

## INTERNATIONAL INTERCONNECT FORUM FOR SERVICES OVER IP

(i3 Forum)

[www.i3forum.org](http://www.i3forum.org)

### **Understanding the different flavors of IPeXchanges (Release 1) May 2011**

#### **Scope**

This purpose of this document is to help the reader to navigate through and understand the differences of the main various forms of IPX networks and solutions that are being offered in the market so far.

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# 1 Introduction

The IPX is a technical network architecture and an ecosystem model elaborated by the GSMA to allow mobile operators to interconnect their IP services in a secure and guaranteed quality environment. In this document GSMA-IPX will be used to always refer to the IPX specifications referred by the GSMA in the AA80 [5], AA81 [6] and IR34 [7].

## 1.1 Purpose of the document

While the GSMA-IPX specifications and the first IPX trials have been available since 2008, it is only recently in 2010 that the first commercial offers for IPX networks have appeared in the industry. It appears that the term IPX is now used as a generic word and goes even beyond the mobile industry itself. It is often used to characterize new interconnections solutions over IP with very high quality. While high quality is a key element of the IPX concept, there is much more to it than just quality. One of the main characteristics of IPX is the interconnection and cascading of services across different IPX networks and IPX providers and for several layers of services. In order to promote future interconnections, it is necessary that these offerings are indeed compatible and interconnectable per the IPX specifications.

The GSMA-IPX specifications are for some of them an ideal and target solution that will be relevant when most of the mobile IP networks are in a full IP environment such as LTE. The I3forum is actively working with the GSMA to incorporate these GSMA-IPX specifications into its transition to IP. However, the carriers of the i3forum recognize that they need to provide a solution that addresses an end-to-end IP environment in the future but a solution that also takes into account and accommodates for the reality of today and a transition period with mixed TDM and IP environments for both fixe and mobile. The i3forum has elaborated and published recommendations for Voice over IPX services [3] which addresses most of the IPX requirements but that is also flexible enough to accommodate the various constraints of today's industry in a path towards full IP.

This document aims at educating the readers with simple and pragmatic service understanding of the several IP solutions that are often called or related to GSMA-IPX but that are all not alike and not all interoperable among them. This document is in no way intended to rank or favor a solution versus another, but rather to help the reader to make its own choice according to its needs and a good understanding of what is available in the market.

This document is to be read jointly with the other related i3 Forum documents which can be found at [www.i3forum.org](http://www.i3forum.org) :

- Technical Interconnection Model for International Voice Services
- White Paper Optimal Codec Selection in International IP based Voice Networks
- White Paper Mapping of Signaling Protocols ISUP to/from SIP, SIP-I
- Interoperability Test Plan for International Voice services
- Technical Specification for Voice over IPX service

## 2 References

- [1] I3 forum “Technical Interconnection Model for International Voice Services” current release
- [2] I3 forum “Bilateral Voice Service Description” Version 1.0, May 2008
- [3] I3 forum - Technical - VoIPX Rel 1, October 2010
- [4] i3forum - Service value and process of measuring QoS KPIs v1 may2010
- [5] GSMA AA.80 —Agreement for IP Packet eXchange (IPX) Services , Version 3.2, July 2009
- [6] GSMA AA.81 —PACKET VOICE INTERCONNECTION SERVICE SCHEDULE to AA.80 , Version 1.2, July 2009
- [7] GSMA IR.34 —Inter-PLMN Backbone Guidelines , Version 4.9, March 2010

### 3 Elements of comparison of GSMA-IPX, VoIPX and IPX.

It is important to understand the fundamental specifications of GSMA-IPX and VoIPX in order to compare IPX offers in the market. The following points will be used for the comparison.

#### 3.1 Scope of service

The GSMA-IPX address 3 layers and model of services

- **The Transport layer:** The service offered is IP transport over an GSMA-IPX network. The GSMA-IPX network is not aware of which upper layer service (voice, video, modem data..) is used by the transported IP packets. The IP packets are transported according to the priority that each packet has been tagged with by the sending party (the customer or another IPX network). Within a type of packet quality there is no other differentiation of prioritization and of quality of service. For instance in the transport layer alone, there is no differentiation possible for transport of high quality voice services and transport of standard quality voice services. There is only transport for IP packets tagged for dynamic and live QoS requirement such as Voice and all packets tagged for voice will received the same transport quality. It is to be noted that it is the sending party that decides of the transport quality for the IP packets that it sends.
- **The Bilateral layer:** In this service mode, the GSMA-IPX network provider is aware of the service transported and is in charge to act as a service proxy between 2 service providers. For instance, in a voice bilateral layer, the GSMA-IPX network will transport the voice IP packets, but it will also be in charge of the signaling functions and call management. In this mode an GSMA-IPX provider could be in charge to produce Call Detail Records (CDRs) and to transcode a voice call if need be.
- **The Hubbing layer:** This mode is technically the same as the Bilateral mode. The GSMA-IPX network provider is aware of the service transported and is in charge to act as a service proxy between 2 service providers. The difference lays on the business model and contractual relationship used in the bilateral and Hubbing mode.

#### 3.2 Business model

The business model underlined in the initial GSMA-IPX specifications calls brings significant changes in the business model used currently in the international voice services industry.

- **The Transport layer:** The transport layer is based on a pay per usage either on a \$/Mbs or flat fee per port. The model is based on sending and receiving parties pay. For instance a service providing sending 100Mbs of traffic and receiving 300Mbs of traffic will be charged for the higher of the two, in this case 300Mbs at either a \$/Mbs rate or a flat rate for the port purchased, 1Gbs for instance. The exchange of traffic between two GSMA-IPX networks can be done on a free peering basis or on a paid model. The GRX model uses a free peering model, the GSMA-IPX mode is unclear about what governs peering between two GSMA-IPX providers, it is therefore up to the GSMA-IPX providers to find their own agreements, possibly a free peering model similar to the GRX.
- **The transport layer as a subset of other services:** The transport layer can be sold alone as the IPX Transport Service defined in the GSMA, and normally does not depend of the type of service transported, it is depends on the type of quality that the SP buys. In the GSMA-IPX, Transport Service has 6 qualities (Conversational, Streaming, 3 for Data and Background), and the Service Provider has to contract the quality(ies) it requires. However, a transport service in the market today may be associated with an upper service such as GPRS data modem, Blackberry data, Sigtran, voice etc. In this mode and per the GSMA-IPX specifications, the cost for the transport should be billed separately

from the cost of the upper service. The IPX providers in the market can decide to use another model, and for instance bundle the transport charges with the service.

- **The bilateral layer:** In this mode also called transit service by the GSMA IPX, the GSMA-IPX network provides 2 services components.
  - The GSMA-IPX provider is just an enabler between two end service providers.
  - Charges in the GSMA transit model
    - The transit Fee: The transport services and the proxy services (voice switching, CDRs..) an upper layer service such as voice.
    - The service related fee e.g voice termination rate
      - Option 1, voice charges are settled outside of the GSMA-IPX directly between the sending and receiving party
      - Option 2, voice charges are cascaded between sending and receiving party THROUGH the GSMA-IPX provider(s)
- This model transit model is the GSMA-IPX suggestion, it is up to the industry carriers to decide if they want to serve that model or keep bundling the charges as per the current international voice business model.
- **The Hubbing layer:** In this mode the GSMA-IPX network provides a full service to a Service Provider. In the case of voice for instance, the GSMA-IPX network provides voice termination to any destination reachable through the GSMA-IPX and beyond. The service includes, IP transport, the proxy service (voice switching, CDR establishment, traffic rating, billing..) and in this case it does always include the termination charges of voice minutes. It has been agreed with the GSMA-IPX specification that for the voice service there would be no separation between the transport/proxy fees and the voice termination charges, they could all be bundled in a \$/minute as it is in the existing international TDM voice model.

### 3.3 QoS

QoS, and more specifically differentiated QoS is a cornerstone of the GSMA-IPX specifications and promises.

- **Transport QoS:** The GSMA-IPX is based on a set of interconnected private IP networks with predetermined and guaranteed IP QoS specificities. For instance. QoS at the transport layer is measured on Round-Trip-Delay between two points, Packet Loss and Jitter are also measured.
- **Upper layer services QoS:** It is important to note that the GSMA-IPX specifications only impose minimum QoS requirements for the IP transport, all other minimum QoS levels for upper services are left to be decided by the GSMA-IPX providers. While a good QoS on the transport layer is a prerequisite for a good QoS on the upper layer, it is not sufficient to have a good QoS on the transport layer to guarantee a good QoS on the upper layer. There are many other parameters that are actually much more important than transport for the overall QoS. The I3forum has published an extensive QoS white paper [4] on all the parameters beyond IP transport that impact the overall QoS for voice services.
- **End-to-End QoS:** The GSMA-IPX specifications promise an innovation to the industry by offering a model where the QoS is differentiated by service and even possibly differentiated among several QoS of a same service (high voice quality, standard voice quality). But the real innovation is the notion of end-to-end QoS, a control of QoS not only in one GSMA-IPX network, but from sending Service Provider up to the receiving Service Provider and through one of more GSMA-IPX networks. It is important to note that End-to-

End QoS does not mean user-to-user but is limited to the GSMA-IPX service between the two handoff of two service providers. See i3forum document [3].

### 3.4 SLAs

Along with QoS, the GSMA-IPX promises guaranteed GSMA-SLAs on the QoS parameters and a concept of cascading SLAs between all the parties in the chain between two service providers.

- **Transport SLAs.** QoS parameters at the IP transport layer are well defined and easy to implement SLAs. However, it is to be noted that most SLAs at the IP transport layers are limited to the GSMA-IPX network providing the SLAs, there is no transport SLAs beyond one GSMA-IPX network and there is no cascaded SLAs. One of the few reason that explain this situation is the lack of commercial contract between GSMA-IPX networks governing SLAs cascading and remedies.
- **End-to-End SLAs and cascading principles for upper layer services.** SLAs can be implemented based solely on a business decision. Such business decision is easier to take when there is a clear solution to assess the risk and to cascade the responsibility and the remedies to the network that is the cause of the QoS degradation. As detailed in the i3 forum white paper Service value and process of measuring QoS KPIs [4], it is not possible for the voice service layer to identify which party in a chain of GSMA-IPX and Service providers is the cause of QoS degradation. Consequently, for the moment there is no cascading SLAs in an GSMA-IPX environment. SLAs can be implemented when there is one GSMA-IPX network only, and where there is no need to cascade responsibilities. However, such environment provides a limited number of destinations with SLAs.

### 3.5 Interoperability

The GSMA-IPX specifications are very strict and detailed. As a consequence it is easy to guarantee and speed-up interconnections between several GSMA-IPX networks.

- **Transport layer:** At the IP transport layer the specifications are reasonably standardized and interoperable.
- **Upper layer services:** For upper layer services like voice, there are various standards and various ways to implement these standards. The GSMA IPX specifications are quite detailed but there is still room for some interpretations that make difficult a wide interoperability of the existing GSMA-IPX networks. Another challenge is the fact that some of the GSMA-IPX specifications are meant for a time when all Service Provider networks will be in Full IP either IMS or LTE. The GSMA-IPX does not fully accommodate for a transition phase with a mix of TDM, IP and in between solutions. As a consequence the market has moved into offering solutions that are marketed as GSMA-IPX and which address today's needs but that do not fully comply to all GSMA-IPX requirements. At the time of printing this document there is no GSMA-IPX network certified by the GSMA, nor is there any IPX services available across several interoperable IPX networks. The I3forum has published a white paper to provide high quality voice service over IP taking into account most of the GSMA-IPX requirements as well as providing alternatives to accommodate a transition phase between TDM, IP and full IP networks [3].

### 3.6 Some key technical specificities

Some of the technical specificities are cornerstones of the GSMA-IPX networks. Some of these specificities define whether or not an IP network is a GSMA IPX, whether an GSMA-IPX network can or cannot be interoperable with other GSMA-IPX networks and ultimately the extent of the

services and reach that the network can offer to its customers. This section describes some of the main technical specificities.

- **Private IP network.** For QoS and security reasons, a full GSMA-IPX network as per the GSMA specifications must only use a private IP network. Which means an IP network logically isolated from other networks using the Internet or accessible from the Internet. It must be an IP network that is only connected to other networks that are part of the GSMA-IPX system only. The GSMA specification recently authorized the interconnection of an GSMA-IPX voice equipment to the TDM network. However, for the moment the GSMA-IPX service specifications still do not account for an interconnection with the internet to reach other VoIP networks. Whether the use of a VPN over the internet is an acceptable solution to connect to an GSMA-IPX and not breach any security rule is still unclear from the current specifications (potential divergent requirements between the technical GSMA-IPX documents IR34 and the GSMA-IPX service documents).
- **SIP.** On the upper voice layer the GSMA-IPX handles the voice signaling. The type of signaling used determines some of the voice features rendered and the extent of the interoperability of the services. The current specs of the GSMA-IPX only support SIP-I [ITU-T Q.1912.5]. There are ongoing discussions to also support SIP-IMS [3GPP SIP]. It is to be noted that SIP-IMS is different and not compatible with SIP IETF [RFC 3261] used in many international and domestic voice interconnections. Consequently, a GSMA-IPX network that does not support SIP-I is not a fully compliant GSMA-IPX network.
- **Security and Border elements.** The GSMA-IPX being a private and isolated network it does not require security border elements. Such elements are required when there is a need to interconnect with or via the internet.

## 4 Main IPX offerings in the market

Since 2010 the market has seen several commercial IPX offers and even more VoIP solutions marketed as IPX solutions. This document segments the main commercial solutions and lists for each one the different specificities and services that these “IPX commercial solutions” offer.

### 4.1 Solutions based on I3forum VoIP interconnections recommendations

The i3forum has published recommendations on how to migrate VoIP traffic over IP. While these recommendations are not meant to be GSMA-IPX compliant, there are many similarities. [2]

### 4.2 IPX offers based on I3forum Voice over IPX recommendations

In the second half of 2010, the i3forum has published its own recommendations on how to transport Voice in an IPX environment while also taking into account interoperability with TDM and other IP networks, including with interconnections over a secured internet access. [3]

### 4.3 IPX offers based on GSMA-IPX

These are the current specifications publications in the GSMA website about what should be a GSMA-IPX solution as per the GSMA specifications. [5,6,7]



#### 4.4 IPX offers from an existing Voice TDM provider with IP access

Many of the existing TDM voice providers are enhancing their portfolio by allowing their customers to connect over VoIP. Some of these connections offer very high quality voice services and are marketed as IPX.

#### 4.5 IPX offers with the use of with Internet access

Some VoIP providers are offering to the mobile customers to move to VoIP and connect to an IP network marketed as IPX but which uses Internet for all or part of the transport network. These services are usually island services not interconnected with other IPX providers. Most of these solutions do not offer SIP-I interconnections.

#### 4.6 IPX offers dedicated for data services

Some IPX providers are offering and marketing IPX network only for the IP transport services and data upper layer services such as GPRS, Sigtran, Blackberry. These IPX providers do not offer voice services over IPX.

#### 4.7 IPX offers for data roaming only

Some IPX providers are offering and marketing IPX network only as an evolution of their GRX network and solely for the data roaming service GPRS.

## 5 Comparison of the market IPX offerings

### 5.1 Comparing the access solutions for the IPX offerings

Comparing specifications of IPX offerings in the market		5.1	5.2	5.3	5.4	5.5	5.6	5.7
		I3forum IP interco	I3forum VoIPX	IPX GSMA	TDM provider with IP access	IPX VoIP but with use of Internet and no SIP-I	IPX with multi data services but without voice	IPX for data roaming only (GRX)
access	Access to the IPX via IP for the purposes of transporting voice services	Y	Y	Y	Y	Y	NA	NA
	access to the IPX via Internet with secure VPN (Ipsec..) allowed (for voice)	Y	Y	NO	Y	Y	NA	NA
	IPX-P access supports SIP-(IMS-3GPP)	NA	NA	not yet	NA	NA	NA	NA
	IPX-P access supports SIP (IETF- I3forum)	Y	Y	NO	Y	Y	NA	NA
	IPX-P access supports SIP-I	Y	Y	Y	likely not	likely not	NA	NA

Among all the IPX offerings in the market, most of those that offer voice services provide access solutions that go beyond what is strictly possible per the GSMA-IPX specifications. For instance the GSMA-IPX does not allow internet access (even though internet VPN is not recommended but tolerated in the GRX specifications) nor the very well established SIP (IETF) signaling protocol. Commercial offerings that enable unsecured Internet access, secured Internet access (VPN..) or SIP signaling are answering a market need, but they are not fully compliant with the target GSMA-IPX specifications.

## 5.2 QoS

		5.1	5.2	5.3	5.4	5.5	5.6	5.7
Comparing specifications of IPX offerings in the market		I3forum IP interco	I3forum VoIPX	IPX GSMA	TDM provider with IP access	IPX VoIP but with use of Internet and no SIP-I	IPX with multi data services but without voice	IPX for data roaming only (GRX)
QoS	IP QoS is provided/guaranteed on the IP access and IPX core backbone	possible	Y	Y	likely not	NO	NA	NA
	Voice media QoS provided/guaranteed including the access and up to the hand-off to the destination network within the same IPX-P island	possible	Y	Y	NO	NO	NA	NA
	Voice media QoS provided/guaranteed including access and up to the hand-off to the destination network across 2 or more IPX-P networks	possible	Y in theory	Y in theory	NO	NO	NA	NA
	Voice media QoS measured through Border Elements on the voice path	possible	Y	NO	NO	NO	NA	NA
	Voice media QoS partially measured through IP routers	NO	NO	not defined	NO	NO	NA	NA
	Voice media QoS provided/guaranteed including access and up to the destination retail end-user network across 2 or more IPX-P networks (includes QoS on the destination domestic network)	NO	NO	Y in theory	NO	NO	NA	NA

While high Quality of Service is a cornerstone of the GSMA-IPX most of the IPX offerings in the market are not able to measure and guarantee the IPX QoS for voice per the GSMA-IPX specifications. This does not mean that these voice services offering do not have a good quality, it only means that they do not comply on how the GSMA-IPX specifications propose to ensure good QoS. It is however important for the reader to remember that the GSMA-IPX specifications for voice QoS are solutions which are only theoretical for the moment and do not have yet clear operational solutions to implement and to measure the QoS for voice. The i3forum recommendations for Voice over IPX [3] provide a detailed gap analysis and pragmatic solutions to provide the highest quality over IPX networks and be transparent on the limits if the model for the moment. A good, accurate and reliable solution to measure QoS is a prerequisite to be able to implement and offer sound SLAs.

## 5.3 Routing

		5.1	5.2	5.3	5.4	5.5	5.6	5.7
Comparing specifications of IPX offerings in the market		I3forum IP interco	I3forum VoIPX	IPX GSMA	TDM provider with IP access	IPX VoIP but with use of Internet and no SIP-I	IPX with multi data services but without voice	IPX for data roaming only (GRX)
Routing	IPX-P provides routing transparency to its SP customers (disclosing in advance how the voice call is routed: through 1 or more IPX, Internet, TDM..)	NO	Y	Y	NO	NO	NA	NA
	The IPX-P can use TDM breakout-breakin to terminate voice calls	Y	Y	Y	Y	Y	NA	NA
	The IPX-P can use a breakout-breakin to an IP network that's not an IPX network (internet, private IP network..)	Y	Y	not yet	Y	Y	NA	NA
	IPX-P is able to manage the termination for ported numbers and guarantee that calls go directly to the SP currently terminating/owning the number called. Onward routing authorized (aka call forwarding) by the SPs is authorized.	for some destinations	for some destinations	NO	for some destinations	for some destinations	NA	NA
	Direct routing and number portability managemnet by the IPX-P is not mandatory to terminate a call.	Y	Y	NO	Y	Y	NA	NA

One of the cornerstones of GSMA-IPX is transparency, which implicates the knowledge by the Customer on how its services will be routed. It is presumed that in a GSMA-IPX network, all voice calls will be routed within networks that meet the GSMA-IPX specifications. When that is not the case, simply because very few destinations will meet this criteria in the coming times, it is necessary for the IPX providers to disclose in advance how the destinations offered will be routed and let the customer make an educated decision on where and how to send its traffic based on the choices that are offered to him.

Another cornerstone of the GSMA-IPX is the direct routing of voice calls to the Service Provider network which owns and terminates the call to the retail customer (for mobile customers in roaming situation a direct routing means to the Home network). This requirement implies that number portability must be managed for all GSMA-IPX destinations, meaning that all retail networks (mobile

and fixed) connected to an GSMA-IPX and advertised as an GSMA-IPX destination must have a solution to manage number portability. For the moment there is no standard solution to manage number portability within the GSMA-IPX, which makes this requirement a theoretical one for the moment. The i3forum recommendations on VOIPX propose that the IPX provider is to disclose in advance which destinations/networks can be number portability corrected and can be guaranteed/sold as a direct IPX route.

### 5.4 Security

Comparing specifications of IPX offerings in the market		5.1	5.2	5.3	5.4	5.5	5.6	5.7
		I3forum IP interco	I3forum VoIPX	IPX GSMA	TDM provider with IP access	IPX VoIP but with use of Internet and no SIP-I	IPX with multi data services but without voice	IPX for data roaming only (GRX)
<b>Security</b>	IPX-P guarantees security even when using Internet access with the use of Border Elements and physical and logical separation from the internet (by dedicated Port and IP addresses not advertised in the Internet)	Y	Y	NO	NO	NO	NA	NA
	IPX-P guarantees security by not using the public internet infrastructure at all for access	NO	NO	Y	NO	NO	NA	NA

Security is also a cornerstone of the GSMA-IPX. It is a strong differentiator of the public Internet solution. The GSMA-IPX specifications guarantee security by totally isolating the GSMA-IPX from the internet. While this method certainly provides an excellent level of security (assuming that all the GSMA-IPX networks and GSMA-IPX customers themselves are deemed trustable), this solution constrains and limits the reach of the GSMA-IPX at the early stage of deployment. It is important to note that all GSMA-IPX offerings in the market that make use of the public Internet are not compliant with the GSMA-IPX specifications. The i3forum VoIPX recommendations [3] provides recommendations on how to use the internet in a very secure way which addresses the pragmatic need for reach of voice destinations as well as the high security targeted in the GSMA-IPX specifications.

### 5.5 Multiservices

Comparing specifications of IPX offerings in the market		5.1	5.2	5.3	5.4	5.5	5.6	5.7
		I3forum IP interco	I3forum VoIPX	IPX GSMA	TDM provider with IP access	IPX VoIP but with use of Internet and no SIP-I	IPX with multi data services but without voice	IPX for data roaming only (GRX)
<b>multi services</b>	IPX-P provides transport GRX data roaming only	NA	not defined yet	Y	NO	NO	Y	Y
	IPX-P provides Transport model (with classes of services)	NA	not defined yet	Y	NO	NO	Y	Y
	IPX-P provides service Hubbing mode for voice termination	NA	Y	Y	Y	Y	Y	NO
	IPX-P provides multi services through one IP access with classes of services and service aware	NA	not defined yet	Y	NO	NO	Y for data	NO

Providing multi-services in a single access pipe with differentiated QoS is a cornerstone of the GSMA-IPX specifications. However, this is not something that is available in the market offerings for the moment. Market offerings are either limited to voice only services, or data mobile only services. New offers are planned to appear in the market in 2011 to combine voice and data mobile services with one same access IP pipe.

## 5.6 Business model

		5.1	5.2	5.3	5.4	5.5	5.6	5.7
Comparing specifications of IPX offerings in the market		I3forum IP interco	I3forum VoIPX	IPX GSMA	TDM provider with IP access	IPX VoIP but with use of Internet and no SIP-I	IPX with multi data services but without voice	IPX for data roaming only (GRX)
Business	IPX-P provides transport SLAs (AA80) for the access and within the IPX-P IP domain	Y	Y	Y	NO	NO	Y	Y
	IPX-P provides transport SLAs (AA80) for the access and across several IPX-P networks	NA	Y in theory	Y in theory	NO	NO	Y	Y
	IPX-P provides SLAs (AA81) for voice for access and within the IPX-P domain	NA	Y	Y	NO	NO	NA	NA
	IPX-P provides SLAs (AA81) for voice up to and including the domestic destination network	NA	NO	Y in theory	NO	NO	NA	NA
	IPX-P provides transparency on routing (how to reach destinations)	NA	Y	Y	NO	NO	NA	NA
	IPX-P provides split of transport and termination fees	NA	optional	Y	NO	NO	NA	NA
	IPX-P provides Transport mode (with classes of services)	NA	NO	Y	NO	NO	Y	Y
	IPX-P provides Hubbing mode (voice multi-lateral)	Y	Y	Y	Y	Y	NA	NA

The business specifications such as SLAs and payment cascading are cornerstones of the GSMA IPX specifications. Most of the existing market offerings for voice IPX services are not compliant with these business GSMA-IPX specifications. Those that are partially compliant are actually very close to the I3forum VoIPX recommendations. There are mainly two reasons; the first one is that it is not the market priority yet to switch to a new business model (for instance there is no major need to split voice transport and termination fees), the second one is that voice SLAs cascading and other business characteristics are complex not yet well sufficiently defined in order to be implemented operationally across several networks.

## 6 Conclusion and recommendations

The GSMA-IPX specifications elaborated by the GSMA aim at providing to the industry an innovative solution to migrate Voice and other services over IP enabling end-to-end QoS, SLAs, cascading, security and convergence. Some of these features are aimed at a time when most retail networks will be in IP, over fiber, IMS or LTE to name only a few technologies.

For the moment, at a time where most services and retail networks are still over TDM, the challenges are to facilitate the migration over IP in a transitional form, with a mix of different technologies that need to interwork among themselves for still quite some time.

As these technologies evolve, so does the market, the need for convergence and the evolution of the business models. However, depending on mobile, fixe or on which region of the world, the changes are happening with different priorities and at different speeds.

The several solutions and offerings marketed as IPX in today's industry are trying to answer these different requirements. All of them bring value and all of them address a portion of the current market needs. However, very few and maybe none of them fully address and are compliant with the GSMA-IPX specifications. With so many and diverse implementations of an IPX offering, most of these solutions are not interconnected among themselves and only provide the limited number of onnet IPX voice destinations and no end-to-end QOS, SLAs and other promises of the GSMA-IPX across several IPX network providers.

As the market matures and as the technical challenges are overcome, the industry should see more and more IPX interconnections. In the mean time, this document aims at helping the reader to understand the main differences of the GSMA-IPX, I3forum VoIPX and other forms of IPX. Some characteristics can be very important for one Service Provider and less important for another one. It is not about which features are good or best (for instance public internet or private network, SIP or SIP-I), but rather to make an educated decision on the best solution to migrate to IP depending to each one current needs.

Along with this document, the reader should read the other i3forum documents about VoIPX [3] and voice QoS [4].