HOW THE
SEAMLESS
AIR ALLIANCE

WILL COLLABORATE TO MAKE IN-FLIGHT BROADBAND
ACCESS OUT OF THIS WORLD

1.0   EXECUTIVE SUMMARY

What if connecting to home-quality broadband on an airplane was simpler than fastening your seatbelt? No more wondering if a flight will have connectivity and no more keeping your fingers crossed that, if it does, it works reliably.

This is the future of in-flight connectivity, and it's what the Seamless Air Alliance is working to achieve right now.

By joining this non-profit organization, stakeholders from across the industry spectrum will play a decisive role in enabling travelers to board any flight on any airline anywhere in the world and use their own devices to automatically connect to the Internet, with no complicated login procedure and no paywall to scramble over.

Like flying itself, broadband access is no longer a luxury. It has become something that people expect, something they yearn for, and the sky should not put a limit on that.

In the early days of air travel, boarding an airplane was the preserve of the wealthy. Flights were bumpy, slow and unreliable. Gradually, through collaboration and determination, great minds worked together to transform those early biplanes into the smooth, fast and dependable jets we all use today.

Transformational things happen when innovators set ambitious targets and work together to achieve them. In-flight connectivity is no exception. What started as an expensive and patchy experience will one day become an expected convenience which can be taken for granted.

Our devices have become our lifelines, both personally and professionally, yet today's experience when boarding an aircraft is extremely limited. From a productivity standpoint, the amount of time spent in flight – which with new ultra-long-range aircraft can be as long as 20 hours – is all too often wasted time.

But delivering home-quality broadband to every seat of every aircraft will require leaders from several different fields pulling together to develop an agreed set of standards on which to build an entirely new ecosystem.

The groundwork for that has now been laid, the legal paperwork is in place and the founding members of the Seamless Air Alliance – Airbus, Delta, OneWeb, Sprint and Bharti Airtel – are inviting new members from across the industry spectrum to join them in turning this pioneering vision into reality.

By taking a seat at the table, players will have a hand in crafting entirely new standards that will result in a win-win situation for everyone.

Passengers will have seamless in-flight Internet access across all of their devices, including the use of bandwidth-heavy applications such as streaming movies and multi-user gaming, made possible by next-generation, lower-latency satellite technology.

Airlines will be able to provide this brand-enhancing experience through a much simpler, less capital-intensive process. Mobile operators will gain access to a whole new market by extending their services into aircraft cabins.

Mobile operators that miss this opportunity risk losing new revenue and an opportunity to simplify their customer's lives. It would only take a brief conversation between two airline seatmates with different mobile operators – one that enables the passenger to seamlessly connect to the outside world at 35,000 feet and one that doesn't – to make the unconnected passenger think twice about their current choice of provider.

In-flight connectivity equipment providers will drive the standardization of component specifications to reduce the complexity of integration, reduce the overall costs, and increase their ability to win key accounts.

Equipment manufacturers will be able to observe and participate in the new standards alongside the airlines and aircraft manufacturers and have a standardized mechanism through which to build their products in a more straightforward and less costly way.

The aim of the Seamless Air Alliance is to drive down the cost of bandwidth while exponentially improving the passenger experience and quality of service.

This reduction in cost will be offset by a significantly higher uptake. The more capacity you provide and the easier it is to access, the more people will use it. The resulting revenues from this higher uptake will be shared across the whole ecosystem so that everybody benefits.

The question facing decision-makers, therefore, is not so much, 'why should we get involved' as, 'why wouldn't we want to be part of setting this new standard?'

2.0   REDEFINING THE SKY AS A NEW GEOGRAPHY

Seamlessly extending mobile telecommunications services into the aircraft cabin is not as complex as it might appear.

The ability of a mobile communications subscriber to use a visited mobile network to automatically access services when traveling outside the geographical coverage area of their home network is nothing new. It relies on something called telecommunication processes of mobility management.

For seamlessness to occur when mobile operators extend their services into an aircraft cabin, the onboard visited mobile network will implement these same processes. This includes the negotiation of legal Roaming Business agreements between the roaming partners for the billing of services, as specified by the GSM Association.

But there is one key difference. The Seamless Air Alliance sees the Sky as a new geography that can be covered by a new type of celestial Mobile Network Operator, offering GSMA roaming-in partnerships with terrestrial Mobile Network Operators, and referred to as the Sky Mobile Network Operator.

When viewed as a new geography, the Sky is a large enough market for several Roaming Enablers to operate in simultaneously, with each one potentially dealing with several airlines for aircraft site rentals and with a key value proposition of enabling roaming for as many Mobile Network Operator subscribers as possible.

Figure 1: The Sky is the limit for Roaming Enablers and Mobile Network Operators
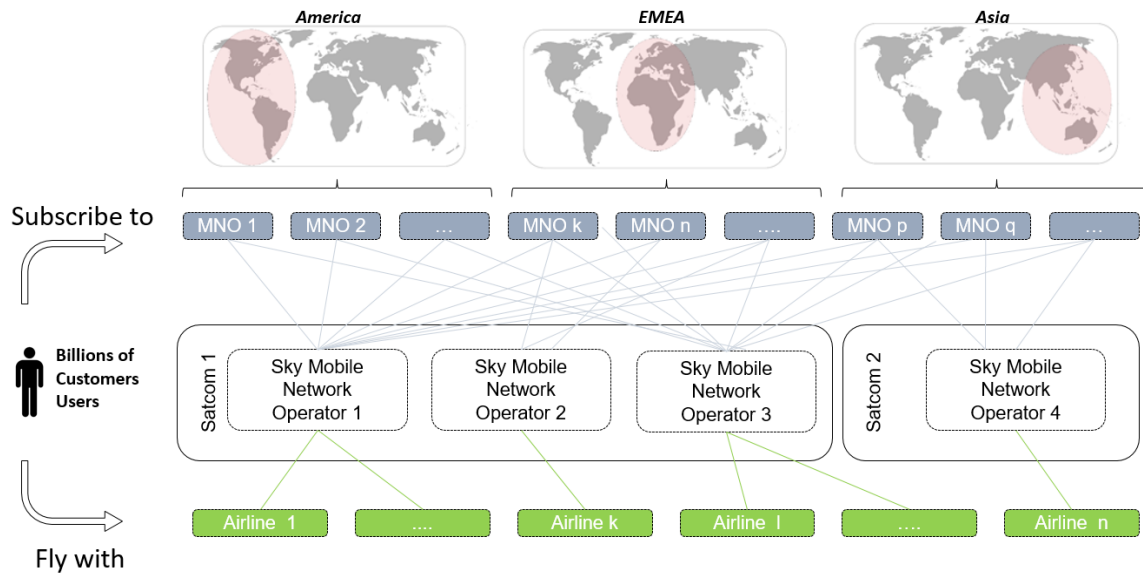
3.0 FREEDOM TO ROAM

The job of the Sky Mobile Network Operators will be to procure, deploy and maintain the antennas and modems that communicate with the satellites, as well as the in-aircraft RF networking products that make it all work, as illustrated in Figure 2.

They will also ensure that all in-aircraft products are certified to aviation standards, and they will comply with country-specific regulatory requirements, including regulatory certification for electronic devices using the radio frequency spectrum.

Figure 2: In-aircraft networking products
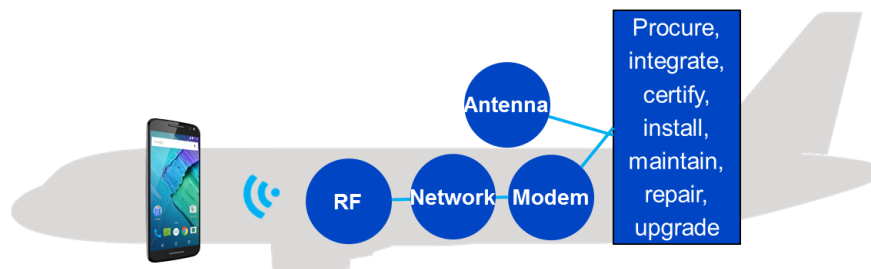
Providing a home-quality broadband experience in the air relies on satellite technology offering the same high-speed, low-latency connectivity from ground-to-air and back again, as illustrated in Figure 3.

Access points for Wi-Fi, LTE, IoT and 5G will be located throughout the aircraft, while app servers will enable unique applications and experiences for passengers, as well as organizational and airline business applications.

Figure 3: Home-quality broadband calls for high-speed, low-latency satellite communication
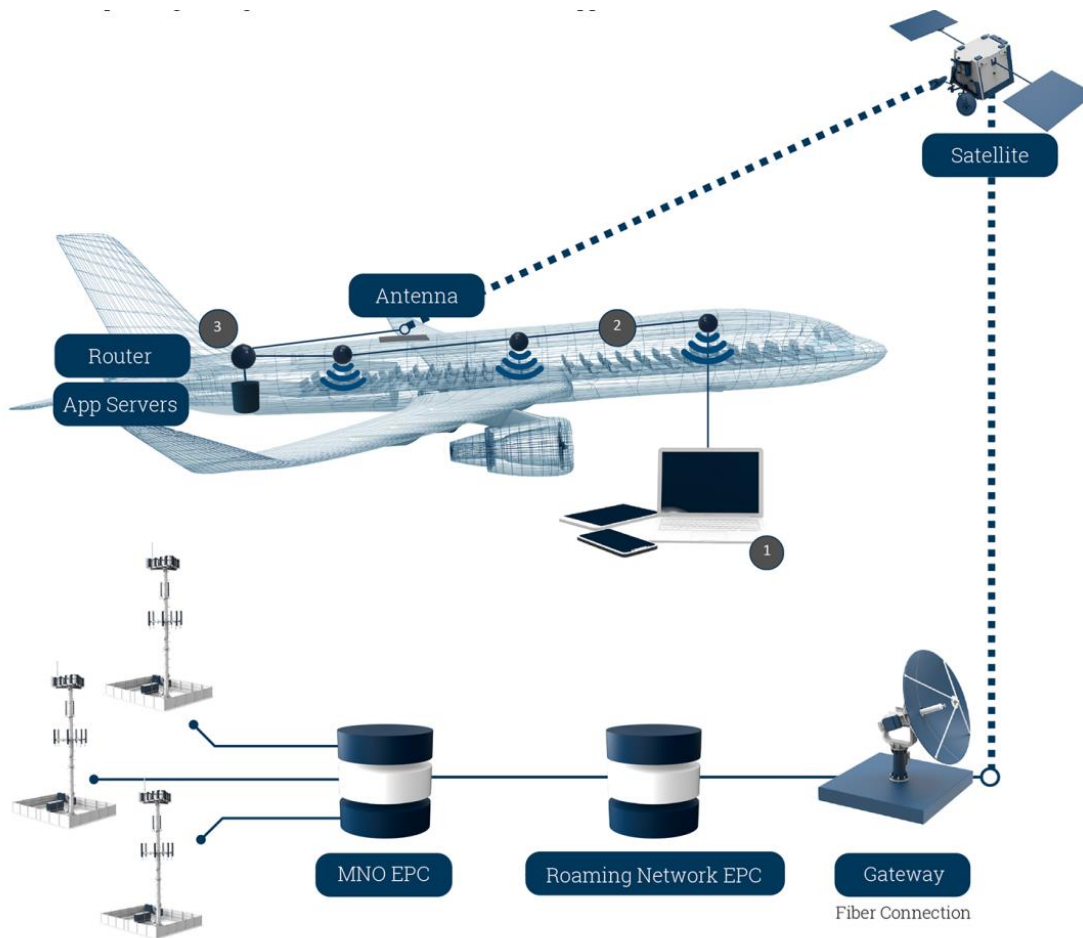
For true seamlessness to occur, satellite capacity must fit into the telecommunications interconnection model, developed by GSMA, for the exchange of IP-based traffic (IPX) between customers of separate mobile and fixed operators, as well as other types of service provider, such as the ISP. The Sky Mobile Network Operators, therefore, will ensure 3GPP standards-based roaming via the core network interface.

The advantages for airlines of having a single, universal 3GPP- and GSMA-compliant connectivity kit for line-fit or retrofit include greatly reduced installation costs and simplified future maintenance procedures.

Satellite communications providers will offer a Wireless Backhaul which will allow the Sky's Mobile Network Operators to split their Mobile Network between their Edge Cloud onboard the aircraft, and their Core Cloud on the ground.

This will require the satcom provider to implement the Handover procedure in a unique way, as illustrated in Figure 4.

Figure 4: High level architecture for Roaming enablement

The Sky Mobile Network Operators will also be responsible for implementing the telecommunication processes of mobility management, both onboard the aircraft and on the ground. They will enable user equipment to connect to the base station, as outlined in the 3GPP specifications. Non-3GPP user equipment, such as text messaging, will gain access by using mobile phone subscription authentication and billing.

Finally, the Sky Mobile Network Operators will ensure that the ground network-to-network interface (NNI) interconnects with the IP exchange (IPX) provider to secure interoperability of IP-based and GSM-based services. This will also enable TAP3 billing records for in-bound roamers to be exported to a clearing house for settlement with the terrestrial Mobile Network Operators, resulting in simple and integrated billing.

4.0   WHO PAYS WHAT TO WHOM?

On the ground, roaming arrangements between mobile carriers typically work in one of two ways. A carrier can reach out to other carriers with which it wishes to roam and they establish a rate card, through which the carriers can settle up at the end of the month, or they can establish and utilize a clearing house.

The clearing house, when it comes to billing for in-flight connectivity, will serve the role of looking at all passengers who accessed the service, which mobile carrier they belong to, and billing accordingly.

Billing relationships will be open to discussion, however, providing another key reason for thought-leaders from across the spectrum to join the Alliance early and participate in these decisive talks around potential models.

For instance, telecommunications operators could offer a package which includes in-flight use, which might be an attractive prospect for frequent flyers and business travelers. For customers who fly less often, in-flight roaming could be offered as an add-on service in much the same way as when a customer travels abroad and wishes to purchase international roaming ahead of their trip. The fee for this could be added as a value-added service, or it could be bundled into their existing rate plan.

Alternatively, an airline might include an in-flight roaming fee in the ticket price. All of these variations and more can be discussed as standards-development work progresses.

Under the Seamless Air Alliance vision, the customer user is seen as a Mobile Network Operator's subscriber while remaining a passenger of the host airline. The airline can offer local, or airplane, services such as buying an in-flight movie. For these services all roaming service network elements reside in the Sky Mobile Network Operator's visited network, and service control is performed in the visited network.

For charging purposes, roaming information must be associated with charging accounts. However, the visited network does not have subscriber charging information and the home network does not have subscriber roaming information.

The Sky Mobile Network Operators will be responsible for implementing the billing interface between the PGW in the Sky Mobile Network Operator's visited network and the billing center in the home Mobile Network Operator, either directly or through an intermediate operator which coordinates and provides bill settlements. The home Mobile Network Operator billing center serves as the charging control point, and the passenger is invoiced through his or her Mobile Network Operator.

If the Mobile Network Operator is unable to support it or the passenger does not have the mobile phone, the Sky Mobile Network Operators will be able to create local access accounts for subscribers in the visited network, to be used only for local breakout charging.

The billing center in the Sky Mobile Network Operator's visited network serves as the charging control point. Service and billing information is stored only in the Sky Mobile Network Operator's visited network, whereas the home Mobile Network Operator does not hold any information.

The Roaming Enablers will also implement an In-Flight Application Server (IFAS) in the radio access network (RAN), which will have an onboard routable address and full virtual machine server capabilities to run a variety of local applications. The IFAS will be capable of delivering highly personalized services directly from the very edge of the network and is transparent to the 3GPP network architecture and the existing interfaces. The IFAS will be a key to providing customizable, locally operating, applications for onboard movies, gaming, inventory control and IoT data collection and management.

Figure 6: The Sky Mobile Network Operators will implement an In-flight Application Server in the RAN
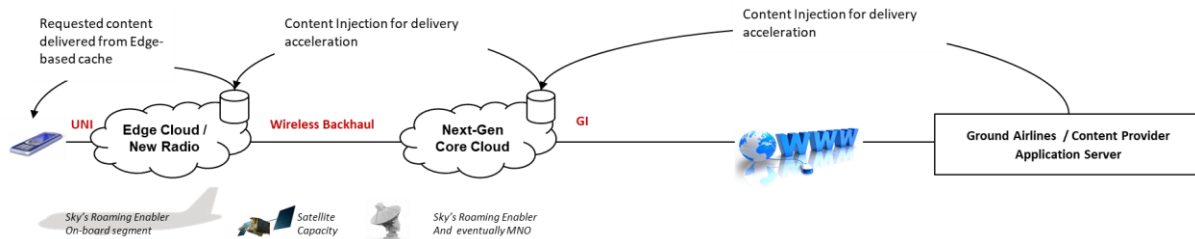
5.0 MAKING IT ALL SEAMLESS

Providing a seamless user experience is the pillar around which everything else is built. All avenues will lead to this final destination: airline passengers seamlessly using their own devices to access the Internet in the air as they do on the ground, without giving it a second thought.

A combination of streamlining systems integration and certification, providing open specifications for interoperability, increasing accessibility for airline passengers, and enabling simple and integrated billing will make this possible.

Four main parties will be instrumental in simplifying the subscriber's journey.

The terrestrial Mobile Network Operator will have the B2C relationship with the subscriber; the Sky's Mobile Network Operator will operate the visited mobile network onboard the aircraft, as well as its ground counterpart for interconnections; the Satellite Capacity Provider will offer the air-to-ground backhaul for the Roaming Enablers; and the Airline will offer aircraft site rentals for in-cabin RF products, as well as for satellite modems and antennas.

Figure 7: How the basic capital flow between the four main parties will look
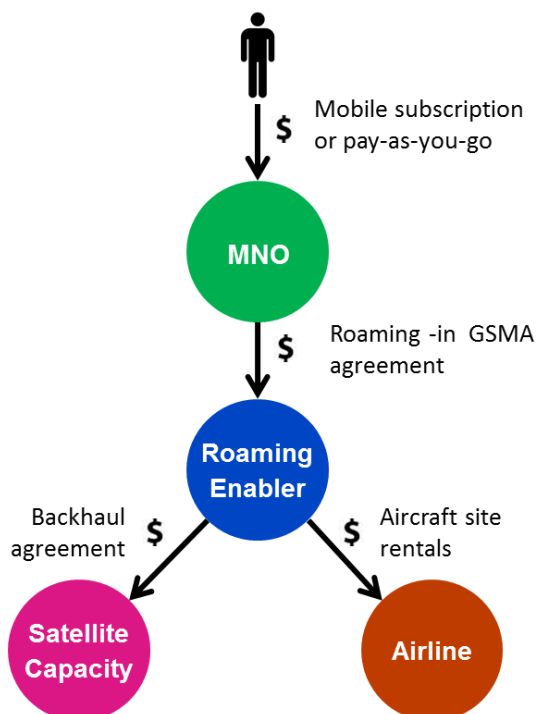
Additional capital flows will materialize when it comes to implementation. For airlines, the ancillary revenue opportunities that will stem from increased engagement with passengers through their devices cannot be underestimated.

The current reality is that airlines must invest heavily in equipping their aircraft with bespoke in-flight connectivity systems, but they have yet to make money from providing what is often a frustratingly unreliable service to their passengers.

While the opportunity to buy standardized components would simplify the initial equipment acquisition process, there is also an opportunity for airlines to monetize their new and improved future in-flight Wi-Fi services.

The increased uptake, fuelled by a cheaper, more reliable and easy-to-access connection, will boost airlines' ability to target passengers with personalized upselling offers through their electronic devices. Through the onboard server, airlines will be able to create a landing page for each user that can be fully customized with applications that appeal to their individual preferences.

The more airlines that join the Alliance, the more seamless the entire process will become. The reality is that airline passengers frequently book trips that involve changing from one carrier to another – sometimes within the same airline alliance group and sometimes not.

Under the Seamless Air Alliance vision, the experience of accessing the Internet from gate to gate and from flight to flight should be consistent.

Other airlines are already following Delta's lead and signing up to be early participants in this paradigm-shifting vision.

6.0   HOW TEAMWORK WILL MAKE THE DREAM WORK

As the Seamless Air Alliance works toward its objective of achieving a standard within the next year, with a view to allow the industry to develop solutions by 2020/2021, three separate working groups will flesh out the details with input from members, focusing on aspects such as equipment needs, billing and deployment models, and defining how the passenger experience will look.

> **The Technical working group** will examine the required hardware and certification thereof. It will be responsible for putting together the portfolio of specifications,

> **The Operational group** will drive the development of third-party product specifications and system performance metrics, and,

> **The Value Chain group** is charged with the customer experience, authentication and billing side. This group will have responsibility for defining bilateral mechanisms, developing proposals for strategy and vision, as well as analyzing and validating.

As demonstrated throughout this document, the Seamless Air Alliance aims to define common standards and interoperability requirements by building on existing and future 3GPP and GSMA standards.

Although 5G technical specifications are not yet frozen the opportunities related some evolutions are already clear. Among them is the notion of 5G Slicing that will enable much more flexible instantiations of networks that can be designed to meet the specific needs (QoS) of the applications, services and operator business models. Thus one key topic for the Technical and Operational working group will be to secure flexible instantiations of 5G Network Slices end-to-end including through the Wireless Backhaul whereas the Value Chain working group will provide the specific QoS needs for a variety of services, business models and customer user experience.

Furthermore, two main areas have been identified as not being fully covered by standard land telecommunication processes of mobility management, as illustrated in Figure 8.

Figure 8: Areas to work on that do not currently fall under standard land telecommunications processes of mobility management
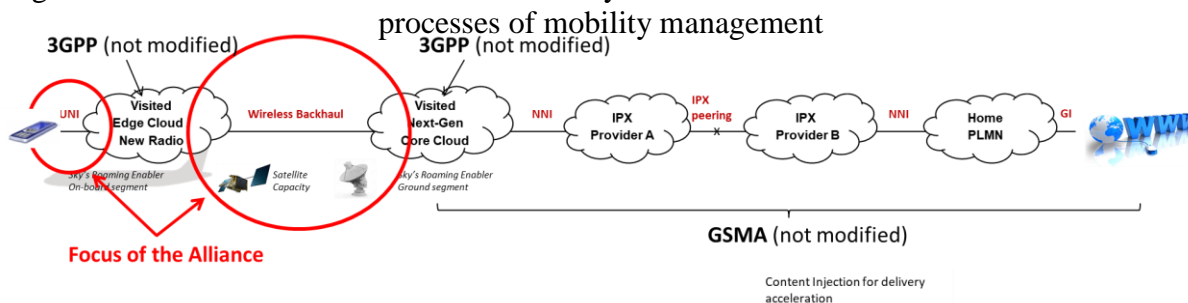
The first of these two areas relate to the LTE eNB/5G New Radio (NR) in a cabin environment, including interface (UNI). The second involves the air-to-ground implementation of the Wireless Backhaul interface between edge and core network.

The working groups described above will have a mandate resolving these two issues.

7.0   SUMMARY

Reliable, high-speed broadband is rapidly becoming a ubiquitous utility service. People expect to be able to access it easily and inexpensively on their own devices, which are never far from their fingertips. The same is true when people travel.

Standing in the way of progress toward making seamless in-flight broadband connectivity a reality is in nobody's interest. Working together to develop solutions to enable true broadband in the cabin, without limitations, will benefit all parties.

This is what the Seamless Air Alliance has set its sights on achieving, and this is why it is vital to take a seat at the table and be a part of this inevitable transformation.

Several membership levels are available, each enjoying different rights.

Charter Members have the ability to submit candidates for Board service over time, voting rights as well as the ability to chair working groups, Board committees and Board subcommittees.

Adopter Members are able to participate in working groups and have access to pre-release specifications and certification activities.

Associate Members are able to access pre-release specifications of the Alliance and can attend select open meetings.

Membership is now open. The Seamless Air Alliance invites stakeholders from all areas of the in-flight connectivity value chain to join its mission to break down the barriers and make high-quality broadband easily accessible to all who travel on an aircraft. As Alliance membership continues to expand across industries, we are thrilled to lead the charge in making this paradigm shifting vision a reality.

8.0   WIRELESS NETWORKING ACRONYM GUIDE

3GPP	Third Generation Partnership Project
4G	Fourth Generation Wireless Systems
5GC	5G Core Network (5G equivalent of LTE EPC)
AAA	Authentication, Authorization and Accounting
eNB	Evolved UMTS Terrestrial Radio Access Network Node B
EPC	Evolved Packet Core (LTE)
HPLMN	Home PLMN
GSM	Global System for Mobile Communication
GSMA	GSM Association
HLR	Home Location Register
HSS	Home Subscriber Server (LTE)
IPX	Internetwork Packet Exchange
LTE	Long Term Evolution
MME	Mobility Management Entity (LTE)
NR	New Radio (eNB in 5G)
OCS	Online Charging System
PCRF	Policy and Charging Rules Function
P-GW	PDN Gateway (LTE)
PDN	Packet Data Network
PLMN	Public Land Mobile Network
RAN	Radio Access Network
SGW	Signaling Gateway (LTE)
SLR	Spending Limit Reporting
SPR	Subscription Profile Repository
VPLMN	Visited PLMN