White Paper

Policy control and charging for LTE networks

Peter Mottishaw

October 2009

Research Sponsored by Openet

analysys mason

Table of Contents

List of Figures

PO Box 1319
Sugar Grove, IL 60554-1319
Phone: +1.630.466.9223
Fax: +1.630.566.3863
E-mail: info@ossobserver.com
Website: www.ossobserver.com

OSS Observer is part of
Analysys Mason Ltd

www.analysysmason.com
research@analysysmason.com

Analysys Mason Ltd
is registered in
England and Wales
Registration No. 5177472

Executive summary

Many mobile network operators have committed to deploy long-term evolution (LTE) technology to deal with the rapid growth in wireless data services. LTE strictly refers only to the radio access standards introduced by 3GPP in release 8. This is part of a broader 3GPP program called system architecture evolution (SAE) that includes a new all IP evolved packet core (EPC). This White Paper explores the implications for operators on the policy control, charging and billing systems of the deployment of LTE/SAE. A critical component in SAE is the policy and charging control (PCC) platform that brings together and enhances capabilities from earlier 3GPP releases to deliver dynamic control of policy and charging on a per subscriber and per IP flow basis.

The most immediate driver for LTE/SAE deployment is the rapid growth in wireless data traffic that many operators are experiencing. LTE/SAE provides a more efficient data transport with a much lower cost per megabyte than existing 3G technologies. Wireless data revenue is growing much more slowly than wireless data traffic. LTE/SAE will enable operators to reduce the cost per megabyte and maintain data services profitability. LTE/SAE also brings high bandwidth, low latency and fine-grained end-to-end control over quality of service (QoS). Policy control and charging are critical in enabling the network operator to control and monetize these new capabilities.

Network operators will follow their LTE/SAE data deployment with support for voice services. This will raise the question of how to migrate the existing control layer, service layer, billing systems and operational support systems towards a full IMS environment. Complete replacement of these systems is out of the question due to both costs and time scales. Network operators will need to proceed incrementally by minimizing the impact of LTE/SAE deployment on these adjacent systems. This will mean focusing development effort on policy, charging and mediation platforms that can hide the changes from the legacy IN platforms, billing systems and operational systems.

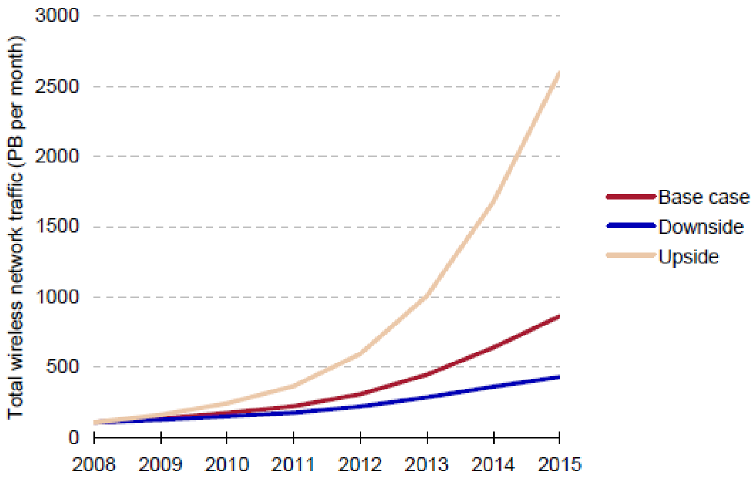
Drivers for LTE and EPC deployment

Wireless data growth will be the principal driver behind the first wave of LTE deployments. We forecast that wireless data traffic in developed countries will increase tenfold between 2008 and 2015, and sevenfold in emerging markets over the same period. Revenue per megabyte continues to fall, driven down by increasing competition and flat rate pricing. Many operators will deploy LTE to cope with data growth and deal with the divergence of revenue and cost. However, LTE is part of a broader SAE that will bring additional benefits. Alongside LTE in the radio access network (RAN) operators will deploy the EPC. Together these provide a flatter, simpler IP architecture with lower latency and a sophisticated PCC architecture. The EPC will also support multiple radio access networks including CDMA, WiMAX and WLAN. This section provides more detail on these underlying drivers for LTE/SAE deployment.

Wireless data growth drivers and forecast

Analysys Mason forecast for wireless network traffic is shown in Figure 1.

Figure 1: Data Growth prediction



Source: Analysys Mason

The key factors behind this growth are:

- Mobile operators are offering higher wireless data rates with attractive flat rate data tariffs. This was made possible by the deployment of 3G technologies. It is being continued by the deployment of HSPA and other 3G enhancements.

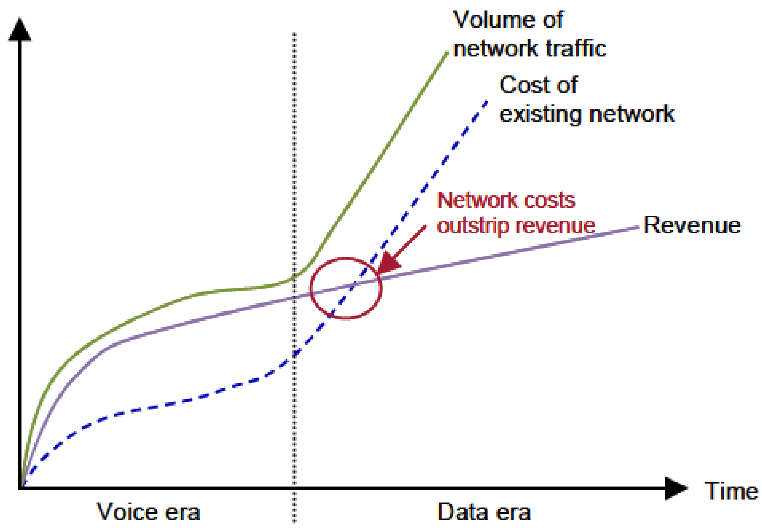
- The use of netbooks and laptops with 3G USB dongles, mainly by enterprise customers, will continue to grow rapidly as tariffs become more attractive.
- Device manufacturers are offering platforms with large touch screens, high bandwidth connections and compelling user interfaces. The Apple iPhone has been the leader in this area, but all major device manufacturers are now offering competing products.
- Advances in mobile data services and mobile devices have made the full Internet available to mobile end users. This in turn has stimulated development of mobile specific applications and services that enhance existing Internet services such as Facebook, Google maps, Google search, Twitter and YouTube with mobile characteristics. These include location, operator billing, reduced bandwidth requirements and mobile specific user interfaces.
- New types of devices and services are starting to exploit the unique characteristics of mobile data services. Amazon's Kindle is an example of an application specific device that uses a dedicated mobile service. Machine to machine type services will drive further growth in these types of applications. Improved network coverage and reliability will also stimulate the use of cloud computing to simplify deployment and management of new applications.

These factors will lead to substantial ongoing growth in wireless network traffic per user over the next five years.

The cost versus revenue challenge

The growth in mobile data usage is good news for operators, but comes with a big challenge; data growth will be accompanied by a relatively modest increase in ARPU and this will result in a significant decline in revenue per megabyte between 2008 and 2015. The cost of maintaining the existing network without LTE will soon begin to erode operators' profit margins and will eventually outstrip revenue, as shown in Figure 2.

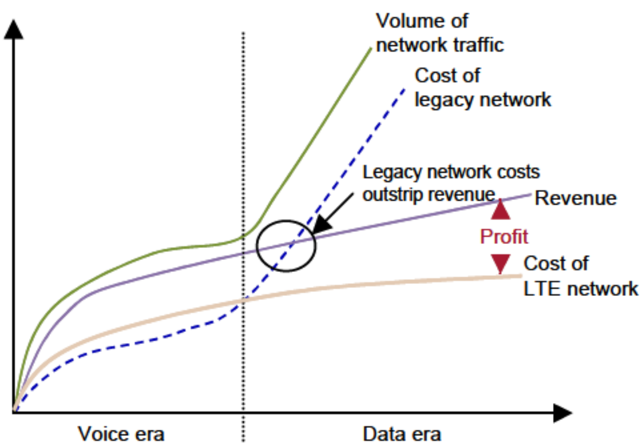
Figure 2: Cost and revenue trend for 3G networks



Source: Analysys Mason

Compared with legacy networks, LTE improves spectral efficiency. Furthermore, LTE employs a flat-RAN architecture, which also reduces the number of network nodes. Jointly, the benefits of improved spectral efficiency and flat-RAN architecture reduce network carriage costs and create a cost-growth curve that tends to track revenue rather than demand, allowing the operator to maintain a healthy profit margin, as shown in Figure 3.

Figure 3: Impact of LTE deployment



Source: Analysys Mason

Policy control and charging for LTE networks

Compared with previous access technologies, like GSM, CDMA or UMTS, the smaller size of the LTE access node brings other operational gains, including easier and quicker sitting of the node, lower power consumption and a much smaller space requirement.

Drivers for EPC deployment

In addition to the cost advantages provided by the combined LTE/EPC deployment, there are a number of other drivers for EPC deployment.

- EPC is designed to support non-3GPP radio access networks including WiMAX, CDMA and WLAN and 3GPP 2G/3G radio access networks. It includes mobility between these technologies and the concept of trusted and non-trusted radio access networks.

- EPC provides a simplified all IP architecture when combined with LTE and delivers a low cost and low latency infrastructure.

- EPC includes a sophisticated PCC architecture that enables dynamic control of IP services on a per-subscriber and per-IP flow basis. This includes support for fine-grained QoS and enables application servers to dynamically control the QoS and charging requirements of the services they deliver. It also provides improved support for roaming. Dynamic control over QoS and charging will help operators monetize their LTE investment by providing customers with a variety of QoS and charging options when choosing a service. Examples would be bandwidth tiered services or purchasing limited time access to specific content or enhanced QoS.

- In combination with IMS, EPC provides a future proof path to the replacement of all legacy circuit switched infrastructure within an all IP control layer. However, it will be many years before we see the end of the circuit switched infrastructure.

Policy control and charging for LTE networks

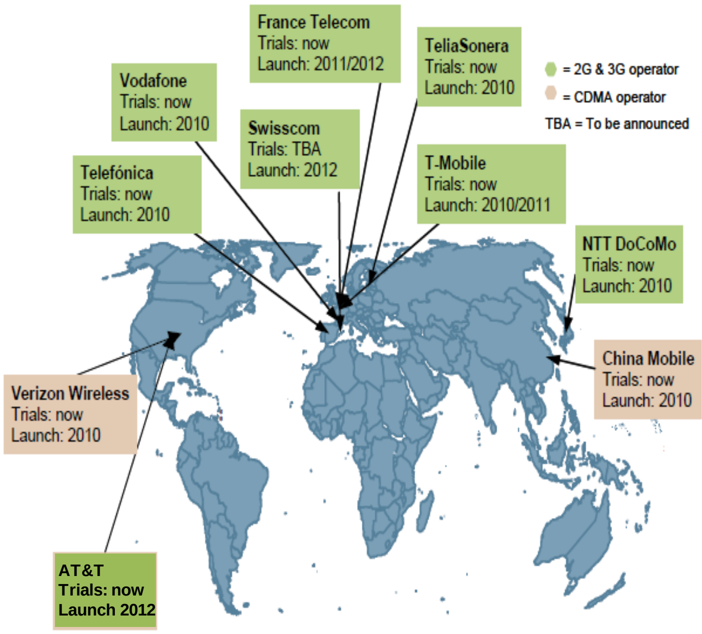
LTE deployment timetable and phases

In this section we focus on the timetable for deployment of LTE/SAE devices, networks and services and the factors each mobile operator well need to consider in making deployment decisions. We also look at the scenarios for LTE and EPC deployment and consider how the existing control layer for voice and messaging services will migrate towards an IMS control layer.

LTE/SAE deployment timetable

Technology, devices, spectrum and demand, along with the operator's business strategy, are the main factors that will determine the timing and strategy for LTE/SAE deployment for any particular operator. These will be different for each operator. Operators will need to consider their local choices carefully, in order to achieve an optimal position to deal with future data demand and demands on their revenue. The announced deployment timetable for a number of operators is shown in Figure 4.

Figure 4: Mobile network operator LTE deployment plans



Source: Analysys Mason and operator announcements

A critical determining factor in the rollout of LTE-based services will be the availability of LTE capable devices. LTE devices will be introduced in phases:

- LTE USB modems or data cards are just becoming available and will achieve volume shipments in 2010.

These will support the initial focus for LTE on data-intensive services for laptop and netbook users.

- LTE Handsets will first become available in 2010 but will not ship in volume until 2011 or 2012. Voice handsets will require 2G/3G radios to support fallback to circuit switched voice unless the network supports VoIP over LTE.

- Laptops with embedded modules will be available in 2011.

Within two or three years, the dominant device for mobile broadband access will be the laptop with an embedded module. In the longer term, the delivery of LTE services will not be limited to traditional devices, but will instead extend to a range of devices including cameras, cars, energy monitors, environmental sensors, health-monitoring devices and many other devices.

LTE deployment phases

There are many technology choices that operators will face when deploying LTE. These include decisions about services, spectrum, network and devices. The focus for this White Paper is on the charging and policy control aspects of LTE/SAE. These are intimately connected with the deployment of the EPC and in the longer term the migration to an all IP control layer based on IMS standards. This will enable a rich set of voice, messaging and other session based services that will eventually replace existing voice and messaging services. However, IMS is not required for the delivery of LTE's data capabilities and so operators have the option of incrementally moving towards the long-term vision of an all IP LTE/EPC/IMS environment.

We identify three phases that operators will consider;

- Phase 1: LTE for data only

- Phase 2: LTE for data with hybrid voice architecture

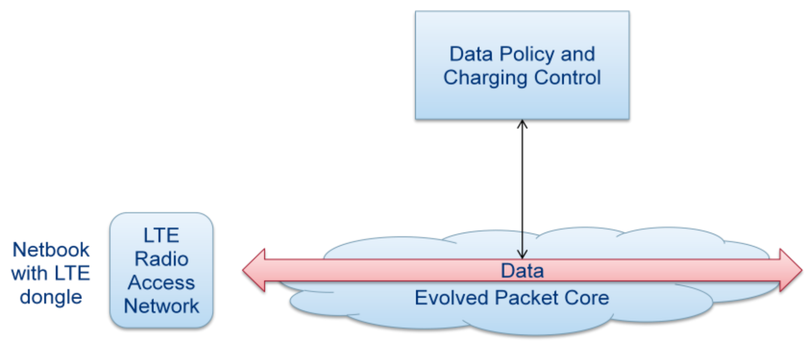
- Phase 3: All IP LTE/IMS environment for voice and data

We address these in more detail in the following paragraphs. Each represents trade-offs between the end user experience and the cost of upgrading or replacing infrastructure and software systems. Phase 1 will support the needs of wireless broadband for enterprise laptop users. Phase 2 addresses the needs of LTE handsets to support voice using some of the existing voice infrastructure. This minimizes additional investment but constrains the service that can be offered. Phase 3 provides the full potential of an all IP rich communications experience, but with major investment in new infrastructure and systems.

Phase 1: LTE for data only

Initial deployments of LTE will be to provide data services for enterprise customers using LTE USB modems with laptops. LTE will be provided first in areas of heavy data traffic and USB modems will support fallback to 3G data services where LTE is not deployed. LTE provides a compelling service with the benefits of higher bandwidth, end to end QoS, and low latency. LTE deployments to support these types of services will effectively be independent overlays (see Figure 5) to existing networks sharing physical locations and some IP infrastructure. They will include PCC functionality to support data services and will be integrated into existing pre-paid and post-paid billing systems. The full implications of this phase are explored in the following chapter.

Figure 5: Phase 1: LTE for data only



Source: Analysys Mason

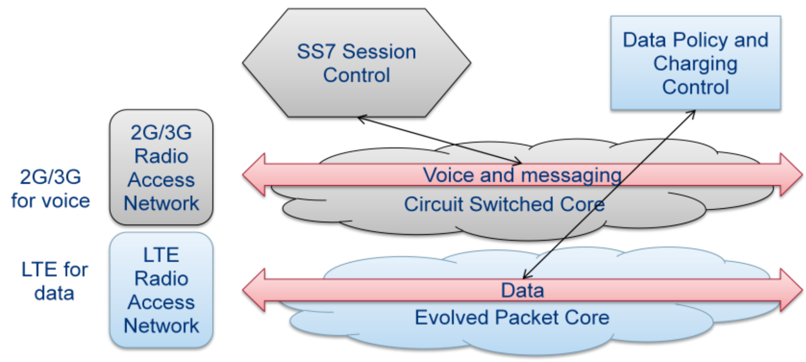
Phase 2: LTE for data with hybrid voice architecture

Some difficult questions will need to be faced when LTE handsets become available and operators need to provide voice and messaging services. Operators have massive investments in the circuit switched infrastructure. This includes the IN/SS7 control layer, IN pre-paid platforms, IN value-added services platforms, mediation platforms, billing systems and operational support systems.

Policy control and charging for LTE networks

A number of approaches have been developed that enable operators to reuse these existing platforms when offering voice services to LTE handsets. The simplest is to fallback to existing 2G/3G circuit switched connectivity for voice and messaging services. In this phase the mobile device will be required to support both LTE and 2G/3G radios. Indications are that to preserve battery life the device will switch of other radios when the LTE radio is in use. Voice and messaging services will require use of the 2G/3G radio where as data services will be provided by the LTE radio. (See Figure 6)

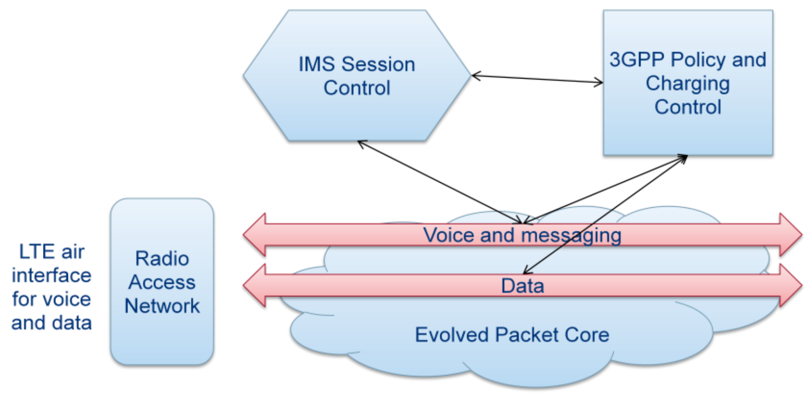
Figure 6: LTE for data with circuit switched fallback for voice



Source: Analysys Mason

This approach satisfies the need to keep existing infrastructure but limits the use of voice and data together and will not allow the rich communications services that IMS can offer. There are various approaches being standardized that provide an incremental step in this direction without the wholesale replacement of the circuit switched systems. These include the VoLGA and VoLTE approaches. These can deliver voice over IP and will start to make use of some of the dynamic policy control capabilities of the EPC.

Figure 7: Full LTE and IMS deployment



Source: Analysys Mason

Policy control and charging for LTE networks

Phase 3: LTE with full IMS

A move to an all IP LTE/IMS environment (see Figure 7) brings the advantage of integrated access to all voice, messaging and data services over a single LTE access. It also provides the rich communications services that IMS was originally created for.

However, the move to all IP will require the replacement of the legacy circuit switched control layer and the replacement of a number of its operational systems. Major system integration projects will be required to adapt the systems that are not replaced to the requirements of an all IP environment. Most operators will choose and incremental approach to addressing these challenges.

Policy control and charging for LTE services

In this section we will focus on the impact of LTE on policy control, charging and billing mediation requirements. Most of the discussion is focused on phase 1, but operators must consider the long term plan to move to full IMS.

3GPP policy and charging control (PCC)

The PCC capabilities in 3GPP release 8 build on earlier releases to provide a rich policy and charging environment supporting dynamic control of QoS, charging and policy by application servers. To illustrate the capabilities of the 3GPP PCC architecture we will use the example of a video streaming session delivered across the EPC and LTE (see Figure 8). To make it more interesting we include a two sided business model where the video stream can be delivered by a third-party paid for by advertising. This type of scenario will become increasingly common as LTE is rolled out.

The PCC functions include:

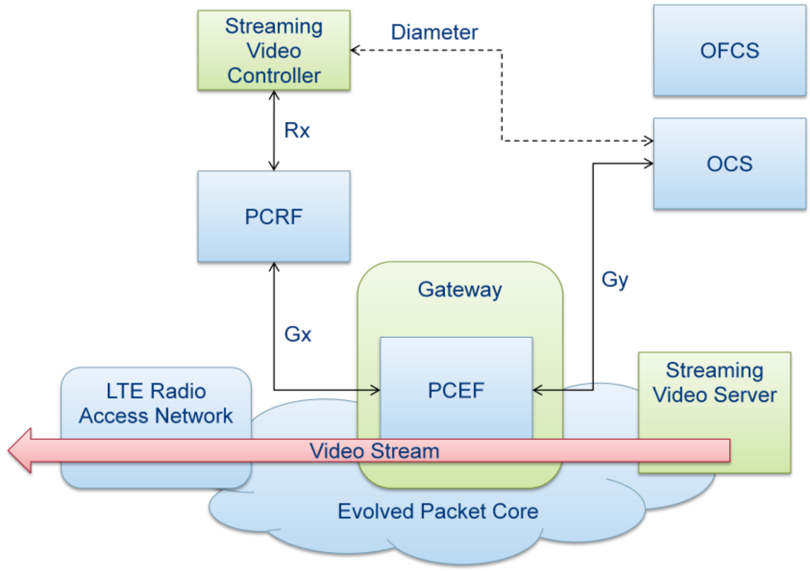
- PCRF (policy and charging rules function) provides policy control and flow based charging control decisions.
- PCEF (policy and charging enforcement function) implemented in the serving gateway, this enforces gating and QoS for individual IP flows on the behalf of the PCRF. It also provides usage measurement to support charging
- OCS (online charging system) provides credit management and grants credit to the PCEF based on time, traffic volume or chargeable events.
- OFCS (off-line charging system) receives events from the PCEF and generates charging data records (CDRs) for the billing system.

In the example shown in Figure 8 a customer has requested a streaming video that will be paid for by the included advertising. We will assume the customer likes the video and decides after five minutes to pay for a higher data rate with no advertising from her pre-paid video account. This requires specific QoS treatment to the requested and modified by the streaming video controller during the session. It does this by appearing as an application function to the PCRF. The PCRF and PCEF work together to ensure the correct QoS is provided. The charging aspects are managed by the OCS. When the customer switches

Policy control and charging for LTE networks

to the non-advertising stream the PCEF will request credit from the OCS. The OCS will check the customer's video balance and provide the appropriate credit for the IP flow. The OCS has the job of correlating charging events to ensure the customer is not charged for the data stream, but only the video.

Figure 8: Streaming video example



Source: Analysys Mason

This scenario could be implemented in many ways and the complexity of subscriber management, off-line charging and the possibility of the video service being provided by a third party is not included here. But the key message is that the PCC capabilities brought together in 3GPP release 7 and enhanced with release 8 are sufficiently powerful to provide dynamic control of charging and QoS on a per flow and per subscriber basis.

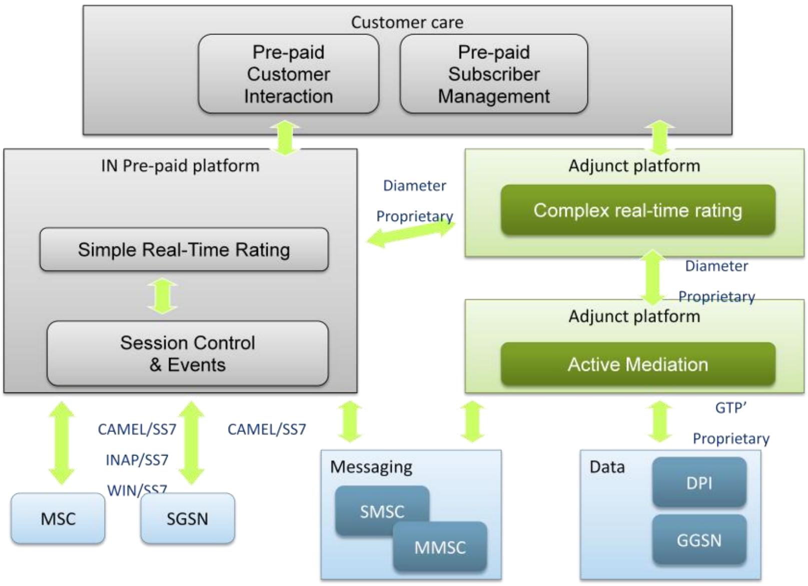
This example also illustrates the sorts of demands that will be put upon the PCC as LTE is deployed. The main sources of growth in transaction growth will be;

- The support for dynamic control of policy and charging will enable applications to make multiple requests per service session.
- Triggers associated with changes in location, network access, device status and security will generate additional requests.
- The greater complexity of the new business models illustrated in the example will also push the transaction rates higher.

As a result the overall transaction load on the PCC will increase significantly from current levels.

Current charging, policy and billing implementation

Figure 9: 2G/3G prepaid charging scenario



Source: Analysys Mason

In current 2G/3G networks policy control, charging and billing mediation are already complex functions. Real-time charging is provided using the following platforms (see Figure 9):

- IN pre-paid platform: originally deployed to provide simple pre-paid voice services, has been continuously extended to include roaming, messaging, data and content services to pre-paid customers.
- Active mediation platforms: have been deployed as adjunct platforms to the IN pre-paid platform to support control and usage measurement for messaging, data and contents services.
- Complex real-time rating platforms: have been deployed as adjunct platforms to the IN pre-paid platform to support more complex tariff models and subscriber models.
- Policy control is already implemented to support existing data services. This includes some PCRF type functionality, but not the full dynamic control of policy that the EPC will provide.
- GGSN and dedicated deep packet inspection (DPI) platforms support active mediation by enabling very detailed usage measurements and control of IP flows. The growth in data rates and the roll out of LTE will put

Policy control and charging for LTE networks

an increasing load on these functions as they migrate to the PDN GW in the EPC.

- Billing mediation integrates with existing 2G /3G network elements to support the post-paid billing requirements.

This real-time infrastructure is being integrated with offline billing to support a hybrid model; where a customer can choose to have individual services billed on a pre-paid or post-paid basis.

The fundamental issue operators will face is how this already complex policy control, charging and billing infrastructure will evolve to accommodate the needs of LTE. A migration path is required from the legacy environment of Figure 9 to the LTE/SAE architecture of Figure 8. The growth in transaction rates that the PCC will be required to support will drive the replacement of most legacy components during the migration. The IN pre-paid platform in particular will be gradually eliminated as balance management migrates to the online billing platform and the circuit switched infrastructure is eventually replaced.

Phase 1: LTE for data only

The evolution of policy control, charging and billing to support phase 1 is illustrated in Figure 10. The critical implications are;

- Active mediation systems and complex real-time rating adjuncts must evolve to support the requirements of the 3GPP to find OCS. Rapidly growing usage will put a significant load on the systems and they will need to be scaled accordingly.

- The migration of functionality away from legacy IN pre-paid platforms will continue. Operators are already moving in this direction to support more complex hierarchical accounts and enable subscribers to choose how individual services are charged (pre-paid or post-paid).

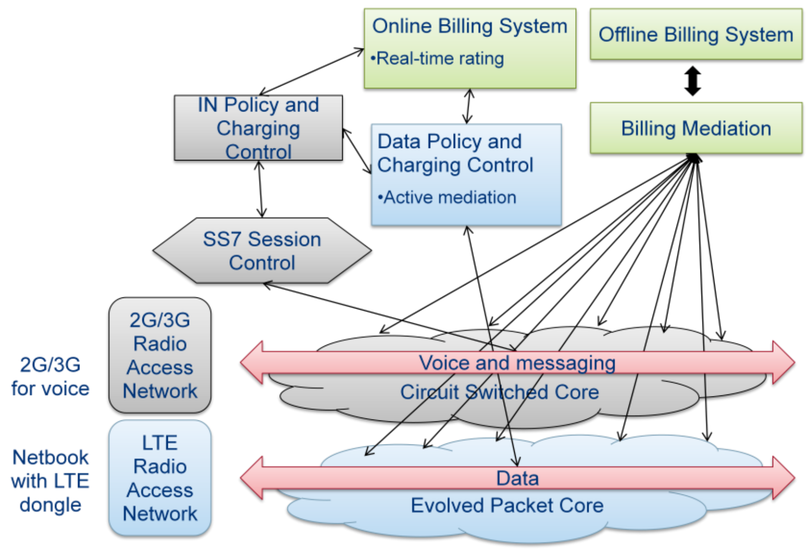
- The PCRF capability should be the focus for any enhancements to policy control. Implementation on the PCRF enables policy control to be used for both pre-paid, post-paid and hybrid billing.

- Existing billing mediation platforms will need to be extended to support the EPC elements. With rapidly increased data traffic these will need significant scaling to meet demand.

- Existing off-line post-paid billing systems are complex and expensive to upgrade. Where possible operators should insulate billing systems from the changes in the network by focusing on enhancements to the PCC.

- The streaming video example at the start of this section illustrated the type of premium service that LTE can offer. This is critical to supporting additional revenue streams and the PCC functionality must be evolved to support this type of scenario.

Figure 10: Billing and charging requirements



Source: Analysys Mason

Managing the transition to full IMS

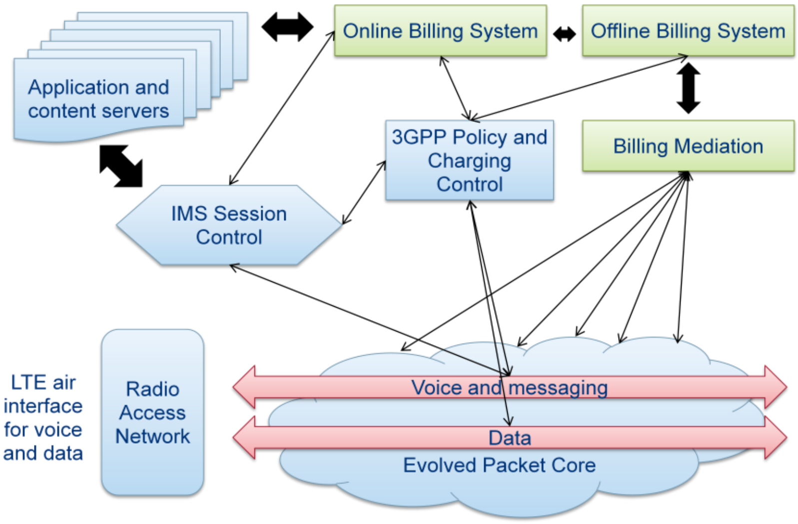
Phase 1 will be the focus for most operators for at least the next three years. However, it is important to remember the longer term evolution to phase 2 and eventually phase 3, when planning upgrades to the policy control, charging and billing systems.

Phase 2 deliberately minimizes the changes to the existing circuit switched infrastructure including policy control, charging and billing systems. However, the variance on phase 2 that include VoIP delivered over LTE will require the full dynamic QoS controls standardized in the EPC. These are required to ensure appropriate QoS for voice calls and use a similar mechanism to the video streaming example in Figure 8.

Phase 3 is the transition to an all IP network for transport, signaling and control based on IMS, EPC and LTE standards. A typical deployment is illustrated in Figure 11. There is likely to be a proliferation of application and content servers that will use the application function to manage quality of service and charging requirements. This will generate a much higher load on the policy and charging control platform. Operators should factor in the scalability requirements of these future needs when selecting solutions to the current data only scenario.

Policy control and charging for LTE networks

Figure 11: Full LTE with IMS – billing implications



Source: Analysys Mason

In Figure 11 the IN pre-paid platform has finally been retired from service and the real-time charging functions migrated to the PCC and online billing systems. Operators should have this transition in mind when planning for the implementation of a data only LTE.

Recommendations

Mobile network operators are faced with some difficult decisions in deciding how to evolve their charging, policy management and billing mediation platforms as they deploy LTE and EPC. The critical trade-off is between delivering the full potential for LTE and IMS to enrich the end user experience and the cost of replacing and upgrading the existing control plane and support systems. The end user experience, with the appropriate charging and billing infrastructure, can be translated into increased revenue and customer loyalty. The release 8 PCC capabilities will be an enabler for new differentiated services and new business models. Moving beyond a simple flat rate to offering customers the choice of bandwidth, QoS, advertising funded services and the like will be important in monetizing the LTE investment. The final choice of how to balance revenue and cost will depend on a particular operator's situation, but the following issues should be considered with relation to charging, policy control and billing systems;

- LTE/SAE supported data services can deliver significant new value to the end customer with increased bandwidth, reduced latency and fine-grained control over QoS. The value can only be realized by flexible charging, policy management and billing solutions. The ability to rapidly deploy new charging models and integrate QoS policies will be critical to competing and succeeding with LTE. Operators must include these requirements in their LTE/SAE rollout plan.
- Billing systems have proved to be costly and time-consuming to upgrade. Operators can minimize the impact of this by using the mediation and charging platforms to hide major changes from the billing system. These tend to be more modern platforms and therefore less costly to upgrade. It is also easier to share capabilities between pre-paid and post-paid billing systems and support evolution towards converged billing.
- Online charging will continue its complex evolution from IN platform to full IMS online charging system. Introduction of an LTE/SAE data service will increase this complexity; requiring management of QoS and requiring greater scalability. Most operators recognize that IN platforms will be around for some time. The focus should be on opening up standardized interfaces

to the IN platform so that new requirements can be deployed on adjunct platforms. This will help with the migration of functions (subscriber management, real-time rating, tariff models, etc) from the IN platform to the online billing platform that will be the core platform when and all IP LTE/IMS implementation is achieved.

- Providing voice over LTE with IMS support for rich communication services can add significant value to the services offered. In evaluating intermediate steps to supporting full IMS operators should carefully evaluate how any upgraded or new systems will support the final IMS architecture.
- Deployment of full IMS capabilities will significantly increase the volume of charging and policy events that the policy and charging control and mediation functions must deal with. The likely proliferation of application servers supported by IMS will amplify this trend. As a consequence operators must evaluate carefully the scalability and performance of systems deployed during the transition phase to full LTE/IMS deployment.
- Deployment of more powerful DPI capabilities, either standalone or as part of the PDN gateway will be important in supporting some of the more sophisticated new service opportunities. Operators should evaluate the requirements and scalability of these platforms as part of their overall PCC deployment.
- Policy and online charging will become increasingly connected as the network evolves towards full LTE/IMS. As a consequence operators must evaluate how these will integrate over time.