Regional data breakout (for roaming and IoT)

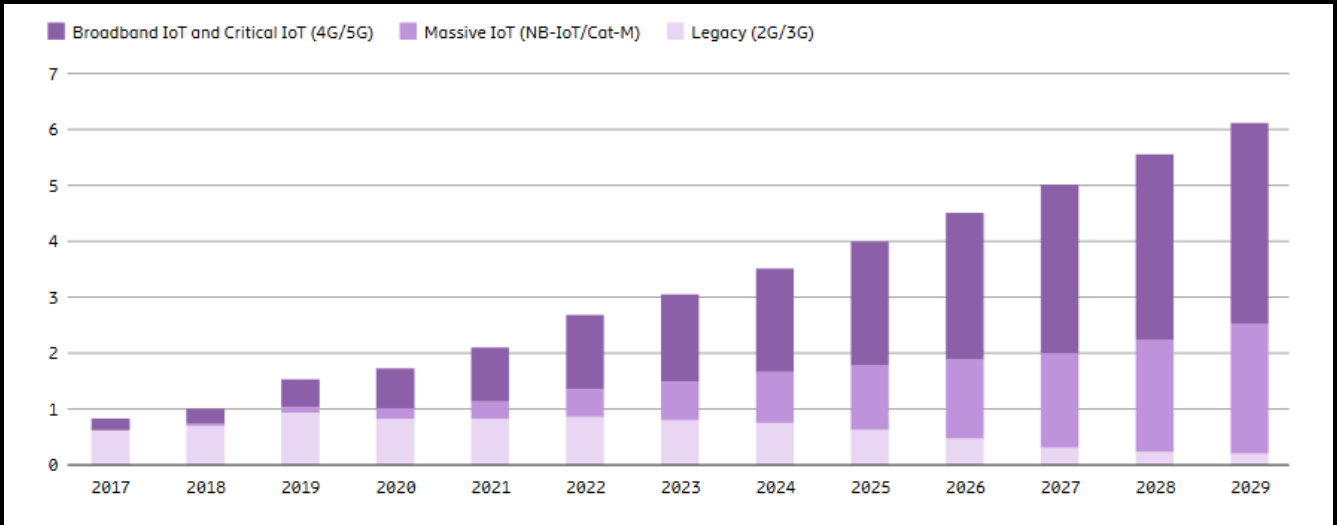
Low-latency architectures for IoT use cases

MyNOG 11, June 2024

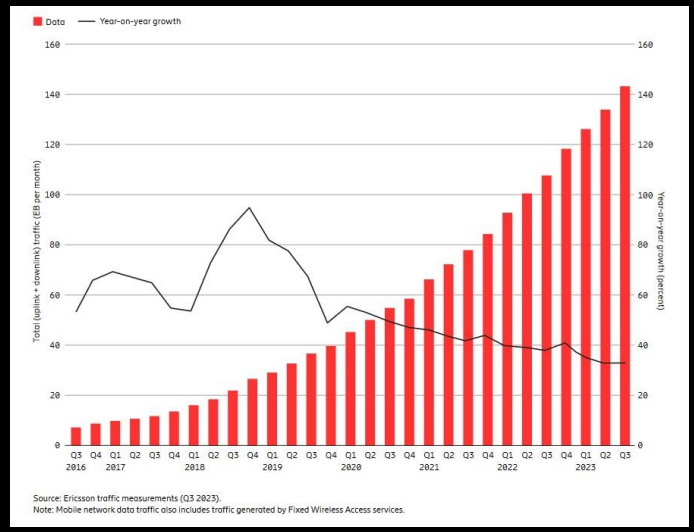
IoT roaming is about delivering more speed, lower latency, everywhere

With the development of IoT use cases in 4G and 5G and the increasing availability of Cloud-based solutions for Core-Network-as-a-service, we take a look at a key enabler of low-latency applications, and its potential integration into a global roaming infrastructure for MNOs.

When high latency in roaming and most operators forcing IoT scenarios towards dedicated roaming relationships (e.g. using MCC 901), this is becoming an issue for dedicated IoT operators looking for worldwide coverage without operating a carrier network. Applications like connected cars and future critical IoT applications relying on permanent roaming services would be primarily affected by the reluctance of local operators to treat IoT traffic in the same way as traditional roaming traffic.
For IoT and traditional MNO players, this could lead to a reduced bandwidth in roaming, with a decrease satisfaction of end user experience.
For IPX Carriers in the middle, such new IoT scenarios lead to a high usage of international transit backbone capacity, with significant variations during holidays and major events.



Source : Ericsson Mobility Report, Nov. 2023



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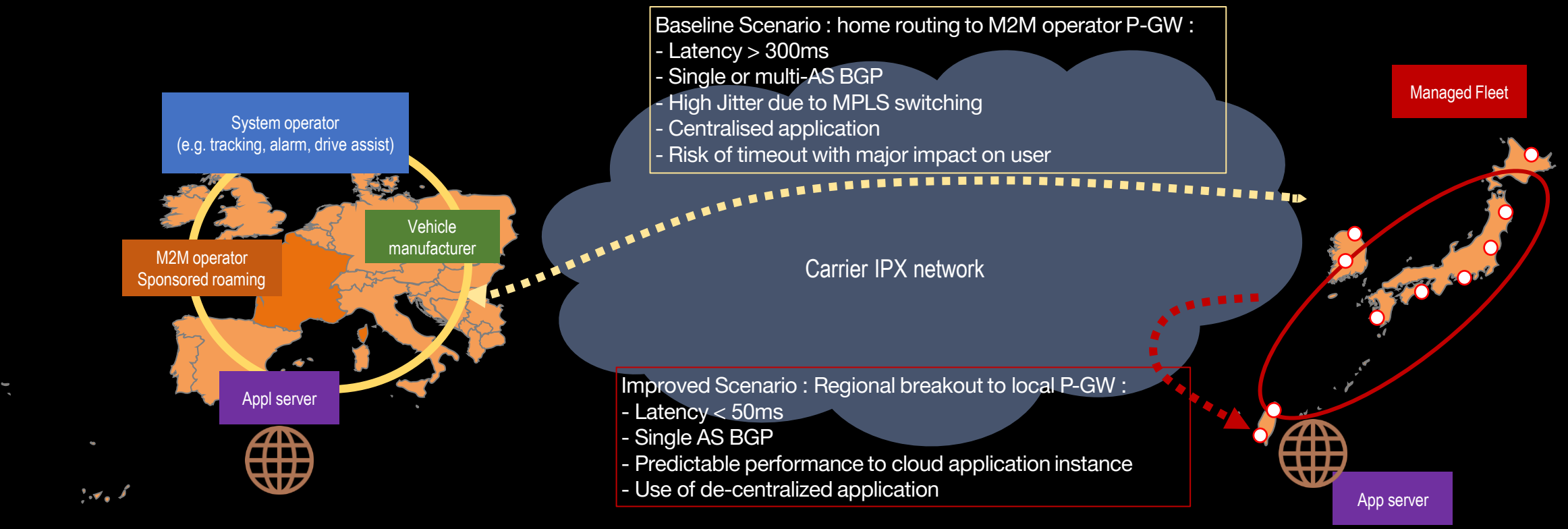
Example use case : Connected vehicles using M2M roaming

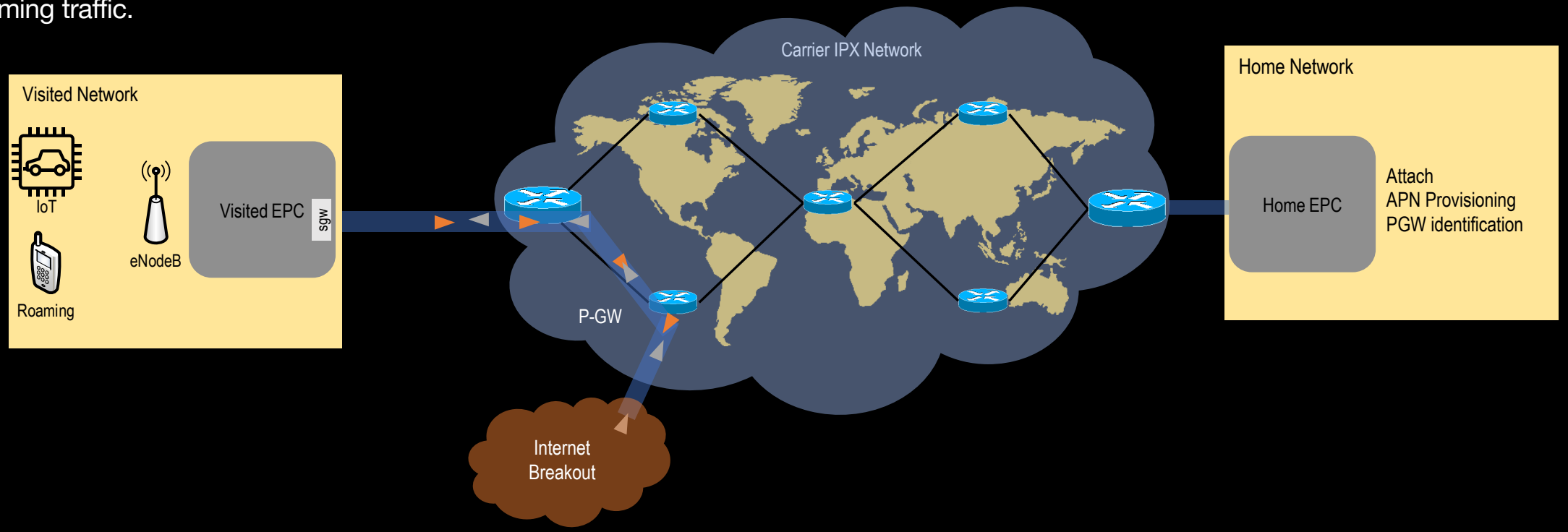


Other latency-sensitive applications directly impacted by latency:
- Tele-medicine
- Remote collaboration tools
- Live content streaming and delivery
- Automated manufacturing

The latency vs bandwidth trade-off has been acknowledged at GSMA level in the development of 5G standard with the emergence of 5G RedCap New Radio to prioritise latency-sensitive applications over high bandwidth.

Traditional wholesale carriers are aiming for multi-local roaming enablers

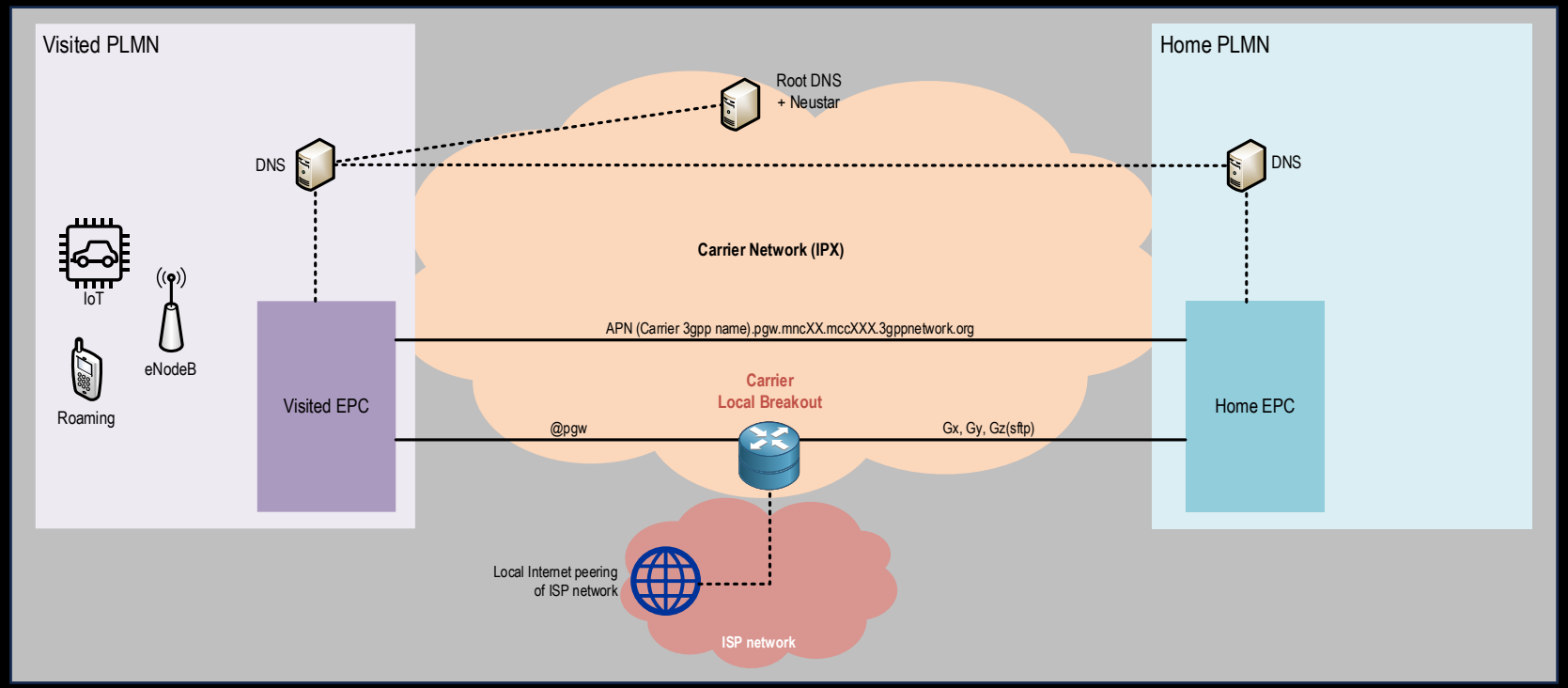
To remain relevant in this space, carriers are proposing solutions to decrease internet payload latency by reducing the distance where IP packets are transported from the user to the gateway. This is the first step in carriers' aspirations towards a global cloud-based infra for 5G core networks, and comes in complement to existing developments in hosted security infrastructure such as hosted SEPP and other 5G hosted core network functions.
The objective for international carriers is to maintain high bandwidth services by accessing local internet with "Roam like at Home" customer experience where applicable, effectively creating a multi-domestic or multi-regional network for internet breakout in roaming scenarios, eliminating multiple network peers and unmanaged peering bottlenecks.
Such solutions also enable to selectively apply local breakout or keep home routing in place depending on use case and user profile, making the Regional Breakout a complementary solution to IPX, LTE & 5G home routing. The operator keeps full control of the control plane, including subscriber policy control (PCRF) and is in turn able to create dedicated roaming packages specifically for IoT applications and move this traffic away from standard roaming traffic.



Global carriers are racing to enable multi-regional breakout to cope with new IoT use cases

Any local breakout solution should include the following features :

1. A cloud-based solution to manage terminating international data roaming locally on behalf of customers.
2. A connectivity solution to target markets for IoT operators already deploying regional Packet Gateways
3. Deployed locally close to the end user directly in the visited country for major destinations or per region or service.
4. Offered as an option on top of IPX connectivity and can be complemented with security options, both for authentication and breakout.
5. Enables reduced latency with the requirements in term of Round-trip delay (RTD) matching delays required by IoT devices: i.e. 100-200ms
6. Ensure end-to-end security of critical and/or sensitive communications using the Regional Packet Gateway with a clear separation from the Public domain.



Pre-requisites for Carriers : Getting ready for LBO

For IPX carriers, enablement of the regional PGW technology requires minor step investment for a major added value:

1. Leverage global IP presence with regional nodes pre-connected to content hosting platforms
2. Build a meshed network of distributed, centrally-orchestrated PGW instances across multiple continents – with added granularity as the use cases develop
3. Manage key roaming corridors to prioritise large-scale deployments and drive growth
4. Enable a distributed security infrastructure to secure both egress and transport within the carrier network
5. Build an extensive IP and IPX peering environment to address key M2M market destinations in Asia.
6. Optimise backbone capacity to move from global to multi-local overall reduce environmental footprint and long-distance cable investment

Operator space

Life cycle management
Detailed reporting
Real-time usage & security monitoring
APIs for native integration
Provisioning process
Network events and troubleshooting

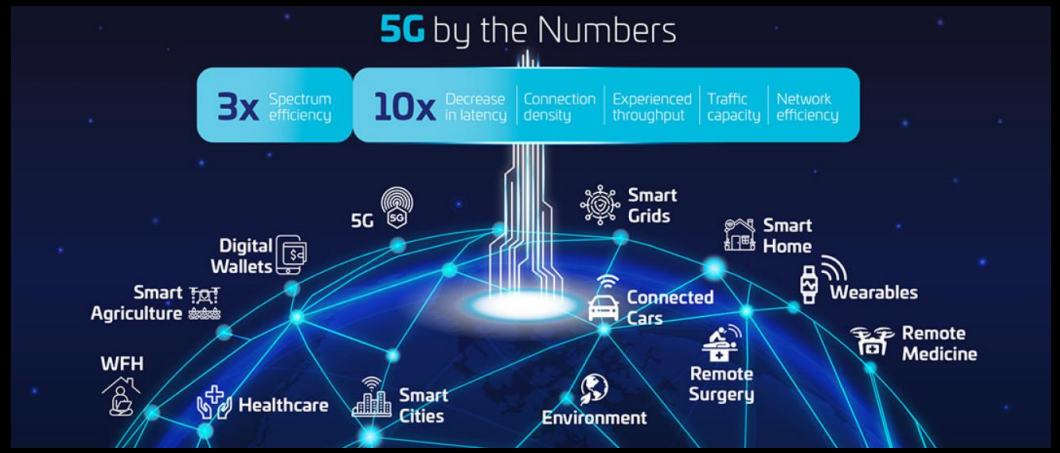
Carrier space

Infrastructure deployment and management
Extensive local and global connectivity
Roaming agreements and enablers
Network Resilience and security
Wholesale Service management
Network events and troubleshooting

Regional breakout is a clear value acceleration for 5G roaming infrastructures

Regional breakout gateways are only the tip of the iceberg but can already provide significant value to carriers :

1. Prelude to CNaaS and support of other use cases e.g. private 5G networks
2. Extract value and benefit from resource sharing on 5G enablers which is increasingly seen as a commodity
3. Clear international backbone cost avoidance by keeping roaming data traffic as local as possible
4. From an operator perspective, the solution enables to offload future LBO investment from Operator to Carrier
5. The solution provide demonstrable increased QoE for subscriber adoption, and can be felt clearly at user level
6. The solution also enables by default the segregation of IoT traffic from standard GTP without need to apply filters
7. Moving from traditional networks, the technology allows opening to new addressable markets
8. The solution is a key enabler of eSIM technology and Sponsored Roaming, proven popular features in the world of IoT



Source : Thales Group

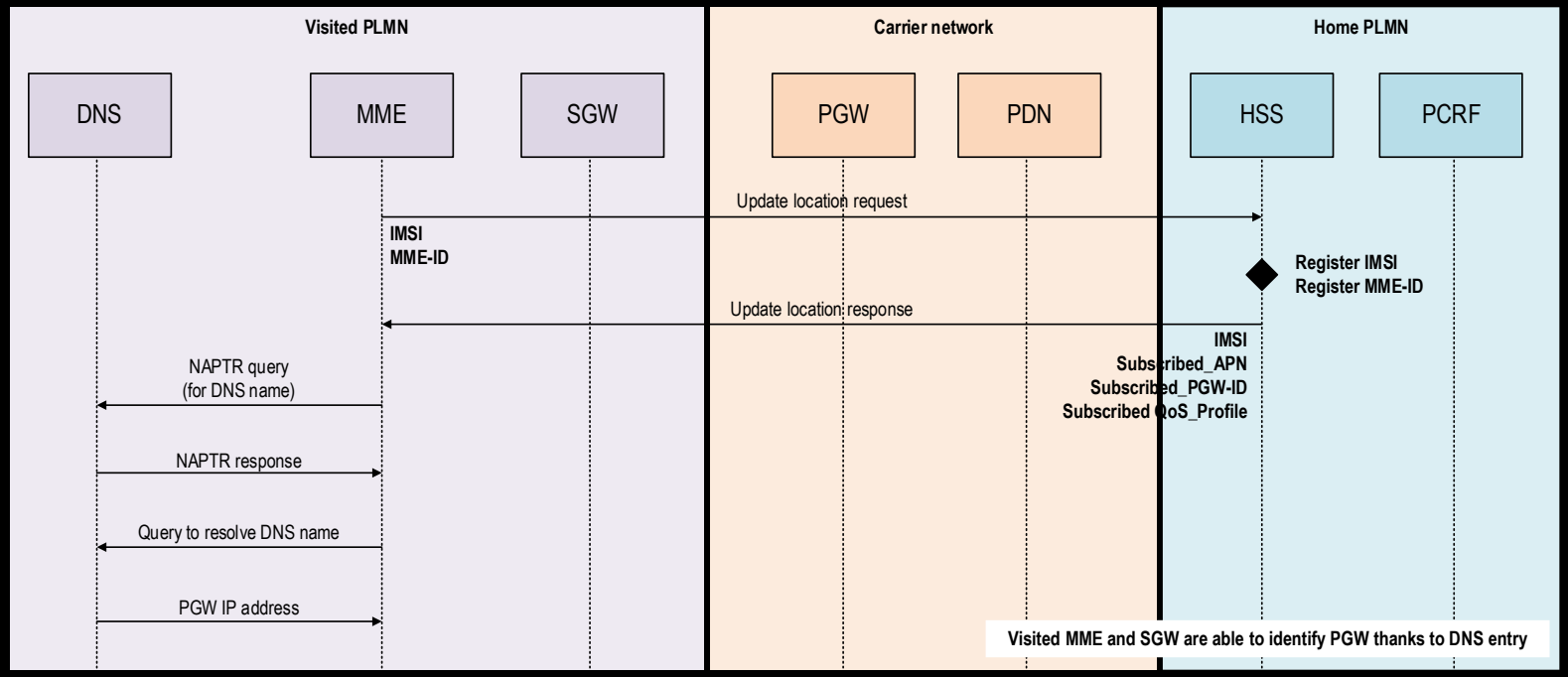
How to enable Regional breakout – P-GW selection

The PGW selection is always done by the MME in 2 different ways accordingly the 3GPP TS 23.401 :

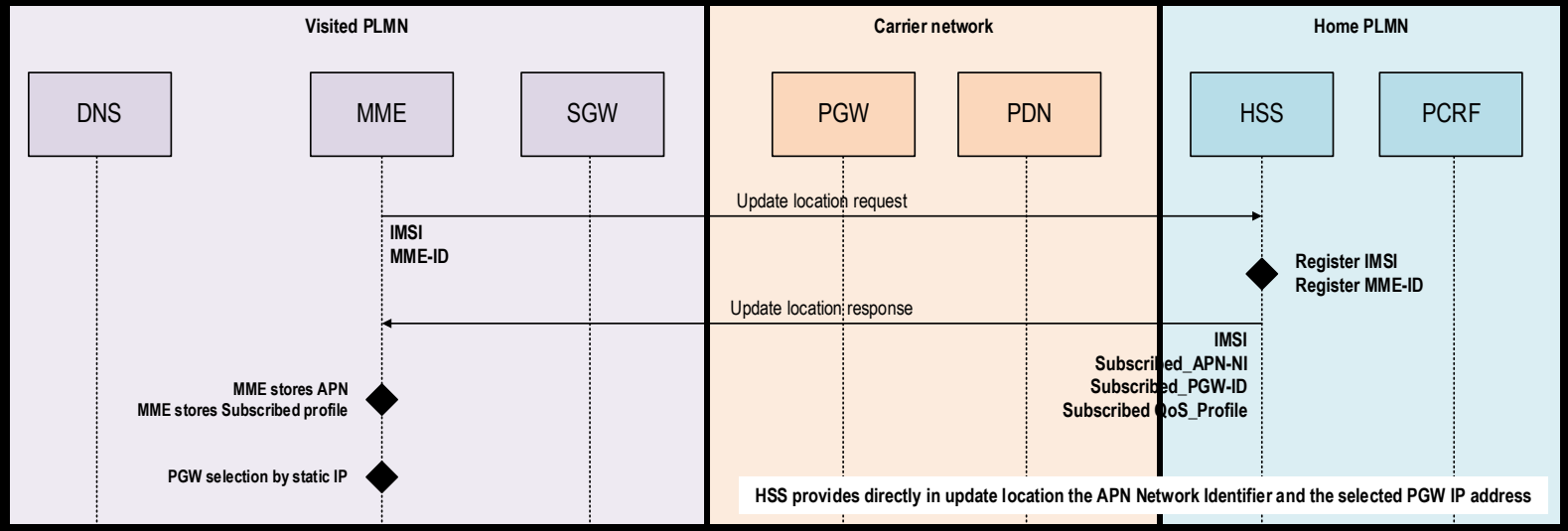
- **Static addressing**
  - In the case of static address allocation, a static PDN GW is selected by either having the APN configured to map to a given PDN GW, or the PDN GW identity provided by the HSS indicates the static PDN GW.
  - Typically, in this case, the PGW selection by static address allocation is done when the HSS provides directly in update location the APN Network Identifier and the selected PGW IP address.

- **DNS resolution**
  - The APN is used to derive a PDN GW identity from the HPLMN. The PDN GW identity is derived from the APN, subscription data and additional information by using the Domain Name Service (DNS) function.
  - The PGW selection by DNS is done when the HSS provides in update location the APN Network Identifier and APN Operator Identifier to let the MME derive the PGW identity thanks to the APN.FQDN standardized by 3GPP TS 23.003.
  - The MME starts the S-NAPTR procedure to recover the PGW IP address.
  - If the operator wants to select a dedicated PGW by DNS, use of the APN.NI is mandatory to select a PGW geographically. The geographical PGW selection by DNS can be done if a geoDNS is used in the HPLMN. The originating address of the MME is providing through the S-NAPTR procedure and allow the geoDNS to select a dedicated PGW.

Regional breakout – P-GW selection – call flow



➢ DNS resolution case



➢ Static addressing case

Regional breakout – Global Architecture

A global roaming architecture can subsequently be derived to generalise the use of regional packet gateways, hosted "as-a-service" within the roaming carrier network

- **4G case**
  - Using carrier-hosted virtualised PGW-C and PGW-U functions (VNFs) interconnected to carriers over Tier I IPX networks.
  - S8c and S8u routed to carrier with GTP
  - All S6a traffic home-routed to HSS with Diameter
  - All Gx/Gy home routed to PCRF/OCS
  - Gz home routed for CDRs
  - All SGi routed to local ISP gateway with IPv4 / IPv6 or dual stack

- **5G case**
  - Using carrier-hosted virtualised SMF and UPF functions (VNFs) interconnected to carriers over Tier I IPX networks.
  - N16 and N9 routed to carrier with GTP
  - All N7/N40 traffic home-routed to PCF/CHF with Diameter
  - All N8 traffic home routed to UDM
  - N40 home routed for CDRs
  - All N6 routed to local ISP gateway IPv4 / IPv6 or dual stack

A 4-Step process to start integration the Local breakout service into your network – The 4Cs

C1

Core Architecture Check

Examination of the core components associated with the solution, primarily focusing on OCS (Online Charging System).

Adjust the solution as necessary based on the PGW selection process during the attachment procedure.

C2

Configuration

Deployment of the solution, including the integration interfaces for core components such as PCRF and OCS.

Configuration of DNS and APN to enable UE selection of the solution based on the user location

C3

Connectivity tests

Testing to check the functionality of all interfaces and communication between the solution and core components.

C4

Case example (UE use)

Performing live tests in roaming mode to assess real Internet usage, evaluating the solution's performance with end-users engaged in typical online activities. This includes browsing, streaming, and accessing various services. The goal is to validate the solution's effectiveness and user experience in dynamic environments.

Thank you !