THE FUTURE OF

IPX

IN BAHRAIN
AND THE GCC

DISCLAIMER

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EXECUTIVE SUMMARY

Objectives

This report and the analysis underpinning it provides a clear understanding of IPX, how it is evolving and what role it will play in the continuing IP services evolution, not only globally but also in Bahrain and the GCC region. This will help the TRA to define its strategy towards IPX to ensure Bahrain plays a leading role in the new IP world. The target audience for this document includes the Bahrain Telecom Regulatory Authority (TRA), operators and stakeholders in the Bahrain telecom industry, GCC regulators and regional carriers and finally any investors or International carriers wanting to better understand the role that IPX can play in the GCC region.

Key telecom trends and drivers

The telecom industry has always been at the forefront of innovation, but more recently a number of radical trends are forcing it to evolve at warp speed and similarly forcing many of the key telecom operators and carriers to re-invent themselves into something more nimble, innovative and customer orientated. The four key trends currently shaping our industry are:

1. Local is becoming global
2. Everything, everywhere, at anytime
3. Customer empowerment
4. Everything IP, everything wireless and everything for free

In addition, our industry is undergoing a number of significant changes, in terms of technology, service offering, customer requirements and business models, which impacts how service providers' conduct their business, the services they offer and the business model they use. A summary of these evolutionary changes is outlined in Table 1 on this page. As a result, service providers are facing a growing number of challenges and the ones that are of interest to us in this study have been identified as the:

- Upcoming data tsunami
- Support of a seamless LTE roaming experience
- Need for global network reach and scalability
- Decreasing ARPU and increasing CAPEX
- Monetization of data
- Increasing pace of innovation to compete with OTTs and new entrants

Table 1: Summary of the telecom industry evolutionary changes

	Evolutionary Changes
Retail service evolution	▪ Fixed to mobile substitution accelerating ▪ TDM to IP migration underway ▪ 2G, 3G to 4G migration starting ▪ VoLTE and VoWiFi in early deployment stages ▪ Video and Content supported over mobile ▪ RCS and IMS used to compete with OTTs ▪ M2M roaming will be required
Wholesale service evolution	▪ Voice termination moving to IP ▪ LTE Roaming requirements are growing ▪ Value added services are added to the mix ▪ Return of quality as a differentiator ▪ Explosion of data roaming traffic expected
Business model evolution	▪ Growing role of the mobile corporate groups ▪ Convergence of the roaming providers ▪ Consolidation of the wholesale market ▪ New pricing models
Customer need evolution	▪ High quality communications ▪ Support of high speed applications ▪ Seamless experience at home, on the road or abroad ▪ Seamless experience between devices ▪ Need for a secure communication experience
Regulatory evolution	▪ Debate over Net neutrality ▪ Continue decline of mobile termination rates ▪ Increased regional regulation of roaming rates ▪ What about OTTs

IPX now and in the Future

IPX or **IP eXchange** is a telecom interconnection model for the exchange of IP-based traffic with service level agreements which guarantee end-to-end Quality of Service, security through a dedicated IP network, service interoperability and a commercial model based on cascading payments. The IPX platform supports multiple services through a single interconnection.

IPX is not intended to replace the Internet as a global connectivity platform, but it offers an alternative option for service providers to respond to customers' evolving high quality requirements. As is well known, the IPX concept was initially conceived and specified by the GSMA as the evolution of all service interconnect requirements for IP based service providers.

The GSMA has very clear requirements for what an IPX service should be:

- Global
- IP based
- Secure
- Multi-service
- Quality Managed
- Open
- Commercially sound

It is important to recognize the massive simplification that the GSMA envisaged in the IPX concept. In their mind-set, the current environment is a highly complex, and sometimes quality challenged, international environment, with thousands of interconnected wholesalers playing a part in delivering voice and potentially committing commercial fraud (bypassing regulated network interconnects). Then, of course, this is then mirrored in a parallel ecosystem for supporting roaming and messaging. This would all be reduced to an IP interface between a mobile operator and an IPX provider, through which all interconnect services could be obtained.

The IPX is a business and service platform built from components that were already available in the industry – private QoS guaranteed IP networks and the various service elements in use in other communications services such as Session Border Controllers, Diameter signalling agents etc. What turns this collection of products and services into a new offering called IPX is the global definition, service and commercial requirements put in place by the GSMA.

As such, there is a common set of services that were pre-defined by the GSMA as being required to support the evolving nature of mobile networks, in particular the need to support LTE roaming. From there, individual IPX providers are seeing the opportunity enabled by a large number of mobile operators being connected to a private IP network with large capacity private connections and are creating services over and above the initial definition. Over time, some levelling of service offerings will occur between IPX providers, but there will continue to be an opportunity to launch something new and compelling that was never envisaged in the original GSMA design.

Services

In addition to voice, data and signalling services, IPX has been defined to support a number of features such as Class of service treatment, routing and rate transparency, and quality guarantees, for example, with the aim of offering a tailored, high quality and secure experience to each end-user. It is worth mentioning that E2E quality is however only offered from the edge to the edge of the IPX cloud and no provider is currently in a position to offer E2E quality from device to device at this time. Work is ongoing between IPX providers to identify ways of meeting this objective.

The next 2-3 years are expected to be the period when IPX usage and capabilities start to expand rapidly, as most LTE operators establish global roaming agreements, roaming charges are brought down to levels that customers are comfortable with, and finally VoLTE is deployed in home networks and then extended globally via roaming arrangements. We expect VoLTE roaming to become a requirement around 2016, once the service has been launched in a minimum number of national networks and once a critical-mass of VoLTE enabled handsets are in use around the globe. In addition, a growing number of applications and features will be added to the current list of supported services. Some of which include RCS hubbing, VoLTE roaming, Real Time Intelligence applications.

Providers

Many international providers have already launched IPX platforms, and they can be largely segregated into two major groupings with distinct initial service offerings. On the one side are the large international voice and transmission network operators such as Tata, BICS and iBasis. They have extensive and very high capacity transmission networks around the globe, often playing a major role in the Internet backbone and they also have large and competitive voice termination capabilities with relationships with hundreds of carriers worldwide to receive and terminate voice calls.

On the other side is a smaller group of companies focused on meeting the roaming and often messaging needs of mobile operators, offering global C7 signalling networks interconnecting the mobile operators for authentication and updates of the HLR databases, offering global GRX networks for data roaming and often providing commercial support to the establishment of roaming arrangements.

Ultimately, the evolution of IPX providers towards a complete voice and data portfolio of services will trigger the convergence of global voice wholesalers and the mobile hubs into a more homogeneous group of wholesalers who cover the full portfolio of voice and data IP services. Both groups are slowly moving into the other's turf and in the next year or so, the service differentiators which exist between the two groups will have disappeared. This means that these players will have to differentiate by launching new high value innovative services and start to move up the value chain from basic voice and data to the provision of value added services over a single IPX pipe. This, of course, is in addition to supporting global reach and network scalability for LTE and the new generation of IP services. Not a small order!

Customers

From its inception, IPX was mostly focussed towards the needs of mobile operators and their evolution to LTE. However, the IPX providers have evolved considerably since then and are gearing themselves up to cover the needs (in terms of services, features, access and business models) of all types of communication service providers (fixed, mobile, OTT, cablecos and application/content providers). As their IPX platforms are built on their global MPLS networks in some cases, it might also make sense to target some of the needs of Multi-National Corporations and key cloud providers going forward.

In the coming years, it is conceivable to think that once a critical mass of mobile operators have migrated to IPX, they will start demanding that their partners interconnect with them and send them traffic or content using the same type of connection. As the platforms were built to support high quality, security and now real-time intelligence, it is also a perfect solution for global multinationals either looking to transport secure, high quality communications between their global entities, to store and access information in the cloud securely with QoS guarantees or to partner with service providers to advertise to their end-users through their mobile devices wherever they are.

It is very early days for IPX providers to target enterprise customers, as only a few are working on developing applications for that segment at this point in time. However as Real-Time Intelligence tools become more sophisticated and as Class of Service routing applications and offerings are further developed, the enterprise segment could become a new source of revenue for wholesalers, especially those with an existing sales team focused towards that segment.

And if we go one step further, enterprises could become a new class of partners for wholesalers, with which they could co-develop new applications and offerings to enable a more tailored communication experience and here again, a new source of revenue.

Further on, IPX can be an enabler of secure, high quality M2M International and roaming transactions and partnerships between wholesalers, service providers and enterprises in this segment can be expected.

Importance and impact of IPX in the telecom evolution

IPX will play a strategic role in the evolution of the telecom industry going forward, mainly enabling roaming and its associated business model, enabling wholesalers and services providers to innovate, while also impacting the industry structure as it currently exists.

Roaming evolution

The rising expectations of customers in terms of the performance of their applications on their LTE phones has pressured many mobile operators to extend their LTE service globally through LTE roaming agreements with other operators. This commercial step requires support of the signalling protocols needed to support LTE service – ie Diameter signalling back to the home network for authentication and authorization of roaming – and also the management of the flow of data back to the home network for internet access and browsing. The IPX network was designed for just this requirement and so is a key enabler of the LTE roaming agreements being established.

In addition, the following question remains: will mobile operators continue to use local voice breakout when a VoLTE call is made while roaming or will the call be routed back to the home network for feature management, quality control, security and further down the line to add value added features to the communication? This subject is still being discussed by the GSMA and many hope that a single set of standards will be applied across the board. The IPX can support various approaches for VoLTE roaming – handling the signalling back to the home network and then back to the visited network to control how that call is then routed (under an approach known as RAVEL), or forcing both signalling and the media itself over the IPX to the home network for termination via their own partners and arrangements.

In a similar way, the routing of simple internet browsing traffic back to the home network is increasingly being questioned. Again, with appropriate signalling, the internet browsing data could be routed to the internet through the visited network's arrangements.

Business model evolution

IPX also has the potential of impacting the business and pricing model currently used by the majority of services providers and carriers. The convergence of voice and data services over a single IP pipe will create opportunities for IPX providers to innovate with new pricing models. For example, there is an opportunity to create bundled services pricing, with discounts if a customer interconnects not only for voice, but also for data and signalling. Also, when value added services are launched over IPX, there is an opportunity for these services to be charged on a per usage basis and/or on a per service basis, on top of the port charge.

Finally, with the convergence of all services over IP and over a single pipe, there is a possibility that down the line, voice may be charged as a data packet per MB and not per minute. Which means that the voice traffic would be bundled and charged as data. This evolution may not be a reality today, partly due to regulation in some countries and the reticence of operators to migrate their per minute voice revenue to a data model, but down the line this is a model that needs to be considered.

This continued convergence of all services onto IP and onto the IPX will also create opportunities for new partnerships – with examples that are already starting to happen between cloud computing providers (eg Amazon, Microsoft) and major IPX global players such as Tata Communications. The opportunity to offer high quality secure access for enterprises to their applications in the cloud is real, and we believe will be a growing market. Other partnerships have been mentioned earlier in this report – between IPX providers and content providers to deliver high quality content to mobile/fixed operators and their customers. It is less clear how OTT players will react – perhaps a partnership by Skype (now a part of Microsoft) with IPX providers to establish higher quality paths for their enterprise solutions would make sense in the future.

Industry structure evolution

There is a growing interest by many mobile corporate groups in establishing an international, or wholesale, arm of their group to pull together the interests of the operating companies – particularly for international transactions. This could involve shared roaming packages and arrangements, making it more cost effective for the customer to roam via the operators that form part of that group. The next stage would be to directly interconnect the operating companies to provide an intra-group IPX, handling roaming signalling, messaging, roaming data and voice interconnects within the group, rather than paying an external company to handle this. Consolidating all outgoing (and perhaps incoming) voice termination could be added to the mix, giving the group the advantages of scale in negotiation, although many local operators may not wish to give up this control. However, the move to IP is enabling this change to the status quo of the international industry.

This has a knock-on effect on the other players in the ecosystem. The removal of a portion of high value, high quality mobile calls from the international voice wholesale market puts pressure on the carriers in that space, especially the mid-sized players. For some time, the smaller wholesalers with a particular niche termination offering could continue to attract business and the large wholesalers are offering their IPX services, but the middle will be squeezed and we can expect to see many of these players dropping out of international voice termination. It is unlikely that many of them will be acquired, because wholesale voice is such a volatile business that a mid-sized wholesaler actually has little value to any of the larger players.

Wholesale innovation

With these changes underway, consolidation around the corner and competing IPX providers converging on a common set of features and services, the opportunity develops for some international wholesalers to focus less on the lowest cost, and more on bringing innovation to their retail service provider customers. Going forward, we envisage that the more successful wholesale and IPX providers will move much more into the role of bringing opportunities and products/services to retail service providers and devote more of their product and marketing experts towards innovation – both in terms of their own direct services and in services they can offer in partnership and IPX will be one of the facilitators of this evolution.

Possible use of IPX in Bahrain and GCC markets

IPX could have a significant role to play in Bahrain and the GCC's successful evolution to an all IP, high quality and high speed communications environment over the next 5 years. The stakeholders who could use IPX as one of the solutions to capitalize on new IP services include:

1. **Bahrain's National operators:** To address some the International service requirements they will have in the near future

2. **Bahrain's International operators:** To improve quality of termination and support new data services

3. **The TRA/Bahrain government:** To ensure the success of some of its 3-year plan's objectives and to strengthen Bahrain's role in the IP era

4. **The GCC region:** To improve intra-regional Internet quality and security, regional communications in general and to ensure that the benefits of the move to IP based service are seen throughout the GCC region.

Operators use IPX to meet their evolving requirements

Looking internationally, the main requirements for Bahrain mobile operators in the coming years are to:

a. Improve and rapidly grow Internet connectivity

b. Evolve incoming and outgoing voice termination connections to support IP interconnects and then enable VoLTE interconnects with HD voice and smooth transition to video sharing and conferencing.

c. Improve quality and reliability of messaging services

d. Facilitate and stimulate LTE and VoLTE seamless roaming within the region and globally while maintaining and enhancing 3G capabilities

e. Implement a Rich Communication experience which enables service mash-ups (voice, messaging, video for example) and enhance sharing between mobile devices

f. Optimize CAPEX and OPEX expenditure

All of the above requirements/services/applications (including roaming 3G services using SigTran) will be carried over IP in the future and so each operator will need to develop its strategy for how those services will be interconnected in a secure and high quality way.

In addition to this basic list, many mobile operators are part of a broader group and may have specific requirements to rollout more specialized services between the group operators – perhaps a customized form of Rich Communications Services, group roaming packages or a mobile banking or money transfer service.

Each mobile operator operating in Bahrain is part of a group, with other operating companies in other countries in the region (and elsewhere) and so both the direct needs for roaming and interconnect, as well as the potential needs to provide enhanced services as a group, must be met going forward.

After evaluating the likely options available to mobile operators in Bahrain to meet their evolving international requirements, it is clear that most mobile operators are expected to continue to maintain a small number of direct interconnections with their main partners, complemented by IPX going forward. In addition, some mobile groups in the region may be investigating the strategy of creating an intra-group IPX managed by their own wholesale arm.

International operators use IPX to become more competitive

Many of Bahrain's licensed International service providers are regional players or wholesalers with operations in a number of countries. Many of these will be migrating their capabilities to support a wider portfolio of IP services and would greatly benefit from an environment which facilitates this evolution, accessing International connectivity and benefiting from relaxed regulation. Some of these players may become IPX providers themselves down the line.

Most global IPX providers operate a two layer network – a limited number of major hubs where major transmission paths converge and the majority of their service technology will be installed, and then a much larger number of transmission access PoPs on their global MPLS networks via which local operators can gain access to these services.

In the Middle East at present, it is not clear that there is a leading regional IPX hub. UAE may be seen as the main hub in the region, however its lack of deregulation and the continued duopoly of Etisalat and du, restrains new players from entering the market.

Bahrain could be a good candidate to become the main Middle East IP hub, which would in turn attract a number of new players into the market. As a direct result, the quality of service (voice, data and Internet) and the connectivity in and out of Bahrain would be improved, whilst investment in the country's telecom market would be significantly stimulated.

It is clear that IPX providers need to extend their IPX networks into the Gulf region, and many of them have not yet committed to a location. It is possible that the perceived difficulties of directly establishing their transmission/MPLS networks into the various

countries of the GCC to enable local interconnects to mobile operators in those countries is behind their delayed investments. From their point of view, it is clear that mobile operators in the GCC need to connect to an IPX for LTE roaming as a minimum, and so the onus at present is on those operators to solve the problem themselves by establishing international connectivity to an IPX PoP elsewhere, or using a secure connection, such as IPSec, over the public internet.

Based on the following attributes of a good hub location, we have concluded that Bahrain would be a good candidate to evolve into an IPX Hub location, however improvement would be required when it comes to access and pricing of transmission connectivity. Attributes of a good hub location include:

1. Access to multiple submarine cables (or land based fiber networks if appropriate).
2. Flexible and competitive access to domestic and regional transmission services.
3. Available data centre or colocation space
4. Growing telecom market with well-structured regulation
5. Rapidly evolving LTE market
6. Large enterprise community
7. A stable economic and political environment

The TRA and GCC region

We understand, from the TRA's Three Year Work Plan (2013-2015) that it is aiming at achieving the following key strategic objectives:

- Foster Competition
- Optimize technology
- Empower the consumer
- Ensure ubiquitous broadband
- Support Secure communication

IPX can help the TRA meet each of these objectives when it comes to International communications, as well as enable it to become one of the region's key IP hubs.

Mobile operators in Bahrain do not necessarily need to have an IPX hub in Bahrain. They could gain all the global connectivity they require by interconnecting to IPX hubs in other parts of the region, by using leased (or owned) capacity to get to those PoPs. As such,

the location of an IPX hub in Bahrain would not necessarily directly impact their ultimate access to those services.

However, there are solid advantages to having Bahrain become the key hub for IPX and IP services in the GCC. As a minimum, this would provide for direct and low cost connectivity to these global IPX platforms, would similarly provide direct and low cost access to the public Internet. With these capabilities in place, other major carriers and multinationals looking to benefit from resilient high quality connectivity would be attracted to the Kingdom.

IPX could therefore play a role in ensuring that Bahrain becomes a location of choice for multinationals looking for high quality, secure communications in the region. The Kingdom could easily become one of the most advanced countries in the region in terms of telecom service evolution and quality, but the necessary policies and plans would have to be implemented and the government will need to put the necessary environment in place to foster innovation.

If we extend the IPX concept to the GCC, a pan-regional high quality, secure network could be created, not only to improve Internet connectivity, but also to support seamless innovative International and roaming services, high quality enterprise/government communication and possibly a regional M2M network for specific applications. This could be achieved either through the interconnection of the different mobile group's IPX networks for example or by creating a separate regional network for this requirement specifically.

Options and recommendations

IPX options for Bahrain's service providers

Four main options are available to the National and International service providers operating in Bahrain to take advantage of the IPX approach to facilitate and enable the evolution to the IP world. As the subject of this entire report is on the opportunities that are potentially available in becoming an IPX provider, several of these options address how a national/international operator or a mobile operator group could approach that objective. Of course, many (or most) service providers around the world are clearly focused on the needs of their customers in their market, and so making use of IPX based services from global or regional IPX providers is the natural choice in that case.

These options are:

1. Use one or more IPX providers to transport traffic in/out of Bahrain
2. Develop a group IPX
3. Become a Regional IPX provider for the Middle East
4. Use a white label IPX provider to build a Regional IPX offering

In our opinion, the simplest option is to develop a number of IP based direct interconnects with key partners, supplemented by the use of IPX services from one or more global providers. Many service providers around the world will use this approach. Some corporate groups may decide to create an intra-group IPX to handle all traffic within the group, and perhaps concentrate incoming and outgoing IP based services via the group IPX.

It is also possible for a service provider with some significant existing regional transmission facilities to create their own IPX and aim to become one of the key regional IPX providers, offering service to the other operators in the region and peering with global IPX providers to reach the rest of the world.

However, we did not believe it appropriate to try to make specific recommendations for steps that each service provider in Bahrain could take, as these are very dependent on the strategy of the company and of the corporate group which has invested in them and a deeper analysis of each company, their group strategy, capabilities and key objectives would be required

IPX options and recommendations for the TRA

The main IPX opportunity for the TRA and the Government of Bahrain is to encourage the creation of a major IPX peering point in the Kingdom, and by the same way, to become the high quality IP communication gateway to the region.

In order to come up with the final recommendations for the TRA, we put ourselves into the minds of global IPX providers to identify how they address the question of an ideal regional hub location, as discussed above. We then formed an opinion on what would be the key steps necessary to put those attributes in place.

Our recommendation to achieve the objective of becoming a major IPX peering point is a phased approach as defined below:

Step 1: Encourage the creation of a neutral Network Access Point in a carrier hotel or colocation centre in Bahrain with competitive access to transmission interconnecting the NAP to the main cable stations and terrestrial fibre networks.

Step 2: Encourage the creation of a neutral internet exchange point in the NAP, utilizing the services of a European or North American IX operator to maximize the competitiveness of the services.

Step 3: Encourage the adoption of this NAP and its transmission access as the key peering point for Global and Regional IPX networks for the Gulf Region. To a large extent, the global IPX providers are also offer large scale backbone internet access and so both these steps will encourage the provision of large transmission systems and capacity into Bahrain.

Step 4: Work with the GCC regulators to identify ways to simplify the access to competitive transmission systems in the region – to allow other service providers reach the NAP in a cost effective manner.

In parallel, training and workshops aimed at increasing the knowledge of IPX opportunities in the country together with presentations by key global IPX providers would help stimulate the underlying demand for the services.

Looking ahead

We believe that Bahrain could play a key role in this evolution in the region, partly through its well regulated, open telecom environment, its will to invest in the future and its central regional location in the region. The key elements for making Bahrain an important Internet and IPX peering location are therefore already in place and ready to be harvested. However, to increase the chances of major global players choosing Bahrain as their gateway to the region, the TRA should not only consider the recommendations outlined in this report, but should also look at ways to further transform the country into one of the world's IP and technology leaders.

We strongly believe that there are further opportunities for Bahrain to become a regional or world leader in communications and related services. The expansion of high quality Internet access and the availability of multiple providers of IPX services, some of which will expand considerably beyond the basic set of services defined by the GSMA, will bring new opportunities to the country.

Extending those new higher quality and secure services to the majority of businesses and individuals in the country by encouraging the deployment of appropriate service layers on the proposed deployment of a national broadband network would help create the environment for a fully connected digital country.

The opportunities for extending a new range of IP based services nationally (content, cloud access, guaranteed M2M connectivity) are still in their infancy, as the industry is first focused on the core services associated with interconnect and roaming. Nevertheless, the TRA could sponsor further work should start identifying the needs and opportunities, in Bahrain's national market, for such future advanced services and aim to become a digital life world leader.

1
INTRODUCTION

1

Introduction

This report and the analysis underpinning it provides a clear understanding of IPX, how it is evolving and what role it will play in the continuing IP services evolution, not only globally but also in Bahrain and the GCC region. This will assist the TRA to define its strategy towards IPX to ensure Bahrain plays a leading role in the new IP world.

The information provided in this report is sourced from many years spent working in the wholesale and IPX segment and collecting data on trends and business growth, coupled with data gathered through interviews and market research projects undertaken over the last 3 years.

We have also worked in close cooperation with the TRA to ensure the context of the development of IPX services in Bahrain and the GCC is reflected in our options and recommendations.

The target audience for this document includes the Bahrain Telecom Regulatory Authority (TRA), operators and stakeholders in the Bahrain telecom industry, GCC regulators and regional carriers and finally any investors or International carriers wanting to better understand the role that IPX can play in the GCC region.

1.1 What is IPX

The mobile industry is much more than a collection of individual companies competing for end users. The mobile networks interwork worldwide for service origination and termination through a common addressing scheme (the telephone number), roaming and

interoperability standards and contracts and it is critical to the industry to maintain this in the future. Indeed, this may be the one unique factor that the industry can use to develop services that are more interesting than those available via OTT Apps.

Hence, the GSMA (the mobile standards and industry management body) developed requirements for a new interconnection approach and solution that massively simplified current arrangements to create, in their minds, a logical environment for the future.

Their requirements called for the creation of secure, multi-service, QoS managed interconnection networks and services that would carry all inter-carrier traffic at the IP level, permitting the development and launch of new high quality services (and gaining the revenue from those) and sharing some of this revenue through the service delivery chain to the distant service provider responsible for completing the service. This new approach was defined as the IP eXchange or IPX

IPX or **IP eXchange** is a telecom interconnection model for the exchange of IP-based traffic with service level agreements which guarantee end-to-end Quality of Service, security through a dedicated IP network, service interoperability and a commercial model based on cascading payments. The IPX platform supports multiple services through a single interconnection.

A fully description of IPX is provided in Section 3 of this report.

2

TELECOM INDUSTRY TRENDS

2

Telecom industry trends

2.1 Key trends

The telecom industry has always been at the forefront of innovation, but more recently a number of radical trends are forcing it to evolve at warp speed and similarly forcing many of the key telecom operators and carriers to re-invent themselves into something more nimble, innovative and customer orientated.

Local is becoming global

Boundaries are disappearing and people now expect the same services in terms of speed, quality, capacity and security wherever they go and once customers have tasted 4G in their local market, they will expect it to be available wherever they happen to be. The challenge will therefore be for operators to ensure the experience is retained wherever someone travels.

Everything, everywhere, at anytime

In addition, customers are always connected and expect to be able to communicate from any device (mobile, tablets, TVs and soon cars) from everywhere (at work, at home, out and about or when travelling) and at any time. This means that services have to become ubiquitous and accessible from any device, in any location, at the time that is important to the customer. This is a significant challenge considering the growing complexity of services and device technology and the increasing number of stakeholders in the industry.

Customer empowerment

Never before in the history of the telecom industry has the end-user played such an important role in the way services are delivered, developed and priced. With the advent of smartphones in particular, coupled with the growth of social media and Apps running "over the top" of data services, the consumer is now more in charge then ever of its communication experience.

Gone are the days when the telecom industry used to dictate the services that customers were going to use. Now the end users are in the driving seat. The customers of today demand flexibility, open access with mobile devices and applications that are interactive and ubiquitous.

Everything IP, everything wireless and everything for free

With everything moving to IP, wireless and free, service providers have to re-adjust not only the services they offer and the technology they use, but also their business and pricing models and their innovation processes must similarly evolve. The operators' ecosystem is showing growing pains while going through this process.

The migration of the underlying telecom infrastructure from TDM to IP is a complex one, not only because of the technology shift required globally, but also with the requirements to replace equipment and OSS/BSS systems. But this technology evolution is coming at a time when the entire business model is undergoing massive change, as customers demand new and innovative customer-centric pricing offerings.

In addition, not only are customers continuing to adopt mobile services and devices to replace their fixed service, but applications and solutions are proliferating that enable chat, voice and video communication directly between individuals without using the switched services of the carriers. Having seen the way these Apps can revolutionize their communications experience (both in terms of quality and price), this becomes the starting point for new services being offered by communications players.

Therefore, although the overall global usage of voice and video communications is increasing rapidly, the lion's share of the increase is being handled by un-metered applications providing voice and video services over a high speed internet connection.

Traditional switched voice services, which are normally charged per minute (or are in a package of minutes) continue to grow, albeit much more slowly. Similarly, overall volumes of text based messaging are growing very rapidly, but, again, most of the growth is happening in Apps over the public internet and not in the chargeable services offered by carriers.

The threats this represents for telecom operators in terms of revenue growth no longer reflecting growth in usage and capacity requirements and costs are real. There will certainly be a debate around data business models and tariff strategies and we can expect the introduction of new approaches to data service pricing structures in the coming 2 years.

Finally, with the advent of OTT type services, the consumer has come to expect everything for free, or at most for the one-off price of the App, and the value of the communication experience has now shifted from basic voice and data services, to high quality content, games and video applications. This will most likely mean that going forward service providers will need to include high quality (and HD) voice and messaging services as a service package that is just "thrown into" the tariff package for high speed and high value digital life services that are the core service offering.

This constitutes a complete paradigm shift in the way operators and carriers offer services.

2.2 Industry evolution

The impact of the key trends discussed above is reverberating throughout the industry and is forcing it to evolve at an increasing speed. Services and how they are offered, Operators and how they interact and finally Customers and what they want and think will never be the same again. Operators must be able to tackle this evolution in order to survive and thrive during the upcoming data tsunami.

2.2.1 Retail services evolution

Both fixed and mobile service providers are seeing a continued evolution in the technology and nature of their services. Although many of these elements are linked, we have categorized them under the headings below.

Fixed to mobile substitution

The telecom shift initiated with rapid rise in mobile connections over the past 10 years is accelerating, such that the very definition of "fixed" is becoming unstable. Traditionally, this meant a telephone that was connected to the local exchange by copper wires and a home or work phone was a typical example. Now that IP phones are just plugged into the office LAN or connect via WiFi to the office or home network, it is increasingly difficult to consider them as "fixed" under the old terminology. What is clear however, is that for many people, telephony has become the mobile phone and currently, the number of mobile subscribers accounts for 85.6% of all subscribers to paid telephony services.

A key factor to this substitution will continue to be the adoption of mobile services by new telecom users in emerging markets – in fact in many developing countries, this is the only option available. In more developed networks, a growing number of households are disconnecting their fixed line (or using the underlying connection to simply obtain high speed internet access) to only use mobile devices for telephony.

This trend will generate ever-growing requirements for new mobile services and applications and will drive rapid increases in both the speed of mobile data connections and the volume of data transferred, putting pressure on the relatively scarce spectrum resources and driving up their costs. This will, in our opinion, drive mobile operators to continue to build or lease fixed assets to enable offload of data to fixed solutions wherever possible.

TDM to IP

A continuing theme underpinning all trends has been the migration of all services to an IP environment. There has been a steady movement towards creating, carrying and interconnecting services using IP rather than the service specific technologies that existed in the past. For instance, voice services migrate away from TDM to Voice over IP (VoIP), Short Message Services (SMS) migrate from being carried in C7 signalling channels to become instant message type services over IP and the myriad layers of dedicated transmission paths migrate towards one pipe carrying these IP based services. However, the migration has been faster in some parts of the industry (international wholesale voice is a prime example) and significantly slower in others – the main example being the mobile telephony industry.

There are many reasons for this - the relatively new mobile telephony infrastructure being one – but several developments are changing this rapidly and are creating a groundswell of demand for new interconnection methods and services that are likely to change the method carriers interconnect in major ways.

2G-3G to 4G

The world of mobility has seen two upheavals in the space of a just a few years. The first was the launch of the iPhone and then iPad, followed closely by the wide range of Android based smartphones and tablets. These powerful computers with high resolution screens and cameras – that happen to be phones at the same time – have given consumers access to content, applications, videos and entertainment wherever they are, and in most developed countries, have rapidly taken the lion's share of the market.

In parallel, the mobile industry was finalizing and launching LTE in the radio network, paving the way for much higher speed data downloads and the potential for quality segregation of services all the way from the source to the handset. This new radio technology drives several trends in parallel that make a big difference to the telecom business. The first impact is that the technology essentially supports only IP communications, hence driving the need for upgrades to the voice networks of mobile companies to an IP environment.

Secondly, the different standards between North America and the rest of the world for mobile communications are removed and so, for the first time, most North American phones can automatically roam in the "GSM countries" of the world. Finally, the much

higher sustained data speeds of the new LTE technology enables the usage of Apps – particularly cloud and video based – that were not feasible in 3G networks.

The rapid rollout of the new networks, coupled with the smartphone's ability to seamlessly choose a local WiFi network when available, has resulted in a massive increase in data usage – without consumers being aware of the scale of that usage. Some networks launched LTE with "all you can eat" data plans, further reducing consumer interest in monitoring their LTE usage as distinct from WiFi usage.
Roaming on LTE is not yet deployed at scale, and the current perception (and reality in many cases) of high data roaming charges means that roaming consumers have significantly altered their home behaviour when travelling, seeking out WiFi hotspots and restricting any 3G activity to the minimum.

However, their usage at home will continue to grow. New applications that provide video conferencing to the smartphone, bridging different standards together, are being deployed, consumption of video entertainment via the smartphone and cutting the "cord" to traditional TV are all occurring and the expectation that this behaviour will continue when travelling will be hard to stop.

VoLTE and VoWiFi
Voice in mobile networks has traditionally been handled using circuit switched technologies and hence full use of LTE and the freeing up of the spectrum assigned to 2G and 3G services requires the migration of voice to an IP based technology known as Voice over LTE (VoLTE). In this design, the audio is converted in the handset to IP, separately opening up the easy migration to High Definition voice, integration of voice and video and the move of associated services (SMS and MMS) into one fully interoperable service package.

This migration has, however, proved to be complex and challenging for operators. Challenges with the underlying IMS architecture, legal interception, handover from VoLTE to 3G mid-call, sufficiently available bandwidth and signal strength and at least maintaining the quality of service of existing voice services have arisen. As a result, most mobile operators have set the end of 2014 and early 2015 as the date for initial commercial launch of VoLTE. In some countries, the mobile operators are competing hard to launch VoLTE as widely as possible, stressing the new technology in their marketing messages. Other countries see it as just too complex and expensive and are content to stay with a voice fall-back to the 3G network for the time being.

In parallel with this move, some mobile operators have recognized that most of their smartphone customers will be attaching their phone to WiFi networks at home, in the office and when traveling. While this reduces data usage on the LTE networks, it can also be configured for the voice service to be routed over the WiFi network preferentially and seamlessly when available. This Voice over WiFi capability provides a big improvement in voice quality when in poor reception areas and overcomes some issues with the radio signals fading rapidly inside buildings. All this is part of the general move for the customer to be offered a service, but not being aware of exactly how that service is being delivered. If it works seamlessly, that is all the customer really cares about. Therefore, handsets and service providers that will enable a seamless VoWiFi/VoLTE experience will ensure the most optimal and highest quality communication possible.

Video and content
When all these different strands are combined, the powerful smartphones, high bandwidth LTE networks, IMS driven service platforms supporting VoLTE and WiFi access inside buildings, the stage is set for rapid expansion of traditional voice services into seamless video communication.

IMS solutions can easily enable the customer to start with a high definition voice call, move to "see what I see" type interaction via video and then move to full video conferencing mid-call. Certain over the top Apps can do this, but almost always just to the community that has downloaded the App.

At a deeper technical level, the native services offered by the mobile operator are designed to use the highest priority packet streams supported by LTE, whereas OTT Apps take their place in the general browsing traffic. Some tests have demonstrated that VoLTE for instance, provides rock solid performance regardless of other activities underway on the phone, while OTT Apps can be seriously degraded by the user downloading a picture at the same time.

Nevertheless, these shifts will also enable significant new opportunities in the form of video content delivery, mobile and video advertising, data sharing, video conferencing over mobile, digital entertainment and digital reality, to name only a few, and all occurring over an increasingly unified communication offering.

RCS and IMS services

This migration of all services off dedicated networks and technology into IP fully supports the development of a new suite of service capabilities defined as Rich Communications Services (RCS) but publicly launched under the brand name Joyn. While this may be seen as a "catch up" exercise by mobile operators to reproduce the functions available in OTT Apps, it is still seen as an important part of the value add package, as the ubiquitous nature of mobile phones and consistent global addressing by telephone number could still give mobile operators an edge.

Early launches of the new services have not made much impact to date and it is interesting to note that the US Operators have made little (or no) mention of RCS type services in their marketing of LTE phones.

With the advent of LTE, RCS and IMS services, a new world of possibilities is opening up for operators and should finally enable them to compete with OTTs on a more equal footing. The possibility of moving seamlessly from a voice to a video call, from a mobile device to a tablet or to a PC, while experiencing an uninterrupted high quality communication session, will soon be reality. Service mash-ups between voice, video, messaging and Internet will enable end-users' to experience real digital life style.

In addition, enhanced sharing of video, photos, and Internet applications while continuing a voice call will also be facilitated by these new technologies. This gives the operators all the necessary tools to successfully compete with the OTTs in the provision of innovative services.

Nevertheless, these service evolution trends will pose a real challenge, as pressure on cost and profit is escalating. As the data tsunami becomes a reality, service providers and carriers will have to find ways to manage an increasingly efficient network, and reduce CAPEX (partly through cloud networks, NFV and infrastructure sharing) while offering the quality and security that high bandwidth services provided over LTE will require.

Machine to machine

While there is one strand of evolution dealing with the capabilities of high power computing systems known as smartphones, there is a separate strand that is growing rapidly where the more basic capabilities of 2G and 3G networks can be utilized to provide an Internet of things.

Long foreseen – with examples of refrigerators ordering more milk as the supply diminishes – this is becoming a reality with cars becoming connected as the norm, and reporting performance, mechanical issues, location, troubles – eg an accident – in real time. Even driverless cars are in development and use in cities around the world. This visibility of transport in all its guises will rapidly increase over time, providing many opportunities for mobile operators to continue to monetize their network deployments. On the other hand, M2M applications will require high quality, security and seamless roaming support. Health applications for example will require the M2M communication to be operational at all time at home or abroad, while the information accessed will need to be kept secure.

The example of wireless access being installed in a car is perhaps a more extreme example of this requirement. A global car manufacturer wanting information about the performance, reliability and security of their car needs to install, in the factory, a SIM that works wherever the car is sold, and so their commercial deal with a major mobile operator (or group) would require that the connection works in all those countries and the concept of roaming in that sense is just the technical way the requirement is delivered. The volume of data may be relatively low, but 100% uptime in the event of an accident is obviously critical.

These diverse and business-critical requirements coming from M2M applications will force operators and wholesalers alike to tailor their capabilities to support such expectations, while continuing to support a profitable business model.

2.2.2 Wholesale service evolution

With the growing complexity of the technology, and the need for rapid innovation and increasing expectations from customers, wholesalers have a growing role to play in the success of service providers and wholesale voice and data services are therefore expected to continue to evolve significantly.

Voice termination

A significant trend in International Voice remains the continued evolution to VoIP. Although this technology was invented perhaps 20 years ago and large scale deployments started 10-12 years back, many carriers have still to make the transition in its entirety and hence are still struggling under some of the issues and restrictions implied

by a traditional circuit switched environment, with high space, power, operational and circuit costs.

Regardless of those issues holding back some service providers, VoIP has already made a big impact in pricing and competition. Many small wholesalers have invented themselves in the past decade, purchasing or leasing VoIP gateways, forming a relationship in a termination country and offering termination to that destination to the larger carriers. In some cases, that special relationship has provided access to a lower cost, but in many cases, the actual termination is obtained by less than official means – using SIMBox bypass into mobile networks, PBXs and other local interconnects into fixed networks.

They have also been adept at using the pricing differences that exist at a local level (between city and rural termination for instance), and the complex number routing that that implies, to offer a lower price to part of a country for carriers that can handle the rejections for numbers they don't want to handle. Other wholesalers combine the efforts of these niche carriers to offer a broader A-Z service and, some unfortunately, add in technical fraudulent measures such as False Answer Supervision to artificially extend the call and increase their own margins – or allow them to offer a slightly lower price and still make a reasonable margin. Although this was often blatant some years ago, it is often subtle now, to avoid detection.

All this activity has resulted in the cost to the retail service provider approaching (or sometimes less than) the true cost of termination in the distant country.

Perhaps, the other broad trend in this area, is the rise of complex routing and rating which, if not enabled by VoIP, is certainly made easier in that technology. Automated exchanges of price lists with increasingly complex destinations and numbering plans, automated routing business systems that analyse the price lists and quality calculations to generate a routing plan, and, finally, real time routing servers that hold the up to date routing rules for the network have all played their part in making this an advanced endeavour for many successful carriers.

Some carriers are incorporating the final piece of complexity into their routing environment, correcting the calls for portability of the distant number where either the service requires it, or there is some commercial advantage (a lower termination fee) to be gained.

Another key trend in wholesale voice termination continues to be lower termination costs and hence lower pricing and margin in the international voice termination business. The regulators in Europe and the Middle East have continued to push down on fixed and mobile termination rates in particular, setting, as a target, the cost base of the networks. The continued ease with which wholesale carriers are formed adds to the competitive pressure, as the very low overheads (and willingness to accept some levels of fraud) allow these wholesalers to offer very low pricing which forces the larger carriers to move towards that price.

To counteract that, we have seen a move towards focusing on quality rather than simply price among the larger wholesalers. Guaranteed CLI routing plans and premium quality plans are increasingly being pushed, and retail service providers are seeing the benefits of that. Some wholesalers are deliberately targeting their teams and business on maintaining and increasing margin, even at the expense of revenue. In effect, they have stopped chasing the lower quality traffic that is simply seeking the lowest price.

LTE Roaming

On the wholesale data and signalling side of the business, the biggest trend undoubtedly is LTE and the interconnection of mobile networks to permit roaming. LTE brings with it significant challenges when it comes to roaming. For a start, it brings a new set of frequencies in many countries with little global standardization. As a result, a phone that works in every LTE network in the world doesn't currently exist, although the manufacturers are trying to include as many radio frequencies as they can, especially the more common frequencies that can be used for roaming.

LTE also migrates all services to an IP core, and the Voice component (VoLTE) has proved complex and difficult to implement, especially when calls have to be handed back, mid-call, to a 3G network. Signalling for roaming moves to the IP based diameter standard, and data usage when LTE is enabled is expected to increase significantly. New features and services are both possible and planned, but offering those in a seamless way globally requires more signalling and complexity.

The GSMA designed solution to support LTE roaming and a broader range of IP services is the IPX, a private, secure, quality managed IP environment, and all players in the GRX space (the data environment for 3G network roaming) have announced IPXs and have migrated some or all of their GRX services onto that IPX.

It provides both the Diameter signalling environment to authenticate and authorize service capabilities for roaming customers as well as the quality managed paths to bring the data back to the home network and into the internet. The IPX also has the capabilities to segregate IP traffic into different quality streams (where quality is a mix between packet loss, latency and particularly jitter) which can be used to enable higher quality access, for instance, for real time voice and video services or to cloud or business services hosted back in the home network. It is also possible that policy signalling via Diameter will be used to route low importance browsing traffic via a local breakout via the visited networks internet access while continuing to route high importance services back to the home network.

The background to IPX as an enabler of high quality international services and roaming is expanded in section 3 of this report.

Value added data services

The final element to a wholesale offering has been the extension of basic termination and roaming services to add value added services to their mix – fraud management, number portability, WiFi Roaming, clearance and roaming intelligence being just a few.

An increasingly important trend in the telecom business, which applies in a significant way to roaming and roaming data, is the advent of Big Data analytics. While this is probably over-sold (in the sense that every major system developer probably now claims that their application is a Big Data application), the monetization of all the data that a carrier or wholesaler has access to is potentially going to be a big business in the future

In the IPX environment, understanding the Diameter signalling messages for authorization and policy (roaming steering, on-net versus local breakout etc.) together with scanning of the IP packets being routed back to the home network, which indicate what services or websites are being accessed, could provide a wealth of information that a mobile operator could use to monetize a roaming customer more effectively. This could be by offering highly customized packages based on usage in the past, or the location of the customer in real time. Increasingly, we expect to see IPX operators investing in this area and offering value added services to their mobile operator customers, generating incremental revenue and increasing the stickiness of their wholesale service.

Taking a broader overview, wholesalers are in a good position to offer many capabilities to their mobile operator customers, which in large part will enable them to better monetize data services.

These can include:

- Portability Correction services
- RCS and IMS Hubbing services
- Data clearing and financial settlement
- Roaming Hubbing services
- WiFi Roaming and Authentication services
- Roaming intelligence (as described above)
- Fraud Management
- Number portability support

2.2.3 Customers' evolution

Customers are the lifeblood of any business and, while the telecom sector may have traditionally developed services and offered them to the public, it is increasingly clear that customers and their requirements have become the driving force in the industry. This section will analyse and discuss their evolving needs in more detail to help define what constitutes the customer of today and tomorrow.

Their needs

As stated earlier in this analysis, customers' needs have evolved significantly from the days when telecom operators were in charge of the end-user communication experience from the launch of the service, to the pricing and the devices used. However, now that the customer is increasingly in control of their communication experience and now that our society has become one that needs and wants to communicate at all times from everywhere and on everything, customers' needs have evolved significantly.

While price is a key determinant of which operator a customer chooses as their service provider, it is increasingly clear that the nature of the package, especially the handsets being offered, the bundling of data, inclusion of roaming and messaging are key drivers behind the choice of carrier. Customers are now expecting high quality communications that support high speed applications, at home, on the road or abroad. In addition, they are expecting to be able to achieve this while moving from one device to another seamlessly.

But one of the fastest growing trends in customers' expectation, and one that will take center stage in the coming years, is the need for a secure communication experience. Whether in terms of protecting personal identity, financial information or the content of the communication itself or even preventing 3rd parties from accessing your personal profile to tailor their offers and push real time advertising or promotion to your mobile devices without your approval. Some mobile operators have installed complex systems to track almost all elements of a customer's usage in order to offer this to advertisers and this uneasy balance between consumers wanting things at low cost (or free), while also protecting their personal information is going to be one of the challenges of monetization of services going forward.

And this is not only true for retail customers, but increasingly the case for enterprise customers as well. Enterprises are progressively expecting secure cloud applications with SLAs, and high quality communication services for their global operations and are expecting it, more and more, from a single telecom operator.

Obviously, these requirements vary from region to region or even from country to country, but as a whole, the customers of today are expecting a high quality, high speed, content rich and secure communication experience.

Their growth

Through the course of 2013, the global aggregate number of fixed and mobile subscribers grew by 7.5% to over 8.2 billion[1]. This represented the first time that the growth in total telecom subscribers dropped into the single digits and this trend is set to continue over the forecasted period, as a growing number of markets are nearing or have reached saturation in both the fixed and mobile sector.

The growth in the number of total telecom subscribers should continue to slow over the forecasted period with a forecasted CAGR of 3.4% over the next 5 years to reach nearly 9.7 billion at the end of 2018[1]. The growth in number of subscribers will continue to mainly be driven by developing countries where there is still pent-up demand from mobile subscribers.

Mobile represents the only driver of growth in customer numbers over the next 5 years. The total number of mobile subscribers rose by 9.0% in 2013 to reach 7.0 billion customers and we expect the number of mobile subscribers to grow by a CAGR of 4.1%

over the next 5 years, bringing the total number of mobile customers to 8.6 billion at the end of 2018 – still a significant growth of 1.6 billion customers over that period, however.

Figure 1: World fixed vs mobile subscribers (million subscribers)
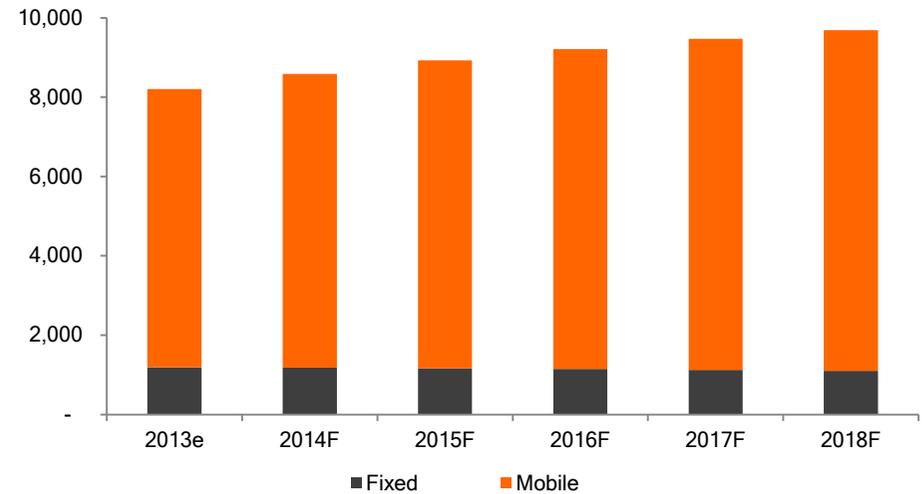
Source: HOT TELECOM report 'The Future of International Wholesale'

With 244 LTE networks launched at the end of 2013, the number of LTE subscribers climbed to 200 million at the end of that year, accounting for 2.8% of the world's mobile subscribers[1]. With accelerating LTE network launches across the world over the next 5 years, we are expecting for the number of LTE customers to grow by a CAGR of 47.1% to reach 1.3 billion at the end of 2018. At that time, we expect the number of LTE subscribers to account for 15.5% of the world's mobile subscribers[1].

We expect the MEA to account for 8.0% of the world's total LTE subscribers in 2018, this compared with 1.5% in 2013, with some of the mobile operators in the region skipping completely the 3G option to migrate directly from 2G to 4G[2].

We estimate that the number of mobile roamers reached 608 million in 2013, which represents 61% of all travellers and we expect for the number of total roamers to grow

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[1] Source: HOT TELECOM report 'The Future of International Wholesale'

[2] Source: HOT TELECOM report 'The Future of International Wholesale

by a CAGR of 9.1% over the next 5 years bringing the total to 941 million at the end of 2018[2]. This growth is significantly higher than the growth of travellers over the period because of the changes happening around LTE and the more extensive usage by customers of their phones.

Currently, it is estimated that an average of 75% of the world roamers are silent data roamers and do not use their phone at all when abroad, with the MEA reaching an estimated ratio of silent data roamers of 85%. This equates to 442 million silent data roamers worldwide in 2013. As a result of these trends, world active mobile data roamers should increase nearly 4-fold from 166 million in 2013 to 639 million at the end of 2018[2].

Their usage

International voice

In terms of traffic trends, it is evident that the growth rate for international voice traffic continues to decline, and this, coupled with decreasing termination rates, particularly for mobile destinations, means that top line revenue is under pressure. Over the past several years, traffic growth was fast enough to counter-balance price declines, allowing aggregate industry revenue to grow modestly.

Volume growth and price declines are now in a precarious balance. With International traffic growth slowing further, and regulators in many countries continuing to apply downward pressure on termination rates, it is likely that revenues will fall overall. Nevertheless, voice is far from dead and net traffic growth is still in the order of 20 billion new minutes of International voice per year.

Total International voice traffic reached an estimated 421 billion minutes in 2013, representing a growth of 7.8% compared with 2012[2]. This traffic is forecasted to grow at a slowing pace over the next 5 years with a CAGR of 4.6%. We therefore expect the International voice traffic to have reached 526 billion minutes in 2018. Figure 2 outlines the forecasted International voice traffic by originating region.

Data roaming

Due to the high percentage of roamers currently turning off their mobile phone altogether when roaming or at least shutting down their data roaming (estimated at between 70%-85% depending on the region), mobile data roaming traffic has remained small and

relatively insignificant. In 2013, we estimate that mobile data roaming traffic reached 4.2 PB, representing a mere 19 MB/year per active roamer[2].

Figure 2: International voice traffic by originating region (billion minutes)
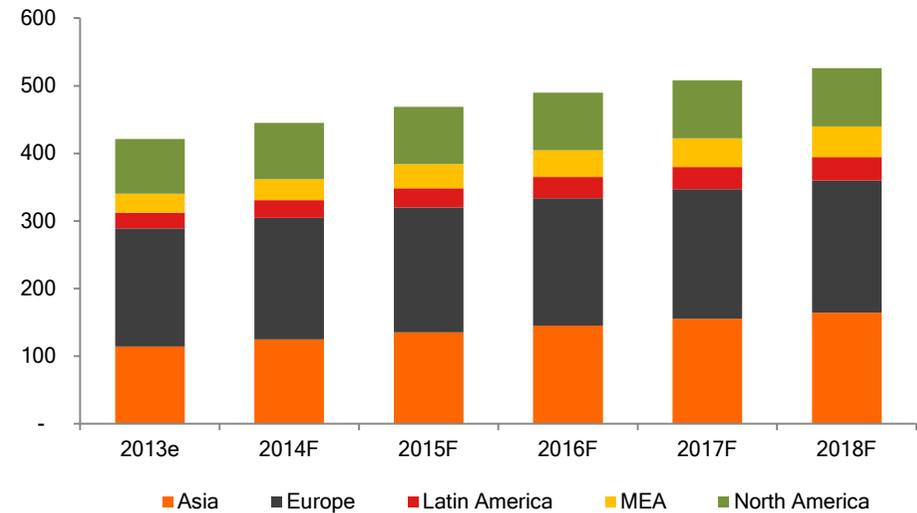
Source: HOT TELECOM report 'The Future of International Wholesale'

With the advent of LTE and its multi-media applications, coupled with the more aggressive roaming packages offered by mobile operators around the world (which would translate into an increase in the number of active roamers), we expect for the mobile data roaming traffic to grow by a CAGR of 96.5% over the next 5 years to reach 113 PB. This would translate into a usage of 161 MB/year per active roamer, representing an 8.5 fold increase in data roaming usage by active roamer.

In 2014 alone, we forecast that the data roaming traffic will more than double to 10.1 PB/year, representing a growth of 143.2%[3]. Total data roaming is set to grow considerably over the next 5 years, and a large portion of this growth will be generated by LTE roaming traffic. However, there is one crucial prerequisite for this to take place and it is the decrease in the retail price of mobile data roaming packages.

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[3] Source: HOT TELECOM report 'The Future of International Wholesale'

LTE data roaming is in its infancy, as mobile operators' main focus to date was to launch the service within their national networks. Once this has taken place, they will increasingly turn their focus on ensuring this high quality service is seamlessly offered to their customers while roaming. LTE data roaming traffic is therefore estimated to have reach 177 TB in 2013 and is forecasted to more than triple to 615 TB in 2014. Over the forecasted period, LTE data roaming is set to grow by a CAGR of 212.1% to reach 44.3 PB/year in 2018. At that time, LTE data roaming will account for 39.1% of the world's total data roaming traffic[3].

Figure 3: Data roaming traffic by mobile technology (PB/year)
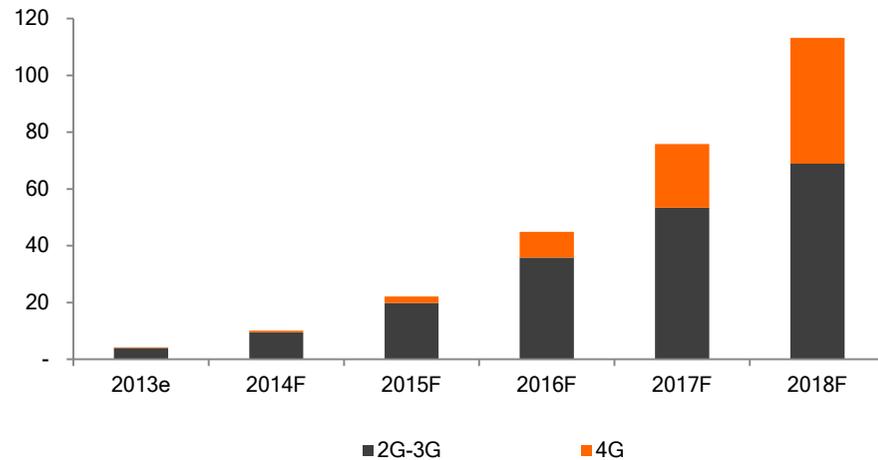
Source: HOT TELECOM report 'The Future of International Wholesale'

2.2.4 Providers' evolution

The evolution of customers' behaviour and expectations and the rapid progression of technology, has forced service providers and wholesalers to reinvent themselves to meet the new era of telecommunications. We will now discuss what impact this has had on the telecom service providers, and how their role has evolved.

First and foremost, we can safely say that the current telecom provider ecosystem looks nothing like the one that was prevalent only 20 years ago. We have moved from an incumbent, monopolistic, fixed telecom industry model, to one of hyper-competition, with multiple service providers which offer the whole portfolio of voice, data, video and content services. This, through time, has triggered the creation of mega-telecom groups which span the globe, and which benefit from deep pockets to finance their operations in multiple countries and markets.

In addition, we have also seen the emergence of new, innovative over-the-top players, who have taken advantage of the reach and scale of the Internet to offer competitive voice and data services without boundaries. The prevalence of these new players and their constant pressure on traffic and revenue, will in our opinion, be one of the triggers of the industry's consolidation and will also create a world where traditional telecom pricing boundaries are a thing of the past

As global is becoming local, as stated earlier in our discussion, gone are the days when smaller country-focused operators were able to thrive, as now operators need to be able to benefit from economies of scale not only in terms of network and equipment, but also in terms of technology, services, applications and brand.

As a result, many of these global groups have also created their own wholesale arms, to benefit from economies of scale and to enable a seamless customer experience between their own Operating Companies, but potentially with other global groups as well.

Nevertheless, we can also expect a growing number of partnerships, obviously between service providers of a same group, but also between different types of service providers. This could be for example between fixed and mobile providers, mobile and content providers and OTTs in order to develop innovative services and benefit from each other's specific strengths and capabilities.

When it comes to wholesalers, this group has also gone through a significant evolution in the last 10 years, from the basic transport of TDM, SMS, signalling and Internet traffic to where some of them are now – enablers of innovation, interworking and interoperability.

With the increased complexity of the provision of services internationally in terms of data roaming, enhanced voice or content, wholesalers will play a growing role in interconnecting the different technologies, types of players and network globally. They will also be key to ensuring a seamless communication experience wherever you are, whichever device you use and whatever service you want to connect to.

2.2.5 Key regulation questions

In this section, we identify the key trends that we believe should be considered and addressed by regulators as the communications world continues to evolve.

Net neutrality

Some elements of current activity and debate about the public internet will impact the requirements and opportunities for international interconnect services in the future. Net Neutrality, which essentially means that service providers involved in the provision of internet access to customers will not take steps that favour one content provider or type of activity over another. This has been a concept that has been in place since the early days of the internet and is often credited with enabling the invention and growth of many new services and companies.

It has been applied more rigorously with fixed ISPs than with mobile operators generally, and is potentially under threat with recent changes to peering agreements in the US and other countries. This latter aspect is worthy of further explanation, as it highlights that discrimination against a type of content, or a content provider need not be overt.

For many years, the internet has grown through the expansion of access arrangements to end users as DSL, cable, and fiber speeds have increased rapidly, and it has also grown by the rise of high bandwidth services, particularly video. Content providers pay their chosen Internet Service Provider (ISP) for access to the "Internet" and end users pay their ISPs similarly for access to the "Internet." Large ISPs, especially the Tier 1 backbone providers, obviously need to interconnect to exchange this traffic from their customers and this has traditionally been implemented via each ISP covering its own costs of the technical interconnect but no payments for traffic have been exchanged.

Recent developments in the US appear to have threatened that arrangement with some large consumer ISPs refusing to increase the size of interconnect pipes to other ISPs hosting some of the content, resulting in congestion and poor performance. The only solution offered was for the content providers to leave their chosen ISP and directly connect to, and pay, the consumer ISPs to restore the normal quality of service. To an outside observer, this can easily be seen as a deliberate attempt to degrade a certain type of service unless direct payment to the ISP is provided.

The second impact we would like to highlight here is that the LTE radio technology can explicitly provide higher classes of service for certain types of data – high priority traffic (which cannot stand much delay or packet loss) such as voice and real time video can be prioritized over the radio link compared to simple browsing.

The design of the LTE networks assumes that this highest priority stream is used by the carrier's own native voice and video services. Similar services from OTT players operate in the un-managed parts of the radio link and IP backbone. The extension of that prioritization through the mobile network and then internationally through IPXs maintains this priority and it is likely that deals could be agreed to deliver content in which the mobile operator has a commercial stake with a higher QoS than content that the customer is just choosing to access on their own. The IPXs can play a part in delivering this content from source to the operator in a higher QoS stream.

Whether this falls foul of net neutrality legislation and regulation will be an interesting area for regulators to consider and watch going forward.

Termination rates and roaming regulation

The worldwide mobile telecommunications industry is a key enabler to global economic growth and hence regulators in many countries have acted to lower pricing when judged to be excessive and hence increase competition and economic opportunity. The European Commission has been in the forefront, introducing regulations that set maximum prices for both retail and wholesale roaming services and also increase competitive pressures by permitting users to choose alternative roaming providers and to directly access the services of the operator in a visited network via a direct relationship, without changing the SIM card or smartphone.

On the domestic side, the EU has strongly recommended a more cost based approach to setting termination rates to mobile networks with the aim of bringing down the cost of in-country calling. Such rates are often used as the benchmark for setting international termination rates as well, although there is a separate movement among European mobile operators to enforce a much higher termination rate (some 3 – 4 times the intra-Europe price) for traffic coming in from outside the EU. However, to avoid a "tit for tat" response, some key relationships have been excluded with the US and Canada continuing to get lower priced termination.

This requires billing and settlement based on the A-number (the originating telephone number), and, in those cases where that number is lost or corrupted, the call is assumed to be an expensive one. This is requiring some very fast development work by some carriers to track and bill/settle based on the A number and undoubtedly will introduce

some interesting fraud challenges where numbers are modified to appear to have originated in Europe. It is not clear whether this will become a major trend or not, at this stage, and whether it should be subject to regulation.

Similarly, given the increasing importance of data services, the Gulf Cooperation Council is now looking at data roaming charges with a view to developing an appropriate price cap and a significant amount of work has been achieved to bring termination and roaming rates closer to cost.

Historically, roaming fees have been a very high margin business for mobile operators; data roaming costs represented the highest cost to consumers when using their device abroad. All these developments are going to impact the roaming activity and roaming revenue of operators going forward – as well as significantly impacting the traffic and revenue that will be carried across IPX networks in future.

OTT applications

The treatment of Over the Top (OTT) applications that provide communications services has taxed regulators worldwide. Some say that OTT communications applications that provide services and capabilities that compete with a regulated service from a licensed operator (such as voice and messaging) in that country should be regulated.

A number of telecom operators in Asia have called for regulators to intervene and level the playing field for competition between OTTs and network operators, noting that OTTs do not face the same constraints as network operators do, giving them an unfair advantage. A number of regulations bind telecom operators in terms of rates, quality of service and network deployment and the same do not exist for OTTs. In addition, OTTs place an additional strain on networks which is not compensated.

Some operators are asking for compensation for the revenue lost from OTT activities, while others are looking to charge mobile subscribers additional fees to use OTT applications. Finally, a number of other telecom operators are considering throttling, blocking OTT traffic or routing it on lower quality connections. In some countries, regulators have strongly advised operators against implementing prohibitive OTT traffic policies.

However, as OTT traffic continues to grow, as capacity and profitability pressures increase on telecom operators' networks and as the line becomes blurred between OTT and pure telecom services, regulators' positions might need to evolve and some

corrective actions may have to be taken to level the playing field, which would have a significant impact on the telecom industry's dynamic.

2.2.6 Technology/Network evolution

Much has already been written in previous sections about the migration to LTE networks, the move from circuit switched voice to VoIP and the general evolution of all services towards an IP infrastructure. At a more detailed level, much research and development is now being aimed at ways of reducing the capital cost of networks with Network Function Virtualization gaining momentum. However, that "behind the scenes" activity doesn't immediately play into the IPX evolution story.

The area of technology and network evolution worth exploring in this section is the rise of Cloud computing. The availability of low cost and highly reliable internet backbone networks coupled with the massive investments in low cost, high power servers in the data centres of major companies such as Microsoft, Google and Amazon has opened up a major new business opportunity in offering those massive deployments of servers as an "as you need it" computing platform where resources are assigned on demand to meet the needs of a specific computing task.

Many enterprises and also a large number of start-ups are making use of this on-demand capability to reduce their costs and allow them to handle unknown or un-forecastable requirements.
A start-up can launch a new service without having to invest in their own data centre, and can turn up resources rapidly if their service is more popular than expected. The relationship of this business/technology development and the IPX will be explored in later sections of this report.

2.2.7 Business models evolution

Role of mobile groups

A longer term trend that may develop is a desire by the international arms of major mobile operator groups to provide the only, or main, quality IP path to the mobile operators in their group. As services that require such paths are developed (HD voice may be the first), this can be a way to control access to those services, control the way calls are handled (avoiding bypass for instance), keep more inter-operator calls on the group network at an IP level, and hence remove considerable premium quality traffic from the

overall wholesale marketplace. This could, over time, be a significant driver to consolidation as more and more small wholesalers chase less and less traffic.

Although this is a form of consolidation, there are moves in a number of large mobile operator groups to consolidate international services in a single company or organization within the group. The logic behind this is that with the migration of services to an IP environment, the need to manage the rapidly growing need for IP access to meet the needs of their customers, the opportunity to offer group wide service packages – especially for roaming – and, finally, the opportunity to use their size and commercial muscle in better deals, there are big financial advantages in taking a "Group-wide" view.

Of course, there are tensions in this approach. Each mobile operator is usually a commercial company in its own right with its own shareholders, and local relationships are critical to providing a cost effective and marketable service.

Finally, centralization is often distrusted in any organization. However, we foresee that traffic will shift off some wholesale arrangements and onto networks and commercial deals organized by the "International" part of the mobile group – especially as IPX networks are rolled out and become a more critical part of the international infrastructure.

Wholesale Consolidation

As mentioned earlier, the international wholesale business is competitive and cut throat, and pricing is increasingly being driven down to the termination rate, with little room for margin above that to cover costs of operating a global network and sales/operations teams. The bypass and fraud activities of many small wholesalers compounds this by setting unrealistic price expectations in the marketplace.

As a result, some smaller carriers (and occasionally larger ones) are pulling out of the wholesale sector to focus on retail opportunities and leaving the delivery of international services to others. We expect this to continue over the coming years and the migration of services to an IPX platform will reinforce this significantly, as calls and services seeking higher quality IP interconnection migrate onto a limited number of IPX providers, again reducing the amount of traffic available in the wholesale marketplace

Pricing

As we have seen, regulators are applying pressure at both retail and wholesale price levels, but competitive pressure between operators is also creating change – for example with the offer from T-Mobile US to drop roaming charges altogether for data

and messaging in a range of countries. Finally, service integration of automatic WiFi authentication and connection to distant networks when in a roaming country will also enable this same seamless environment that consumers see at home, but without some of the network costs currently incurred. All these pricing and technology changes will result in a significant expansion of usage in a roaming environment.

But, by far the most interesting evolution of a business model will be the potential change of voice termination away from the price per minute that has been in place for decades towards a price based simply on the data transmitted. Many commentators have been predicting the demise of per minute pricing ever since the first voice calls were routed over the internet, but it has stayed remarkably healthy.

However, some changes can be predicted as a result of the latest developments in the mobile space, with the launch of Voice over LTE or VoLTE. The initial launch with voice calling is perhaps not remarkable. The ability of VoLTE to seamlessly support High Definition voice is not necessarily causing any change. However, the final step when a voice call can migrate to video mid-stream, or one party shares their video feed with another raises significant questions for both operators and regulators.

Does the significantly higher data requirements of a video session require a new termination fee? How are incoming video calls to be rated by the terminating operator – using the Mobile Termination Rate (MTR)? What about a call that shift mid-session to video – does that get rated differently? How about roaming of VoLTE when the signalling that normally defines a call for the operators gets routed in a different path than the media? These questions, and the complexity of the billing solutions they imply if the current model is retained, could finally result in the movement of voice pricing (at least at a wholesale level) to a data based charge.

2.3 Trends specific to Bahrain and the GCC

Customer profile

The total number of telecom subscribers in the Gulf Cooperation Council region reached an estimated 91.8 million in 2013, 90.9% of which connect via mobile. This number is expected to grow by an average of 2.3% over the next 5 year to reach 102.8 million in 2018. The majority of the growth will be generated by mobile subscribers, as the number of fixed subscribers is expected to stagnate with an average of 0.14% growth per year, while mobile subscribers are expected to increase by an average of 2.5% per year over the next 5 years.

Figure 4: GCC fixed vs mobile telecom subscribers (`000)
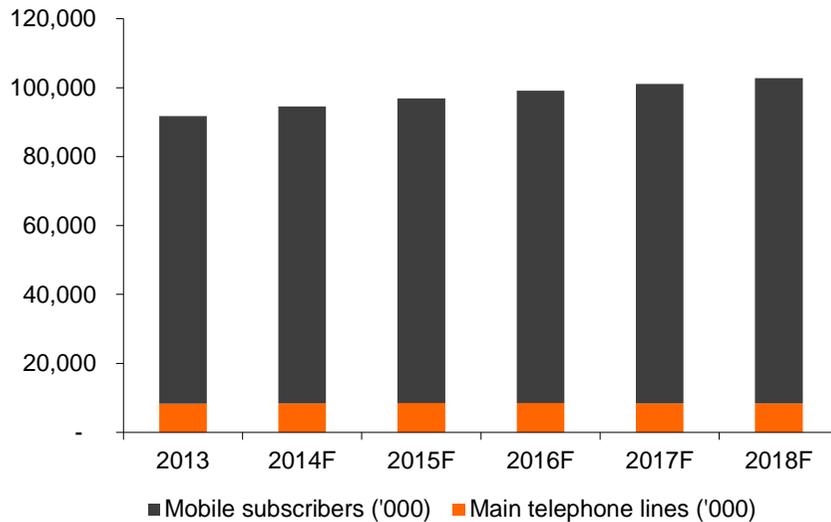
Source: HOT TELECOM estimates

Saudi Arabia is by far the largest telecom market in the region, accounting for 56.6% of the fixed subscribers and 61% of the mobile subscribers in 2013. In Bahrain, the number of total telecom subscribers is expected to grow by an average of 3.0% over the next 5 years, increasing to 2.9 million from 2.5 million in 2013. The majority of the growth will

continue to be generated by new mobile subscribers, as the number of fixed subscribers is expected to grow by an average of 1.8% over the forecasted period to 274,000 by the end of 2018. The number of mobile subscribers however should have surpassed the 2.6 million mark by 2020, compared with 2.25 million in Q1 2014 and are expected to account for 2.7% of the region's total at the end of 2014.

Figure 5: GCC mobile subscribers by country ('000)
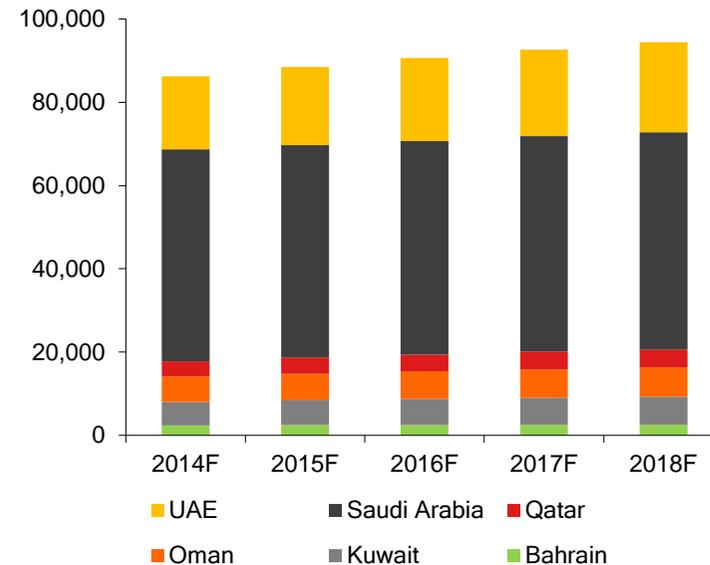
Source: HOT TELECOM estimates

In Bahrain the 3 mobile operators, namely Batelco, Zain and Viva have recently launched LTE. And a similar trend is seen in all GCC countries, with LTE quickly moving into the mainstream, with every single carrier in the GCC having at least one LTE network. The number of LTE subscribers in the individual countries and the region remains limited, as this is a new offer in all markets, however that number is expected to grow rapidly as all

new mobile packages and subscribers are, by default, LTE subscribers. As existing mobile customers move to LTE enabled handsets, this trend will accelerate.

We estimate that the GCC countries generated 29.8 billion International outgoing minutes in 2013, representing a growth of 6.8% over 2012. This total is forecasted to grow by a CAGR of between 1.7% over the next 5 years, bringing the total number of minutes to 32.3 billion by the end of 2018. Saudi Arabia is here again the largest market, generating close to 56% of all outgoing International traffic in the region.

Figure 6: GCC International outgoing and incoming traffic (million minutes)
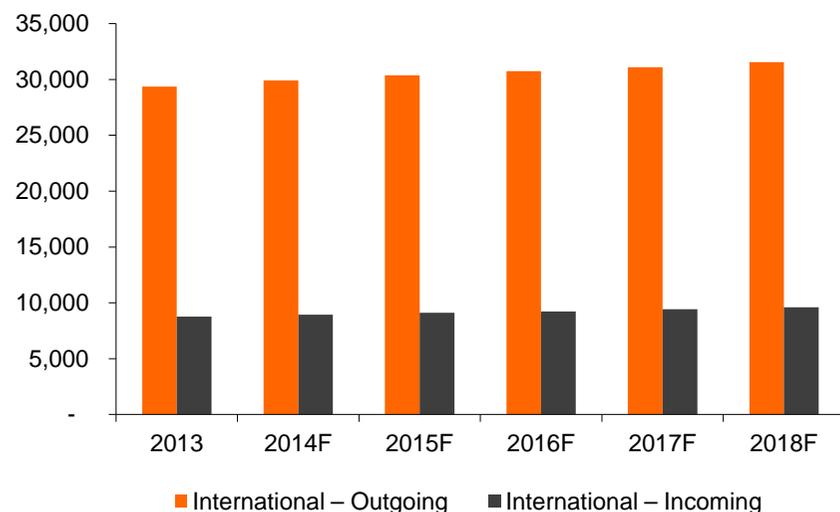
Source: HOT TELECOM estimates

Bahrain accounts for 10.6% of the International outbound traffic in the region, and generated an estimated 3.2 billion International outgoing minutes in 2013, representation a 20.6% growth over 2012.

International outbound traffic has exploded over the last 5 years partly due to the growing number of expatriates coming to the country (in 2012, it was estimated that 51.5% of the Bahraini population was composed of expatriates). If this trend continues, we can expect the International voice traffic to grow by an average of 2.9% over the next 5 years. 96% of Bahrain's International traffic is generated by mobile subscribers.

In 2013, the large majority of Bahrain's International outbound traffic (87.5%) terminated in Zone 2 (South Asian countries) and this terminating region is continuing to increase (in part due to the growing number of expats from that region and the constantly decreasing prices also). The total number of voice traffic terminating in zone 3[4] however, has been constantly decreasing since 2010 and now accounts for 5.9% of Bahrain's outgoing International traffic.

On the inbound front, the region received an estimated 7.2 billion inbound international minutes in 2013 and this number is forecast to have reached 7.9 billion in 2018, representing an average growth of 1.8% per year. In 2013, Bahrain's International inbound traffic reached a mere 289 million minutes, representing a decrease of 7.7% against 2012 with around 90% of this traffic terminating on mobile devices. Bahrain accounts for an estimated 4% of GCC's inbound International traffic.

Almost 70 TBs of data roaming traffic were generated in the GCC in 2012, with the highest volume coming from the UAE, followed by Kuwait and Saudi Arabia. Due to increased smartphone penetration and the introduction of capacity hungry LTE applications, data roaming traffic in the GCC is expected to continue increasing at close to 100% per year over the next 5 years.

When it comes to enterprise customers, they play a significant role in Bahrain's telecom industry growth. In 2013, they accounted for 33.1% of the country's fixed customers and generate 78.1% of the fixed markets' total revenue. With broadband however, residential customers account for 93% of the country's total fixed broadband subscribers but enterprise customers generate 83.1% of the revenue. No mobile-specific enterprise statistics currently exist in the country, but we can expect that similar trends exist, when it comes to subscribers and revenue, between enterprise and retail customers in the mobile segment.

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[4] Zone 3 countries: Australia, Canada, France, Germany, Greece, Italy, Iran, New Zealand, Thailand, UK, USA, Yemen

MTR and roaming rates

National and international terminations rates are regulated in Bahrain and the TRA has set a number of rules as follows:

1. All termination rates should be based on cost

2. International gateway operators are to charge a minimum of 12 fils per minute to terminate International voice traffic on the national fixed network and a minimum of 22 fils to terminate international traffic on the national mobile network

3. The national mobile termination rate is set at 6 fils per minute, while the national fixed termination rate varies between 2.382-3.040 fils per minute depending on the number of tandems involved.

4. All three of Bahrain's mobile operators have been identified as dominant for termination services on their own networks, however none of them (including Batelco) have been identified as dominant in the International wholesale segment.

On the roaming front, GCC countries are following the trends seen around the world and most particularly the developments in the EU. The GCC Ministerial committee recently initiated a process to determine new rules to be applied to voice, sms and data roaming traffic within the region. The consultation process should be completed by the end of 2014. The objective behind this consultation process is to set fair, reasonable and non-discriminatory prices and conditions for the exchange of traffic related to International Mobile Roaming (IMR) between GCC member states. Some of the key concepts being considered include:

- Local break out
- Roam-like-home (or as close to home rates as possible)
- No decoupling of the roaming provider and national roaming provider is allowed

One of the reasons behind the push of Local break-out in the region is to enable each of the governments of the GCC countries to enforce their sets of security rules and policy on the roamers and keep some control of the roaming traffic generated within their country. If a roaming packet is sent back to the home network it is much more difficult for the governing entity to enforce restrictions on the content (in and out) and security of the packet itself.

A total of 207 million roaming voice minutes were generated in 2012 while 69 million MB of data traffic was exchanged. The greatest volume of roaming traffic across all roaming services analysed is generated in the UAE.

Bahrain is the third largest generator of outbound and inbound voice roaming traffic and sms sent while roaming, behind the UAE and Saudi as the fourth largest generator of data roaming traffic. It is important to note that 60% of the Bahraini roaming traffic is generated by local roamers travelling to Saudi Arabia.

2.4 Main industry challenges and role of IPX

As a final section in this part of the report, it is useful to bring together the challenges that the telecom industry will face in response to the different trends we have discussed. The ones that are of interest to us in this study are:

- Upcoming data tsunami
- The support of a seamless LTE roaming experience
- Need for global network reach and scalability
- Decreasing ARPU and increasing CAPEX
- Monetization of data
- Increasing pace of innovation to compete with OTTs and new entrants

Obviously, at the top of the list is the need to be able to profitably handle the data tsunami that is already underway. Every new development, new application, new device and service gives the end customer another reason to consume more data. Whether it is watching higher definition YouTube videos, watching on-demand movies, chatting on video with friends, uploading photos to the cloud storage areas - everything is consuming more data. In the home, there are perhaps cost effective ways to increase the capacity available in cable, fiber and DSL networks and in the backbone of the internet, but with mobile data the restraints of a scarce spectrum constantly come into play. Hence, working on offload schemes using WiFi and coping with poor in-building signal strengths with Voice over WiFi are key to profitability.

Just as critical for mobile operators in particular is the need to gain profitability from the massive investments that have gone into LTE deployments and now VoLTE infrastructure at a time when users are demanding more for less money and are shifting much of their voice and messaging service growth onto free Apps. The actual volume of voice calling and SMS messaging may not be decreasing in many markets, but the majority of the growth is going onto the OTT apps instead of generating incremental revenue to operators.

As we have discussed earlier, there is an increasing expectation that the service at home is the same as the service when travelling, whether to more distant parts of their home country (with some work in the UK to enforce domestic roaming to minimize dead spots in rural areas) and increasingly as they travel around their region or globally.

Especially for business travel, good communications are now taken for granted, and so the rapid expansion of LTE roaming and then VoLTE roaming are going to be capabilities that are just expected to work wherever you are.

This requires the global wholesale carriers to have cost effective capacity and deep reach around the globe to permit these roaming agreements to operate securely and with high quality.

Monetization is the next major challenge. How to persuade the customer to pay for enhancements to service - whether with higher definition voice calls, or good quality video interaction when they have seen the "free" services from the OTT players. Stressing the high quality, reliable and globally reachable service available from properly engineered LTE services is perhaps key here as there is evidence that VoLTE provides a much more stable and high quality service under all usage conditions than the best of the OTT apps.

Meeting the challenges of smooth and user friendly operation of these new services is also important in gaining consumer acceptance. Within certain privacy requirements, the monetization of the vast amount of data available on consumer usage of services - the what, where, when questions can easily be answered with appropriate analysis of the data and truly useful and beneficial services could be overlaid on the basic communications service that helps the consumer navigate an unfamiliar city, or provide valuable coupons that allow them to buy a needed product from a local store. The commercial companies of the world will pay for such customized access to consumers and the telecoms industry could benefit financially from some data.

Finally, there is no end in sight for innovation - in fact the pace will only increase. Hence service providers and their wholesale partners need to look at all ways to add service richness - through their own developments plus partnerships and co-creation models with the full range of application developers who may be more nimble and customer savvy.

3

IPX NOW AND
IN THE FUTURE

3

IPX now and in the future

3.1 IPX – The basics

IPX or **IP eXchange** is a telecom interconnection model for the exchange of IP-based traffic with service level agreements which guarantee end-to-end Quality of Service, security through a dedicated IP network, service interoperability and a commercial model based on cascading payments. The IPX platform supports multiple services through a single interconnection.

IPX is not intended to replace the Internet as a global connectivity platform, but it offers an alternative option for service providers to respond to customers' evolving high quality requirements. As is well known, the IPX concept was initially conceived and specified by the GSMA as the evolution of all service interconnect requirements for IP based service providers.

Over the course of 2013 and 2014, the confusion that existed about what is and what is not an IPX has somewhat diminished. There is a much greater degree of agreement and understanding that an IPX at a minimum should be based on a private secure managed transmission platform, that multiple services should be supported over the access link(s), that peering at both the transmission and services level will extend the services to a

broader range of destination service providers, and that SLAs will guarantee the performance of those services.

Most people also believe that the link from the service providers should also be over a private managed connection, although many IPX operators clearly believe that the requirement is also subject to the commercial and technical wishes of the customer and will evolve over time.

The GSMA has very clear requirements for what an IPX service should be:

Global: The combination of IPX providers must provide an end to end service from originating service provider to terminating service provider on a global basis.

IP based: The IPX service must be IP based from end to end with no change of technology which would prevent end to end handset driven services from being established.

Secure: No access from the public internet to any of the nodes, circuits or services in the IPX domain is allowed. Break-in and Break-out from the IPX network is permitted through closely managed session border controllers or equivalent technology which maintain a clear break between public and private IP domains.

Multi-service: All services provided by service providers (now and future) should be carried across this one infrastructure.

Quality Managed: Each section of the IPX network from entry to exit point should be managed according to defined SLAs on quality. Different classes of service are to be provided to meet the needs (and the cost sensitivity) of different services.

Open: Open to all IP based service providers. Fixed line, "over the top" or OTT service providers, content providers – all are welcome on this network to exchange services in a secure quality managed way.

Commercially sound: This is seen as supporting cascading billing where the entity gaining revenue from the end user shares some of that in a cascading fashion with the providers who are involved in the delivery of the service.

The IPX model is not the only way that international connectivity and roaming support could be provided. One alternative, using a secured connection over the public Internet to interconnect two service providers, generally provides a very good service as interconnects to global ISPs are over high capacity links and peering between the ISPs is similarly large. However, any packets sent will be handled in the same way as general internet traffic and hence subject to any short term congestion issues, or, as has recently happened in the USA, disputes over the timely augmentation of peering interconnects between backbone ISPs.

For local in-country interconnects, and connections between two major partners within a region, with much traffic to exchange, a direct IP based interconnect can make a lot of sense. However, in both cases, direct interconnects between service providers bring with them much complexity in terms of interfacing differing equipment types, provisioning and maintaining security through access lists, commercial contract, trouble shooting arrangements, rating, billing and settlement and so on. A potential saving by setting up a direct interconnect can easily be outweighed by the many and varied operational costs associated with such an interconnect.

Figure 7 on page 38 give an idea of the complexity of the current International interconnect environment, requiring connections to multiple wholesalers, carriers and mobile hubs for the transport of each of the voice, data and signalling services, over non quality assured network.

It is important to recognize the massive simplification that the GSMA envisaged in the IPX concept. In their mind-set, the current environment is highly complex, and sometimes quality challenged, international environment, with thousands of interconnected wholesalers playing a part in delivering voice and potentially committing commercial fraud (bypassing regulated network interconnects), which is then mirrored in a parallel ecosystem for supporting roaming and messaging. This would all be reduced to an IP interface between a mobile operator and an IPX provider, through which all interconnect services could be obtained.

Of course, these IPX providers may also connect to one additional IPX operator to reach the designated number holder/service provider at the distant end. But clearly it was believed that this highly simplified structure using massively shared IP infrastructure must be more efficient and hence less costly in the long term than the present approach.

As mobile operators are the originators of a lot of international demand – voice, roaming, messaging – and as mobile end users generate a much greater share of the traffic, especially in countries without much fixed line infrastructure, the demands of this group of customers is hard for the international industry to ignore. In 2013, for example, we believe that 56% of international voice traffic is generated by mobile users and that this will increase to 65% by 2018 and hence many international carriers have developed and launched IPX service platforms to meet the expected demand for these services as full LTE rollout advances[5].

The outline requirements of an IPX were identified above, but when translated into a real world design, an IPX becomes essentially a secure and private transport layer – usually created using MPLS routing/switching technology operating on owned or leased transmission – with a range of service support capabilities available to the customer service provider. The service provider connects to one or more nodes on this transport network through a private connection and can use this one "pipe" to carry all the required services to the IPX provider for onward delivery/support. Schematically, an IPX can be represented as an underlying network supporting numerous services and interconnecting different types of providers as outlined in Figure 8 on page 39.

The connection pipe itself needs to be secure, private and quality managed to maintain the end to end quality management and so that would generally be an in-building cross connect, a metro Ethernet circuit, or a private leased connection to the closest IPX PoP. The capacity available in the pipe can be segregated into different classes of service – guaranteed low latency capacity for real-time services such as voice and video calling, secure but lower priority for signalling (Diameter for roaming, for example) and then a general quality for browsing traffic.

The service provider can also obtain Internet transit (the commercial term for buying access to the public internet) from the IPX provider if appropriate, using a defined and separate part of the capacity in the pipe to ensure that the rest of the IPX services are kept secure and distinct. Internet transit would normally break out from the IPX providers network at the first core node – there is no commercial rationale for carrying basic internet services over a separate secure network around the globe.

It is foreseen that may not be feasible, technically or commercially, to always have a dedicated connection from a service provider to an IPX operator.

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[5] Source: HOT TELECOM report 'The Future of International Wholesale'

In that case, services can still be accessed via a connection through the public internet secured by encryption (IPSec). While all services will work over this type of connection, quality of service cannot be guaranteed as the service is dependent on the congestion status of the public internet over which the connection is travelling.

Finally, all service providers are extremely unlikely to be connected to the same IPX network – hence, in order to maintain global connectivity, IPX providers are expected to peer with each other to make services interwork from end to end.

Peering implies a multi-level interconnection. The transport classes of service need to be transparently interconnected and the service layers need separate arrangements to ensure that each service continues to work from end to end. To keep the solution from spiralling out of control, the GSMA and major operators have agreed that no more than two IPX providers should normally exist in any one connection, although it is recognized that in some circumstances where regulation requires the involvement of an in-country IPX operator, then three will be allowed.

It is important to realize the full impact of what is being proposed here. The telecom world is currently highly interconnected with thousands of providers competing in the interconnect space between service providers for each service type. There is a voice wholesale world, an SMS termination world, competing global signalling providers, CDR management and billing interconnect service providers, multiple GRX providers handing roaming data and content distribution networks handling the delivery of video to end users over the public internet. Some of the above has quality criteria, but not many.

The solution being proposed and implemented is a secure, quality managed private IP network interconnecting all the IP consumer devices (smartphones and feature phones) connected to mobile networks of the world, with a very simplified interconnection structure carrying all services. If the IPX environment is adopted by mobile and other IP based service providers, this will constitute a massive shake-up of the current industry.

**Figure 7: Current complex Int'l voice and data services interconnect and network environment**

Internet cloud

International voice network

Service provider layer

International SMS and signaling networks
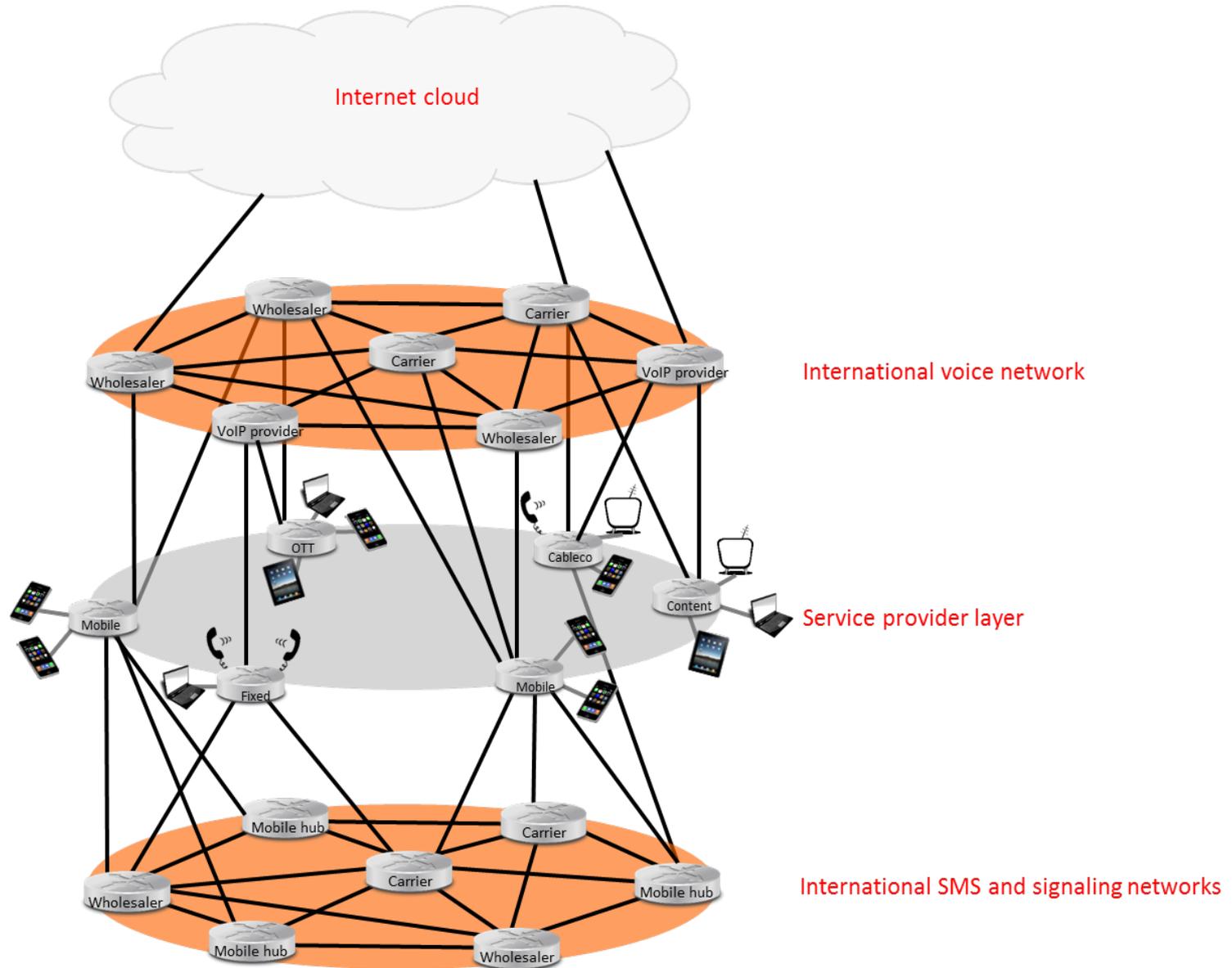
Figure 8: IPX – Simplified multiple services and providers over a single platform
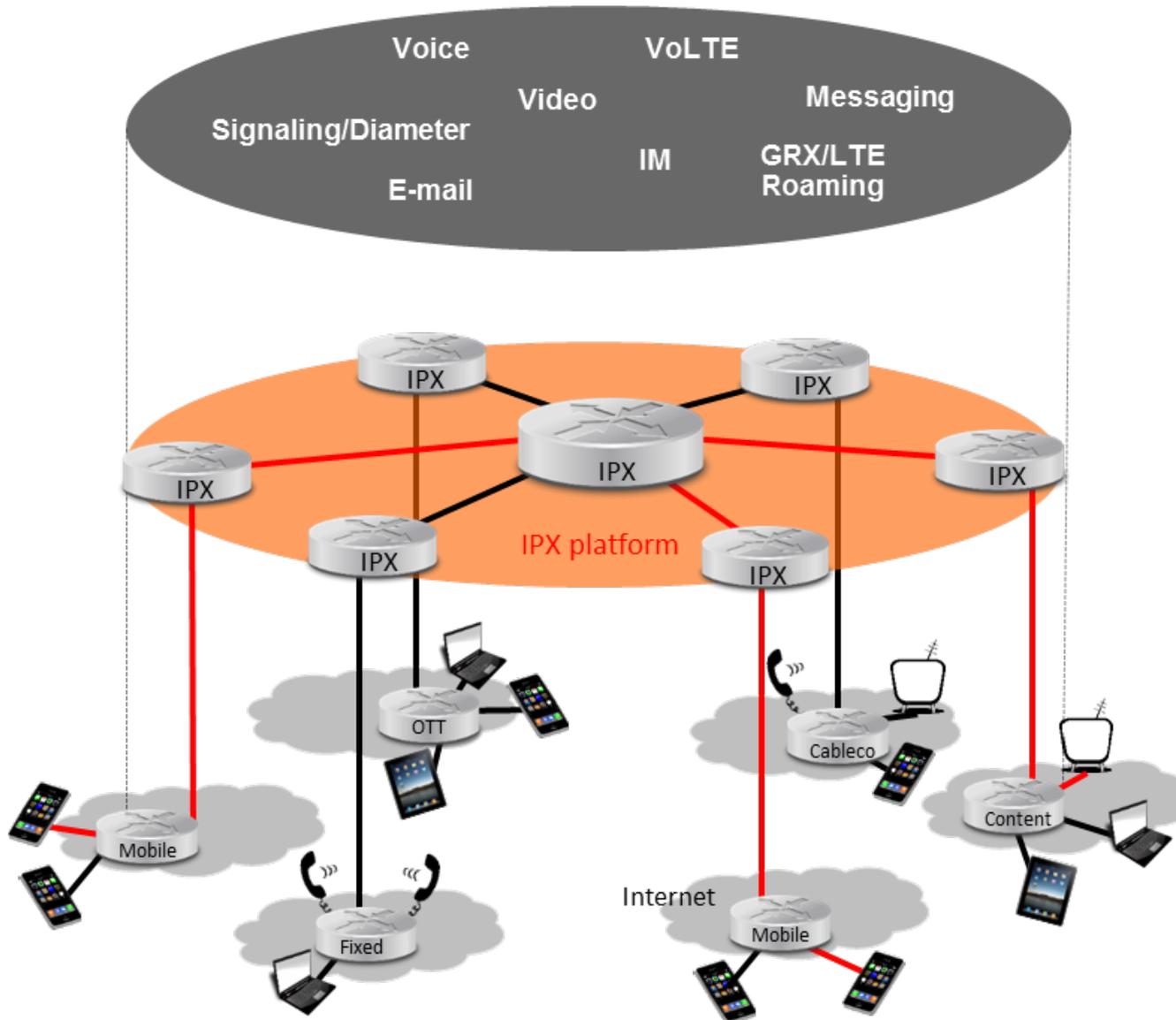
3.2 IPX Services capabilities and features

3.2.1 Initial IPX services

As may be becoming clear, the IPX is a business and service platform built from components that were already available in the industry – private QoS guaranteed IP networks and the various service elements in use in other communications services such as Session Border Controllers, Diameter signalling agents etc. What turns this collection of products and services into a new offering called IPX is the global definition, service and commercial requirements put in place by the GSMA.

As such, there is a common set of services that were pre-defined by the GSMA as being required to support the evolving nature of mobile networks, in particular the need to support LTE roaming. From there, individual IPX providers are seeing the opportunity enabled by a large number of mobile operators being connected to a private IP network with large capacity private connections and are creating services over and above the initial definition. Over time, some copying of service offerings will occur between IPX providers, but there will continue to be an opportunity to launch something new and compelling that was never envisaged in the original GSMA design.

The initial services that were offered differed depending on the history of the IPX provider. Providers coming from a voice wholesale background offered direct, high quality, SLA guaranteed voice termination between connected operators, and the providers evolving from roaming and messaging support to mobile operators tended to focus on the migration of 3G data roaming support onto their IPX, and extended that to supporting diameter signalling for LTE roaming and provide the high capacity pipe carrying the LTE data roaming traffic back to the home network. As the market developed further, the voice IPX networks have added diameter signalling and LTE data roaming support, although there is less movement from the roaming providers towards offering full voice termination.

At the present time, there has been a coalescence around the main services necessary to support LTE roaming – Diameter signalling and the carriage of data back to the home network. To some extent, that is "table stakes." The voice wholesalers are making a major push to incent mobile operators to route their normal outgoing international voice traffic over the IPX, converting from TDM to IP if needed and offering a special routing table that guarantees to keep traffic to named destinations "on-net" even it if has to route via a peer IPX, their agreements will ensure that the voice traffic routes direct with no possibility of overflow onto grey routes.

The "roaming group" have not seen this as a priority, judging that most mobile operators still use a circuit switched network for voice. They may convert to IP for some interconnects, but until VoLTE is rolled out at scale, the real need for end-to-end voice traffic being routed over an IPX is absent. Once VoLTE is in place, then the IPX can smoothly and simply take that traffic at the native IP level and route it to directly connected operators at the distant end. Handling lots of off-net traffic to global destinations is a complexity that need not be handled on an IPX, in their view.

In addition to voice, data and signalling services, IPX has been defined to support a number of features such as Class of service treatment, routing and rate transparency, and quality guarantees, for example, with the aim of offering a tailored, high quality and secure experience to each end-user. It is worth mentioning that E2E quality is however only offered from the edge to the edge of the IPX cloud and no provider is currently in a position to offer E2E quality from device to device at this time. Work is ongoing between IPX providers to identify ways of meeting this objective. A detailed list of supported features can be found in Table 2 on page 44.

3.2.2 Expected IPX services evolution over the next 2-3 years

The next 2-3 years are expected to be the period when IPX usage and capabilities start to expand rapidly, as most LTE operators establish global roaming agreements, roaming charges are brought down to levels that customers are comfortable with, and finally VoLTE is deployed in home networks and then extended globally via roaming arrangements. We expect VoLTE roaming to become a requirement around 2016, once the service has been launched in a minimum number of national networks and once a critical-mass of VoLTE enabled handsets are in use around the globe.

At a minimum, LTE and VoLTE roaming requires IPX operators to have capabilities to handle:

- Growing volumes of data traffic on quality managed private networks
- Reach to many parts of the globe to allow easy and cost effective local connections to their IPX
- Peering agreements at both a transport and service level with other IPXs to provide access to the vast majority of mobile operators globally
- A service environment that supports diameter signalling interworking and VoLTE call handling.

As outlined earlier, many will also have integrated their GRX networks, SMS termination service and C7 signalling networks (over SigTran) into the IPX offering as well. Others will also be offering on- and off-net voice termination for any voice calls, not just VoLTE.

The following sections will discuss some of the potential service evolution and innovative use of IPX over the next 2 to 3 years

VoLTE Roaming Signalling

A common feature appearing towards the end of the 2-3 year period will be the handling of the complex signalling needed in VoLTE to offer various sorts of local breakout and the splitting of the signalling establishing the call from the media that comprises the session itself. Current VoLTE roaming designs have the media transiting the home network, which is not ideal when many roaming calls are made to devices in the roaming network. With more complex signalling, this can be overcome, although there are some commercial challenges in how to charge for such "calls". In a similar way, instead of general internet browsing traffic being routed back to the home network before accessing the internet, this can also be routed out via the local capabilities of the visited network. It is likely that most IPX platforms will support the separation of VoLTE signalling from the media path as those standards are completed.

From that point, IPX platforms will start to diverge and offer services that depend on secure, high quality, high capacity global transmission networks and globally accessible services. There is the start of that evolution already visible with some IPXs offering to host components of an IMS infrastructure in their private IPX cloud, allowing a mobile operator to use that component on demand, rather than invest up front in the equipment. RCS services equally depend on a series of defined components and both hosting and hubbing (interconnecting services between a group of operators) is being offered. The concept is similar – don't invest up front in a network technology that may or may not take off rapidly, instead use the capability as you need it via the secure IPX.

WiFi Roaming

Other IPX providers are also investing significant efforts into creating global WiFi services based on one common authentication account (and making use of locally deployed WiFi environments in different countries). Many WiFi routers provided to home and business customers can support a separate public secure connection for a "visitor" and such systems, with one common sign-on, can seamlessly offer high speed connections and can be the preferred connection for data even when an LTE connection is available as this avoids use of an expensive and relatively scarce spectrum resource.

To some extent, a mobile operator whose customer is connected to a WiFi router in a distant country is being offered a low cost "roaming" service without being dependent on the commercial agreement with the home operator in that country, and so making use of a widespread WiFi network can lower costs significantly. The traffic may not even flow over the IPX in this case, but the IPX operator has used their global reach to establish the commercial and authentication arrangements and has offered this as a service to their IPX customers.

High quality Cloud

Continuing with the cloud computing theme, it is likely that mobile operators will establish certain apps and services that are offered to their customers via cloud computing environments in their network. A roaming customer accessing those services would expect high performance standards and so those data streams would be routed in a priority stream back to the home network via the IPX, even if local breakout of normal browsing traffic has been established.

In addition, high quality, secured cloud computing environments could be directly hosted on the IPX platform, and so enterprises connected via a local service provider would get quality guaranteed secure access to those service. A cloud hosted on an IPX platform could therefore be the subject to SLAs following stringent KPIs (such as availability, time to recover, time to access) in addition to the guaranteed security of the communication and the data hosted. As security of the data and communication become increasingly important for enterprises (as discussed in the prior chapter) this type of offering will make more and more sense.

High quality Content

As the evolution of services delivered via an IPX continues, the most likely development would be to deliver content over the quality guaranteed path to end users. This is unlikely to be highly popular TV shows as it would be better to host those locally in the country, but access to "long tail content" – the niche entertainment that still has an audience but is relatively specialized – could be provided via an IPX. As we saw earlier in the discussion about Net Neutrality, the performance of the public internet can be degraded by congestion or by commercial disputes between ISPs, and a mobile operator wishing to offer high quality content to its customers – especially if they are paying a premium – would want that quality to be guaranteed.

Connecting the source of the content to an IPX in one country and distributing it, on demand, to the end users via the smartphones in a distant country could become a

significant business for IPX operators. This could be passive – ie the mobile operators organize the service and the IPX enables it, or, more likely, the IPX operators finds and contracts for certain types of content and brings the commercial package to the mobile operators connected to their network. Although entertainment is an obvious offering, real time training – such as language training where nuance of pronunciation is important – could be a growth market for these services.

Perhaps related to these high bandwidth requirements is an offering to provide access to the Global Internet using the IPX connection mobile or fixed operators are already using for their high priority, high quality services. Every operator needs to be offering internet access to its customers, which is a combination of access to local in-country content usually obtained through local peering agreements and access to the rest of the Global Internet through IP Transit deals. A large IPX operator, that is also a backbone ISP, could combine both services in a large interconnect pipe, segregating the services into private and public access and consequently breaking out the internet access traffic at its first major IP node. The combined access pipe does not mean common pricing – the pricing for internet access would be at market whereas the high quality IPX traffic would be priced appropriately…

Secure mobile banking

Mobile banking currently tends to use SMS messaging as a way to confirm transmission of funds. A global network of mobile operators interconnected via a secure and private IP network in the IPX could be used as a platform for a secure banking and money transfer service. This could be driven by an innovative IPX provider or by a grouping of mobile operators and banking interests.

Today's consumers want real-time access to financial accounts and expect continuous availability to conduct financial transactions across various mobile device platforms at home or abroad.

In the past, a payment was either approved or disapproved, but now, you want to validate the location of where the customer is physically or how far he or she is from home, all those things are data around a transaction that can add real value for banks. When a customer is travelling, a bank is now able to identify if this customer's mobile device is located at the transaction point (in a foreign country, providing a validation that the customer is the one completing the transaction. IPX, via the data it collects when customers are roaming, can help identify where a customer is in real-time and provide

banks with the information they need to authenticate the validity of a transaction when customers are traveling.

Real Time Intelligence and Big Data

Deep analysis of the data flowing across the IPXs – signalling and the browsing data itself using "Big Data" techniques could open up a wealth of opportunities for the mobile operators to understand the behaviour of their roamers and to then extend that knowledge to offer them, with commercial partners, ads and offers that are closely linked to their location, profile and activities.

For instance, in the early evening, customized ads offering specials at restaurants close to their location could be highly beneficial to a traveller in an unknown city. Some IPX operators already offer some elements of this to improve the monetization of roamers, but its full capabilities have yet to be explored.

In addition, real time intelligence tools could be used to offer a more personalized communication experience. It could be used to monitor the quality of the telecom experience of each user in real-time, even when abroad and the mobile operator could therefore take pro-active actions to solve issues.

Another application of real time intelligence could be to enable real-time control of end-users' roaming experience. For example an end-user could choose different quality and price packages to be applied to different types of communications while he is roaming. He may decide that business communication should be routed over high quality, higher price routing, while personal communication are to be routed over best effort, lowest price routing. The same could be said about video or e-mail. All-in-all, these types of capabilities could give increased power to the end-user while roaming, and at the same time giving him confidence that he is in control of his roaming experience. In many circumstances this is likely to increase his voice and data roaming use.

This is only the tip of the iceberg, as a number of new innovative applications are on IPX providers' roadmap. Some of which include:

- Geo-location applications
- Pro-active data roaming quality monitoring
- Silent roamer detection
- VIP or premium customer service
- Personalized customer offerings through real time intelligence

RCS Hubbing

Rich Communications Services (or RCS) is a design for enhanced services and applications that will be enabled by the move to LTE and VoLTE, but can still use the ubiquity of the global numbering plan. The early standards are not as feature rich as the market perhaps requires, and so some IPX operators (especially those that are also part of a mobile group) are taking the lead by developing an enhanced set of rich services and offering and supporting them via the operators in their group, giving both a richer experience in each country and consistency and regional reach being enabled by the IPX. This often includes the hosting of RCS components in the IPX, and the hubbing of services to ensure interworking and seamless interoperability between the operators.

It is likely that some IPX operators are working on other services that they will keep confidential until they have sufficient connected carriers to gain rapid traction – the promise of a global secure and quality controlled network interconnecting billions of smartphones must be an environment that generates many innovative ideas and businesses going forward.

Services for the other segments

Finally, although this section has focused on the needs and opportunities of the mobile operators, most IPX operators will be also trying to attract fixed carriers, other international carriers, OTT operators and potentially enterprises to this IPX platform. High quality (and HD) voice termination services could be the initial offering with the promise of direct and "clear channel" IP interconnect to support HD voice and video would be the pull, with the extension to a more enhanced set of services later.

But ultimately, IPX could become an interworking and interoperability agent between the different types of telecom service providers and operators of related services that require access to end users. At some point, high value OTTs may want to interconnect together for example and IPXs could be the perfect solution to enable the complex interoperability required to achieve this.

A list of IPX services, capabilities and features currently offered and developed can be found in Table 2 on page 44 of this document.

Table 2: List of IPX services, capabilities and features

Basic Services	Value added services	Capabilities	Features
VoIPX	WiFi Roaming and authentication	HD Voice for 3G network implementations	Cascade billing
Voice signalling separate from voice termination	Number portability queries as a service	VoLTE in-call transition to video	CoS treatment to offer different QoS
Voice break-in, break-out	Fraud management	Signalling interoperability (between GSM/CDMA)	Multi-service across access circuits
SMS Hubbing and termination	Geo-location applications	Number portability based routing	E-2-E QoS guarantees
MMS Hubbing and termination	Pro-active data roaming quality monitoring	Signalling interworking between 2/3G and LTE	KPI reporting
RCS Hubbing	Silent roamer detection		SLAs with penalties
RCS Hosting	VIP or premium customer service		Transparency – Routing
IMS Hubbing	Personalized customer offerings through RTI		Transparency – Performance
SIGTRAN Signalling for 2G/3G services	HD Videoconference		Transparency – Commercial rating & settlement
Diameter Signalling			
2G/3G data roaming (GRX)			
LTE Data Roaming			
VoLTE termination (including support for video)			
VoLTE roaming			

3.3 IPX Providers

Many international providers have already launched IPX platforms, and they can be largely segregated into two major groupings with distinct initial service offerings.

On the one side are the large international voice and transmission network operators such as Tata, BICS and iBasis. They have extensive and very high capacity transmission networks around the globe, often playing a major role in the Internet backbone and they also have large and competitive voice termination capabilities with relationships with hundreds of carriers worldwide to receive and terminate voice calls.

On the other side is a smaller group of companies focused on meeting the roaming and often messaging needs of mobile operators, offering global C7 signalling networks interconnecting the mobile operators for authentication and updates of the HLR databases, offering global GRX networks for data roaming and often providing commercial support to the establishment of roaming arrangements. A non-exhaustive list of IPX providers can be found in Table 3.

Ultimately, the evolution of IPX providers towards a complete voice and data portfolio of services will trigger the convergence of global voice wholesalers and the mobile hubs into a more homogeneous group of wholesalers who cover the full portfolio of voice and data IP services. Both groups are slowly moving into the other's turf and in the next year or so, the service differentiators which exist between the two groups will have disappeared. This means that these players will have to differentiate by launching new high value innovative services and start to move up the value chain from basic voice and data to the provision of value added services over a single IPX pipe. This, of course, is in addition to supporting global reach and network scalability for LTE and the new generation of IP services. Not a small order!

We also expect IPX to have a further impact on wholesalers' organisations. As multiple services are offered over a single IPX pipe, the way wholesale services are sold and provisioned is evolving. Up to recently, voice and data wholesale services were developed, managed and sold by different groups within the company and ultimately sold to different groups within mobile operators. But as voice and data services are converged over a single IP connection, the segregation between the two services is diminishing, both technically and commercially. Wholesalers might, in the future, want to bundle voice and data services together in terms of pricing and features for example, this over a single connection, and VoLTE might be the key trigger for this shift.

Table 3: List of current IPX providers

IPX Operators	Type of IPX provider
BICS	Global provider
BT	Global provider
BTS	Global provider
Citic Telecom	Regional provider
Comfone	Mobile Data Hub
Deutsche Telekom ICSS	Global provider
Etisalat	Regional provider
Hutchison	Regional provider
iBasis	Global provider
IDT	Global provider
NTT Communications	Regional provider
Orange	Global provider
PCCW Global	Global provider
SAP Mobile Services	Mobile Data Hub
TI Sparkle	Global provider
Syniverse	Mobile Data Hub
Tata Communications	Global provider
Telefonica International Wholesale	Global provider
Telekom Austria Group	Regional provider
Telenor Global Services	Global provider
Telstra	Regional provider
TeliaSonera International Carrier	Global provider
TNS	Regional provider
Vodafone Carrier Services	Global provider

To be able to support this consolidation, wholesalers are merging their voice and data product management and sales group into one, to create a new converged, IP focused organisation. This might also take place in mobile operators, where in the past different people were in charge of buying voice and roaming services, to move to a single IP voice and data/roaming buyer in future. This might take some time, but this evolution process is underway.

Consequently, wholesalers are moving towards more of a customer orientated organisation, where sales teams are organised around different types of customers with IP communications needs (OTTs, cablecos, mobile, fixed and content providers), rather than around different types of voice and data services.

IPX providers' strategy

Apart from the mobile data hubs, most wholesale voice carriers, just 5 or 6 years ago, were focused on interconnecting to the international carrier in each country and interconnecting to the larger mobile operators where they could. As a result they had relatively few direct relationships with mobile operators. A few, such as BICS and perhaps Tata did change that focus, realizing that mobile operators would be the key to growth in the future and so they had a determined attempt to directly connect mobile operators to their voice networks. The majority, however, were concentrating on connecting mainly fixed and some mobile operators for basic voice termination services.

When IPX was launched, many had to catch-up with the likes of BICS, Syniverse and Aicent, when it came not only to the number of mobile operators connected to their networks, but also to the types of mobile-centric services they could offer. As mentioned earlier in this document, IPX is mainly a mobile operator focused platform (for now) and if an IPX provider wants to be successful going forward, it is crucial that it interconnects as many mobile operators as possible to its IPX platform.

We therefore saw many wholesalers migrate their focus from connecting fixed operators to serving mobile operators and launching a number of mobile-focused services. This meant that a number of voice wholesalers started to offer GRX and SMS services as a complement to voice.

Additionally, when talking to current and potential IPX customers, it is clear that service providers using IPX are planning to interconnect with a maximum of 2 to 3 IPX providers[6]. What this means is that if an IPX provider is not early in the game to become one of the

first 2 or 3 IPX platforms interconnecting with a service provider, they will probably not be able to interconnect with them in future.

This has significant implications for the future of international wholesale, one of them being the potential consolidation of the market. The carriers that have understood that fact have worked extensively in the last few year to interconnect as many IPX customers as possible on their platform, in some cases by doing the necessary TDM to VoIP conversion, in some cases by connecting via the public internet (to make the transition cheaper and more rapid) and then guaranteeing a direct voice routing to the destination operator. To further incent connection, they are pricing this higher quality service at the same price as generic high quality voice termination. In addition, Mobile hubs have been busily migrating their GRX customers to IPX, often in a transparent fashion for the customer. So in the last 2 years, we have been witness to what we can call the IPX land grab.

Now that IPX providers are reaching a critical mass of customers, they are building on this base to offer new services such as LTE diameter signalling, LTE data roaming support, HD voice support and a number of Value added services to generate new sources of revenue and capitalise on their efforts.

Peering strategy

Many IPX operators announced IPX interconnection or peering agreements during 2013 and 2014, mainly to enable the extension of the LTE roaming capabilities. It should be noted that peering does not imply anything about the cost or commercial model underpinning the interconnect, but peering is essential in this environment for a couple of major reasons.

First and foremost, mobile operators expect the service to work globally – they don't expect to connect to ten different IPX operators just to get global coverage. The second underlying reason is that several IPX operators are also part of a group that owns or is a majority shareholder in mobile operations, and they fully intend to make their IPX the route into those mobile networks – hence peering with them is an essential part of making the global environment work.

Peering has to occur at a number of levels – transport, maintaining the correct classes of service, then at the service level, and finally at the management/operations level to ensure that end-to-end quality of service and the SLAs are maintained. It is clear that the latter area is the most difficult to achieve at present, as every IPX operator we have spoken to

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[6] Source: HOT TELECOM report 'IPX, What customers want and think'

mentioned that they were able to measure and report against their SLAs for their own IPX environment, but that the measurements stopped at the IPX peering boundary.

Maintenance of an end-to-end SLA is managed by a back-to-back agreement with the two IPXs agreeing what each other will do, and relying on reports of overall performance to measure this. A true end-to-end customer view of service is not yet something that the industry has a solution for, but the IPX provider and/or mobile operators who will be able to enable this feature will gain significant advantage and mobile groups with IPX platforms are well positioned to find a solution to this challenge within their own group.

Finally, a subject that has been discussed by many is whether to charge for the privilege of peering with ones' IPX platform. The opinions vary greatly on that subject, with a number of large IPX providers with an extensive network and customer reach wanting to charge other smaller IPX providers for the privilege of accessing their network and ultimately the end-user devices connected to their IPX platform.

Similarly the wholesale arms of mobile groups will say that the only way to access our mobile operators directly is via our IPX and hence it is reasonable to pay for that peering interconnect. Of course, still others believe that traffic is being exchanged and that the actual peering interconnect should not be charged although services running across it will obvious require appropriate commercial fees in the cascading payments structure being adopted. As in many areas as new technological and service platforms require interconnect, it is not yet clear how these commercial ideas will play out in the long term.

3.4 IPX Customers

From its inception, IPX was mostly focussed towards the needs of mobile operators and their evolution to LTE. However, the IPX providers have evolved considerably since then and are gearing themselves up to cover the needs (in terms of services, features, access and business models) of all types of communication service providers (fixed, mobile, OTT, cablecos and application/content providers). As their IPX platforms are built on their global MPLS networks in some cases, it might also make sense to target some of the needs of Multi-National Corporations and key cloud providers going forward.

Nevertheless, at this point in time, all agree that the main segment and target market for IPX services remains mobile operators, with the second target group being fixed operators' VoIP traffic.

In the coming years, it is conceivable to think that once a critical mass of mobile operators have migrated to IPX, they will start demanding that their partners interconnect with them and send them traffic or content using the same type of connection. An example of this could be that mobile operators connected to IPX will request for their content or application provider partners to only send them content over IPX to ensure quality and security.

With IPX, through one physical and commercial connection, operators will be able to interconnect a complete range of IP telecom services with other global operators.

Table 4 outlines current wholesale services offered with the types of service providers using them and some of the end users services that are being extended globally.

As mentioned earlier in this document, IPX was created to target mobile operators as well as fixed, OTT and content services providers to a smaller extent and by definition, the platform was created to support International interconnect services.

Nevertheless, as the platforms were built to support high quality, security and now real-time intelligence, it is a perfect solution for global multinationals either looking to transport secure, high quality communications between their global entities, to store and access information in the cloud securely with QoS guarantees or to partner with service providers to advertise to the end-users through their mobile devices wherever they are.

Table 4: IPX wholesale and retail supported services

Services	Fixed	Mobile	Cableco	OTT	ASP
VoIPX	●	●	●	●	
MMS transit	●	●	●	●	
SMS transit	●	●	●	●	
LTE Roaming		●			
LTE Signalling		●			
VoLTE roaming		●			
Voice Signalling	●	●	●	●	
GRX		●			
RCS/IMS Hubbing		●			
VoIP	●	●	●	●	
HD Voice	●	●	●	●	
VoLTE		●			
RCS	●	●	●	●	●
High quality content	●	●	●	●	●
Video	●	●	●	●	●
IP-VPN	●	●			
Cloud	●	●	●	●	●
M2M	●	●			

It is very early days for IPX providers to target enterprise customers, as only a few are working on developing applications for that segment at this point in time. However as Real-Time Intelligence tools become more sophisticated and as Class of Service routing applications and offerings are further developed, the enterprise segment could become a new source of revenue for wholesalers, especially those with an existing sales team focused towards that segment.

And if we go one step further, enterprises could become a new class of partners for wholesalers, with which they could co-develop new applications and offering to enable a more tailored communication experience and here again, a new source of revenue.

Further on, IPX can be an enabler of secure, high quality M2M International and roaming transactions and partnerships between wholesalers, service providers and enterprises in this segment can be expected.

3.4.1 What IPX customers think and want

Little had been known about what current and potential customers are thinking regarding IPX, how they plan to use it, what services and features they really want. As a result, HOT TELECOM undertook research[7] in 2013 about the requirements of customers of these services. Through the course of a series of interviews and surveys with over 70 service providers from all industry segments and regions we are able to outline what customers really think and want in relation to IPX and here is a summary of the key findings.

Plans for migration

Apart from a minority of service providers who said they will never migrate their International services to IPX (mostly OTTs), the majority of the service providers have a time frame in mind for migrating some of their international interconnect services to an IPX. Over 60% of the services providers we contacted plan to have migrated some services to IPX by the end of 2015 with the remainder migrating by the end of 2018.

Unsurprisingly, mobile operators lead the pack in terms of today's usage, most likely a result of the migration of GRX services (which almost all mobile operators use in some form) onto IPX platforms, adding QoS management and multi-service capabilities.

Capabilities of interest when choosing an IPX provider

When it comes to the criteria behind the choice of an IPX provider for their international interconnects the large majority identify guaranteed quality on an IP connection as very important, followed by the ability to carry multiple services on a single connection – both a simplification and potential cost saving to many service providers. Guaranteed capacity on an IP network is the next most important feature.

What at first glance would seem to be an important feature – Local IPX PoP in your country - is identified as Very Important by less than 40% of the service providers we interviewed.

This still implies that it is an important feature but there is some willingness to connect internationally to a more distant IPX PoP.

Important features to support by IPX

When we ask IPX customers to identify a range of potential services and features that an IPX provider could offer, International Voice Termination tops the list with close to 100% of the service providers we interviewed believing that to be a Very Interesting use of IPX. LTE Roaming support comes in a close second.

Features identified as important are Guaranteed QoS to streaming video providers and SMS/MMS. This reinforces the conclusion that service providers really are looking for a single platform/solution to their international interconnect needs.

Important when choosing an IPX provider

When asking service providers what their priorities are when choosing an IPX providers the top quality by far is the facilitation of Global reach, followed by access to a local PoP. Mobile operators we interviewed state that they expected IPX providers to be able to offer interconnections directly to their switching centres within the major countries, while offering connection at NAPs in smaller countries. Larger mobile operator groups (with multiple operators connected with a private backbone) are also planning to transport some of their international traffic over their own IP backbone to an IPX peering point. The third most important factor when choosing an IPX provider is to seek a provider offering a complete portfolio of IPX services.

Number of interconnection to IPX providers

When discussing with service providers how many IPX providers they plan to interconnect with, it was clear that the common thinking was that service providers would interconnect with at least two IPX providers to ensure redundancy and negotiating power and they were not planning to interconnect with more than three or four. This partly explains why it is so important for IPX providers to be in a position to offer global reach as service providers expect to use only a few to reach the world directly.

Based on these results, it is clear that service providers are and will be looking to interconnect with only a few global IPX hubs to cover all their needs, which means that it is important for IPX providers to rapidly position themselves in the IPX ecosystem and connect customers to their IPX cloud as soon as possible, before they align themselves with a competing IPX offering as stated earlier in this Chapter.

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[7] IPX – What customers think and want – Hot Telecom

3.5 Regulation

An IPX is a platform over which international interconnect services can be offered, and so IPX itself is not necessarily a regulated service. It is mostly an International wholesale proposition built on components that may themselves be subject to regulation.

For instance, the landing and use of international transmission capacity, offering international voice termination services are likely subject to regulation and license. In some cases, the IPX operator providing internet transit services (ie access to the public internet) may be subject to Net Neutrality regulations, but this is an area that is not clear in many regions at present.

Licenses

When it comes to licenses, IPX providers who want to offer the service in a particular country, using an IPX PoP or access point, will require a specific International Voice service and/or facility license, depending on the situation in each country. Usually, no other licenses are required. However, if the IPX provider wants to offer its service to enterprises in that country it will also require the necessary license to do so. Usually a Value Added service type license, which covers voice and data services.

Pricing

The same applies to pricing, as most of the time International termination rates are not regulated. However, in some countries, this rate is regulated and IPX providers will have to take this into account when defining their IPX voice and/or SMS pricing model.

In addition, in regions such as Europe, the regulating body extends its powers to wholesale roaming rates for voice, sms and data within the region, and here again, IPX providers' wholesale pricing models may be impacted.

Nevertheless, on most occasions, the regulators apply a cap on the rates charged and not necessarily a floor price, which means that International wholesalers could charge for services at the price they want, using the model they want, so long as it is below the cap set by the regulator.

Going forward, things could get a bit more complicated. When VoLTE and RCS come into play and when seamless transitions between voice, data, presence, messaging/chat and video becomes a reality within a single IP communication session, it will become increasingly complex to define if the session should be rated as a voice call, a video call or even a data session. No regulation has been defined yet to address this challenge.

Net neutrality

IPX and what a service provider utilizes it for could be significantly impacted by a Net Neutrality strategy within a country or a region. By definition, IPX was built to enable different class of service prioritisation that could be charged at different price levels, a concept that goes against most net neutrality positions around the world if applied to Internet traffic. However, most net neutrality policies are to be applied within a country and not necessarily for International backbone communications providers. However, if an IPX provider wanted to offer a national flavour of IPX to interconnect national service providers together or enterprises and wanted to offer different class of service treatment for Internet traffic charged at different prices, the net neutrality policy of the country the service was offered in would have to be taken into account.

These types of scenarios are limited at this point in time, however when the time comes when most services are transported over a single pipe and when class of service offerings are more mature, these situations could arise.

3.6 The Impact of IPX

In this section, we will discuss the likely and potential impacts of IPX platform deployments on the telecom industry and on service offerings going forward.

3.6.1 The roaming evolution

As discussed earlier in this document, IPX is designed as a secure quality enabler of IP based international connectivity. To a large extent, an IPX provider cannot create a service in isolation, but can extend and interconnect services between different service providers, although this can change in the future.

The initial challenges faced by mobile operators, seen as the major initial customers of IPX based services, were the extension of LTE based services to a global audience. The initial step in this was the establishment of LTE roaming capability. A mobile operator could (and many initially did) support roaming only at the 3G level. A customer would have the high speed and rapid connectivity of LTE service in their home network, but the phone would fall back to a 3G connection when roaming.

As explained earlier, voice in almost all LTE networks is supported using a technical approach known as Circuit Switched Fall Back (CSFB) which basically means that a voice call causes the radio in the handset to switch back to 3G and the voice call to be set up in the traditional circuit switched environment that 3G supports. Hence, when roaming, voice would continue to be supported in this way, and data would be provided at 3G speeds.

The rising expectations of customers in terms of the performance of their applications on their LTE phones has pressured many mobile operators to extend their LTE service globally through LTE roaming agreements with other operators. This commercial step requires support of the signalling protocols needed to support LTE service – ie Diameter signalling back to the home network for authentication and authorization of roaming – and also the management of the flow of data back to the home network for internet access and browsing. The IPX network was designed for just this requirement and so is a key enabler of the LTE roaming agreements being established.

At present, the rollout of Voice over LTE is in its infancy domestically, and so all voice roaming still makes use of CSFB back onto 3G networks and onto the international voice networks supporting those networks. In 3G roaming arrangements, the home network simply authorizes that their customer is able to make calls when roaming – it is up to the visited network to determine exactly how those voice calls are routed to their destination. The voice traffic may be converted to IP and be carried via an IPX to the called destination,

but equally it could remain as TDM and be passed into the wholesale voice termination market for delivery. The further expansion of VoLTE and particularly the establishment of roaming agreements that support VoLTE will move the IPX networks from being a potential option for voice roaming and termination into a full requirement for that support.

But the following question remains: will mobile operators continue to use local voice breakout when a VoLTE call is made while roaming or will the call be routed back to the home network for feature management, quality control, security and further down the line to add value added features to the communication? This subject is still being discussed by the GSMA and many hope that a single set of standards will be applied across the board. This might be challenging however, due to the disparity between each country's regulatory environments and mobile operators' desire to control the routing of the call. The IPX can support various approaches for VoLTE roaming – handling the signalling back to the home network and then back to the visited network to control how that call is then routed (under an approach known as RAVEL), or forcing both signalling and the media itself over the IPX to the home network for termination via their own partners and arrangements.

The same question can be applied to data roaming traffic. At present, in 3G data roaming arrangements, the data traffic is sent back to the home network over a GRX when customers are roaming before being sent out into the public internet to the destination server. Return packets follow the same path. The diameter signalling associated with LTE data roaming has more flexibility to enable local breakout of packets into the visited network's internet access, or even to route some browsing via a local breakout while other activity is routed back to the home network. In a 3G world, the volumes of data being transported over GRX networks was not high, but with the much higher speeds of LTE data connections, the volumes of data being transported back across the IPX may cause operators to move to local breakout earlier rather than later.

3.6.2 The business model evolution

This section is considering how the business models around the GRX/IPX are evolving. Currently, IPX providers are generally offering IPX service on a port-based model. The mobile operator pays for a circuit (or cross connect) to the nearest IPX PoP, is connected to an available port – 100Mbit/s or 1GBit/s – and requests a certain amount of capacity to be made available for their use – eg 80Mbit/s. This amount is configured and forms the basis of charging for the IPX service. For an IPX data service to work, there obviously needs to be an operator with a port in a distant country, and so the IPX operator receives

two port payments. Most IPX operators do not charge for actual data packets exchanged between the two mobile operators – the port charge includes data transport fees. There is some discussion in the IPX community however as to whether that should change, but we understand this is the current structure.

On top of the port, there are service level charges – currently for Diameter signalling and for voice termination. Voice termination is the easiest to understand – the originating mobile operator is given a price list for voice termination "on-net" to the IPX and may also be given a price for "off-net" or breakout voice termination to all other destinations in the world. Calls are billed per minute, usually with a 1 second rounding of duration. The IPX operator passes a slightly lower amount per minute to the distant terminating mobile operator and keeps the difference as their margin.

Diameter Signalling is more in flux. Traditionally, 3G roaming was supported via global C7 signalling networks and pricing was clearly understood to be a price per signalling message. Margins were high for the signalling networks providers but these are specialized dedicated networks with expensive Signalling Transfer Points (STPs) and there was relatively little competition. Diameter signalling used in LTE networks is IP based, uses common computer hardware with software packages providing the diameter signalling agent features and capability. In addition, there are now many IPX providers with this diameter signalling offering, and many of those have no existing signalling business to defend. As a result, pricing for diameter signalling over IPX networks is much lower than the equivalent C7 message, and some IPX operators are coming up with bundled pricing rather than pricing per message.

In addition, the convergence of all these services over a single IP pipe will create opportunities for IPX providers to innovate with new pricing models. For example, there is an opportunity to create bundled services pricing, with discounts if a customer, interconnects not only for voice, but also for data and signalling. Also, when value added services are launched over IPX, there is an opportunity for these services to be charged on a per usage basis and/or on a per service basis, on top of the port charge.

Finally, with the convergence of all services over IP and over a single pipe, there is a possibility that down the line, voice may be charged as a data packet per MB and not per minute. Which means that the voice traffic would be bundled and charged as data. This evolution may not be a reality today, partly due to regulation in some countries and the

reticence of operators to migrate their per minute voice revenue to a data model, but down the line this is a model that needs to be considered.

This continued convergence of all services onto IP and onto the IPX will also create opportunities for new partnerships – with examples that are already starting to happen between cloud computing providers (eg Amazon, Microsoft) and major IPX global players such as Tata Communications. The opportunity to offer high quality secure access for enterprises to their applications in the cloud is real, and we believe will be a growing market. Other partnerships have been mentioned earlier in this report – between IPX providers and content providers to deliver high quality content to mobile/fixed operators and their customers. It is less clear how OTT players will react – perhaps a partnership by Skype (now a part of Microsoft) with IPX providers to establish higher quality paths for their enterprise solutions would make sense in the future.

In a broader view of this area of the interest, the ability of an IPX provider to analyse the transactions being carried over the IPX to extract valuable information about roaming customers, for instance, could result in partnerships between the home mobile operator, IPX and the many commercial companies interested in marking appropriate messages to those customers based on where they are and what they are doing. The IPX provider could bring the commercial entities into the partnership, as they will be the central point seeing this type of data from many home networks and many visited networks.

3.6.3 Telecom industry structure

Earlier sections have mentioned the interest, in many mobile groups, in establishing an international, or wholesale, arm of their group to pull together the interests of the group. This could involve shared roaming packages and arrangements, making it more cost effective for the customer to roam via the operators that form part of that group. The next stage would be to directly interconnect the operating companies to provide an intra-group IPX, handling roaming signalling, messaging, roaming data and voice interconnects within the group, rather than paying an external company to handle this. Consolidating all outgoing (and perhaps incoming) voice termination could be added to the mix, giving the group the advantages of scale in negotiation, although many local operators may not wish to give up this control. However, the move to IP is enabling this change to the status quo of the international industry.

This has a knock-on effect on the other players in the ecosystem. The removal of a portion of high value, high quality mobile calls from the international voice wholesale market, puts

pressure on the carriers in that space, especially the mid-sized players. For some time, the smaller wholesalers with a particular niche termination offering could continue to attract business, the large wholesalers are offering their IPX services, but the middle will be squeezed and we can expect to see many of these players dropping out of international voice termination. It is unlikely that many of them will be acquired, because wholesale voice is such a volatile business that a mid-sized wholesaler actually has little value to any of the larger players.

3.6.4 The role of wholesalers in innovation

With these changes underway, consolidation around the corner and competing IPX providers converging on a common set of features and services, the opportunity develops for some international wholesalers to focus less on the lowest cost, and more on bringing innovation to their retail service provider customers. We have seen companies like BICS and Tata Communications focus heavily on fraud management in their offerings, with BICS bringing that as a solution that retail service providers can access and deploy in their own networks.

Tata Communications has also partnered with retail service providers to bring a more secure and reliable access to cloud service to the market. Syniverse is marketing its leading edge data analysis skills to help mobile operators understand their roamers and better serve them, while increasing their revenue from roaming. Going forward, we envisage that the more successful wholesale and IPX providers will move much more into the role of bringing opportunities and products/services to retail service providers and devote more of their product and marketing experts towards innovation – both in terms of their own direct services and in services they can offer in partnership.

3.6.5 Financial success

As mentioned earlier, the simplification that IP is bringing to the international interconnect market is putting some pressures on the finances of companies in that space. The falling prices of IP ports generally, the falling pricing of signalling, as Diameter is introduced, and the continued reduction in mobile termination rates all cut into margins. However, consolidation will act somewhat as a countervailing force and some of the competition will be removed from the market, allowing some growth in volumes handled by the larger companies.

It is likely, however, that the margins of the basic services will continue to be under pressure, and hence the desire to move up the value chain towards more innovative and higher margin activities.

Over time, as more international services migrate onto IPX platforms, there will be a consequent CAPEX and OPEX saving as the remaining TDM infrastructure and support teams are no longer required, but there is a short term peak when investments are required for the IPX platform while most traffic remains on the older infrastructure.

On the retail side, the convergence of all voice and data services over a single pipe will also create significant financial and operational savings, making the international part of their network much more efficient. From a circuit for each service, IPX will enable all services to be sent over a single pipe, creating a network which is much simpler to optimize, but will also enable service providers to order larger ports at a lower per unit cost. So both CAPEX and OPEX savings are expected for this segment when using IPX.

Additionally, as mentioned earlier in this document, operational savings will be generated by combining the voice and data product and sales teams to an IP-centric type of organisation.

3.7 Example of IPX strategies

A number of wholesalers and mobile hubs have successfully initiated their transformation from a TDM/GRX environment to a fully secure IP/IPX ecosystem and were therefore able to be early providers supporting diameter signalling and LTE data roaming traffic. Others have also been able to capitalise on their IPX platform's capabilities to improve the seamless transport of voice and data traffic between their groups operating companies thereby improving customer satisfaction while generating savings. Here are two examples of such successful strategies.

3.7.1 Syniverse

Syniverse's strategy is a logical combination of its hub capabilities with its own managed international MPLS network. As one of the world's leading providers of technology and business services to the mobile industry, it is strongly promoting its IPX as the ideal mechanism for mobile operators to transition to IP and LTE. This while continuing to support legacy services, to enable full global interworking with 2G and 3G networks and utilizing a single, future-proof connection to access the platform and enable them to deploy new, advanced services.

Up to now, Syniverse has not developed a specific voice offering, but is planning to support VoLTE interworking when mobile operators migrate their networks to that technology. This can support direct interconnect and also the roaming of VoLTE. The company has also focused on developing an extensive list of data, interworking and real-time intelligence services including retail roaming monetization, mobile intelligence and other class of service solutions in home and visited markets. It is also working on supporting a number of value-added services, such as policy management by class of service, real-time intelligence at a subscriber level, and network and technology interoperability.

It is already one of the strongest in North America, and with its recent acquisition of Aicent, this makes it one of the strongest IPX providers in Asia as well.

A key focus is on the expansion of its network capacity to support the extensive data traffic growth expected with the rise of LTE data roaming and it has been very successful at interconnecting customers to its LTE diameter and data roaming IPX service.

Syniverse offers transport services over its IPX network with SLAs supported by class of service and quality of service. It provides transport for a range of services on that network, including voice, SMS, MMS, GRX, CRX, video calling, signalling and ENUM.

It also provides an application/service layer including data and financial settlement and clearing, reporting, billing, agreement management, and end-to-end quality options.

Syniverse has been one of the mobile data hubs that has been the most successful in migrating its business model from GRX/3G to IPX/4G. It is now growing its business through the support of LTE as well as through new segments such as enterprises via its real-time intelligence portfolio of services.

3.7.2 TeliaSonera

As part of the TeliaSonera group, TeliaSonera International Carrier (TSIC) provides network infrastructure and services to more than 1,000 customers in 80 different countries worldwide. It owns and operates one of the largest fiber-optic networks across North America and Europe, including Russia which means that it is in direct control of reach, diversity and service performance. TSIC has 200+ PoPs across Asia, Europe, Middle East, Russia and North America.

Ranked as the world's second largest internet backbone by Internet intelligence authority Renesys, it also carries 1.2 million voice minutes every hour over its network, over 18 million MMS and counts more than 1 Exabyte of data over its network every month.

TeliaSonera has retail operations in 17 Nordic and Eurasian countries (and Spain), all of which are connected to TSIC's network. One of TeliaSonera's objectives is to interconnect all its retail operations over its IPX to enable seamless customer experience at home or when roaming.

TSIC formally launched its IPX offering in May 2013, offering a portfolio of services through an extensive number of PoPs from day one. TSIC's IPX network is built upon their wholly-owned and fully redundant optical network, recently 100G-enabled, which has very extensive reach in Europe, in particular, which give TSIC a big advantage in making it easy for mobile operators and carriers to connect in their local country/city and with a high degree of resilience. The scale of the TSIC network also makes it very cost effective to provision incremental bandwidth as required.

TSIC will also be able to capitalize on the retail operations of the group, gaining knowledge and experience of the current issues and requirements of operators, and having an immediate source of traffic and interest in their IPX.

Strategically, we understand that they see their mobile operating companies as a major asset for their IPX service, in the sense that any other mobile group (such as Vodafone) simply needs to set up a peering agreement with TSIC and directly exchange voice, signalling, messaging, roaming data between their respective mobile operators without the involvement of any wholesale third party. This direct interconnection, if it occurs at scale, will undoubtedly remove voice traffic from the international wholesale market and also reduce the available market for "independent" ie none-aligned IPX providers in the global business.

3.8 IPX as an enabler of the IP revolution

To close this review of the IPX ecosystem and what services it could deliver, this final section offers more of a "blue-sky" vision of how the platform could evolve and what it could mean for global consumers. This is by no means a forecast - there are many elements at play, technical, commercial, regulatory which could impact the future, but it is still worthy of consideration.

The world - albeit perhaps mainly the developed world - is moving rapidly towards LTE connected smartphones and tablets that seamlessly move to WiFi high speed connections when available - ie they are always connected to a high speed, high data throughput connection to networks. At present, that is often just the "public internet" with all its challenges of security, reliability, congestion, delays and drops. Of course the internet can also provide near perfect service, but the almost daily reports of hacking and loss of privacy are challenging to say the least. As we know, many services that we traditionally delivered by separate platforms - telecom services such as voice and messaging, entertainment services such as cable and satellite as well as the limitless supply of information on the internet are increasingly being delivered by that internet connection to our devices.

The rapid rollout of LTE gives mobile operators a key differentiator, that may not have been activated in some networks, but is a critical capability - the ability to segregate services on the smartphone in terms of how they use the LTE radio channel and how services designated as high priority are then carried through the IP networks of the mobile operators themselves, and extended internationally, if required.

Native applications in the phone - such as VoLTE automatically use that designated channel. We understand that the mobile operator can assign other applications to use the higher quality path as well going forward. This opens up the possibility of creating a separate "internet" which is not accessible except via the applications defined by the mobile operators and which route separately via internal classes of service onto IPX networks for international access to global services.

A separate secure internet would have significant potential - perhaps not for watching cat videos on YouTube, but for applications that customers and enterprises would naturally require to be secure and for which they would pay incremental fees. This could theoretically be established as a new construct, but it is by no means clear how that would happen, but the fact that IPX networks are being established now for a different commercial purpose gives the industry a head start in creating something new.

Within that new ecosystem, applications that demand security - banking and paying via the mobile, medical and healthcare applications, secure voice and video communications - could be supported, and, of course, legal interception could be applied to the transactions as required by law. This could be an environment where the mobile operators, in particular, can finally gain some pricing stability for services that would be impossible for Over the Top players to emulate.

A graphic depiction of what this new IPX world could look like can be found in Figure 9 on page 57.

The next section of this report now focuses in on the IPX opportunities and challenges in Bahrain and the GCC to explore what can be done to make the IPX revolution a reality.

Figure 9: Ultimate IPX vision

4
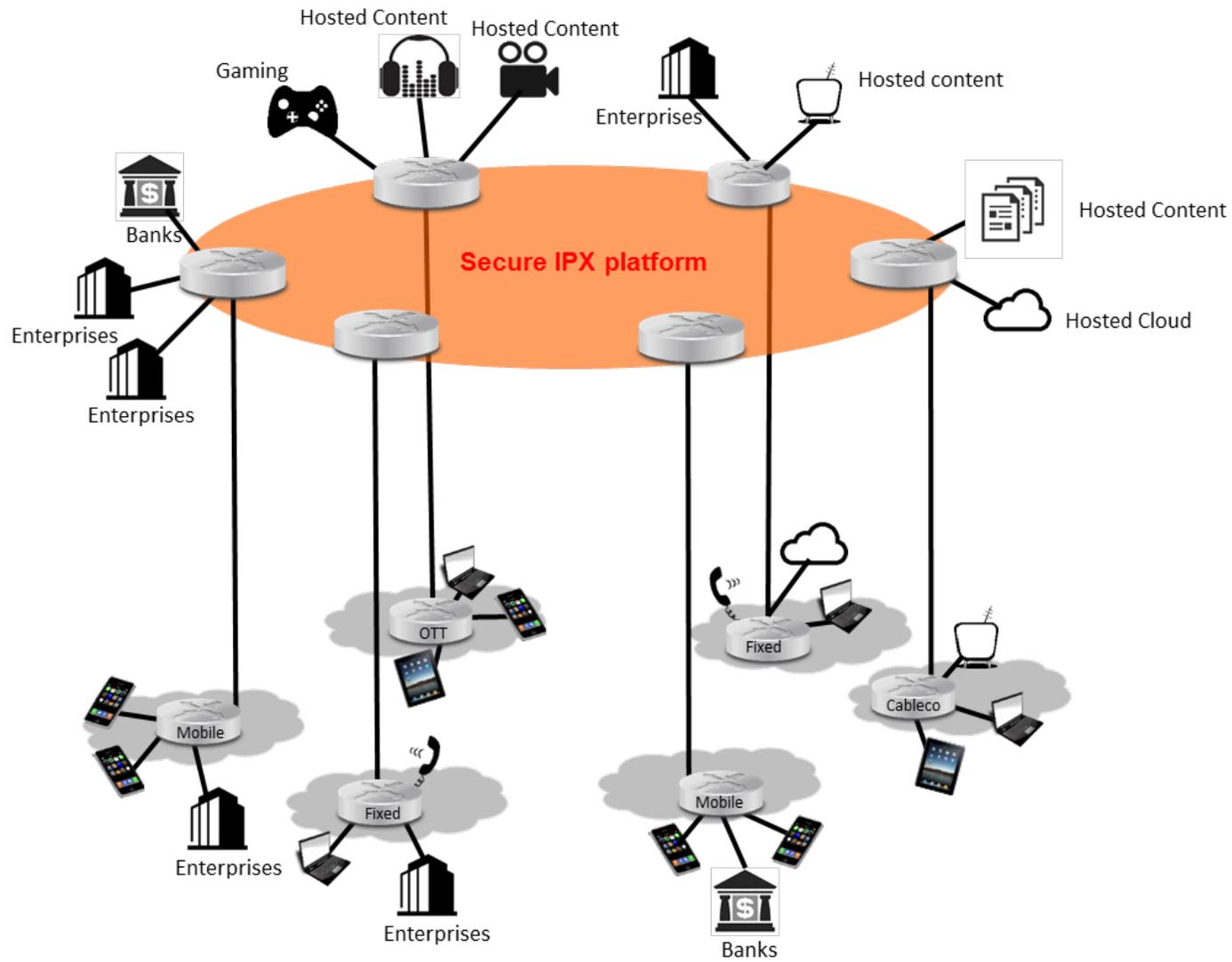
POSSIBLE USE OF IPX IN BAHRAIN AND THE GCC

4

Possible use of IPX in Bahrain and the GCC

IPX could have a significant role to play in Bahrain and the GCC's successful evolution to an all IP, high quality and high speed communications environment over the next 5 years. The stakeholders who could use IPX as one of the solutions to capitalize on new IP services include:

1. **Bahrain's National operators:** To address some the International service requirements they will have in the near future

2. **Bahrain's International operators:** To improve quality of termination and support new data services

3. **The TRA/Bahrain government:** To ensure the success of some of its 3-year plan's objectives and to strengthen Bahrain's role in the IP era

4. **The GCC region:** To improve intra-regional Internet quality and security, regional communications in general and to ensure that the benefits of the move to IP based service are seen throughout the GCC region.

This chapter will delve into each of these possible use cases in more detail and define if and how IPX can help.

4.1 Bahrain's National operators and IPX

As discussed in Chapter 2 of this document, the vast majority of the existing telecoms business is conducted through mobile devices and almost all of the growth going forward in Bahrain and the GCC will be in incremental mobile connections. So a focus on the needs of the country's three mobile operators is going to form a key part of our discussion.

Of course the Bahraini mobile operators have in-country needs – spectrum, towers, transmission capacity etc. – but we are considering here the international needs of these operators in particular. How those international needs are met can certainly play back into the development of the telecoms infrastructure in the country and these points will be explored as well later in this analysis.

Looking internationally, the main requirements for Bahrain mobile operators in the coming years are to:

a. Improve Internet connectivity

b. Evolve incoming and outgoing voice termination connections to support IP interconnects and then enable VoLTE interconnects with HD voice and smooth transition to video sharing and conferencing.

c. Improve quality and reliability of messaging services

d. Facilitate and stimulate seamless roaming within the region and globally while maintaining and enhancing 3G capabilities

e. Establish and rapidly expand LTE roaming for all services, including VoLTE

f. Implement a Rich Communication experience which enables service mash-ups (voice, messaging, video for example) and enhance sharing between mobile devices

g.   Optimize CAPEX and OPEX expenditure

All of the above requirements/services/applications (including roaming 3G services using SigTran) will be carried over IP in the future and so each operator will need to develop its strategy for how those services will be interconnected in a secure and high quality way.

In addition to this basic list, many mobile operators are part of a broader group and may have specific requirements to rollout more specialized services between the group operators – perhaps a customized form of Rich Communications Services, group roaming packages or a mobile banking or money transfer service.

Each mobile operator operating in Bahrain is part of a group, with other operating companies in other countries in the region (and elsewhere) and so both the direct needs for roaming and interconnect, as well as the potential needs to provide enhanced services as a group, must be met going forward.

Mobile operators in Bahrain now have a number of options available to them for meeting this increasing set of needs for international service connectivity for voice, messaging, internet access and roaming at 3G and 4G speeds as discussed below.

Direct interconnect

The first, and most obvious way of establishing interconnects is the one generally used in country – establishing a bilateral connection between the home and distant networks. This bilateral connection could be established using one or more leased private circuits – either SDH or IP/Ethernet based or by utilizing an MPLS service offered by a global or regional transmission provider. This will provide the basic connectivity, on which the various services can be interconnected – direct capacity between voice switches, interconnection of diameter signalling agents, capacity for roaming data to be brought back to the home network.

We understand that the largest community of interest is between Bahrain and the Kingdom of Saudi Arabia (KSA) and each of the operators has established either dark fiber or high levels of capacity between the two countries either over the King Fahd Causeway or via the GCCIA. It is also noted that each operator, through its group, has investments or ownership of operating companies in KSA, and so setting up direct

bilateral arrangements is likely to have occurred already for some services and can be transitioned into IP based interconnects as required.

Equally, it could be cost effective to establish similar arrangements with STC, because of the large amount of traffic routing to that operator, although this is being assumed without direct knowledge of the commercial issues involved. Suffice it to say, the decision to adopt direct bilaterals, and for which service, is a combination of technical, commercial and operational factors coupled with knowledge of the traffic flows between the parties.

Figure 10 on page 61 provides an illustration of the direct interconnection scenario.

Wholesale providers

A mix and match solution where some the more important traffic relationships and services are routed direct, while the smaller routes make use of third party wholesale provider is often a common approach. However, bilateral connections come with the need for appropriate security controls, commercial agreements, rating, billing and settlement arrangements and operational testing and trouble-shooting processes. As a result, they tend to be used between partners between which a high volume of transactions will flow as they can become highly complex if many parallel bilateral arrangements are maintained.

It is impossible to provide full global service for voice, messaging and roaming without making use of one of more wholesale providers, particularly currently when each service tends to have a strong group of players but relatively little overlap between the services. Traditional wholesalers have few restrictions on how they provide the services they offer – they can route direct, route via a partner, or simply pass the voice call or service on to another wholesaler for them to handle the onward routing. Once the originating service provider has handed the call to a wholesaler, they have lost any control of how it will be routed and terminated.

As will have become clear, the larger wholesalers from both the voice and the messaging/roaming worlds are offering IPX-based solutions that do offer security and guarantees on service levels and also allow multiple global IP based services to share one connection and one commercial relationship. Figure 11 on page 61 provides an illustration of the wholesale scenario.

Figure 10: Direct interconnect scenario
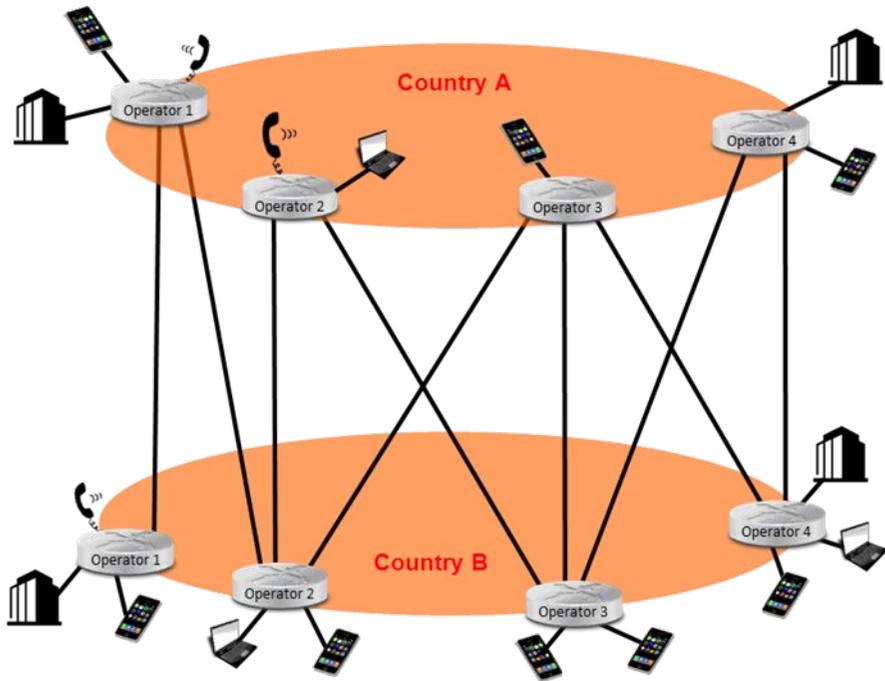
Figure 11: Wholesale interconnection scenario
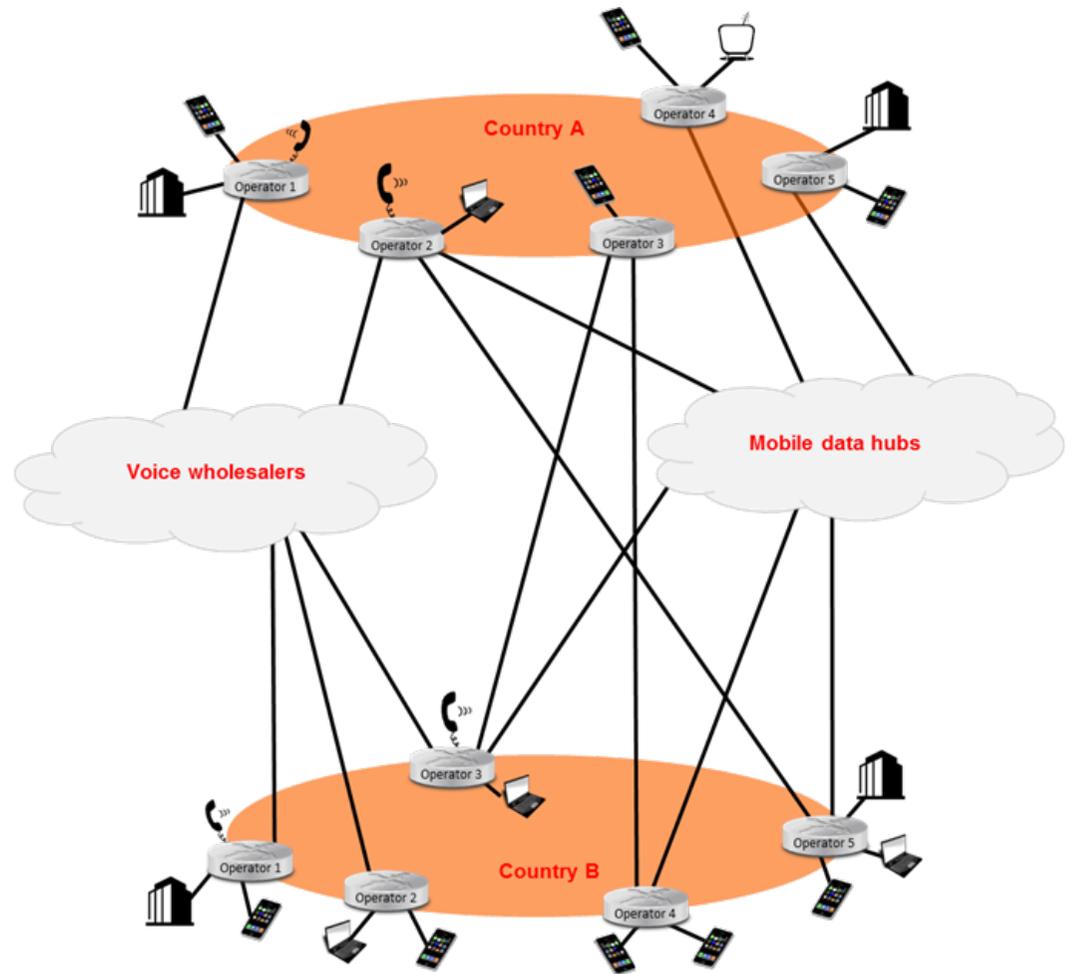
Mobile group platform

Mobile Operators that are part of a group often have a group-wide wholesale arm charged with solving some of the intra-group traffic exchange. If the various operating companies have a large amount of "community of interest" where their customers often travel to the other countries and there is a volume of voice and messaging traffic between those countries, then a group-wide interconnection platform can make economic sense.

In most cases, this group wide IP network platform can fulfil all the requirements of an IPX, being based on private transmission, secure and separate from the public internet and carrying the service platforms that the group thinks are worth handling internally. This can involve the various service interconnections mentioned above, as well as access to the backbone of the public internet in some cases.

It can be expensive to carry rapidly growing general Internet traffic on a private network, but in some circumstances, for instance between a country where backbone Internet access is expensive, it can make sense to carry that traffic to a different country with a much more competitive Internet exchange or market.

It is also possible for an intra-group IPX to meet more than just the needs of the mobile operators in that group. For instance, the group could decide to route all incoming international services to its operating companies through that IPX connection, peering at a transmission and service level with other global IPXs. Similarly, all outgoing traffic could be routed via the group IPX. And taking this one step further, the group could decide to offer IPX services to a wider range of service providers.

For instance, choosing one group purely as an example in the Bahrain market, Zain could create an IPX between its main mobile operators in the region (Bahrain, Jordan, Kuwait and Saudi Arabia for example), and then offer commercial IPX services to the other operators in its countries of operation – perhaps to Viva in Kuwait and in Saudi Arabia. Depending on the strategy of the group, adjacent countries could be added as access PoPs and a wider range of operators in adjacent countries could be also be added. This would have the potential to turn the groups' backbone into a major regional IPX through which the global operators would reach the connected carriers in the region.

This final steps of extending the IPX into a full commercial offering would require investment in transmission capacity, licenses, sales and operational staff, but could add

incremental revenue to the group. The example given here was with Zain, but similar logic could apply to both Viva and Batelco and other groups in the region.

As an example already in service, the Telenor group is building an intra-group IPX and offering access to its operators and IPX services more broadly to all service providers in its catchment area. In the Telenor group's case, all its operating companies connect to the group's IPX platform for the transport of LTE roaming traffic, with voice on the roadmap for phased implementation.

Extending IPX services beyond the region is undoubtedly more difficult, and without major ownership in submarine capacity across the Atlantic and Pacific oceans and fiber in the US and mainland Europe, this would be a complex and expensive project and difficult to see the commercial rationale in competing with well-established global players. Figure 12 on page 63 provides an illustration of the mobile group scenario.

Figure 12: Mobile groups' scenario
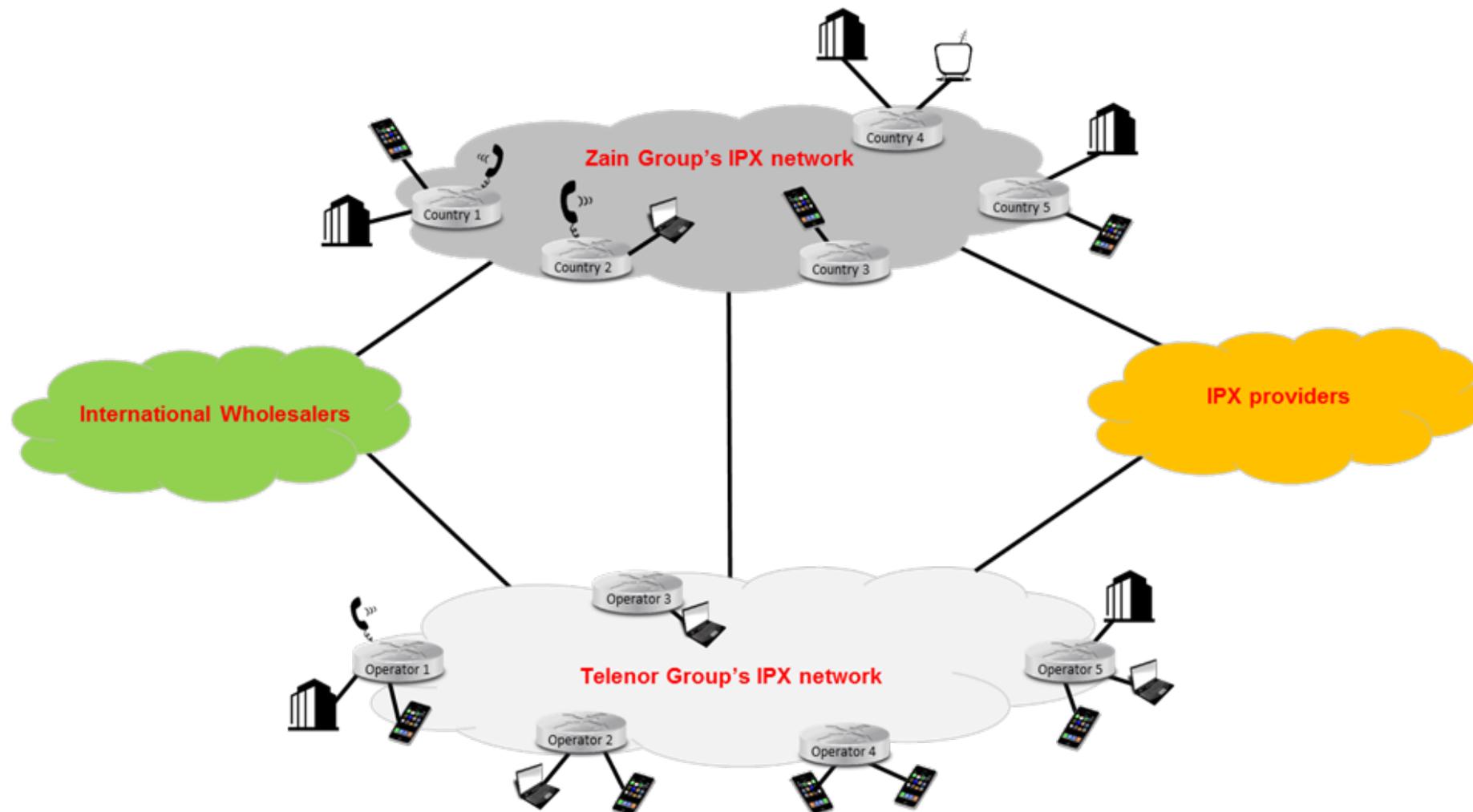
IPX providers

The final option, and one that is increasingly being seen as the long term solution to international interconnect of communications services, is to make use of IPX services offered by one or more IPX providers. Here, the IPX provider will offer a range of access PoPs where access to their platform is available. The mobile operator will generally organize some private transmission solution to interconnect to this PoP, which may be in the country or within the region.

The GSMA guidelines aimed at maintaining both security and end-to-end quality highly recommend that a private transmission interconnect is used, although it is possible to use an IPSec approach over the public Internet. In this latter case, security may be assured, but the quality of the connection in terms of packet loss, latency and jitter is subject to the normal behavior of the public Internet in the region.

Once connected, the mobile operator can use one of more service offerings in either a bilateral way (where the source and destination operators do their own commercial deal) or a multilateral or hub fashion where the IPX operator offers a price for the service including any termination charges applying at the distant point. In most cases, the hub service seems to be gaining the upper hand as the preferred option as it removes the need to maintain multiple unique commercial contracts and potentially rating and settlement arrangements as well.

Earlier chapters have outlined the different services available now and in the future and the mobile operator can use its access pipe to carry any or all of these services as they are required. Some IPX providers will also offer access to the Internet backbone over the same (larger) access pipe, which may make sense in some locations. When this is offered, the Internet access will run in a separate "path" within the physical connection to maintain security and quality of service for the full range of IPX offerings.

IPX providers may be global in scope, or more regionalized, in which case that IPX provider will be peering with others to extend their services globally. The advantage of a regional IPX provider is that they generally would have a much deeper geographic coverage with more PoPs available for interconnection and access to the services.

Specifically in Bahrain, we are only aware of one IPX hub or PoP in the country – the IPX installed and operated by BT. BT has taken a slightly different strategy to most of the other IPX providers in that it is focused mainly on getting as many service providers

connected as it can, using any technology, including public IP, as it believes that a key initial service of an IPX is to handle complex interworking issues. Their aim is to seamlessly handle the technology transitions such that a company connecting via IP can interface with one with a TDM connection for voice interconnect, for example.

BT will handle any necessary TDM/IP conversion between the two carriers. When that distant operator changes to a full IP interconnect, that can be handled independently by BT without any involvement for the originating carrier. BT also started primarily offering voice interconnect services, and only recently has extended that to the wider range of signalling, messaging and roaming support for mobile operators.

Etisalat has offered a different model with their IPX located in the UAE. They have gone for a hub and spoke model, with all their service equipment in the UAE but with transmission links on the region's transmission infrastructure allowing regional carriers to interconnect all their services by transiting via the Etisalat hub in the UAE. We understand that their hub is then connected back to Frankfurt and Amsterdam, through which Internet access and peering with other global IPXs can be established. Some pros and cons of each of the potential solutions are outlined in Table 6 on page 68.

As a conclusion to this section, we have evaluated each potential solutions' capabilities to help mobile operators in Bahrain meet their evolving requirements. It is clear from the results found in Table 5 on page 67, that the traditional wholesale option will not be able to support the mobile operators of the future. Most mobile operators however expect to continue to maintain a small number of direct interconnections with their main partners, complemented by IPX going forward. Some mobile groups in the region may be investigating the strategy of creating an intra-group IPX managed by their own wholesale arm. Figure 13 on page 66 provides an illustration of the Etisalat Smarthub scenario.

While local operators can establish transmission arrangements to access the hub of a Global IPX in another country, it does appear, from the information that we have seen, that this can be expensive depending on the transmission cable chosen. In some countries, multiple transmission providers compete to provide inter-country transmission service and hence the pricing is competitively set. In other countries, where more services remain in the hands of the incumbent provider, no choices exist other than this carrier to either transit the country or perhaps access a submarine landing station in that country and pricing in much less competitive in those instances.

Some pros and cons of each of the potential solutions are outlined in Table 6 on page 68.

As a conclusion to this section, we have evaluated each potential solutions' capabilities to help mobile operators in Bahrain meet their evolving requirements. It is clear from the results found in Table 5 on page 67, that the traditional wholesale option will not be able to support the mobile operators of the future. Most mobile operators however expect to continue to maintain a small number of direct interconnections with their main partners, complemented by IPX going forward. Some mobile groups in the region may be investigating the strategy of creating an intra-group IPX managed by their own wholesale arm.

**Figure 13: Etisalat's IPX Smarthub scenario**
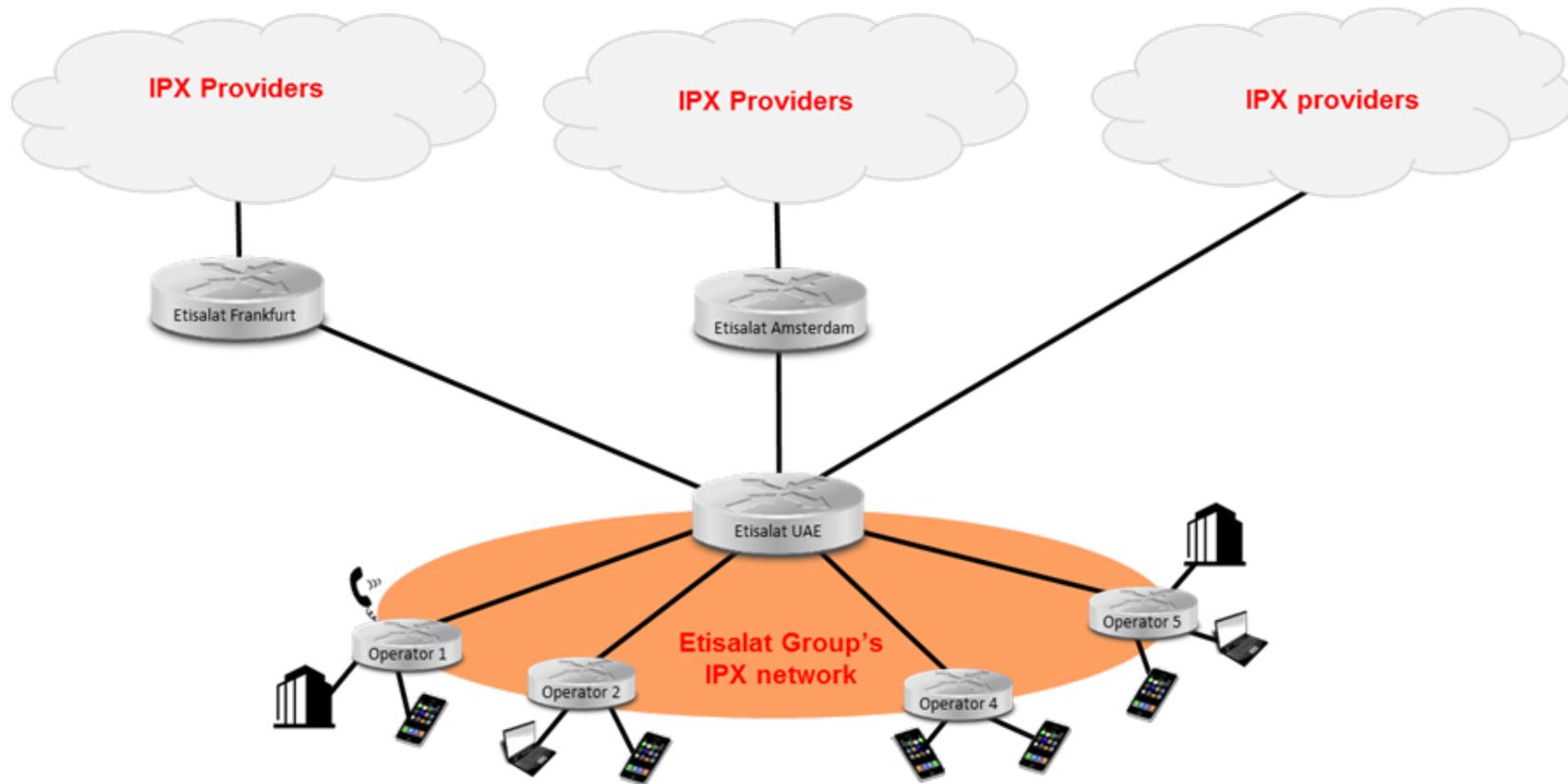
Table 5: Evaluation of potential solutions to meet Bahrain's operators' requirements

Bahrain mobile operators' requirement	Direct interconnect	Wholesaler	Mobile group platform	IPX provider
Improve Internet connectivity	3	3	3	3
Migrate voice termination to IP and support VoLTE	3	1	3	3
Improve quality and reliability of messaging	3	0	3	3
Facilitate seamless roaming	1	0	3	3
Rapidly grow LTE roaming reach	1	0	3	3
Implement a rich communication experience	1	0	3	3
Optimize CAPEX and OPEX	1	0	2	3

Ratings:

0	Poor
1	Average
2	Good
3	Very good

Table 6: Potential International interconnection solutions pros and cons

Possible options	Pros	Cons
Direct interconnections	· Private and secure connection · No middleman costs and delays · Can support many commercial models as required	· Resiliency must be considered · Operational costs can be high in support, billing, settlement · Rapidly becomes impractical (N^2 problem)
Traditional Wholesale providers	· Lower cost · Global reach	· Not a private and secured connection · Lower quality in many cases · Does not support LTE roaming and VoLTE capabilities
Private mobile group platform	· Private and secure connection · Can help create some economies of scale · Enables the group to negotiate as a single entity hence giving it increased bargaining powers. · Enables the creating of a seamless product and package experience amongst the group's operators	· Not all mobile operators in the group may want to join the group's platform · If the group has never been involved in wholesale before it could be complex and time consuming to create this entity from scratch
IPX providers	· Private and secure connection · Multiple service on a single pipe · One hub agreement for multiple destinations · Support LTE and VoLTE roaming · Support interworking between different types of service providers · Enables rapid migration to a full IP environment Internationally	· Priced at the premium voice termination level · Requires a private circuit interconnection to the IPX access point, which could be expensive

4.2 Bahrain's International operators' and IPX

Bahrain has licensed 15 International telecom facilities operators and 21 International telecom services operators, some of which benefit from both licenses. Many of these are regional players or wholesalers with operations in a number of countries.

Many of these will be migrating their capabilities to support a wider portfolio of IP services and would greatly benefit from an environment which facilitates this evolution, accessing International connectivity and benefiting from relaxed regulation. Some of these players may become IPX providers themselves down the line.

As discussed earlier in this chapter, BT is one of those operators and is in the midst of implementing its own IPX hub in the country. If Bahrain was to create the necessary environment for this to happen on a larger scale, a number of global IPX providers might consider Bahrain as a place of choice to implement an IPX hub or PoP.

Most global IPX providers operate a two layer network – a limited number of major hubs where major transmission paths converge and the majority of their service technology will be installed, and then a much larger number of transmission access PoPs on their global MPLS networks via which local operators can gain access to these services.

An access transmission PoP may only contain a rack or two of equipment with the ability to use local engineering staff (perhaps employed by the data centre they have leased space in) to manage the physical cross connect and interconnection of a new customer. Our definition of a major regional IP and IPX hub is one in which multiple IPX providers have installed core network and service equipment, are also offering competitive and high capacity links to the backbone of the Internet and where they normally have their own engineering and perhaps sales team in country to manage the growth of that hub.

In the Middle East at present, it is not clear that there is a leading regional IP and IPX hub. UAE may be seen as the main hub in the region, however its lack of deregulation and the continued duopoly of Etisalat and du, restrains new players from entering the market.

Using an example from the Far East, Singapore has become recognized as the place that global GRX and IPX networks will peer and interconnect and local operators from the region will establish capacity to Singapore for access to these various networks.

Bahrain could be a good candidate to replicate this business model and become the main Middle East IP hub, which would in turn attract a number of new players into the market. As a direct result, the quality of service (voice, data and Internet) and the connectivity in and out of Bahrain would be improved, whilst investment in the country's telecom market would be significantly stimulated.

It is clear that IPX providers need to extend their IPX networks into the Gulf region, and many of them have not yet committed to a location. BT has made its move with the installation of their IPX Hub in Bahrain, but we understand that few of the other major providers have made significant investments so far.

It is possible that the perceived difficulties of directly establishing their transmission/MPLS networks into the various countries of the GCC to enable local interconnects to mobile operators in those countries is behind their delayed investments. From their point of view, it is clear that mobile operators in the GCC need to connect to an IPX for LTE roaming as a minimum, and so the onus at present is on those operators to solve the problem themselves by establishing international connectivity to an IPX PoP elsewhere, or using a secure connection over the public internet.

GCC regulators should be considering what changes to regulation and competition policy would encourage more rapid IPX hub deployments as, to some extent, once one or two IPX providers make their investments, the others will follow quickly to avoid being left behind.

But the key question is: ***What is needed to become a successful Regional IP and IPX Hub?***

To answer this question, we have put ourselves into the minds of global IPX providers and have identified a number of factors that will influence their decision on where to install and operate major hubs on their IPX platform. As we outlined above, a major hub will access multiple transmission paths interconnecting to other global hubs on their network, will house service equipment and also supporting staff and engineering teams. They will support a number of more remote access PoPs off this hub, and directly connect mobile and fixed operators connecting via their own transmission paths or via cross connects in the data centre in the country.

A short list of key attributes of a good hub location would be:

a. **Access to multiple submarine cables (or land based fiber networks if appropriate).**
   The submarine cables need to be modern, high capacity, reasonably priced in comparison to the global norms, competitive in terms of being able to purchase or lease the capacity directly and responsive in terms of activation and maintenance. Easy access to the cable stations to gain access to their leased or purchased capacity (perhaps at the 10Gbit/s level) is equally essential.

   Owning submarine capacity but being unable to access it except via an incumbent local carrier is unlikely to make the location attractive. Multiple transmission paths are essential to provide reliable and resilient service to their other global PoPs, which is why London and Amsterdam have become such key interconnect points in Europe, for instance.

b. **Flexible and competitive access to domestic and regional transmission services.**
   These domestic fiber networks provide the ability to establish smaller regional access PoPs, and also allow the mobile operators to cost effectively establish high capacity links to the IPX PoP. Linked to this is the likely market for connected service providers that can be reached from this one location, more is better! The service providers will often be in other countries in the region, but need to be easily and cost effectively accessed using regional transmission capacity.

c. **Available data centre or colocation space**
   State of the art facilities with solid power, air conditioning and backup arrangements is also key. Although the number of racks needed for an IPX hub is not going to be large, many operators would be thinking about the potential for hosting customer servers, or establishing cloud based server platforms in the data centre to provide a wider range of services to the region.

d. **Growing telecom market with well-structured regulation**
   An environment where new services can be launched and sold to a large number of mobile and fixed operators at a wholesale level without complications and where voice and data traffic is growing. Also, it is important for a large portion of potential customers to be prioritizing high quality and secure services over lower cost, lower quality termination, as that is the market that IPX is targeting.

e. **Rapidly evolving LTE market**
   Any IPX provider looking to invest in a PoP, will prioritize countries or regions where LTE and VoLTE services are being launched at scale and where a number of customers will be expecting the advanced capabilities to be supported when they are roaming. This provides some certainty that there is a potential market, not only for outgoing and roaming traffic from that country, but also that other mobile providers around the world will be looking at reaching this destination for LTE termination.

f. **Large enterprise community**
   An environment where the IPX provider can support communications for the local offices of its multinational customers and potentially sell voice and data services to other enterprises in the country, again without complications.

g. **A stable economic and political environment**
   A safe environment for their employees, both expat engineers and sales personnel and local hires. Also, the long term stability of the economy and political environment is key, as service providers may think twice before they commit to significant investments in a country where the future is uncertain.

Extending beyond the direct IPX services, many global IPX operators are also large internet backbone companies and will be looking to offer IP transit, or access to the global Internet via their PoP. As mentioned earlier, this could be delivered to a local service provider over the same shared transmission path in some cases.

Once multiple IP backbone providers are offering service, this tends to encourage local peering (and perhaps regional peering) at an Internet Exchange. In addition, this creates the opportunity to route traffic going to the rest of the Internet over one or more backbone providers for resiliency and to get the best competitive price for the IP Transit service. Many of the requirements discussed above are equally applicable to establishing a competitive internet exchange with a focus on easy and cost effective access to submarine capacity back to the major global exchange points.

The next question that needs to be answered is: *Is Bahrain a good fit as a major IPX hub?*

Based on the pre-requisites outlined above we have analysed the potential for Bahrain to become a significant IPX hub in the region as follows:

Submarine and Fiber Networks

Although the major intercontinental cables, Flag and SeaMeWe4 do not land in Bahrain, there are several submarine cables that have been built to the country, including Flag/Falcon, FOG, Tata and GBI plus fiber routes via the King Fahd Causeway and the fiber route established along the power route operated by GCCIA.

Some of these are high capacity cables and extend – perhaps via India – to Europe and the USA. The fiber routes via Saudi Arabia provide connectivity into that country, but it is not clear that the capacity to other cable stations is available at a reasonably low cost. Similarly, we understand that the pricing of capacity on the submarine cables is not particularly competitive and that there are difficulties in reaching some of the cable stations in a competitive way. Without investigating this in detail, which is outside the scope of this report, it is fair to say that there is no shortage of capacity to Bahrain, but the commercial availability of high capacity transmission towards Europe and the Far East could be improved.

Flexible regional transmission capacity

A major IPX provider will want to see the opportunity to rapidly connect regional service providers, in Bahrain and in all the surrounding countries to their PoP with high quality, resilient and cost effective IP based transmission paths. This could be done by leasing transmission at SDH levels and deploying IP/MPLS switches and routers, or by making use of an MPLS service network if available. Some global providers may wish to deploy their own MPLS based regional network to make connection to their PoP easier, and to be able to extend global services to their multinational customers where possible and permitted by regulation.

It does appear that the submarine systems landing in Bahrain do connect to a number of adjacent countries, the GCCIA fiber system provides alternative paths between a number of countries, but it is not clear that an International IPX provider could obtain capacity on those facilities and extend it between countries to enable service providers in those countries to access the IPX Hub in Bahrain. It is recognized that this may not be in line with the aspirations of the incumbent international carriers in those countries, but this is a question for the GCC regulators to consider.

Available Data Centre colocation

The requirement here is for a competitive colocation centre with high quality accommodation and power/cooling without restrictions on how cross connects and relationships between carriers are supported.

It is understood that there is not currently a neutral colocation centre in Bahrain for carrier telecom equipment. An international carrier wishing to install equipment would generally form a partnership with one of the domestic operators and collocate equipment in their POP, generally using their transmission services to reach both submarine cables and other potential customers in the country and region. From an international IPX providers point of view, this can be seen as restrictive and certainly not ideal if the intent is to rapidly and cost effectively provide IPX services to all potential operators both in the country and also in adjacent countries.

Flexible licensing for wholesale services

In Bahrain, the global IPX provider would expect to be able to offer and provision wholesale voice termination both in the country to the licensed service providers and provide global termination for their outgoing calls. This needs to be able to be extended to HD calling, VoLTE and the potential that VoLTE offers to be able to switch to point to point video or video sharing as the customer requires.

In messaging, the ability to terminate SMS/MMS into the country and deliver SMS/MMS to other countries via direct relationships and via other wholesalers is a key requirement. While with roaming arrangements, both C7 and Diameter signalling would be supported to provide global roaming of Bahrain customers and also the roaming of global customers into Bahrain. Routing of their data browsing traffic back to the home network would be the normal approach, as the standards for local breakout of data roaming traffic do not exist for 3G roamers, and are not fully developed for LTE based roaming.

The regulatory environment is very well structured and defined in Bahrain and the International wholesale market is open to competition and presents little barrier to entry. However, while the Bahrain regulatory environment may support the wholesale roles, the Global IPX provider would also be looking to support similar wholesale services in the adjacent countries in the region and hence this is also an area for the GCC regulators to consider going forward. Not all countries in the GCC allow competition in the

International wholesale market and this may cause a hindrance in encouraging operators to invest in the region.

Providing service to local offices of a multinational customer

Although this is lower on the priority list, many global IPX providers also offer MPLS based services to interconnect the offices of a multinational customer that may be based in the USA, but have significant facilities in Bahrain. An oil company would be an example. The multinational would like the IPX provider to use their private MPLS network underpinning the IPX to interconnect all those regional offices, and so the licensing required to provision such services (which may not include actually selling services within the country) would be a bonus.

Growing telecom market and rapidly evolving LTE proliferation

As we discussed earlier, Bahrain does have rapidly growing adoption of LTE technologies (with the 3 mobile operators having launched LTE). A similar trend can also be extended in the region. As such, Bahrain would meet this criteria.

A safe environment for the engineering and sales team

We understand that Bahrain has a very large and active expat community and so we do not believe this would be an issue. Nevertheless, the recent political instability which currently prevails in the region, may be a factor that some of the potential IPX providers would take into account when choosing their PoP location.

From our summary analysis found in Table 7 on page 73, we can conclude that Bahrain would be a good candidate to evolve into an IPX Hub location, however improvement would be required when it comes to access and pricing of transmission connectivity.

Table 7: Requirements necessary to make a good IPX hub location

Requirements	Bahrain status	Rationale
Modern International cable connection	2	Connectivity exists but access to cable stations is not clear and pricing is high
Good regional cable and fiber connection	3	Connectivity is in place, but pricing and ease of provisioning not clear
Deregulated market (national and International)	4	Clear and open licensing environment
Well-structured and dynamic regulator	5	Clear licensing environment with focus on future developments
Large number of mobile operators in in region	4	All GCC countries have competitive mobile environments
Large and growing number of mobile subscribers in region	3	The GCC boasts a little over 83 million mobile subscribers, which accounts for only 1.2% of the world's total mobile subscriber base.
Extensive deployment of LTE in country and in region	4	LTE is being deployed rapidly in all GCC and adjacent countries
Growing International mobile traffic (voice, data and roaming)	4	International service demand is high and growing. Outgoing International voice traffic in Bahrain grew by 20.7% in 2013 and 27.7% in 2012.
Large enterprise and business community	4	Many global multinational (Oil and Gas and Banking) are in the region with a supporting infrastructure of local companies
Customers interested high quality global services	4	GDP per capita is generally high in the region with all GCC countries rank in the world's top 40. Qatar boasts the world's 3rd highest GDP per capita. [8]

Ratings:

1	Poor	
2	Average	
3	Good	
4	Very good	
5	Excellent	

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[8] Source: IMF World Economic Outlook, October 2014

4.3 The TRA/Bahrain government and IPX

We understand, from the TRA's Three Year Work Plan (2013-2015) that it is aiming at achieving the following key strategic objectives:

- Foster Competition
- Optimize technology
- Empower the consumer
- Ensure ubiquitous broadband
- Support Secure communication

As discussed at length in this report, IPX can help the TRA meet each of these objectives when it comes to International communications, as well as enable it to become one of the region's key IP hubs.

As we have explored in this section, the mobile operators in Bahrain do not need to have an IPX hub in Bahrain. They could gain all the global connectivity they require by interconnecting to IPX hubs in other parts of the region, by using leased (or owned) capacity to get to those PoPs. As such, the location of an IPX hub in Bahrain would not necessarily directly impact their ultimate access to those services.

However, there are solid advantages to having Bahrain become the key hub for IPX and IP services in the GCC. As a minimum, this would provide for direct and low cost connectivity to these global platforms, would similarly provide direct and low cost access to the public Internet, and that combination of benefits would attract other major carriers and multinationals looking to benefit from resilient high quality connectivity.

IPX could therefore play a role in ensuring that Bahrain becomes a location of choice for multinationals looking for high quality, secure communications in the region. The Kingdom could easily become one of the most advanced country in the region in terms of telecom service evolution and quality, but the necessary policies and plans would have to be implemented and the government will need to put the necessary environment in place to foster innovation.

Within the Kingdom, the extension of high quality IP based services all the way to the end user could be achieved by dedicating parts of the internal networks of the operators for this separated service, and ensuring that the bilateral connections between the operators are similarly segmented. Alternatively, the TRA could encourage the creation of a specific

IPX platform in Bahrain onto which all IP based service providers could connect for local and perhaps international extension. This network could be used to transport enterprise traffic with specific quality and security requirements, high quality advanced retail voice, data or video services and possibly M2M applications that require accessibility at all times. Simply put, enabling a complete Digital Lifestyle experience.

In addition, as content delivery will increasingly require high speed, high quality connections, if Bahrain was to become a location that meets this segment's pre-requisites, it could be in a good position to entice content providers to the country and it could then become a key hub for content in the region also.

Fostering high quality and security is already one of the TRA's objectives, but one of the keys to achieving this transformation is easy to access, high quality and affordable connectivity not only in and out of the country but also within it and this is maybe a point that needs to be worked on.

We therefore believe it is in the interests of the TRA and the Kingdom to encourage the development of Bahrain as a key IP interconnect node in the region as a first step.

4.4 The GCC region and IPX

If we extend this concept to the GCC, a pan-regional high quality, secure network could be created, not only to improve Internet connectivity, but also to support seamless innovative International and roaming services, high quality enterprise/government communication and possibly a regional M2M network for specific applications.

This could be achieved either through the interconnection of the different mobile group's IPX networks for example or by creating a separate regional network for this requirement specifically.

This could be a complex and lengthy project to achieve however, as none of the region's mobile groups currently have an IPX backbone. Nevertheless, it could be achievable as the region is small enough for a consensus and a common goal to be agreed between its members. It is definitely worthy of consideration if the region is serious in creating one of the most advanced telecom ecosystems in the world.

5

POSSIBLE OPTIONS FOR BAHRAIN'S OPERATORS

5

Possible options for Bahrain's operators

The previous section outlined the various ways that the stakeholders in Bahrain can solve their international service interconnect issues both now and into the future as technology evolves and the service requirements change. The option that is most appropriate for each company in Bahrain is obviously very dependent on their company strategy and objectives, overlaid with the strategy of any corporate group to which they belong. Equally, the level of investment of an outside group in the local operating company also plays into the best decision to be made.

This chapter will therefore outline and describe the possible options available to Bahrain's national and International operators, without necessarily giving specific recommendations regarding which option each of the operators should choose.

Four main options are available to the National and International service providers operating in Bahrain to take advantage of the IPX approach to facilitate and enable the evolution to the IP world. As the subject of this entire report is on the opportunities that are potentially available in becoming an IPX provider, several of these options address how a national/international operator or a mobile operator group could approach that objective. Of course, many (or most) service providers around the world are clearly focused on the needs of their customers in their market, and so making use of IPX based services from global or regional IPX providers is the natural choice in that case. These options are:

1. **Use one or more IPX providers to transport traffic in/out of Bahrain**

    Finally, the most likely option that can be used by service providers in Bahrain would be to not offer IPX services to other carriers and service providers and simply to use another IPX providers' offering to support its traffic in and out of Bahrain for direct interconnects and for roaming. This option minimizes the necessary investment and risk, while ensuring high quality and security for Bahrain's International traffic.

    It also supports LTE roaming, VoLTE termination and roaming and future service evolution but this is dependent on the chosen IPX providers' capabilities. So the choice of the IPX provider used is crucial. In many areas, mobile operators are choosing to interconnect to at least two IPX providers to give themselves resilience and some competitive negotiating power over pricing. As we have discussed before, moving all services onto one or two large IP based interconnects with global or regional IPX providers should result in capex and operating cost savings over time.

    While many mobile operators around the world will choose this option, it could restrict some group-wide features depending on the way those features are implemented. For instance, an enhancement to RCS type services that require access to a shared service platform could be more complex to implement if each operating company is using a different IPX provider.

When choosing an IPX provider to fulfil this role, key characteristics to look for would include:

- Global reach
- Scalable and flexible network
- Complete portfolio of voice and data services
- Advanced features such as RTI, Number portability, Fraud Management
- Clear long term strategy in terms of services and network
- Interconnection point in Bahrain and/or the region

It is important to note that service providers offering fixed, International, value-added or Internet services do not necessarily have to use IPX to transport their International traffic in and out of Bahrain. So not using IPX at all and continue with the status quo is also an option for these operators.

2. Develop a group IPX

One of the options that regional mobile groups could consider to become more competitive is to build a dedicated IPX platform between its regional mobile operations. This could support intra-group IP voice and data traffic, as well as traffic of all types between the groups' operators and the rest of the world.

If a group has multiple operations in-region and around the world, as is the case for the three mobile operators in Bahrain, this could be a good solution to facilitate seamless LTE and VoLTE roaming between its mobile operations as well as launch innovative group-wide enhanced customer applications to help monetize the higher data volumes and increase customer stickiness.

This option would also trigger significant network and operational cost savings (with all services being transported over a single IP based pipe), while giving the group (as a single entity) increased negotiation power with global wholesalers.

Nevertheless, this option is quite complex to implement initially, as investment in infrastructure and service equipment is required and the buy-in of most, if not all, of the groups' operators is key to its success. However, the benefit of being able to manage the group as a single cohesive entity, with pan-regional services, roaming pricing plans and applications could be beneficial, especially if there is a strong community of interest between the countries in the group.

3. Become a Regional IPX provider for the Middle East

An option that both mobile groups and International services providers in Bahrain could consider, if regional growth is on their agenda, is to build a strong regional network with the aim of becoming the Middle East IPX provider specialist.

There is currently no clear IPX provider specialised in the Middle East region at the moment, perhaps with the exception of Etisalat to some extent, so there is a need for someone to take the lead here and offer a more neutral service offering.

This strategy would enable this IPX provider to not only become a leader in the transport of International voice and data traffic within the region, but also to become one of the key gateways for the world's high quality and secure traffic to and from the Middle East. This would be a significant differentiator for an International provider looking for revenue coming from high quality, premium traffic.

Nevertheless, here again, a significant amount of investment in regional infrastructure and service equipment would be required, as well as work to acquire the necessary licenses in each country (if not already acquired). In addition, signing a number of peering agreements with key IPX providers in the rest of the world would be crucial to this providers' success.

4. Use a white label IPX provider to build a Regional IPX offering

As an alternative approach to building a regional IPX service platform from scratch, an option to offer IPX services rapidly, with lower risk and investment, could be to offer services using white label capabilities from one of the already operational global IPX providers which offer such service. This could also be a first phase for an operator looking to offer the service on its own network ultimately but wants rapid time to market or it could be used to complement its already existing IPX-based voice and data services.

This option is used by many to launch LTE diameter and data roaming for example to complement their already existing Voice over IPX offering. It is definitely an alternative to consider if a service provider is considering entering a new market, such as signalling for example, for which it has little knowledge and underlying network and equipment.

Nevertheless, this option puts the operator at the mercy of the white label IPX provider for services supported, quality and destinations reached. It is also an alternative that minimize competitiveness in terms of pricing as a local margin needs to be added onto a wholesale price from the white label company. Also, if this option is used to provide group-wide IPX, it could limit the services, features and capabilities that can be developed in a seamless fashion amongst the group's operators.

Even so, this is often a good first step in launching IPX or extending a service portfolio.

A summary of the pros and cons of the different approaches can be found in Table 8 on page 79.

Table 8: Summary of possible IPX options for national and Int'l operators

Options	Description	Pros	Cons
Use one or more IPX providers to transport traffic in/out of Bahrain	In this option, the national/International operator would use one or more IPX providers' offering to support its traffic in and out of Bahrain for direct interconnects and for roaming traffic and possibly to gain access to the global internet.	• Minimizes investment and risk • Ensures high quality and security for Bahrain's originating and terminating International traffic • Enables LTE roaming and future IP service evolution • Generates cost savings and economies of scale in the long term • You can use one hub agreement for all destinations	• Does not easily support group-wide features or offerings • Each of the op-cos in a group may use a different IPX provider, which could result in complexity and does not maximize group savings
Develop and Build a group IPX	Build a dedicated network between the operations of the corporate group to support intra-group IPX traffic as well as traffic between the groups' operators and the rest of the world.	• Facilitates seamless roaming between op-cos • Enables LTE roaming evolution • Enables the group to come up with shared enhanced customers application and data monetization possibilities • Generates cost savings and economies of scale in the long term • Gives the group negotiation power with global wholesalers • Increases competitiveness of the group	• Complex at first • Requires investment in infrastructure and services equipment • Some op-cos may not want to use it • Need to peer with other IPX providers to reach the rest of the world
Become the IPX provider for the Middle East	Build a strong regional network with the aim of becoming the Middle East IPX provider specialist.	• Enables you to become the leader in originating and terminating voice and data traffic in that region • Provide best quality and security to your own customers within the region • Enables LTE roaming evolution • Could create new sources of revenue	• Need to peer with other IPX providers to reach the rest of the world • Complex at first • Requires investment in infrastructure and services equipment • Requires sales and support staff
Use a white label IPX to build a Regional IPX offering	Use another IPX providers' white label service to start offering your IPX service. This could be a first phase to offering the service on your own network. This could also be used to complement your IPX offering for voice or data services.	• Minimizes investment and risk • Reduces the time to market • Good as a first step to give you time to develop your own IPX • Enables LTE roaming evolution	• At the mercy of the white label IPX provider for services, quality and destinations • Makes you less competitive when providing IPX services • Group-wide features or offering capabilities may be limited
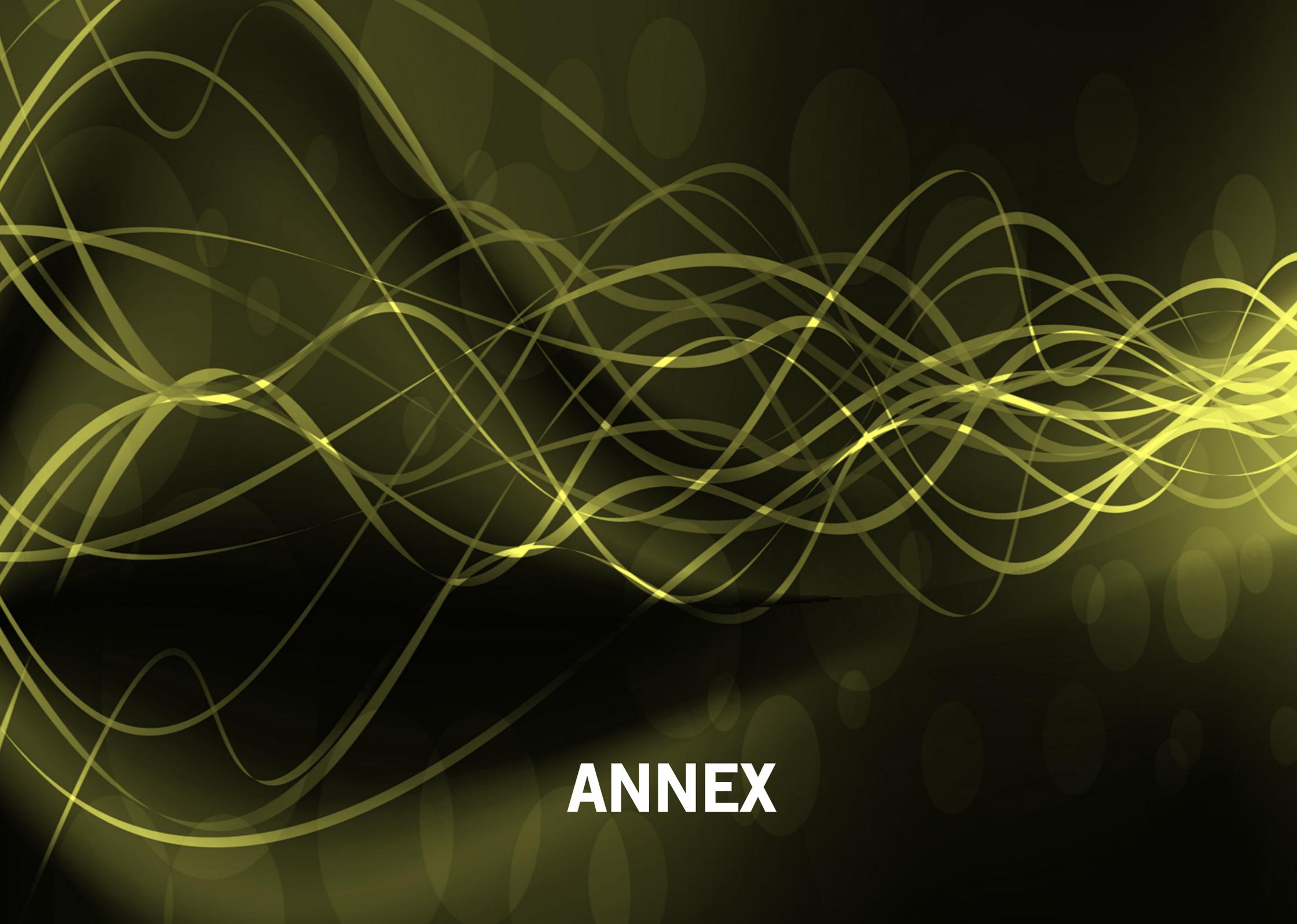
ANNEX

Acronyms

CAGR:	Compound Annual Growth Rate
CLI:	Calling Line Identification
GRX:	Global Roaming Exchange
GSMA:	GSM Association
HD:	High Definition
IMS:	IP Multimedia subsystem
IP:	Internet Protocol
IPX:	IP Packet Exchange
LATAM:	Latin America
LTE:	Long-Term Evolution
MEA:	Middle East and Africa
MMS:	Multimedia Messaging Service
MNO:	Mobile Network Operator
MOS:	Mean Opinion Score
NAP:	Network Access Point
OTT:	Over-the-Top service providers
PGAD:	Post Gateway Answer Delay
PoP:	Point of Presence
QoS:	Quality of Service
RCS:	Rich Communication Services
RIM:	Research in Motion
RTI:	Real Time Intelligence
SIP:	Session Initiation Protocol
SMS:	Short Message Service
TDM:	Time Division Multiplexing
VoIP:	Voice over Internet Protocol
VoIPX:	Voice over Internet Packet Exchange
VoLTE:	Voice over LTE