



# Preparing for LTE Roaming

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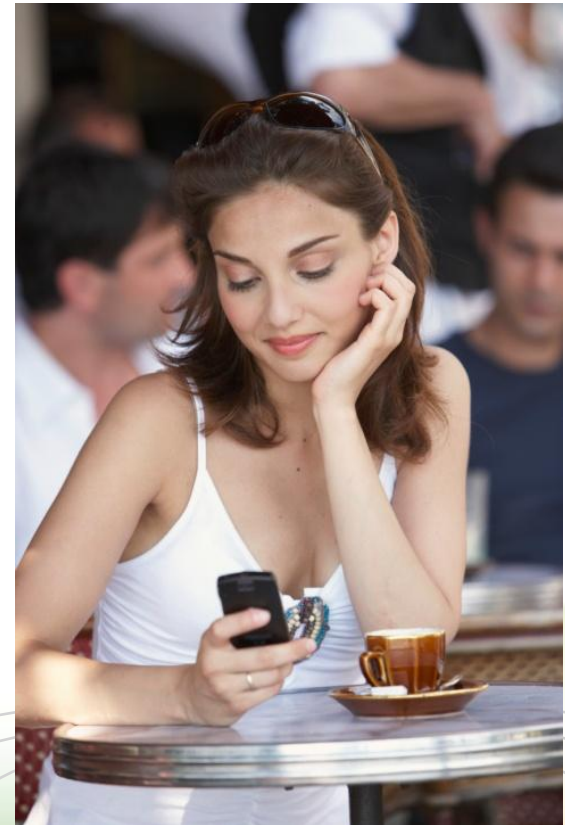


# Agenda

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- LTE today and tomorrow
  - Technology – What's different?
  - Implementing LTE Roaming – what is it going to take?
- Addressing LTE roaming challenges
  - Business operations
  - Wholesale
  - Retail
  - Finance
  - Strategy





# 3G Versus 4G Evolution



Competing standards

Limited devices

Lack of applications

Multiple bands and  
frequency

Slow rollout

Interoperability &  
interworking



**Complex technology**

**Limited devices**

**Voice, messaging & data**

**Multiple frequency/  
spectrum fragmentation**

**Expanded ecosystem**

**Interoperability &  
Interworking**

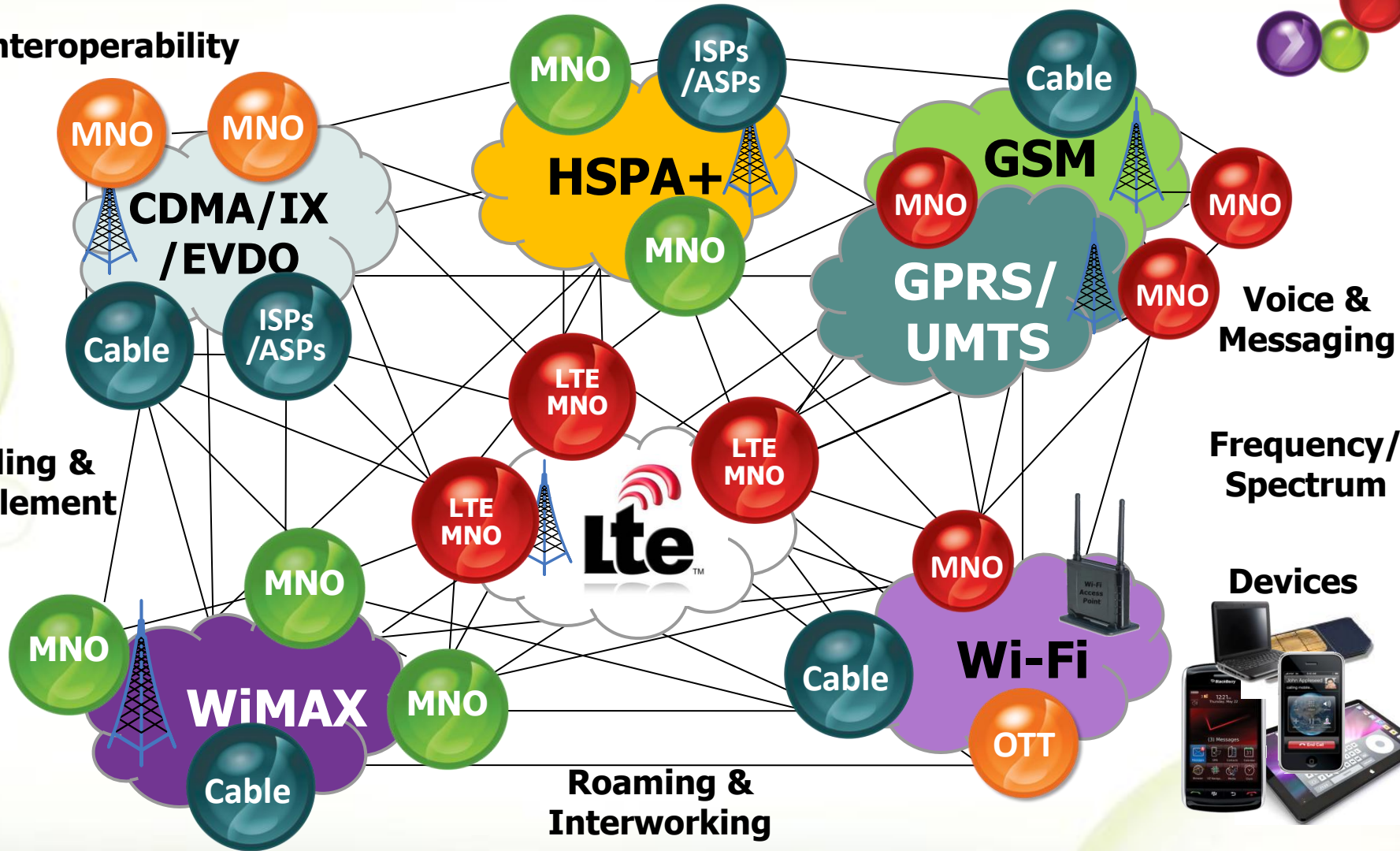
**Billing & Settlement**

# LTE Ecosystem

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**Interoperability**



**Billing & Settlement**

**Voice & Messaging**

**Frequency/Spectrum**

**Devices**

**LTE will bring more complexity and fundamentally change the mobility ecosystem**



# What is LTE/SAE

- LTE (Long Term Evolution) is the 3GPP quantum leap project to evolve the UMTS technology towards 4G
- SAE (System Architecture Evolution) is the corresponding evolution of the GPRS/3G packet core network evolution
- Key element delivered by LTE/SAE is the EPS (Evolved Packet System) consisting of the
  - New air interface E-UTRAN (Evolved UTRAN)
  - The Evolved Packet Core (EPC) network
- The term LTE is typically used to represent both LTE and SAE
- LTE/SAE standards are defined in 3GPP Rel. 8 specifications



# The Buzz around LTE

- Why LTE?
  - Enhanced user experience
  - Simplified network architecture (Flat IP-based)
  - Efficient interworking
  - High level of security
  - Robust QoS framework
  - Lower CAPEX (long-term) and OPEX
  - Common evolution for multiple technologies
- What does LTE offer?
  - Real-time, interactive, low latency true broadband
  - Multi-session data
  - End-to-end QoS/QCI versus only QoS
  - Policy control and management

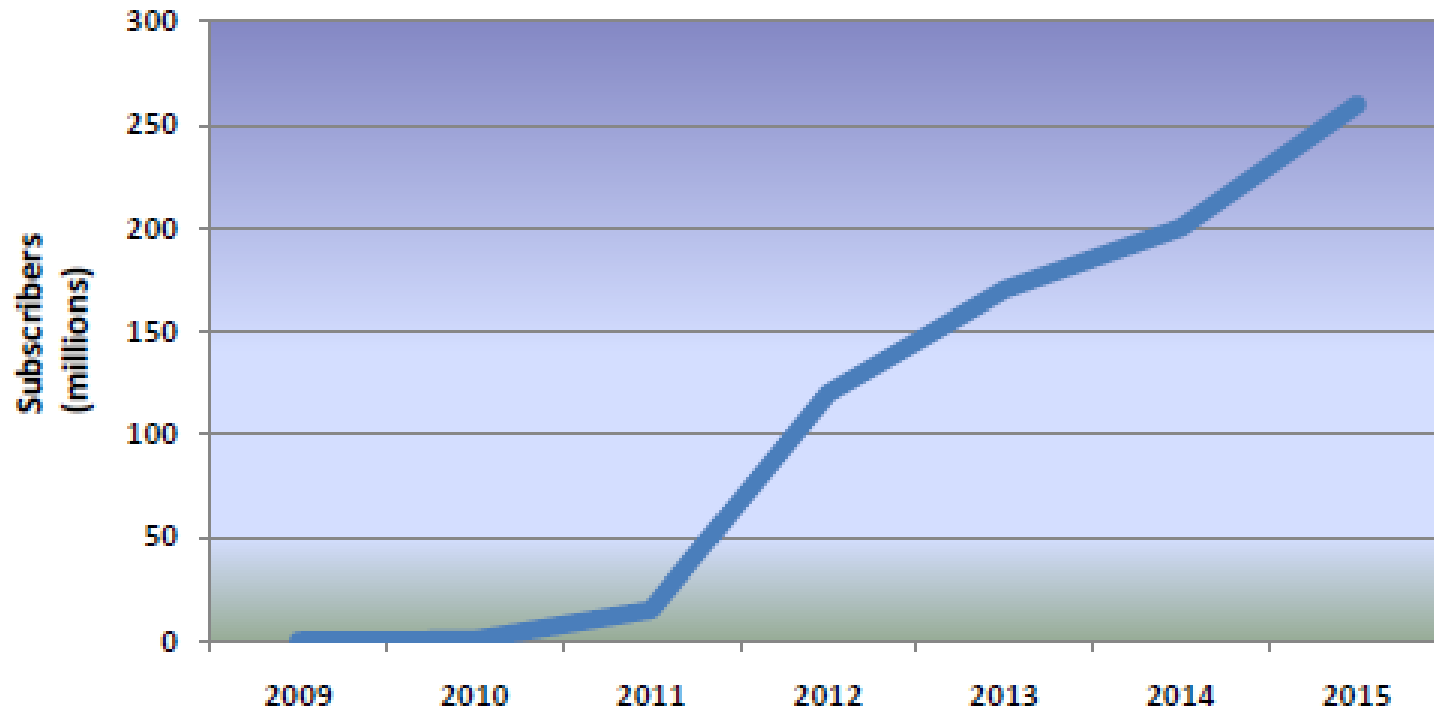


# Global LTE Adoption Forecast

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## Global LTE subscribers

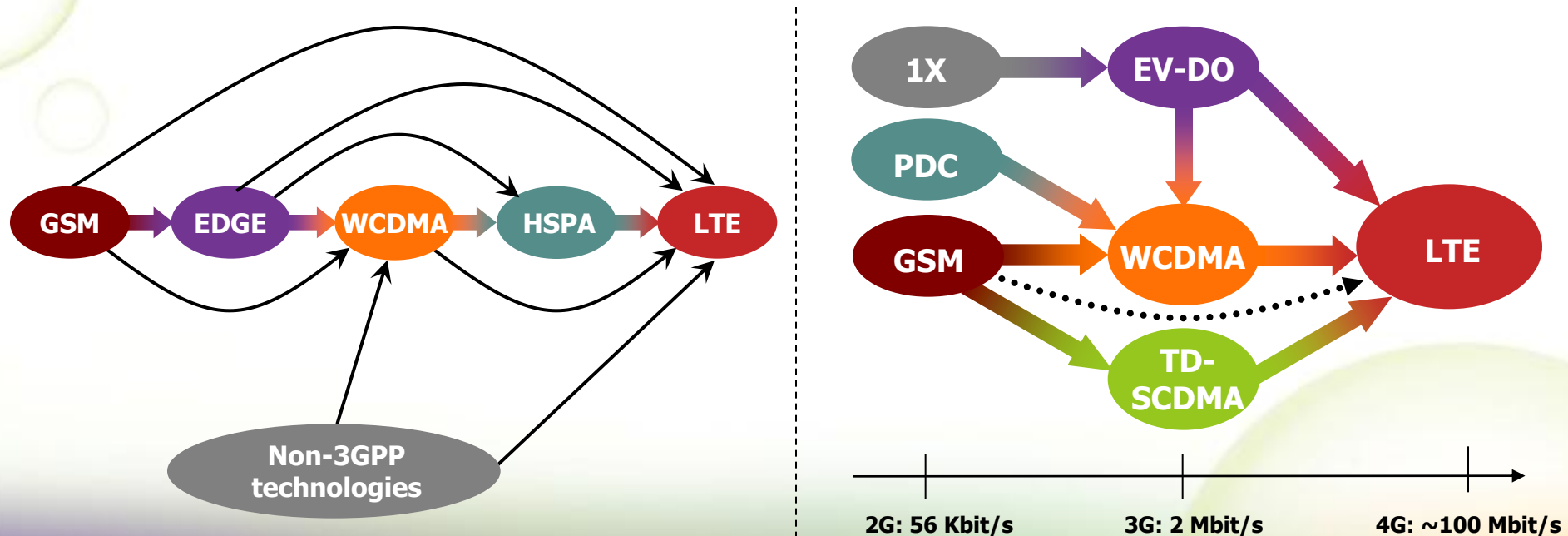


Source: Visiongain



# Evolution Paths to 4G/LTE

- Mobile operators are evolving toward LTE/SAE using different evolution paths
  - 3GPP family: GSM, GPRS, EDGE, WCDMA, HSPA
  - Non-3GPP family: 1xRTT, EV-DO, 3xRTT, WLAN, WiMAX





# What is different in LTE?

- New network and functional elements
  - MME, SGW, PGW, PCRF, ...
- New interfaces
  - **S6a, S8**, S9, S13, S13', ...
  - **S6a/S6d** in LTE is the equivalent of MAP-based Gr and D in Pre-Rel.8
  - S13/S13' in LTE is the equivalent of MAP-based Gf in Pre-Rel.8
  - \*\*\*THESE REPLACE SS7\*\*\*
- New protocols
  - **PMIP, GTPv2, Diameter, SIP, ...**





# Challenges in LTE

- Very complex technology
  - 130+ 3GPP specifications
  - 35 specs for devices, 56 specs for eNodeB, 41 specs for EPC
- Frequency/Spectrum fragmentation
- Interoperability
  - 15 network types with which to interoperate
    - Access networks
    - Converged core
    - CS core and PS core
- Voice, SMS and SS
  - Lack of voice support in early LTE networks
- Collaboration between multiple, diverse ecosystems



# Network Elements & Signaling Evolution: 2G/3G versus LTE

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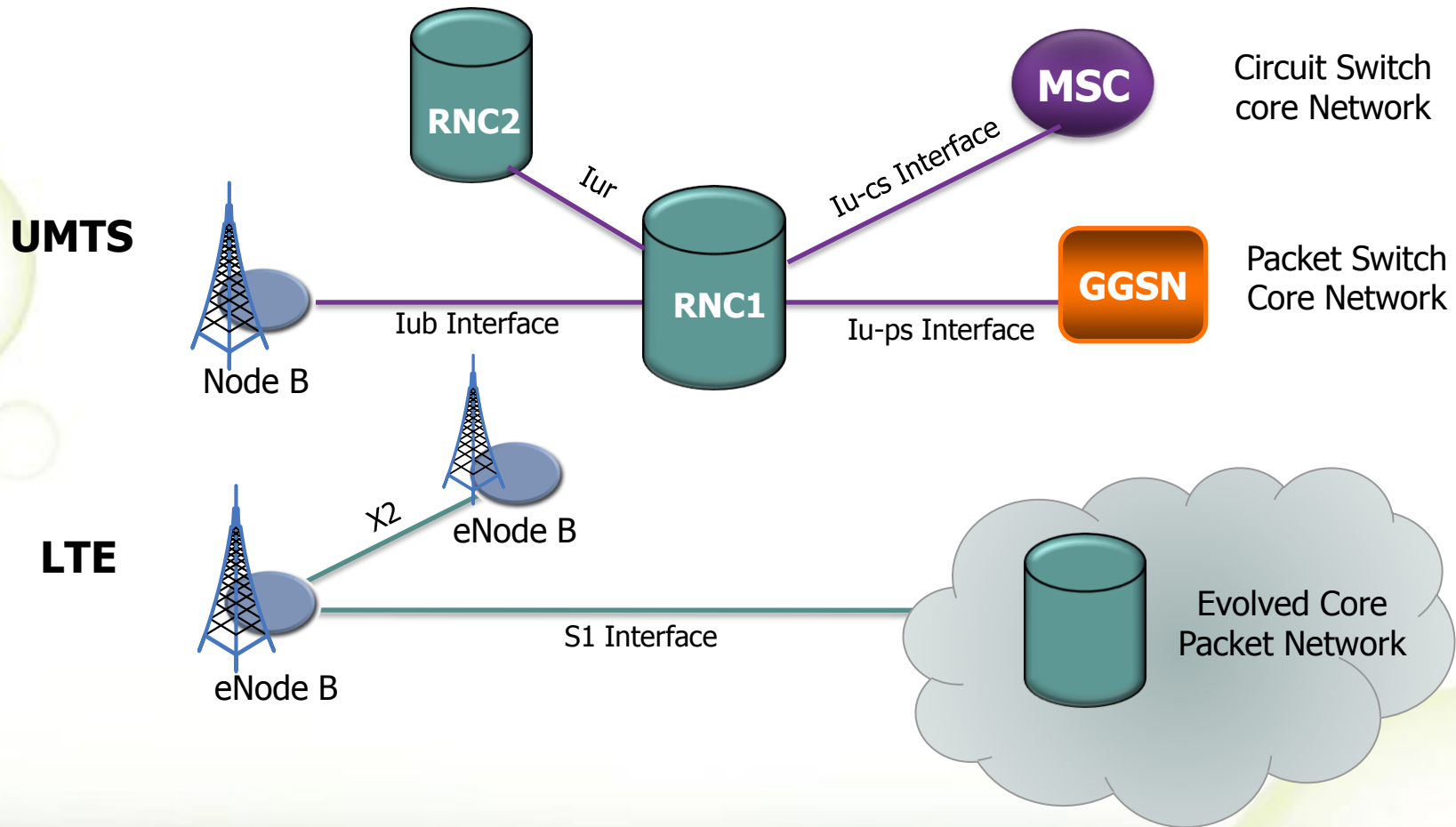


- GERAN and UTRAN → **E-UTRAN**
- SGSN/PDSN-FA → **S-GW**
- GGSN/PDSN-HA → **PDN-GW**
- HLR/AAA → **HSS**
- VLR → **MME**
- SS7-MAP/ANSI-41/RADIUS → **Diameter**
- GTPc-v0 and v1 → **GTPc-v2**
- MIP → **PMIP**



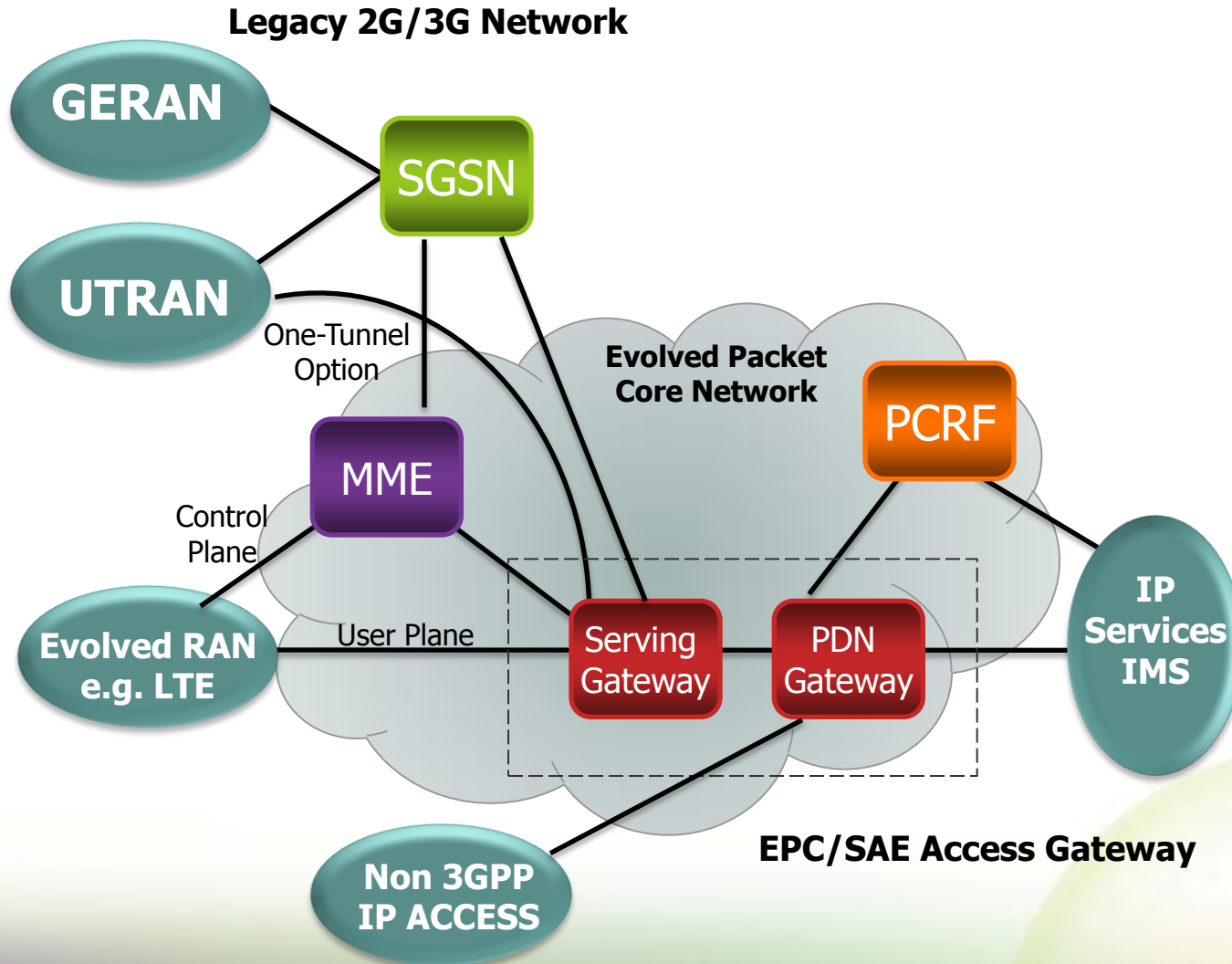


# Network Architecture: LTE and UMTS





# Evolved Packet System (EPS)



# Diameter in LTE

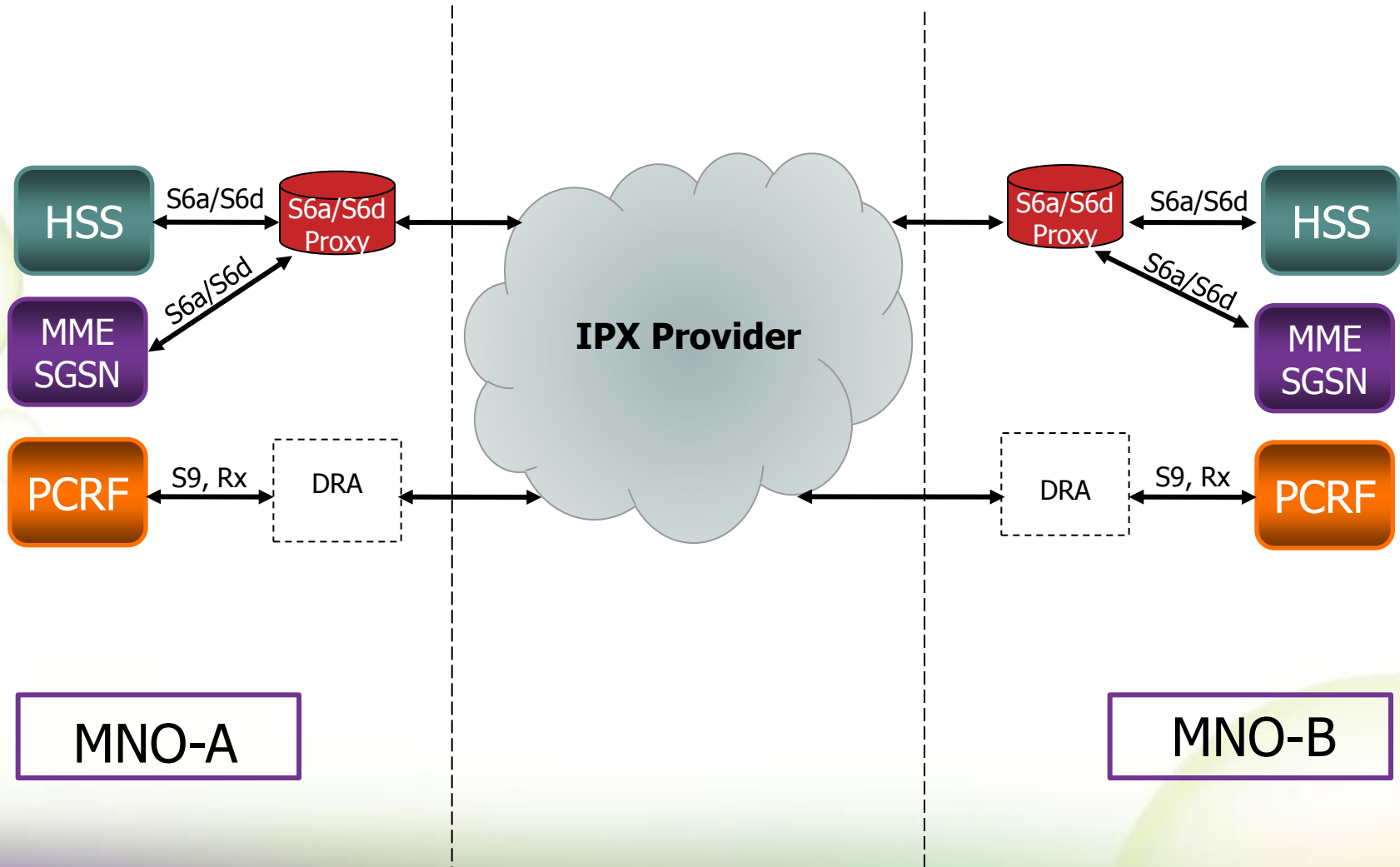
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- Today's 2G/3G networks use SS7-MAP protocol for location/subscriber/access/handover/authentication/security/identity management & handover services
- However, in LTE/SAE (3GPP Rel. 8), Diameter protocol has been chosen for many of these procedures and is increasingly used for inter-operator signalling network and roaming infrastructure
- In LTE environment, registration messages received would be based on Diameter (rather than SS7-MAP)
- Diameter Base Protocol is defined within IETF RFC 3588 (published in September 2003)
- Based on Diameter Base Protocol, 3GPP (like IETF) has also defined some specific Diameter applications to support more specific requirements in different scenarios



# LTE End-to-end Diameter Architecture



# Diameter Agents

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- The Diameter protocol introduces the notions of Diameter Agents:
  - **Relay** Agents: accept requests and route messages to other Diameter nodes based on routing decision performed using a list of supported realms, and associated known peers.
    - Advertise "Relay Application Identifier" in CER/CEA
  - **Proxy** Agents: Relay function + messages modification to implement policy enforcement.
    - Advertise supported Diameter applications in CER/CEA
  - **Redirect** Agents: return information necessary for Diameter agents to communicate directly with another Diameter node.
    - Advertise "Relay Application Identifier" in CER/CEA
  - **Translation** Agents: provides translation between two protocols (e.g., RADIUS $\leftrightarrow$ Diameter)
    - Advertise supported Diameter applications in CER/CEA
- A Diameter implementation MAY act as **one type of agent** for some requests, and as **another type** of agent for others

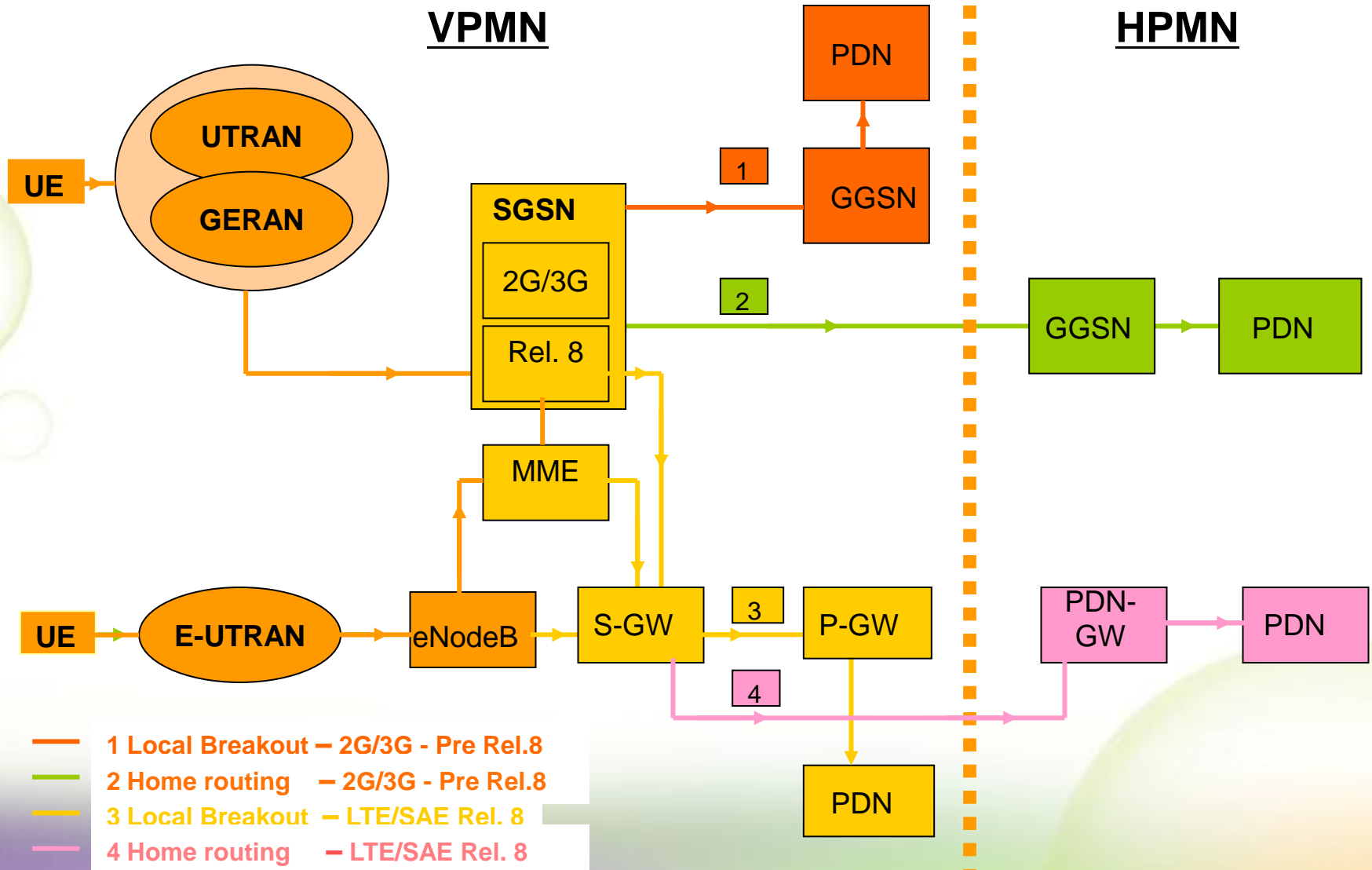


# LTE Interfaces based on Diameter

- Packet Core related interfaces towards HSS & EIR
  - S6a (MME to HSS) and S6d (SGSN to HSS)
  - S6b, S6c (external AAA functions for non-3GPP accesses)
  - S13 (MME to EIR) and S13' (SGSN to EIR)
- Network signalling for Policy Control & Charging
  - S9 (H-PCRF to V-PCRF)
  - S7 (PCRF to P-GW)
  - Gx (PCRF to PCEF)
  - Gxc (PCRF to S-GW)
  - Rx (AF to PCRF)
  - Gy (PCEF to OCS)



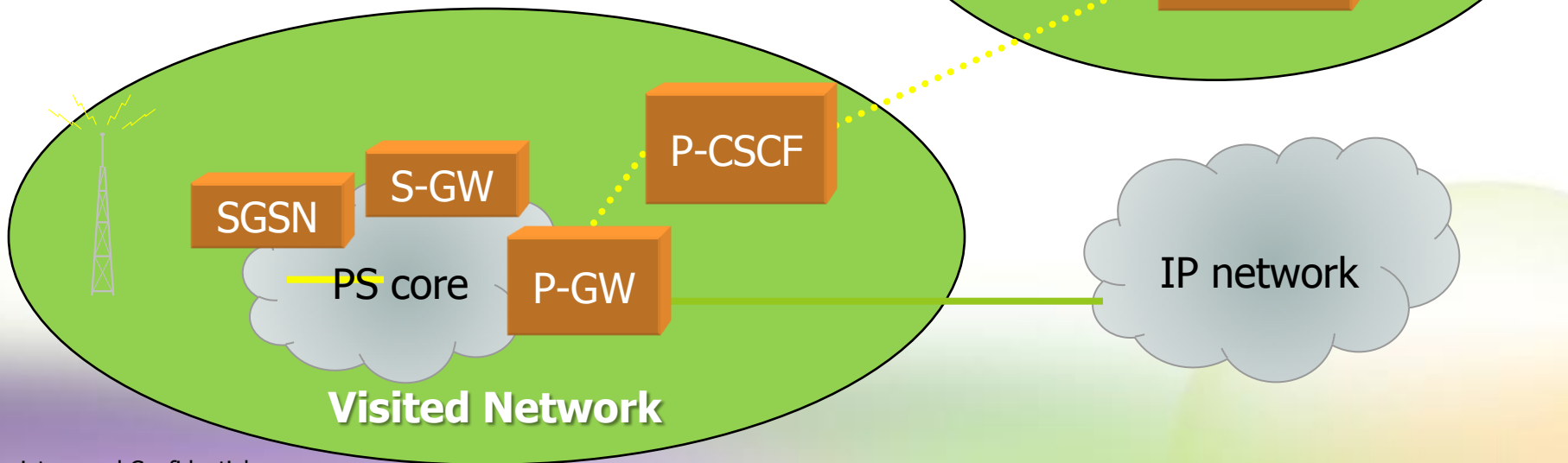
# High Level Architecture





# Accounting & Billing Flow

Network element	Location	Charging Information
SGSN S-GW P-GW	VPMN (PS core)	Call records, DIAMETER
P-CSCF	VPMN (IMS)	Call records, DIAMETER
AS S-CSCF	HPMN (IMS)	DIAMETER





# Addressing LTE Roaming Challenges

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## How It Impacts Your Roaming Business

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- Roaming business operations
- Wholesale roaming
- Retail roaming
- Roaming strategy



# Addressing LTE Roaming Challenges

## How It Impacts Your Business Operations

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- Roaming Agreements & Launch Letters
- Accounting & Billing Flow
- RAEX/IOTs
- Testing LTE Roaming
- Impact on Quality Monitoring
- Impact on Fraud-Related Issues & NRTRDE in LTE
- Impact on Roaming VAS (Steering, WSMS, VHE, etc.)
- Support for Sponsored Roaming
- Impact on Roaming Hubbing
- Impact of M2M services on LTE roaming

# Roaming Agreements & Launch Letters

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- The AA.12 and AA.13 (standard roaming agreement templates) were updated in 2003 to be technology-neutral
  - So no updates are required for LTE
  - VZW is currently reviewing AA.12/13
- Still many roaming agreements were signed before 2003, so they would need to be updated
  - However GSMA will not provide any template agreements for that
- There will be a specific LTE launch letter (like for 3G)

# Addressing LTE Roaming Challenges

## How It Impacts Your Wholesale Roaming Business

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- Impact on Wholesale Roaming Relations
- Impact on Wholesale Charging
- How to Ensure Steering Will Continue to Work in LTE
- Impact on Invoicing & Settlement

# Impact on Wholesale Roaming Relations

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- New players will enter the LTE space
- Some of your preferred roaming partners might not be ready for LTE roaming launch. What do you do?
- Will LTE impact the value of roaming as it is today?
- Will LTE bring additional revenues?
- Will LTE change your wholesale or re-sales strategy?



# What impact will “Islands” of Technology have on my Roamers’ Experience?

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- LTE will be deployed in “islands” initially; HSPA/3G will be used to cover the gaps
  - HSPA operators should take into account such LTE roamers
  - LTE operators may support both Gp (GGSN/PGW) & S4/S8 (PGW) interfaces
- A large number of operators won’t deploy LTE for some time
  - Inter-system roaming (LTE  $\leftrightarrow$  HSPA) likely to be used
- Both FDD and TDD LTE variants will be seen in the market
- Devices will be required to support multiple radio technologies as well as both FDD and TDD LTE variants

# Addressing LTE Roaming Challenges

## How It Impacts Your Strategy

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- What are the critical decisions areas?
- Strategy for Voice & SMS
- Will There Be An Impact on Roaming Regulation ?
- Non-GSM Family Operators
- 2G/3G Roaming
- Additional Questions to Help You Define The LTE Roaming Strategy



# Impact on Invoicing & Settlement

- With TAP also being in use for LTE, there should be minimum impact on existing invoicing and financial settlement processes
  - For example: financial clearing would work like it does today
- New CDMA players have a different settlement cycle
  - 16th to 15th of month instead of calendar month
  - It is expected that they will move to calendar month when settling with GSM family operators



# Impact on Wholesale Charging

- GSMA BARG and TADIG have reviewed impact on wholesale clearing and settlement processes and TAP
- For data over LTE possibility for the VPMN to use call records from SGSN and SGW for home-routed access and additionally from PGW for local-breakout, just like today for GPRS/3GPRS
  - New recording entity type codes for the SGW and PGW added to TAP3.11 1 May 2010
- Full TAP support for LTE/IMS roaming approved by BARG 10 March
  - Pending TAP3.12 (or TAP4) specification by TADIG by May 2011 for implementation 1 May 2012
  - Two new TAP record types to support Voice over LTE and SMS over LTE
  - Will be made generic and future-proof to allow for future IMS services

# Impact on Wholesale Charging (continued)

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- Key assumptions
  - **Quality:** Voice call routing for Voice over LTE when call originator is Roaming shall be at least as optimal as that of current CS Domain
  - **BAU:** The bearer path for a VoLTE call shall be routed from the Visited network of a Roaming call originator to the terminating network – not going to tunnel home
  - **TBD:** The charging model for roaming used in the CS Domain shall be maintained in VoLTE
- If the above assumption is correct: VoLTE service invocation should be subject to the “normal” IOT for Voice
  - There would be only a single IOT for Voice / SMS – bigger fish to fry
  - Potential differences in quality of service may drive different models
- The bearer usage underlying VoLTE is an enabler for the Service
  - The bearer usage should not be charged for separately – it’s just another packet
  - Charge only for the service and not for service + bearer

# Impact on Wholesale Charging (continued)

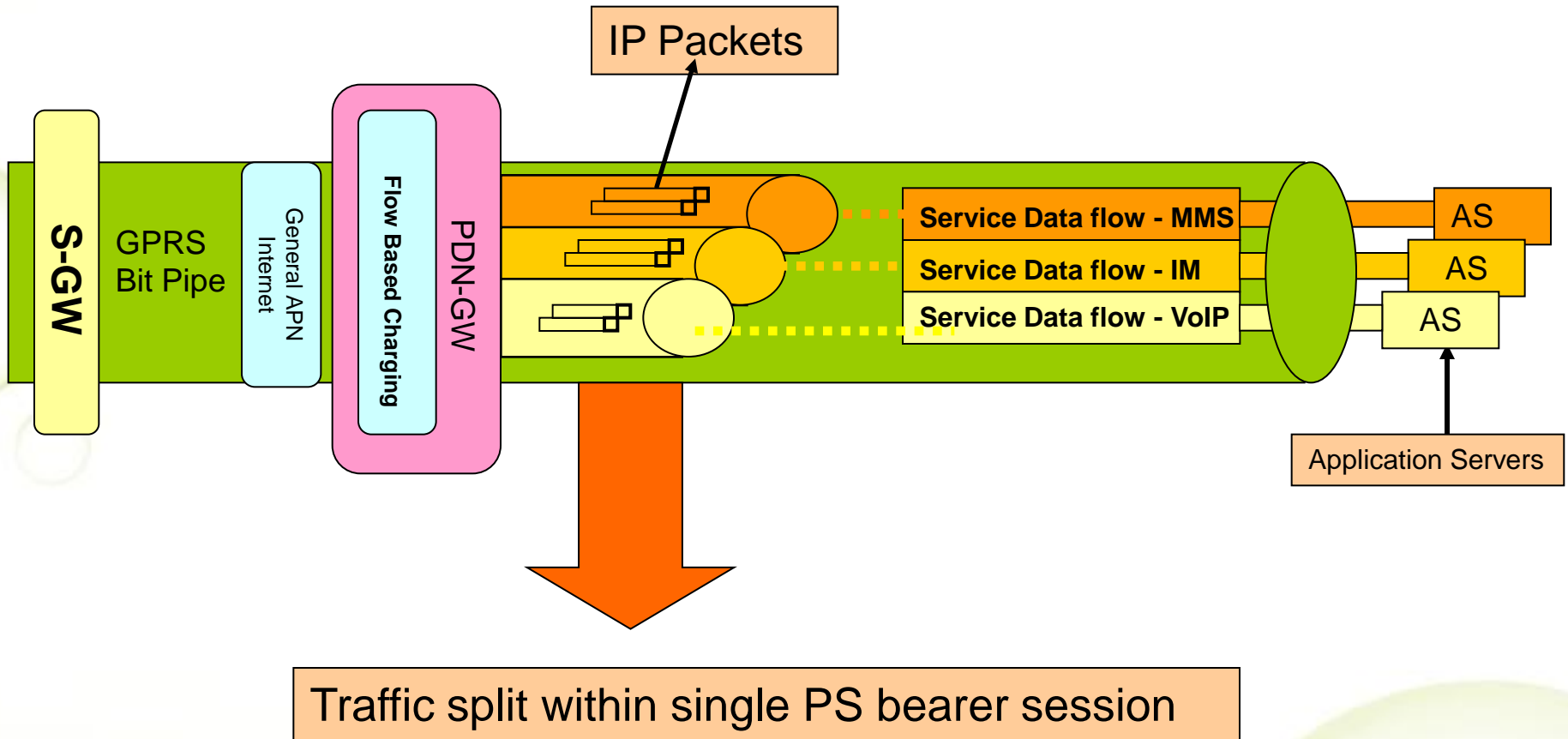
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- The recommended approach not to charge for the bearer usage underlying VoLTE is not straight forward
- In order to simplify implementation dedicated APNs could be used
  - Currently under investigation in IREG
  - Unclear whether HPMNs are willing to use dedicated APNs as in general many operators try to systematically reduce the number of APNs
- If no dedicated APNs are used the VPMN needs to rely on more complex mechanisms (like Flow Based Charging)
  - These mechanisms are not implemented so far for local breakout

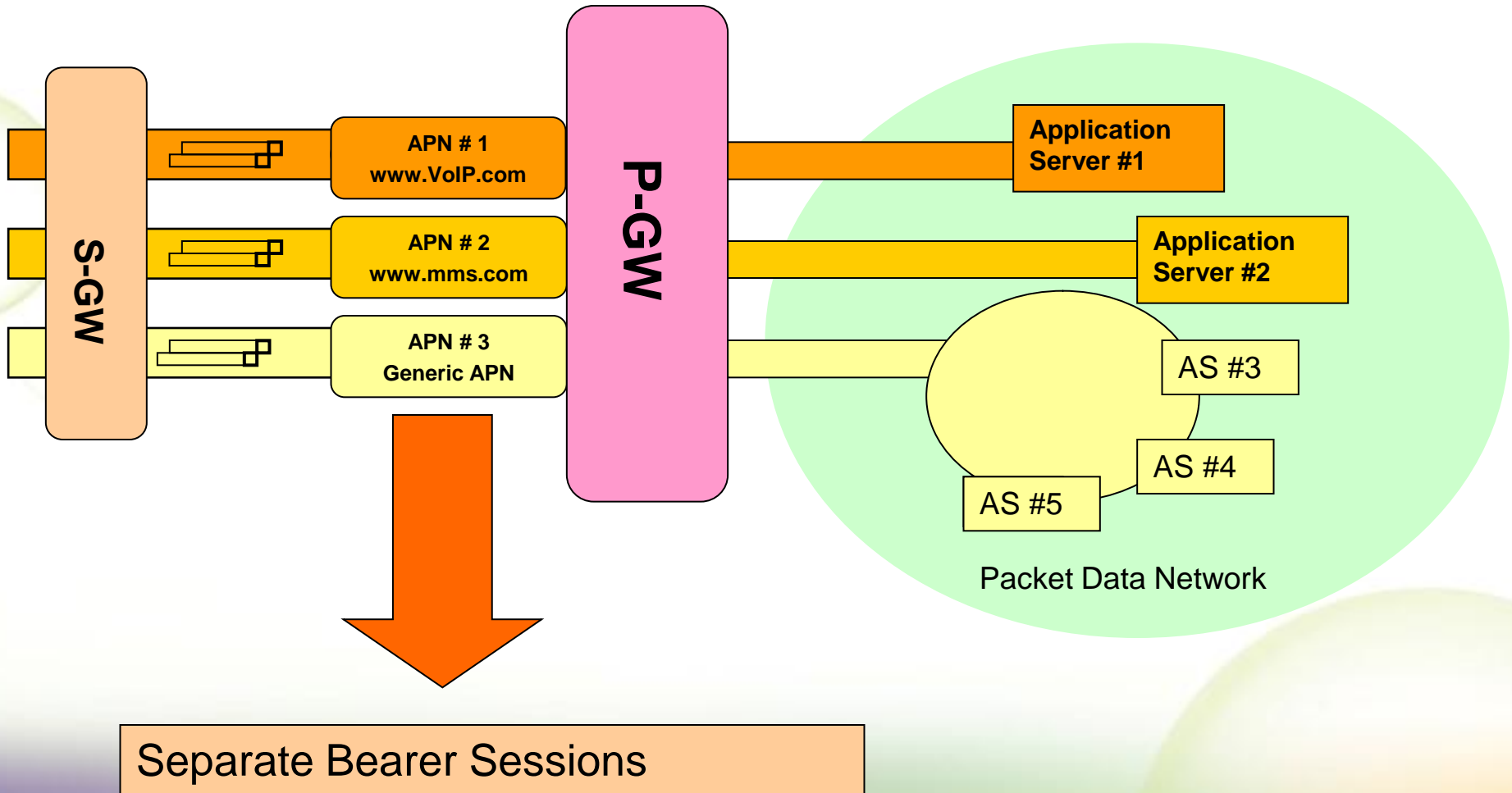


# Single PS Bearer Session





# Separate PS Bearer Sessions



Separate Bearer Sessions

# Impact on Retail Pricing of New Roaming Services

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- New type of calls?
  - What impact will voice over PS have on retail charging principles?
  - Probably charged the same as CS?
- For local breakout, CDRs are not available from home PGW
  - Unlike 2G/3G where operators have chosen to have everything routed back to the home network
  - May cause operators to move to retail billing based on visited network, TAP only, or a combination of visited network TAP and home PDN-GW CDRs
- More real-time information available?
  - May be interesting to look into, but huge impact on existing processes
- Two separate processes (2G/3G and LTE) or the same?



## RAEX/IOTs

- RAEX AA.14 does not yet support LTE
- Next version (2012) will mean major changes, like breaking out the IOT from the operational data
- Support for LTE will be implemented at the same time
- For example, as for 2G → 3G, the IOT structure for LTE is likely to be the same as 3G, at least initially (before local breakout)
  - Will the level of the rates need to be different?

## RAEX IR.21/IR.85

- RAEX IR.21 has been updated to support LTE, including multiple PDP contexts
- RAEX IR.85 (IR.21 for Roaming Hubbing)

# How to ensure Steering will continue to work in LTE

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- Most steering solutions based on SS7 node-based redirection method
- LTE roaming architecture is different (from 2G/3G architecture)
- Many roaming scenarios are possible
- Diameter support on steering solution
- Solution should address LTE-to-LTE as well as LTE-to-legacy roaming

# Impact on Fraud-Related Issues & NRTRDE in LTE

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- TD.35 (NRTRDE specification) has been updated to support LTE
  - Only minor changes, to support new network elements (S-GW, P-GW) and new cause for termination value
- Local breakout scenarios have to be analyzed given that GPRS is not scheduled to be made mandatory
  - It is possible that NRTRDE could be updated for the Oct'2012 release
  - Changes should be kept to a minimum
  - Need to be backward compatible with older NRTRDE versions

# Impact on Roaming VAS (Steering, WSMS, VHE, etc.)

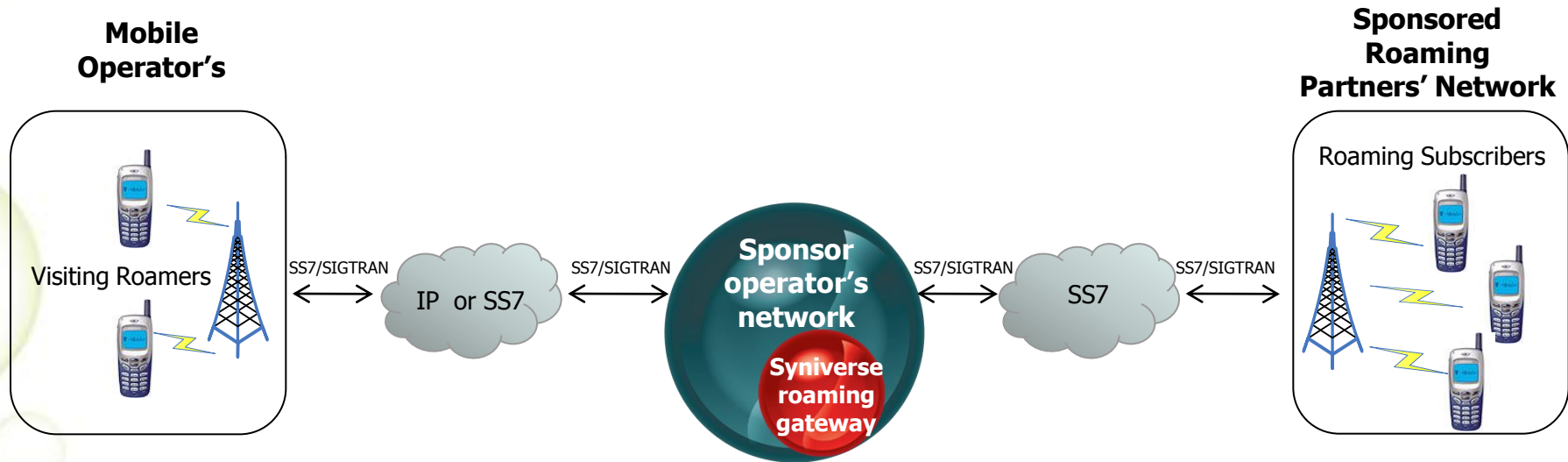
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- Many value-added services (VAS) exist today
  - Traditionally based and relying upon SS7 signaling procedures
- In LTE, S6a, S6d, S13 and S13' interfaces replace the legacy Gr, Gf, D interfaces
  - S6a, S6d, S13, S13' interfaces are based on diameter
- VAS ecosystem needs to evolve
  - To support diameter-based procedures as well as IWF
  - Flexible to support multiple services, protocols and scenarios

# Support for Sponsored Roaming

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- Sponsored roaming support for LTE implies subscribers of LTE HPMN roaming into either LTE VPMN or 2G/3G VPMN
  - Uses sponsor network and sponsored roaming platform; utilizes implicit IMSI range from sponsor network
  - **No customer impact:** operation is invisible to subscriber; retains the MSISDN
  - Operator retains control in home HLR; support for inbound roaming is subject to GSMA BA.21 requirements
  - Roaming agreements updated suitably to reflect LTE service where applicable (including C.11s for inbound roaming)
  - Signaling connectivity between sponsored roaming platform and LTE HPMN will be established using SS7-MAP or diameter over IPX depending on the capabilities and preferences of the LTE HPMN
  - Syniverse platform may be required to perform SS7-MAP to diameter IWF to enable signaling
  - TAP support for LTE will be provided by the sponsored roaming solution



# M2M Strategy for LTE

- Local breakout is more relevant for M2M services
- Superior performance and improved QoS
- More suited for many M2M services



# What are the Critical Decision Areas?

- Define the LTE roaming partners
- Determine Pricing for LTE roaming subscribers
- Choose an IPX provider
- Check that the DCH/FCH/NRTRDE is LTE-compliant
- Check that all roaming VAS are LTE-compliant

# Will there be an impact on Roaming Regulation?

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- It is not yet clear how the EU will view LTE
  - Likely that regulation will continue to be technology independent
- VoLTE likely to follow voice and SMS regulation, rather than the data regulation
  - Calls and SMS cannot be more expensive than today
- Will termination rates be regulated for VoLTE?
- APT, ITU-T and OECD also are looking at regulation
  - APT: Asia Pacific Telecommunity
  - ITU-T: Telecommunication standardisation sector of the International Telecommunication Union
  - OECD: Organisation for Economic Co-operation and Development



# Non-GSM Family Operators

- It is likely that the GSM family operators will expect the non-GSM family operators to follow GSMA rules and procedures
  - AA.12/13/14 (bilateral roaming) and AA.73/74 (hubbing)
  - RAEX AA.14 / IOT / IR.21 / IR.85
  - TAP, RAP, RTDR, NRTRDE
  - Calendar month invoicing period
- Non-GSM family operators need to consider the cost of implementing all of this, or use conversion services
- BARG AGREE has asked Verizon Wireless to review the standard AA.12/13 with the aim to update these standard templates to cater to both worlds



# Key Takeaways

- Define your LTE strategy in all areas
- Analyze and mitigate impacts in all areas
- Consider both roaming and interworking environments, and all services
- Consider technical business and commercial and operational aspects



# Conclusions

- Operators need solutions that enable seamless 4G evolution
  - Addressing the main areas of signaling, roaming, networking, messaging, VAS, BI, legacy interoperability
  - Basic/core roaming solutions need to evolve to support LTE protocols, interfaces, network elements as well as interworking with legacy technologies
  - Managing the significant impact of LTE while continuing to manage and deliver value for existing technologies and services
  - Integrated solutions across operator core/transport network, billing and operations support to ensure optimal QoE
  - VAS and enhanced roaming solutions need to adapt for LTE
- Operators also need trusted brokers to work with different players and ecosystems that LTE will bring along

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**Uniquely qualified to support evolution to LTE  
and provide integrated solutions**



# Thank You!

**Mary Clark**

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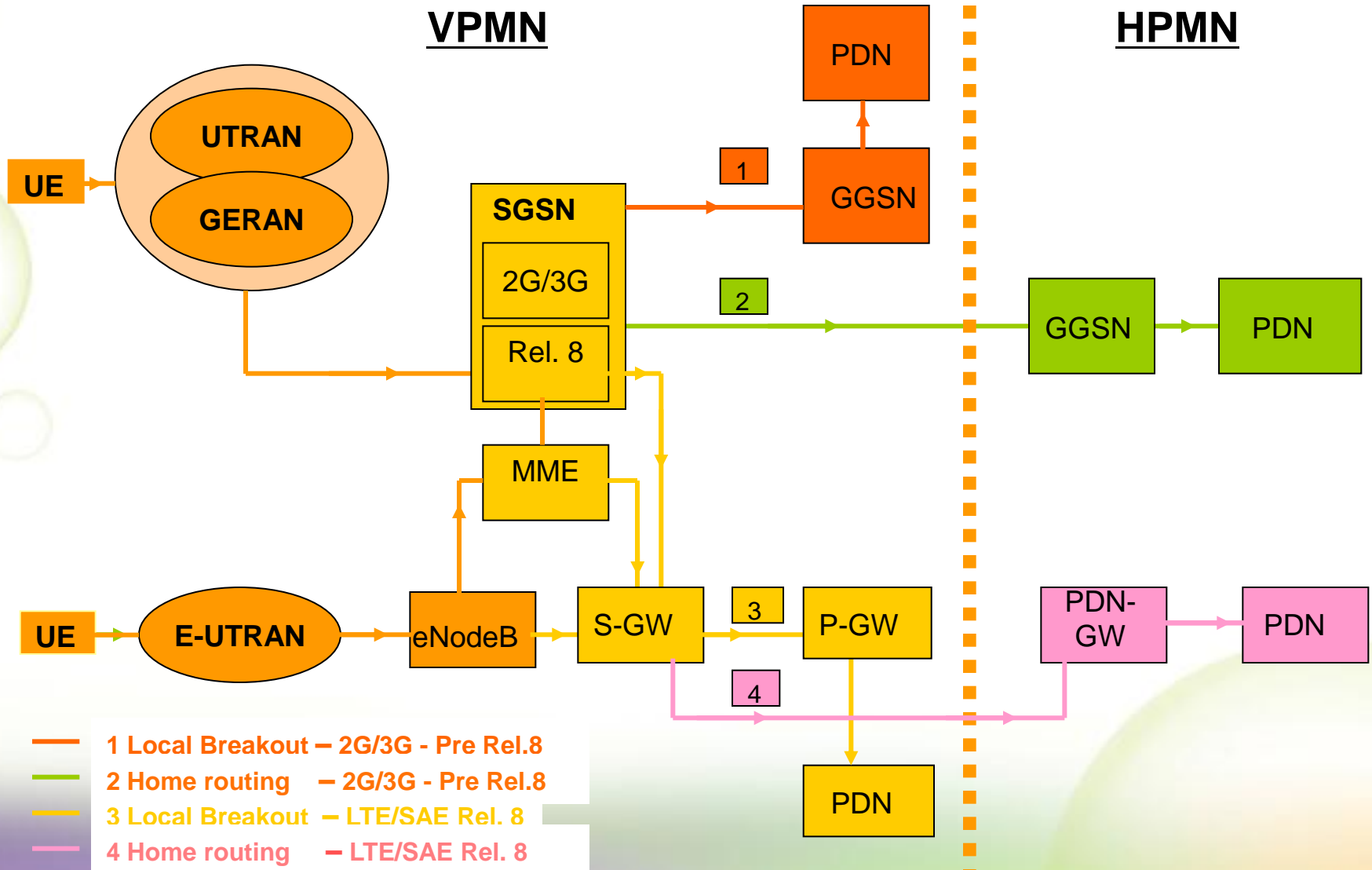
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# High Level Architecture

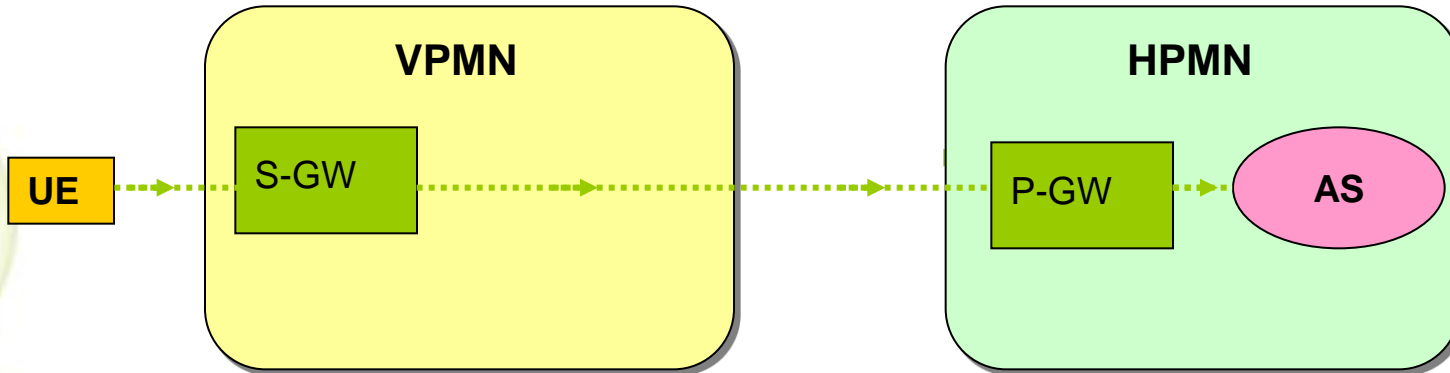


# Local Breakout vs. Home Routing Scenarios

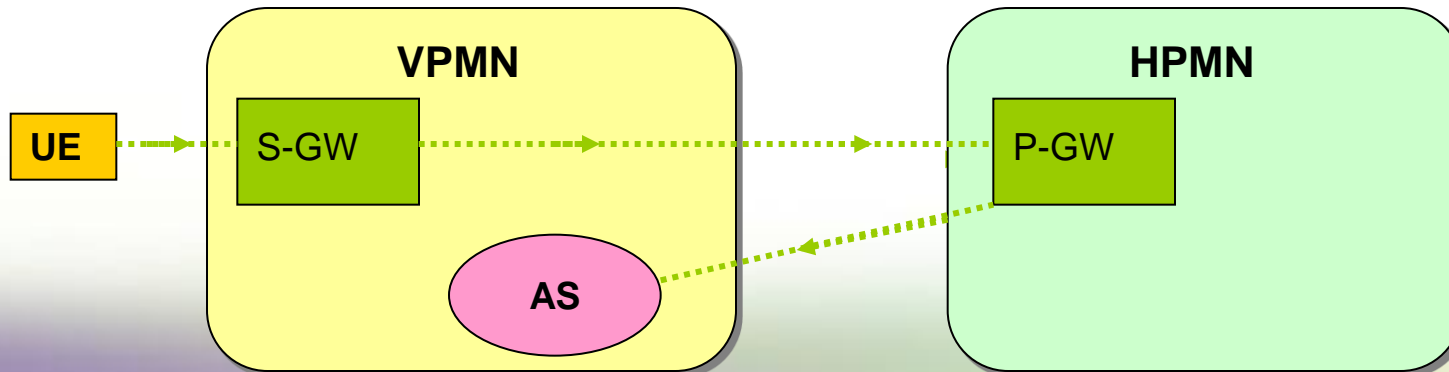
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The bearer traffic is home routed and the service logic is provided by the Home Network

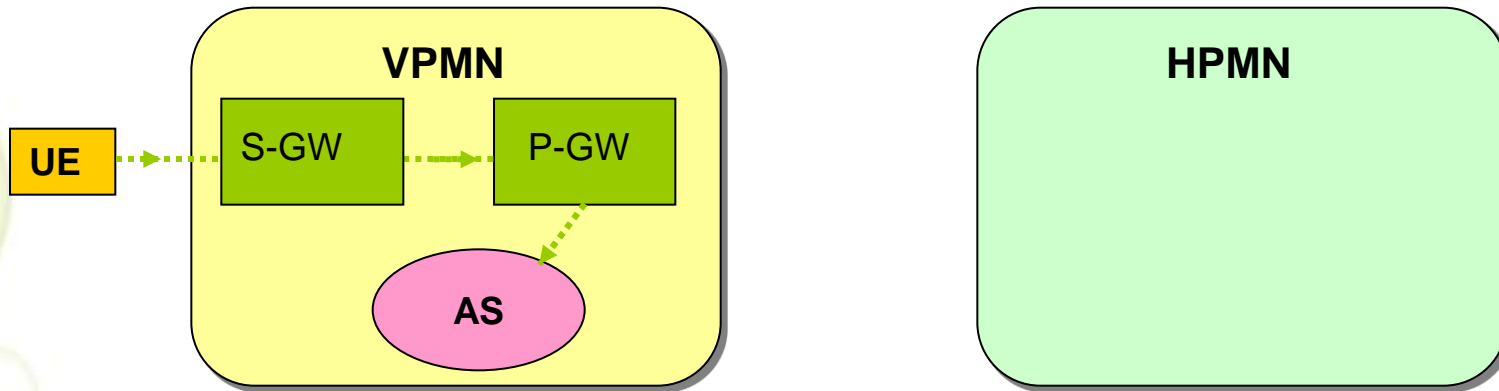


The bearer traffic is home routed and the service logic is provided by the Visited Network

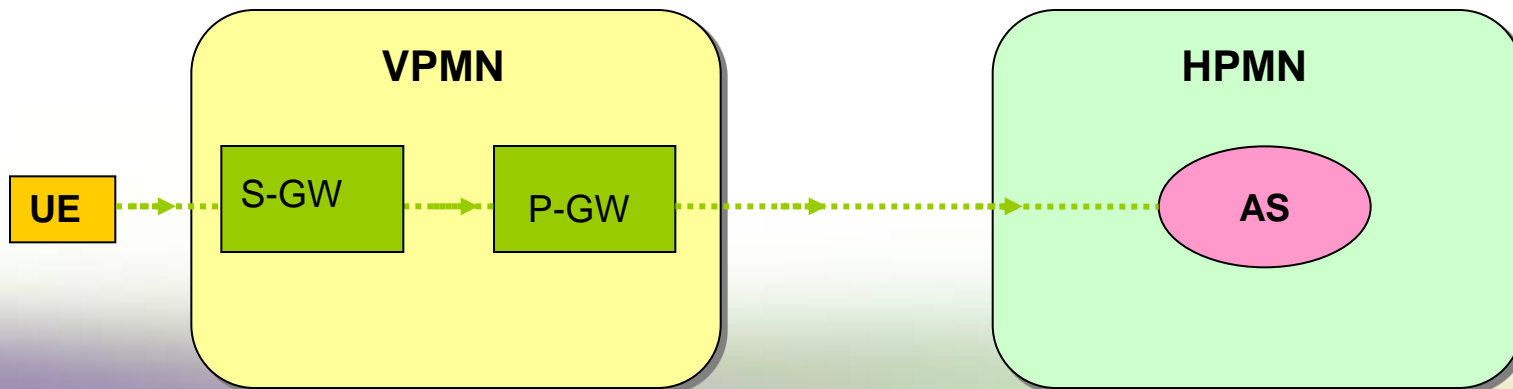


# Local Breakout vs. Home Routing Scenarios

The bearer traffic is locally routed and the service logic is provided by the Visited Network

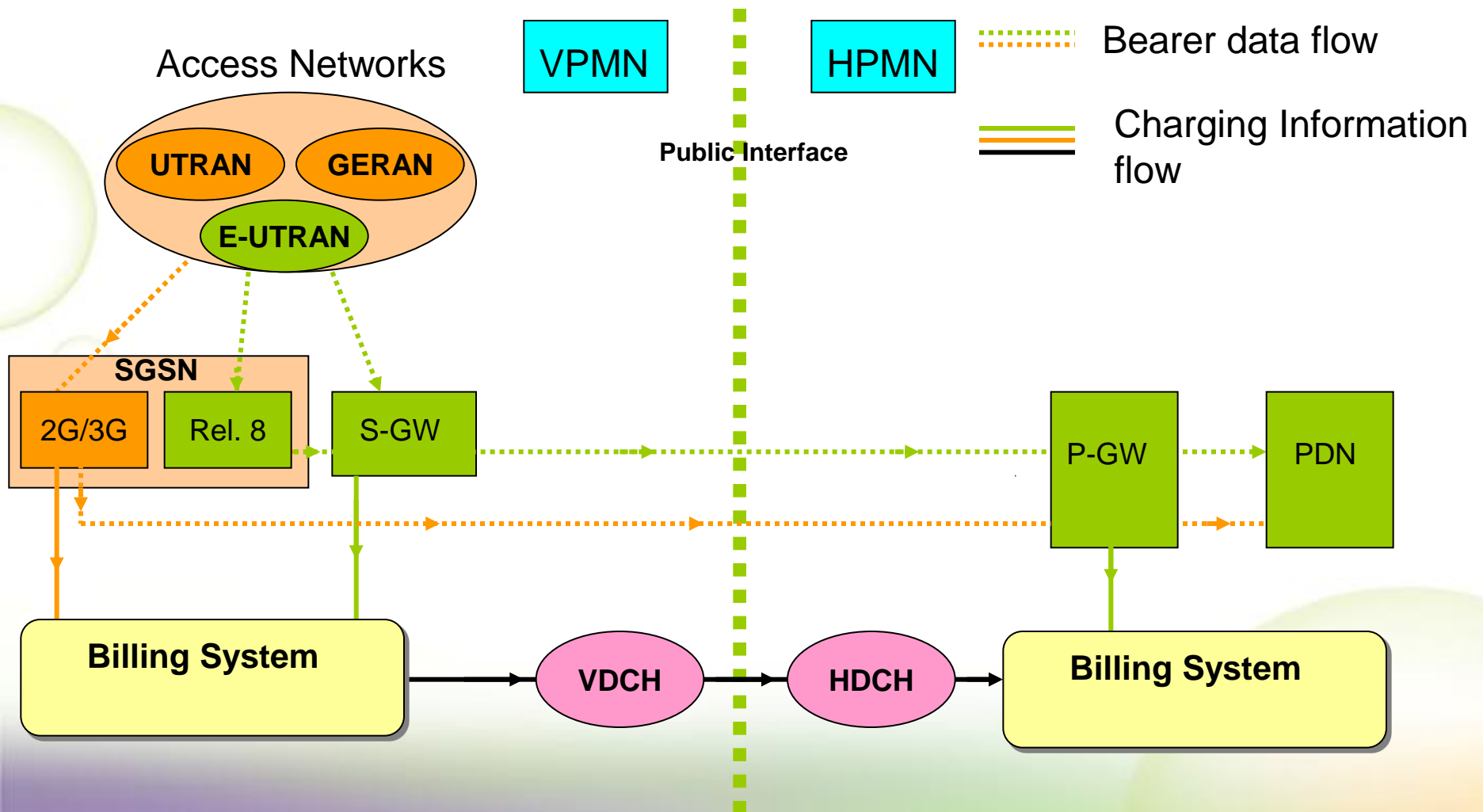


The bearer traffic is locally routed and the service logic is provided by the Home Network



# Charging Information flow in Home Routing Scenario

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# Charging Information flow in Local Breakout Scenario

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