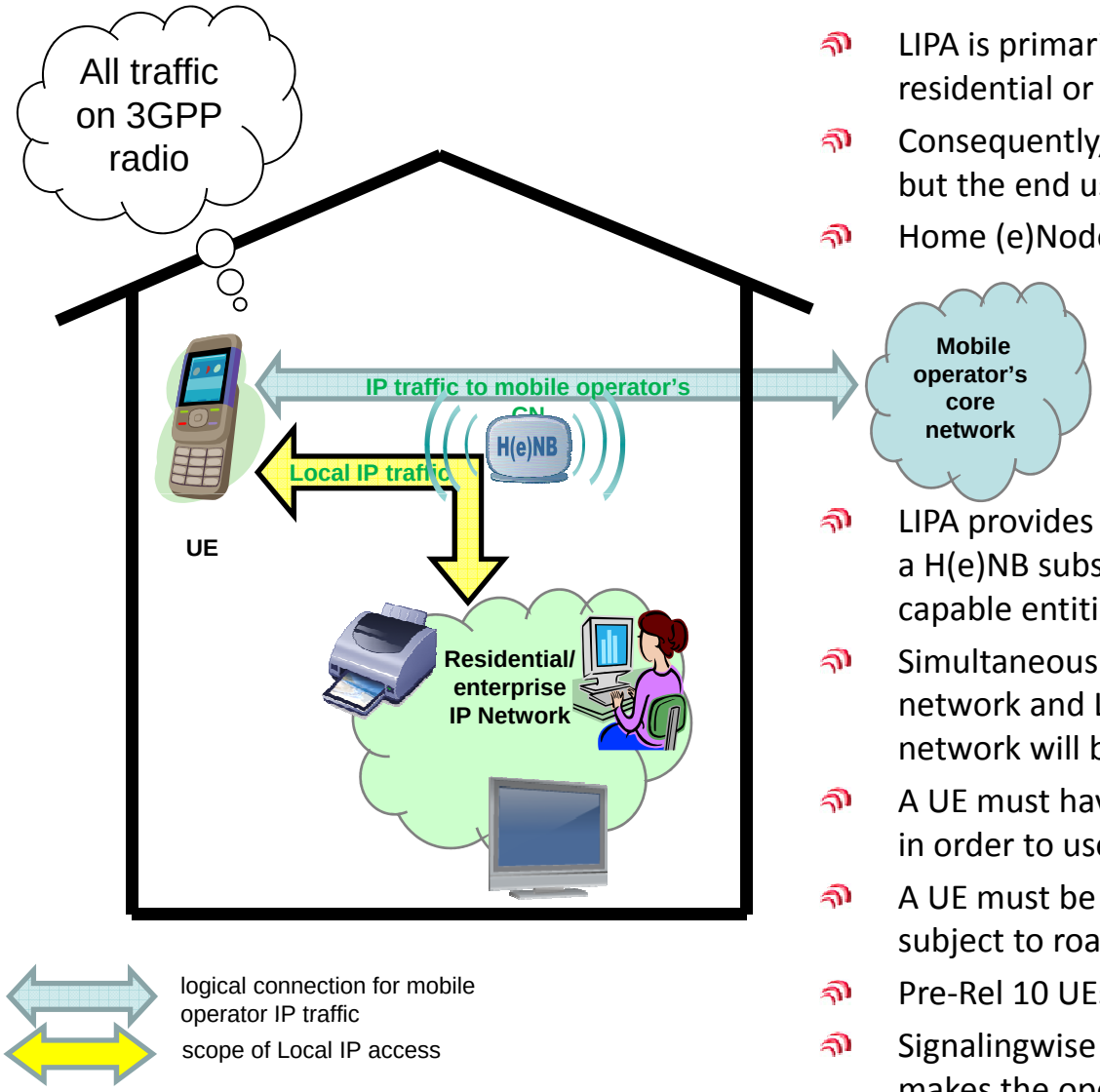


ANDSF

- Access Network Discovery & Selection Function
  - Optimises non-3GPP access technology selection
  - Does not affect the selection of the PLMN operator
- AN selection policy can be downloaded from the network
  - Either HPLMN or VPLMN policy
  - Access technology preference
  - Multiple policies can exist but just one is active at any time
- Policy attributes
  - Policy priority
  - Access priority
  - Validity area
  - PLMN
  - Time of day
  - Discovery information



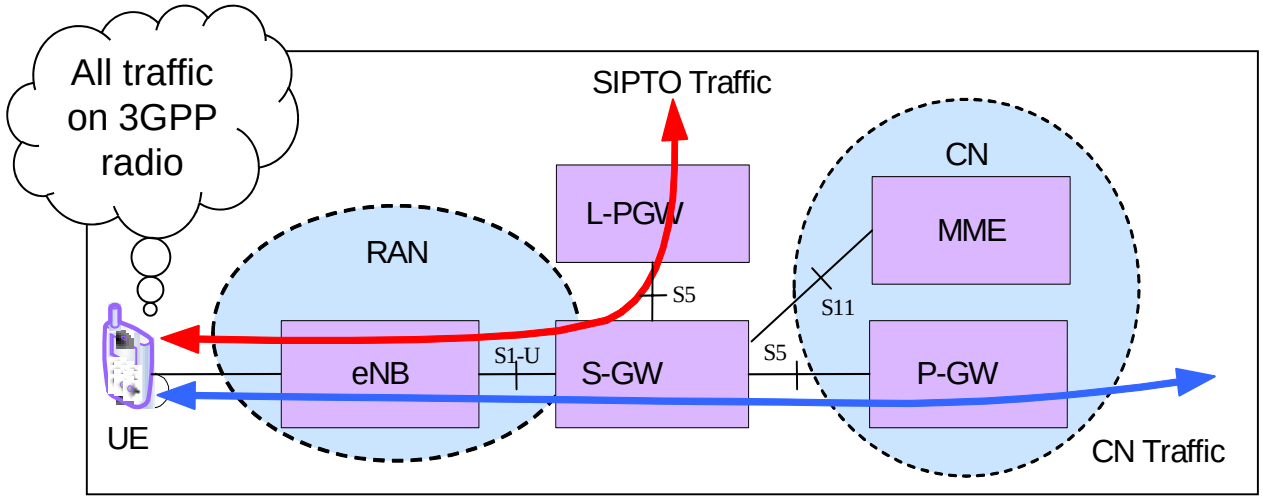
Local IP Access (LIPA) in 3GPP



- LIPA is primarily for end user's benefit, to allow access to local residential or corporate network through a 3GPP device
- Consequently, LIPA service does not need to be transparent, but the end user may have to "select" LIPA access
- Home (e)NodeB may advertise the available LIPA access (tbd.)
- LIPA provides access for IP capable UEs that are connected via a H(e)NB subsystem (i.e. using H(e)NB radio access) to other IP capable entities in the same residential/enterprise IP network.
- Simultaneous access from a UE to the mobile operator's core network and Local IP Access to a residential/enterprise IP network will be supported.
- A UE must have a valid subscription with the mobile operator in order to use Local IP Access.
- A UE must be able to use Local IP Access in a visited network subject to roaming agreement between mobile operators.
- Pre-Rel 10 UEs should be able to use Local IP Access.
- Signalingwise the operator gains or saves nothing, but LIPA makes the operator's Home Cell more attractive to the user!

Selective IP Traffic Offloading (SIPTO)

- Optimising “cost per bit” is becoming essential in the “flat rate” era
- SIPTO is a specific routing scenario within the operator’s network, allowing *selective* offloading of the traffic away from the Evolved Packet Core network
  - Selective offloading e.g. based on the QoS needs of the service
- SIPTO benefits the cellular operator and it is transparent for the end user
- SIPTO is intended for allowing cost optimized handling of the internet traffic that is not intended for the operator’s core network (i.e., operator services)

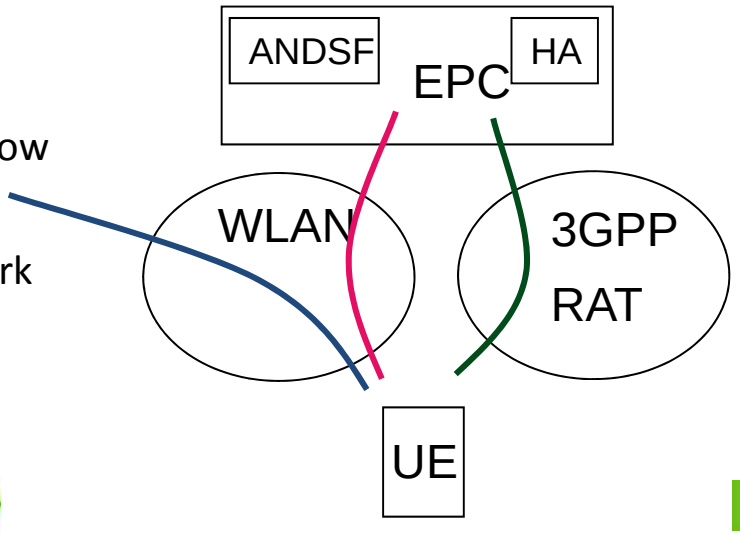


Baseline approach for “SIPTO above RAN” scenario. Local GW is selected for the traffic to be offloaded

WLAN Offloading

- WLAN offloading refers to the dual radio scenario where part of the traffic (PDN connections, IP flows) is routed via WLAN access and part via 3GPP access
  - Assumes a UE capable of operating WLAN and 3GPP radios simultaneously
- The 3GPP Evolved Packet Core network (EPC) as the common core network serves both 3GPP radio access technologies and non-3GPP radio access technologies
- WLAN offloading covers both the scenario where the traffic via WLAN radio is anchored in the EPC (i.e., seamless offloading) and the scenario where it is not anchored (i.e., non-seamless offloading)
- Access Network Discovery and Selection Function (ANDSF) is there to provide the UE with the access network discovery information and the policy on how to use the available access networks
  - Available access networks
  - Preferred routing of the traffic per APN, per IP flow

There is no mobility support in 3GPP network for flows offloaded in non-seamless way



MUPSAP - Multiple PDN Connections to the Same APN for PMIP-based Interfaces

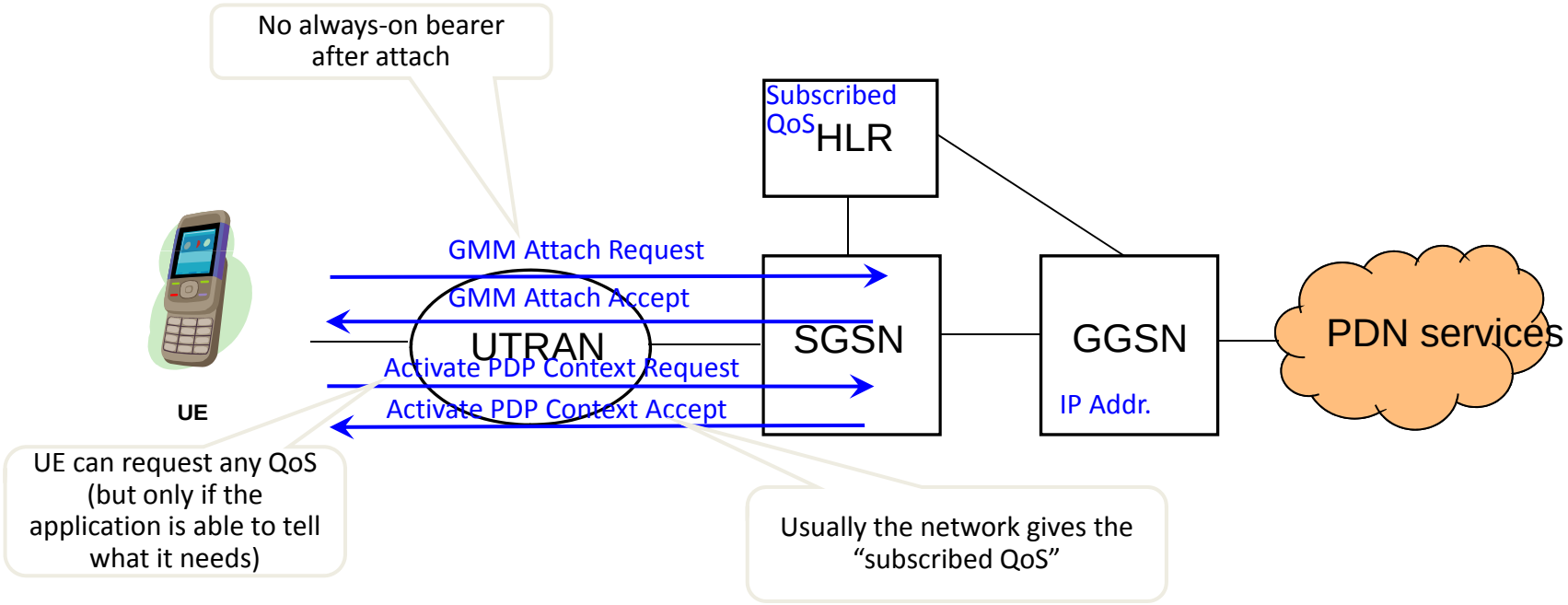
- GTP – based core network interfaces (Gn/Gp and GTP S5/S8) support multiple PDN connections to the same APN
  - Use case: can be established due to dual-stack connectivity (v4 + v6)
  - Use case: dial-up case where the terminal acts as a modem for a TE whilst maintaining a PDN connection of its own in parallel
- The support for PMIP based interfaces was added in release 9 to add the same capabilities to all core network protocols.
  - For PMIP S5/S8, the PDN GW can differentiate the PDN connections to the same APN based on the EPS bearer identity signalled by the Serving GW
  - For PMIP based S2a and S2b, the PGW can differentiate parallel connections to the same APN based on specific identifier assigned and signalled by MAG

QoS management

- Terminal initiated QoS
- Network initiated QoS

Terminal initiated Quality of Service (QoS)

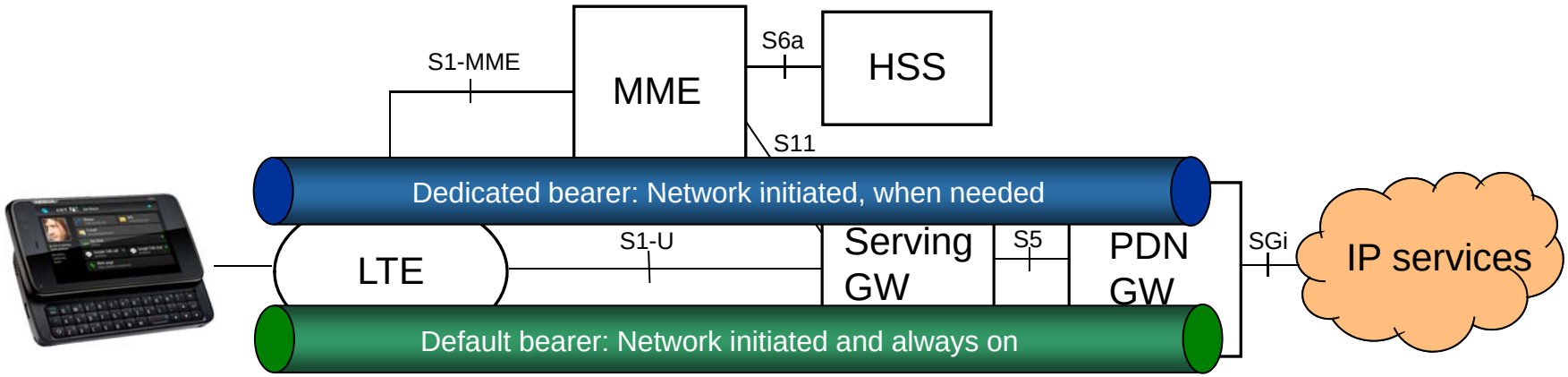
- Rel-6 GPRS negotiation contains all the necessary parameters to determine QoS, but…
  - Only very few UE applications can indicate their QoS needs to the UE protocol layers
  - Any QoS request from the UE must be considered against real-life restrictions
    - Subscribed maximum QoS
    - Available capacity in the network and radio interface
    - Parallel PDP context with the same UE + IP version to the same APN is considered an error
  - UE initiated QoS is not widely used and in practice “subscribed QoS” PDP context is used



Network initiated Quality of Service (QoS)

Improvements in EPS QoS negotation

- **Default bearer** is assigned during attach and provides always-on IP connectivity
  - Internet-like default connectivity for QoS-agnostic needs (browser, email, etc.)
- **Dedicated bearer** is assigned only when needed to provide guaranteed bit rate QoS control
  - Assigned only for those QoS sensitive applications that can be recognised
- Rel-8 allows also 2G/3G GPRS to use the EPS principle of network initiated QoS negotiation
- QoS differentiation improves cost-efficiency via assigning QoS only when needed
  - Different service packaging and priorities are possible
  - Mapping of different applications to different bearer pinpoints QoS to the applications that needs it
- Operator control on QoS is improved via enabling different deployment models
  - User differentiation (different users have different subscribed QoS)
  - Service differentiation (different identified services have different QoS)
  - Mixture of user based default QoS enhanced by service based QoS for identified higher QoS needs



End of presentation

(more information at www.3gpp.org)