

360 VISION

04
2016

VoWiFi ROAMING

A LOOK AT HOW VOWIFI MAY CHANGE THE ROAMING WORLD FOR EVER

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BACK**



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VoWiFi ROAMING, A GAME CHANGER

Imagine a world where worrying about exorbitant roaming rates is nothing but a distant memory, where switching off your roaming capabilities on your mobile device is not the first thing you do when you land in a foreign country, and where the OTTs are not the first roaming choice of the subscribers.

Well this world is finally becoming a reality, and the catalyst is Voice over WiFi (VoWiFi). Mobile operators can now equip themselves with what could become the long awaited technology to go toe to toe with the OTTs on their own turf - the internet - and put an end to the era of the silent roamers.

Through WiFi roaming, operators can now offer high quality, auto connect zero touch authentication, which morphs the roaming experience to re-create what end-users enjoy at home.

In addition, VoWiFi as an extension of Voice over LTE (VoLTE) integrates with the operator's mobile core which, enables the seamless transition of voice calls from WiFi to cellular and ensure that quality and network availability are always optimized.

At the end of the day, customers don't really care about the network (cellular or WiFi). What they care about is: does it work everywhere and at anytime. They also now care if the connection offers high quality and speed, to support evolved voice and video applications, and more and more, if it is secure.

These expectations have created the perfect storm for operators to get the roamers back onto their network and offer them what they

have been yearning for all along: high quality, painless and affordable voice and data roaming.

But all this is fruitless, if mobile operators do not accept that the death of the silent roamer and the demise of the OTTs can only become a reality if they share the cost benefits of VoWiFi roaming with the end-users. This means extending the home experience to offer roam-like-home type plans or something similar for both voice and data.

If mobile operators succeed in doing this, it could mean that 100% of the roamers use their mobile operators' roaming packages to make calls when travelling, translating into a potential increase in voice roaming traffic between 50% and 400%, depending on the region. Furthermore, once the customer is back on the home operators' radar, it is up to the latter to make sure quality of experience and usage (and therefore revenue) is optimized, using a growing portfolio of real time monitoring and intelligence tools.

But this new world does not come without its sets of challenges. Some of the complexities operators will have to resolve to make this a reality include:

- Possible loss of quality of service control as the voice is carried over the public internet
- Incremental latency and associated issues brought on by the home traffic routing
- Real time metrics about the WiFi connection quality, based on ongoing voice session.

- Intricacy of managing the seamless authentication and access without the customers' intervention
- Managing complexity of hand-off between WiFi and cellular network in a roaming environment through intelligent and dynamic routing
- Ensuring the security of customers' personal information
- Negotiating and managing a global set of internet and hotspot partners

Part of the solution to tackle these challenges will certainly include the IPX providers as VoWiFi roaming hubs into the equation. Through their central location and role in the international telecom interconnect and network fabric, and through their rapidly evolving real-time traffic monitoring and visibility capabilities, these players are perfectly positioned to simplify the complexity of the VoWiFi roaming.

These providers could not only play a key role in dynamically defining the optimal local access points (WiFi or cellular), but they could also optimize the whole traffic routing process to its final destination.

This 360 vision paper will delve into each of the key elements of VoWiFi roaming. From the opportunity it represents for the different stakeholders, to the network architecture that needs to be put in place. It then goes on to define the challenges that this represents and how IPX providers can play in all of this.

Hopefully, by the time you have finished reading this paper, you will be convinced that, if operators play their cards right, VoWiFi could



become one of the greatest game changers in the history of roaming.

It is time to fight back!

Isabelle Paradis
CEO
HOT TELECOM





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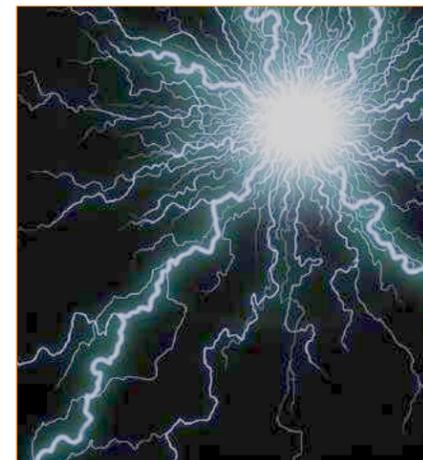
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CATALEYA

DEFINING THE FUTURE

Jay Jayasimha
CEO, Cataleya

Cataleya is, in my opinion, a dark horse in the carrier vendor space. A new kid on the block, having been formed only 2 years ago, it is already making its mark in the industry. Its next generation Session Border Controller (SBC) called Orchid One, already supports real-time fraud management and big data analytics, dynamic signalling, seamless SIP compatibility and last but not least, is VoLTE and VoWiFi ready. But more is to come and carriers around the world are increasingly taking on the future through Cataleya's solution.

I recently had the chance to talk with Jay Jayasimha, a telecom visionary and CEO at Cataleya, to find out his views on the future of our industry, with its challenges and opportunities. We also discussed how VoWiFi may revolutionize the industry, as we know it and finally, how the company sees its evolving role to help carriers future-proof their business.



TAMING THE IP NETWORK

What do you think are some of the key challenges that telecom operators are facing at the moment in terms of technology?

As smartphones are dominating the marketplace, subscribers are increasingly demanding high quality, rich content services and are expecting video and mash-up services as table stakes.

Unfortunately, mobile operators' legacy TDM infrastructure is really only optimized to support voice and SMS and these operators are therefore now migrating towards a new type of IP infrastructure that can enable these evolved services. However, this migration comes with associated challenges.

TDM by definition is very reliable, predictable, high quality and secure, but an IP infrastructure is none of the above. So the challenge is for operators to meet the evolving high quality demands from their subscribers, while rolling-out these new advanced services over an IP network. Regrettably, the IP network does not work as is and needs to be tamed and this is where a lot of the innovations need to come into place.

For example, mobile operators are busy implementing LTE networks, but voice over LTE is very complex and is therefore a key challenge that needs to be addressed. Operators and vendors have to develop the necessary technology and solutions that will make VoLTE a reality. This takes time, and end-to-end VoLTE crossing carrier borders is therefore not currently a reality in most cases.

By definition, LTE is end-to-end IP, but today due to the inability of the networks to support interconnected VoLTE, the voice traffic still

falls back to 3G infrastructures in large parts. As a consequence, for a long time to come, operators will be forced to maintain two networks to support voice.

This is where some of the IP innovations will come into play, so that operators can migrate voice to 4G and to an end-to-end IP environment swiftly, to ultimately be able to retire their 3G and 2.5G infrastructure and re-farm the spectrum.

THE PARALLEL UNIVERSE OF THE OTTS

Do you think the OTT challenge can still be tackled, or is it too late?

With the proliferation of Skype, Viber and WhatsApp in the voice and messaging business, subscribers now have a parallel universe to bring their voice needs into. As we all know, this has resulted in a massive loss of minutes for the traditional operators.

This is even more acute in the roaming world, where subscribers turn-off their roaming completely when in a WiFi-enabled zone. As a result, roaming revenue is completely lost. What is surprising, is that many operators are not even considering offering VoWiFi to their subscribers to compete with the OTTs and gain back some of their lost roaming traffic, because they do not see the revenue associated to this.

In my opinion, the roaming revenue train has already left and gone to the OTT players. So I do not think operators should even worry about this loss of roaming revenue. They should instead think of revolutionizing roaming completely, using VoWiFi. Because if they are able to offer customers a simple, straight forward and transparent roaming solution,



customers will choose that first instead of going to OTTs.

One of the benefits for mobile operators to offer VoWiFi roaming is in part to keep the customer on their network, both while he is in his home or in the visited country, something that does not exist now. At the end of the day, VoWiFi is a much simpler, lower cost solution to offer roaming to their end users, while ensuring high quality.

WHOLESALE AT THE CENTER OF THE VOWIFI ROAMING STORY

What role, if any, could wholesalers and IPX providers play in VoWiFi roaming?

Carriers should focus on supporting VoWiFi as a service in the roaming environment and creating the right commercial model, in conjunction with the mobile operators, to win this traffic back.

Many mobile operators are in-country based and do not have any visibility outside of their home network. Wholesalers and IPX providers on the other hand have global visibility and

connectivity with many mobile operators and ISPs and are therefore perfectly positioned as key partners to enable global VoWiFi roaming.

They can easily implement VoWiFi infrastructure in their global wholesale network to enhance the capabilities and service quality of mobile operators who are more locally based. This could be a very big play for wholesalers.

CATALEYA, EMPOWERING IP NETWORKS

What role is Cataleya playing in the current industry IP revolution?

Our main goal is to make IP networks as high quality and as predictable, reliable and secure as any TDM network. As mentioned earlier, one of the key issues is the adoption of IP infrastructure into the operators' networks to be able to offer complex multi-media type services as cost effectively as possible.

The main role of Cataleya is therefore to enable this migration from legacy to all-IP. This is a fundamental area of innovation that Cataleya is bringing.

‘Our main goal is to make IP networks as high quality and as predictable, reliable and secure as any TDM network.’



We uncovered many issues while developing our solution and are now able to offer comprehensive real-time visibility on the IP network utilisation, subscriber experience and quality. We were then able to add real-time fraud management packages on top of these visibility and analytics tools.

The next application we have added on our SBC, called Orchid One, is the support of VoWiFi. We have a partnership in place with a VoWiFi provider to offer an end-to-end solution and are presently engaging in trials with customers to help them support this feature.

Can you tell me a bit more about your capabilities in supporting VoWiFi?

The role of Orchid One in VoWiFi is to provide the connectivity between the client that uses the native features of the phone, and the virtual mobile core, where the VoWiFi application resides.

The benefit of using Orchid One in VoWiFi is threefold.

Firstly, due to our strategic position between the user, the WiFi Hot spot and the VoWiFi application, we have access to valuable information on a call-by-call basis and in real-time. For example, we are able to monitor the call quality and congestion levels of the hot spot (how it is behaving, how many subscribers are on it, is it overloaded or under-utilized, etc...).

We can then provide this intelligence to the VoWiFi application pro-actively, and enable it to take the decision to move the user from WiFi to mobile and vice versa, in order to ensure high quality of experience.

This is a great improvement to what exists today in terms of quality management over WiFi where decisions are not taken in real-time. This is one of our differentiators that stems from the basic analytics framework that we have.

The second advantage is that we can provide the necessary real-time analytics and the congestion level measurements that would enable a 3GPP node, and consequently the phone itself, to determine if the handset should go onto WiFi or not, based on quality and availability.

We are working with 3GPP on this feature to be able to deliver it in 2016. This information could also be used by WiFi hot spots to help them dimension their networks and identify where there are congestion points or quality issues.

Finally, we have the capability to provide local voice breakout in VoWiFi and this is a significant advantage to keep the service quality and routing efficiency as high as possible.

ORCHID ONE IS A LIVING AND BREATHING ORGANISM

What is on Cataleya's road map over the next 2 to 3 years to help international carriers support the IP evolution?

The analytics that Orchid One is generating has created a really interesting pool of data for us when it comes to the quality of interconnects. We provide a lot of this information in our real-time dashboards. From there, one of the things we invested in is to provide a backend big data analytics platform.

We will have two levels of analytics: one is aimed at the operation of the network and



services, looking at the performance of the network, of the interconnects and the quality.

The other one is aimed at the management, with business reports that show operators how much money they are making or losing with a specific interconnect and why. We are therefore giving them a clear picture of how their business is doing. This feature will be made available in April 2016.

IoT is another area where we are undertaking a lot of research and we are expecting that by the third quarter of 2016 we will produce some really concrete IoT use cases aimed at the fixed and mobile operators and carriers. This will be based on the actionable information we are gathering through our solution and/or through third parties.

We are also working on proofs of concept in media and content in cooperation with IPX providers using our Orchid One platform. Some of the concepts we are working on aim at optimizing the routing of the media to ensure optimal quality and efficiency.

We will also have an Network Function Virtualization (NFV) version of our Orchid One that will be launched in April 2016. We will offer both a software and virtualized version and will include some accelerators for virtualization into our solution going forward.

Finally, we are working on supporting VoLTE interoperability between operators and networks, which will enable operators to offer a comprehensive end-to-end VoLTE solution. This is achieved through the adaptation of different SIP signalling.

This will enable IPX providers to take VoLTE traffic and to terminate it to any other types of

networks (simple SIP networks, IMS networks, VoLTE networks, etc...) by adapting the signalling and keeping the call continuity. We are presently in the trial phase for this feature.

We see Orchid One and our big data platform as a living and breathing organism. We will therefore continue to work with operators and carriers to continue its evolution in parallel with their needs.



THE DEATH OF THE SILENT ROAMER

VoWiFi is not a new concept by any stretch of the imagination, but its integration into mobile phones is rapidly increasing in popularity with both end-users and mobile operators alike.

Technological advances around next generation WiFi calling, together with the proliferation of LTE networks and VoLTE services, means that this integrated solution is an ideal weapon to fight back against voice applications such as Skype, WhatsApp and Viber.

Could VoWiFi really be the long awaited instrument that mobile operators have been waiting for to finally win back their customers' voice roaming traffic from OTT applications and trigger the death of the silent roamers?

Time will tell... but let's see what impact it would have if it did.



A WIN-WIN FOR CUSTOMERS AND PROVIDERS

In a perfect world, voice calling should be totally seamless for customers, no matter where they are. This means that the voice application should be embedded natively within the phone dialer, should just work regardless of where you are, and should also work on any mobile devices and over any networks.

This is everything that mobile operators can enable with VoWiFi and everything that the alternative voice applications are not.

Through VoWiFi, end-users benefit from:

- seamless call transfer between WiFi and cellular (VoLTE, 3G and 2G)
- a single and uniform voice dialer integrated in the smartphone (no need to download a special application or have a separate identity)
- voice over any quality WiFi networks (home, office and hotspots)
- transparent user experience for voice and messaging whether the user is in WiFi or cellular coverage (with single call and messaging logs)

While at the same time, mobile operators benefit from:

- better network coverage (indoor and outdoor)
- a lower cost solution to expand their footprint
- an environment which bypasses the high roaming settlement fees
- offloading of the cellular access network to reduce spectrum needs

So there is still hope yet for mobile operators to win back their customers from other voice applications. Nevertheless, they need to get their act together fast and take the leap to enable VoWiFi capabilities and couple them with innovative pricing models. The success of the first is completely dependent on the other. No matter how simple, painless and efficient VoWiFi calling is, if the pricing is not right, customers will not embrace it.

This becomes even more the case when we extend this concept in a roaming environment. A world where mobile users are able to benefit from seamless VoWiFi/VoLTE while roaming, with all the benefits that it brings (including competitive roaming rates), may finally be a world where the evil word 'silent roamers' may become a plague of the past.

PRICING AT THE CENTER OF THE ROAMING WAR

Clearly, the main benefit of the use of VoWiFi in a roaming environment is that it enables mobile operators to by-pass the high roaming settlement fee charged by the visited network operators.

It therefore gives them practically complete control to create competitive roaming packages for their customers. This is key. As stated earlier, unless mobile operators are brave enough to finally charge for roaming at a sensible rate, they can forget about ever winning the operator/OTT roaming race.

They can therefore continue to expect between 50% to 75% of their roamers to switch-off their voice roaming capabilities as soon as they touch ground in a foreign country.

But priced correctly, VoWiFi roaming is



in my opinion the perfect opportunity for mobile operators to mitigate the voice traffic cannibalization they have suffered from in the last 3-5 years.

So what options do mobile operators have when it comes to setting VoWiFi roaming packages? In theory, mobile operators have 2 pricing options (see table below) to choose from and each comes with benefits, but also with some drawbacks, and using the right one is crucial.

Realistically, if a mobile operators' objective is to improve customer experience and stimulate usage, while accepting a lower margin on the potentially higher revenue stream, the best pricing option is Roam-like-home. From a roamer's point of view, this option virtually removes roaming related voice charges and his roaming call usage should, from there on, more closely mirror the usage he would have generated while at home.

It will be key here for operators to extend

the Roam-like-home type of packages to all roaming calls, both over WiFi or cellular networks. This will firstly keep this offering as simple as possible for customers to understand and use.

Secondly, it should ensure that maximum roaming traffic stimulation and repatriation (from the OTTs) is achieved. Through this offering, mobile operators therefore have the chance to finally give the customers what they have been looking for: sensibly priced, high quality roaming.

THE DREAM HAS BECOME REALITY

Some have decided to grab the VoWiFi roaming opportunity, namely T-Mobile, AT&T and Google (through its Project Fi) in the US. In Europe more recently, Orange Romania has started to offer this option and EE-UK will soon follow by extending its VoWiFi functionality from its national network to the rest of the world in a roaming environment.

VoWiFi roaming - packages options

	Status quo	Roam-like-home
Package options	Same rates and packages apply for WiFi roaming as they do now for cellular roaming	WiFi roaming calls are charged at the same rates as a call initiated from the home network
Benefits	<ul style="list-style-type: none"> ▪ Simple to implement ▪ No revenue cannibalisation ▪ Increased profitability for WiFi roaming calls 	<ul style="list-style-type: none"> ▪ Simple for users to understand ▪ Stimulates voice roaming traffic ▪ Compete with OTT offering
Drawbacks	<ul style="list-style-type: none"> ▪ Will probably not stimulate roaming traffic ▪ Customers will continue to choose cheaper or free options 	<ul style="list-style-type: none"> ▪ May put pressure on operators' roaming revenue and margin ▪ For simplicity, this same package should apply for calls initiated on cellular also



So, what type of voice roaming packages have been made available to subscribers so far over WiFi?

For subscribers of a T-Mobile Simple Choice plan, international roaming calls from any Simple Global country to any other country are US\$0.20/min (over WiFi or cellular networks). Additionally, subscribers get free Wi-Fi calling within the U.S., Mexico, and Canada, and free Wi-Fi calling from any other country to these three destinations.

Wi-Fi calls made from non-Simple Global countries to other countries are charged at T-Mobile's usual roaming rates.

In the case of Google, their Nexus 6P, 5X and 6 customers have access to transparent VoWiFi and cellular roaming to 120+ countries. After having paid a basic Fi fee of US\$20/month, Fi customers benefit from a flat fee of US\$0.20/minute while roaming on cellular network.

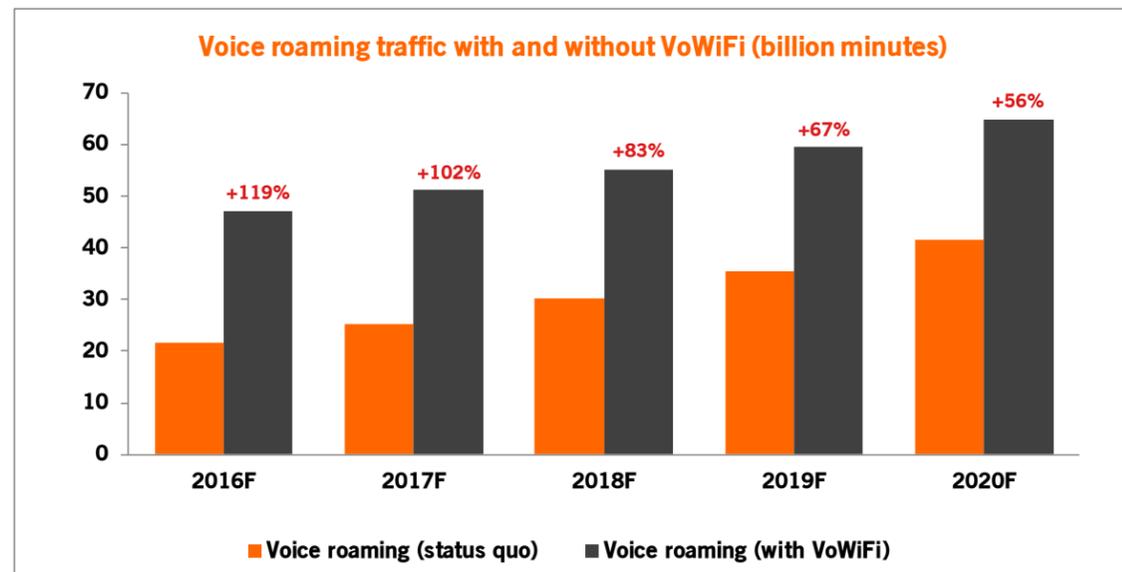
However, this is offered only for destinations supported by Google Fi. For WiFi calling, rates vary by destinations (these are rates used by Google Hangouts) and inbound calls are free.

This is only the tip of the iceberg, and I am convinced that as time goes by and as the number of VoWiFi roaming offerings increase, we will see a number of creative packages that will finally convince roamers to use their native phone applications to make calls when travelling.

THE POTENTIAL IMPACT OF A PERFECT ROAMING WORLD

If we were in a perfect world and if mobile operators across the globe switched to a Roam-like-home type of pricing structure (triggered by the introduction of VoWiFi roaming into the mix), what impact would that have on the roaming traffic worldwide over the next 5 years?

If a Roam-like-home pricing structure was to be implemented across the board for both VoWiFi and cellular network calls, we believe that the roaming voice usage would tend to mirror the home voice usage. In addition, the silent roamer phenomena would disappear, as roamers move away from having to seek out a WiFi connection and then start up their communications App and simply choose to use their native mobile operator's voice dialer.



Based on these two assumptions, we believe that if this had been implemented at the start of this year, voice roaming traffic would increase by close to 120% in 2016 alone. From an estimated 21.5 billion minutes (if using the status quo pricing structure), traffic would climb to an estimated 47.1 billion minutes.

As we move through time on our way towards 2020 however, the impact of a Roam-like-home package using VoWiFi would slowly decrease, as we believe that regulators around the world are moving towards that roaming pricing structure anyway, as we have seen in Europe more particularly.

Nevertheless, based on our current estimates, we believe that roaming traffic could easily grow by a Compounded Average Growth Rate (CAGR) of 63% over the next 5 years, bringing its total to 64.9 billion minutes in 2020, compared to 41.7 billion minutes if the status quo continues.

If we look at the potential impact on a regional basis, we see that the greatest impact would be felt in North America, where home usage is the highest of all regions on average and where current roaming rates are still very high. Additionally, the time spent away on each

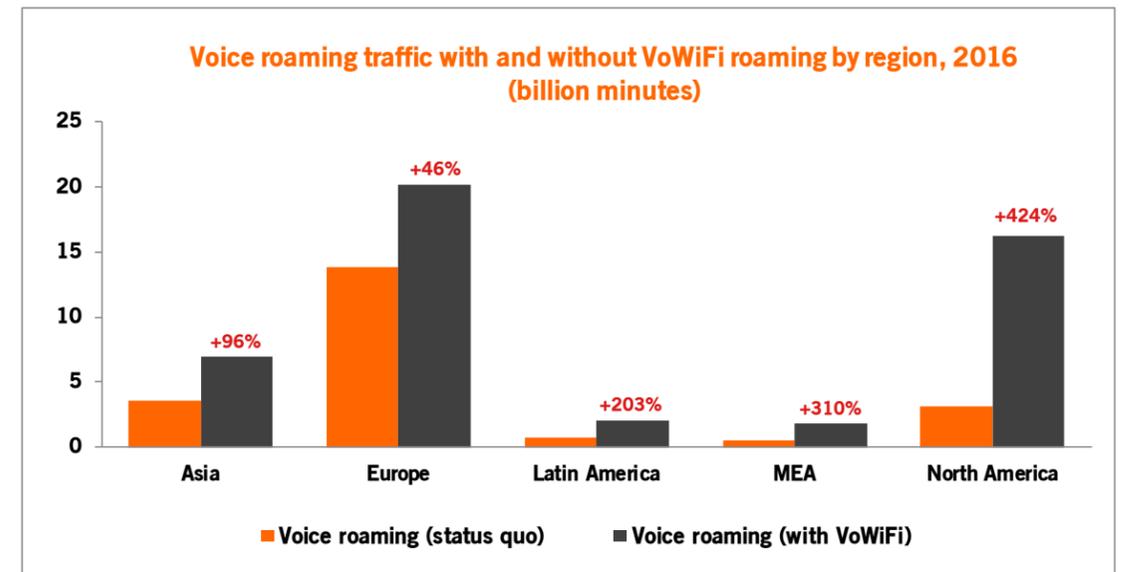
roaming trip (on average 11 nights) is the highest of all regions.

We therefore estimate that if Roam-like-home pricing was implemented, the roaming traffic generated by North American users would increase by 424% in 2016 (not a small number). The MEA and Latin America follow with a forecasted increase of 310% and 203% respectively.

At the other end of the spectrum, we find Europe, where roaming rates have already decreased significantly and where many are already benefiting from a Roam-like-home type plan while travelling. In addition, voice usage is continuing to drop across the region.

So in Europe, the impact of VoWiFi roaming coupled with Roam-like-home type packages would have a smaller impact. Nevertheless, an increase of 46% in roaming traffic is not negligible.

Now only time will tell if this becomes the new reality: a world where roaming fees and silent roamers are a thing of the past, and where OTTs lose their place at the head of the roaming empire.

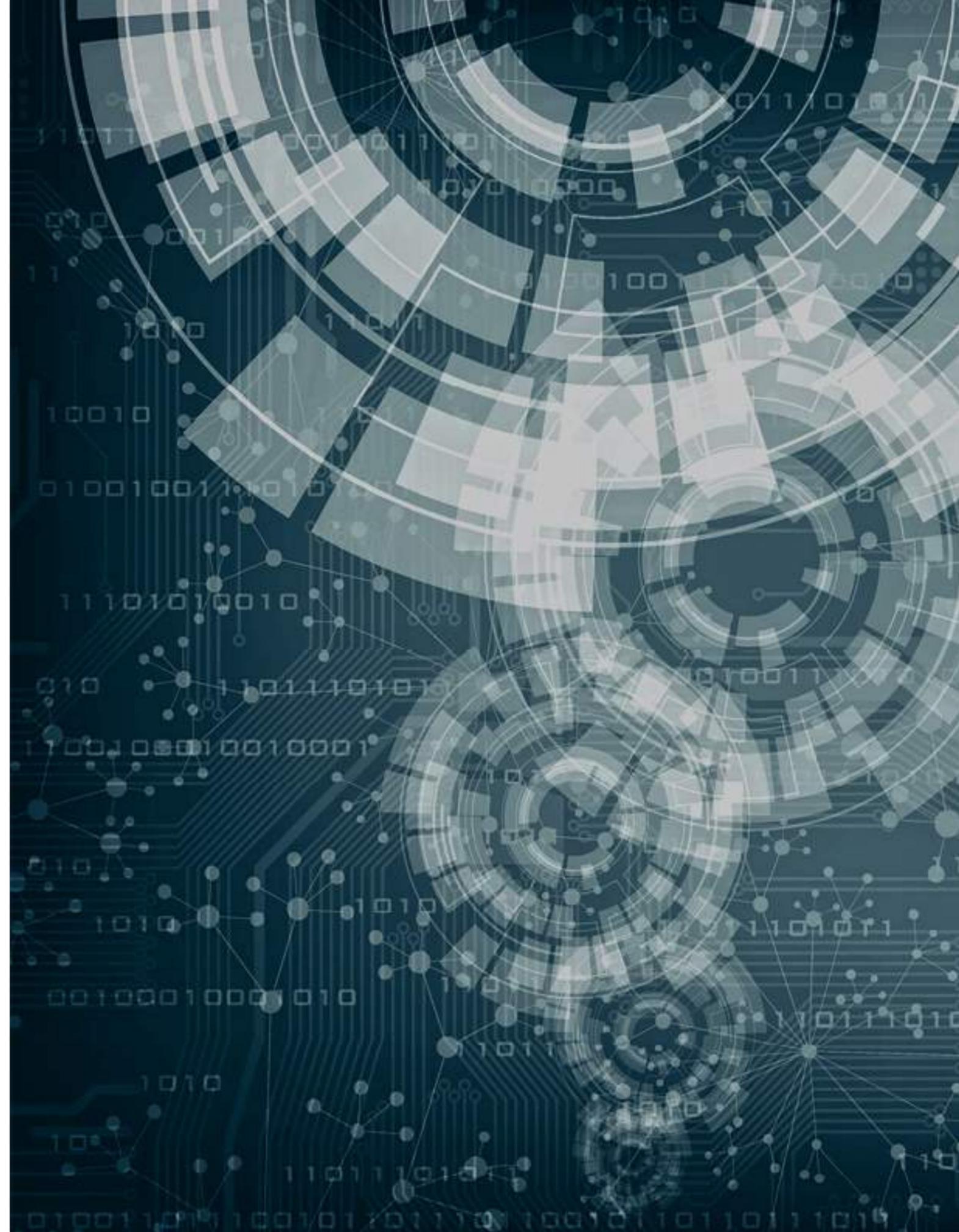


VoWiFi ROAMING

SIMPLE COMPLEXITY

The architecture required to support not only WiFi roaming, but also to enable transparent transition between WiFi and 2G/3G and LTE networks during a voice session is quite complex.

In this article we therefore need to delve a little deeper into the technology behind Voice over WiFi (VoWiFi) and how the extension of the service to the roaming environment introduces new challenges for operators and opportunities for intermediaries, such as IPX providers, to make the overall ecosystem work smoothly.





THE ECOSYSTEM

The VoWiFi roaming value chain is composed of 4 key components, each with its own set of opportunities, challenges and stakeholders:

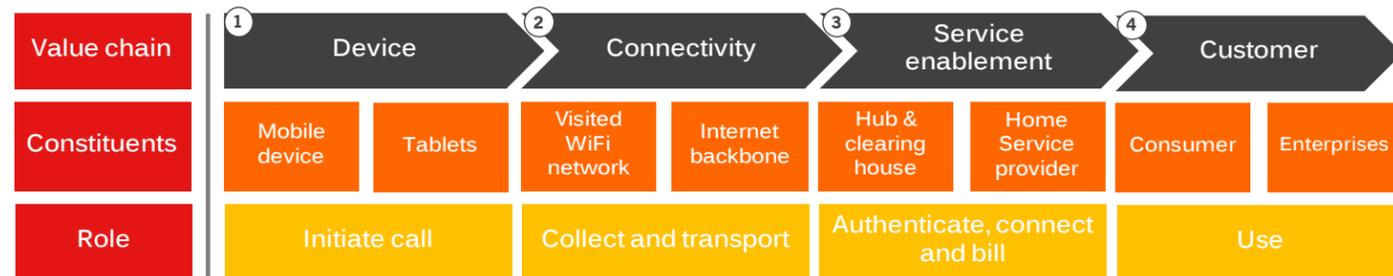
1. Device
2. Connectivity
3. Service enablement
4. Customer

The device is the mobile device (SIM or non-SIM smartphone or tablet) that has both WiFi capabilities and a VoWiFi client that could be either natively integrated into the main dialer or an additional App. Without that capability, the VoWiFi service cannot exist.

Prior to initiating a call, the connectivity must be assured by two different actors, the visited WiFi Network Provider through which the mobile device is connected (either a mobile operator's WiFi network or a WiFi hot spot) and the backbone internet provider, which ensures that the communication is transported back to the home network for processing and routing.

Next in the chain is the service enablement, which encompasses the authentication of the user as being able to make VoWiFi calls, the analysis of the call or session data to enable routing and call termination and, finally,

VoWiFi Roaming value chain



Source: HOT TELECOM

reporting and billing.

The last (and perhaps also the first) link of the chain is the user, who could either be the consumer or the enterprise customer, who uses and pays for the service.

While it is possible for a home service provider to establish all the arrangements with distant WiFi network operators via multiple bilateral arrangements, the complexity of commercial arrangements and contracts, location information, billing and settlement and quality optimization means that a hub and clearing house between the various players becomes highly preferable.

By virtue of their role as the "glue" in international communications, wholesalers and IPX providers therefore have a natural role to play in providing international connectivity and transport. However, some can also play the role of hub and clearing house and become central to the whole process.

THE TECHNICALITIES

While the hub and clearing house is a clear requirement for the initial WiFi connection and ongoing usage, VoWiFi has been designed to work directly with the home service providers' network, and some mobile operators will

choose to connect directly, at least for some of their major destinations.

Nevertheless, even if a direct relationship is developed between the home and the visited network providers for WiFi roaming, normal roaming arrangements with the distant visited service provider, for LTE and 3G services, will be operating in parallel. It will almost certainly involve the use of an IPX to enable and support those roaming capabilities.

But let's get down to basics and review what a directly connected VoWiFi roaming network architecture and call flow entails.

Network architecture and call flow

1. Creation of event

When roaming, customers can connect to either the mobile network (LTE, 2G and 3G) or a WiFi network. When connecting to WiFi, there are two possible scenarios: connecting to what is called a trusted WiFi network (if owned and managed by the mobile operator that the user is subscribed to) or an untrusted network (if owned and managed by a WiFi hot spot provider).

In the case of WiFi roaming, most of the WiFi networks are considered to be untrusted and will be treated as such, unless the visited WiFi network is owned by a mobile operator which is in the same mobile group as the home network operator.

From an architecture point of view, when a call is initiated over a trusted WiFi network, a SaMOG tunnel is used to reach the Trusted Wireless Access Gateway (TWAG) within the Evolved Packet Core (EPC) of the home service provider. From there on, the 3GPP S2a interface is used to integrate the EPC



with the Packet Data Network Gateway (PGW) and then onward to the IMS core.

When the call is initiated from an untrusted WiFi network, the device establishes an IPSec tunnel with the Evolved Packet Data Gateway (ePDG) in the home network, which then uses the S2b interface for integration with the PGW and the IMS core.

2. Authentication

Once the connection is initiated through the appropriate tunnel, the device will then communicate, using Diameter signaling, with the Policy and Charging Rule Function (PCRF) and the Home Subscriber Server (HSS) in the home network to confirm policy and approval for making VoWiFi calls.

3. Call routing

With the tunnel and authentication in place, the device is now communicating directly with the core IMS network of the home service provider. Voice calling can now be handled by that network (with voice SIP signaling) and the media can be routed via the tunnel over the public internet to the home network.

Calls from the device to the home network itself are directly terminated in that network, while other calls are routed onward to their destination. In the case of a traveler calling a colleague in the visited network, the voice call and media will trombone through the home network back to where it started in the visited network, which could add significant latency to the call.

This issue and potential solutions (through the use of an IPX provider as a VoWiFi roaming hub) will be discussed in the next article in this series.

4. Monitoring

The device is made aware of approved WiFi access points in its vicinity via communication with the Access Network Detection and Selection Function (ANDSF) server and it is continually monitoring the radio signal power it is receiving. It is also monitoring the strength of the public service wireless options (2G, 3G and/or LTE).

But nothing in this architecture is actually monitoring IP network congestion or comparing the performance of the WiFi network against the cellular network's quality to determine which will provide the best quality of experience. The only characteristic which is monitored is the strength of the signal.

Nonetheless, in real life, it is very plausible that even if a network provides a strong signal, it

could be congested or of low quality. While this is a complex issue to solve, monitoring of the voice session itself can give good information about the performance of the underlying infrastructure, and as we will see in the next article, is a function that an IPX provider could perform to optimize quality of experience.

5. Handover

As the customer moves around, or as the quality of the network it is connected to varies, depending on the policy established by the home service provider, the device will connect to alternative WiFi access points and maintain the voice call during the transition.

If no suitable available WiFi points are present, the device can connect via the public network (LTE or 3G or 2G with

some incremental network capabilities) in its vicinity. Furthermore, depending on the roaming plan offered to the end user, different billing arrangements will be triggered by the handover between WiFi and cellular and vice versa.

6. Clearing, billing and settlement

As mentioned above, during a call via a WiFi access point, the billing of the end user will take place according to the tariff set for VoWiFi calls by the home network. Although termination charges may be required for onward routing of the call from the home network, there are no voice related charges payable to the visited network. Data usage on the WiFi network will be settled (probably via the Hub).

However, when the call migrates to a 2G/3G or LTE connection, the operators involved will settle for that "new" call using their agreed roaming rates and the end user may or may not see an incremental charge on their bill, depending on the roaming package they have chosen.

- Back and forth of calls to the visited network and countries surrounding it, with incremental latency and associated issues
- Difficulty defining the optimal WiFi point to access, based on quality, congestion and availability

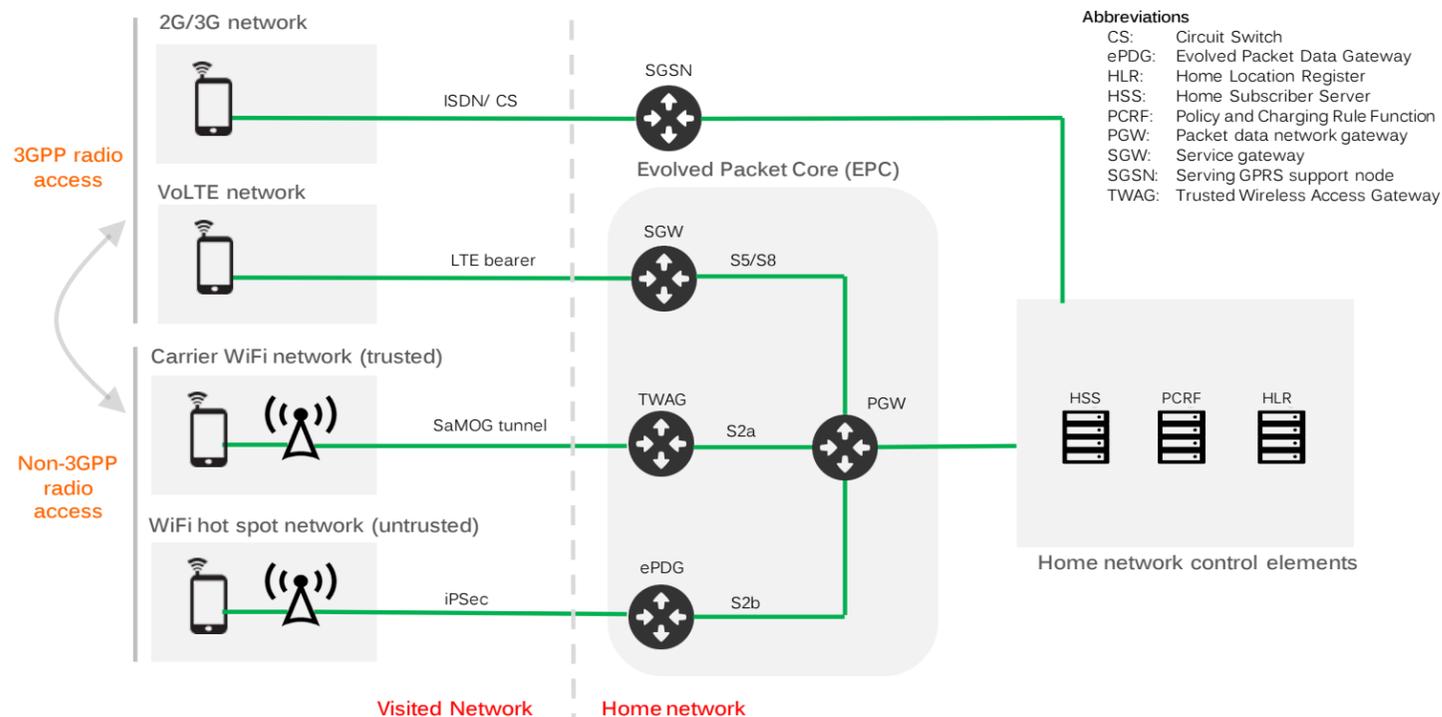
Security and Accounting

- Intricacy of managing selection, authentication and connection to appropriate WiFi access points
- Challenges supporting emergency services and locating the caller in case of crisis
- Complexity of meeting lawful intercept requirements
- Ensuring the security of customers' personal information

Access and Hand-over

- Managing complexity of hand-off between WiFi and cellular network in a roaming environment
- Managing accounting and settlement for WiFi connection charges
- Managing settlement of voice calls when a call transitions to a 2G/3G or LTE connection

VoWiFi roaming network architecture



THE CHALLENGES

The implementation of VoWiFi roaming does not come without its challenges, as the complexity is amplified by the many potential players now part of the solution, and as quality of service is increasingly on customers' mind. Some of the challenges that mobile operators need to tackle, if they want to support VoWiFi, while optimizing their customers' quality of experience include:

Quality

- Loss of quality of service control as the voice is carried over the public internet via many possible access points

Now that the scene is set, and the required basic architecture is clear, the final article of this series will investigate options for resolving some of these issues.

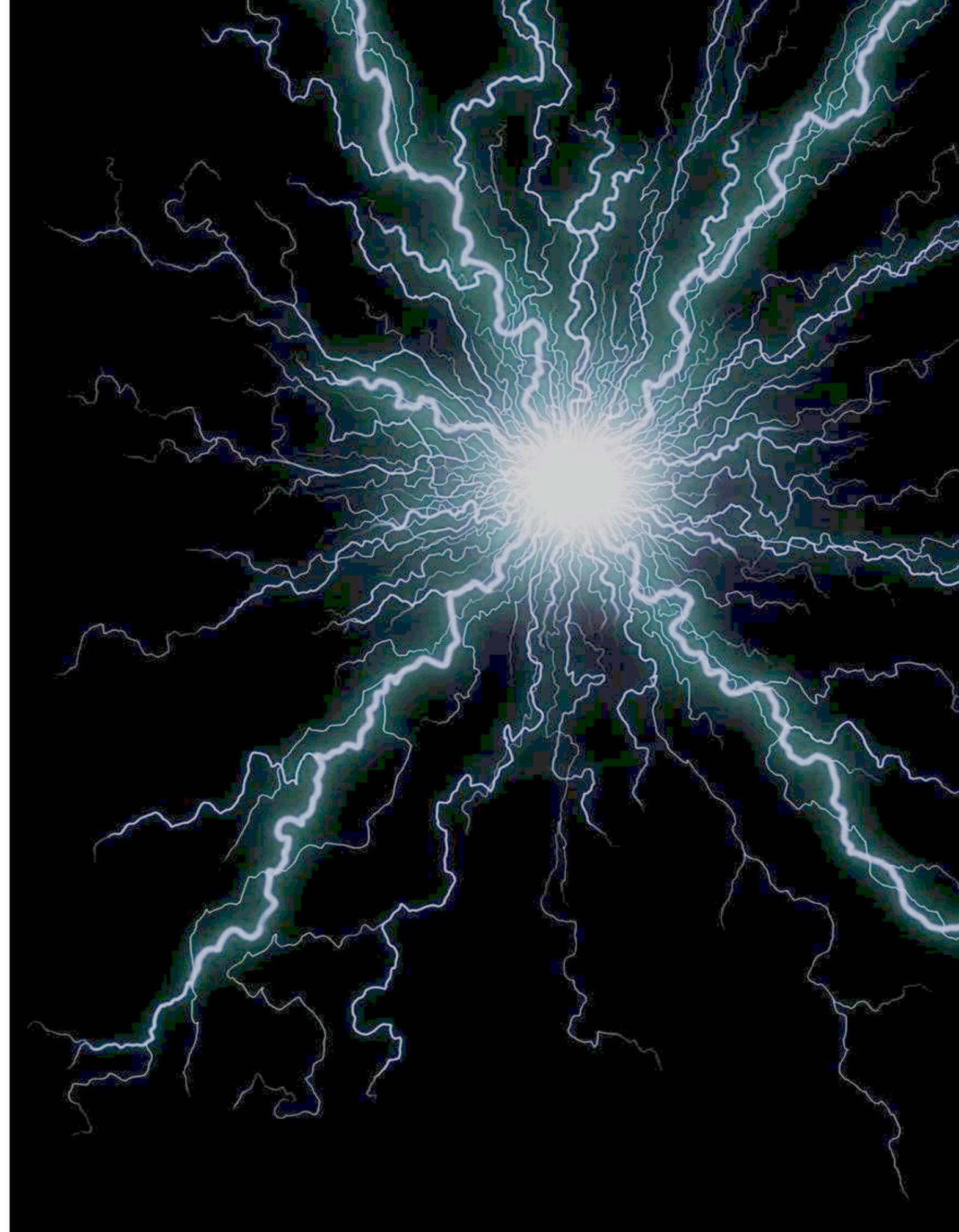
With continued technological advancement in real-time monitoring and control, the use of intelligent applications can enable new solutions to help tackle these challenges and, as we will discuss, IPX providers have a central role to play in this equation.

IPX PROVIDERS THE NUCLEUS OF VoWiFi ROAMING

Voice over WiFi (VoWiFi) roaming is a complex undertaking, which requires the involvement of multiple stakeholders for it to become a reality. Challenges therefore not only come from its technical intricacies, but also from a multitude of commercial and quality aspects, as well as the coming together of a number of stakeholders.

As a central point to the whole WiFi roaming ecosystem, wholesalers and IPX providers have the relationships and the visibility required to play a key role in the success of VoWiFi. We therefore believe that enabling WiFi roaming should be on any major IPX providers' roadmap, if they are serious about playing a role in their mobile operator customers' evolution.

Here are our views on the role IPX providers could play in the VoWiFi equation, what is in it for them and finally, what are some of the potential business models they could implement to climb up the VoWiFi roaming value chain.





IPX PROVIDERS AT THE HEART OF VOWIFI ROAMING

Making Voice over WiFi calls while roaming is essentially invisible to either the visited network or the IPX provider handling normal roaming signalling and call handling. This is due to the fact that once the WiFi roaming connection is set-up, the voice call is handled in an IPsec tunnel over the public internet between the handset and the various servers in the home network.

The call is then either terminated in the home network or onward routed to its destination (the visited network or internationally).

One of the issues here is that voice calls to the visited network (which could be significant for business travellers) are routed around the world. In addition, the quality of the call is potentially compromised, as it is dependent on unmanaged internet access.

I therefore believe that major wholesalers and IPX providers are perfectly positioned to help mobile operators deal with these routing and quality issues. They will be able to support the growth of the VoWiFi roaming ecosystem by playing a central role in simplifying interactions between carriers around the world.

Partly based on specifications developed by the Wireless Broadband Alliance and 3GPP, which define the different processes to facilitate a successful WiFi connection and then a VoWiFi roaming call, I think that IPX providers, who want to play a key hubbing role in VoWiFi roaming, should aim to support the 6 following functions:

Authentication and Policy

Here, the VoWiFi roaming hub is involved in

enabling the authentication and authorization of the user by terminating the IPsec tunnel and then confirming the ability of this user to make VoWiFi calls with the home network.

Financial clearance and wholesale billing

This activity encompasses the validation, processing and rating of the call records, together with the wholesale invoicing and settlement between carriers. The same records can be used for retail billing by the home network.

Transport and termination of voice session

As distinct from data WiFi roaming, the media for a VoWiFi call will be routed back to the VoWiFi roaming hub in the IPX for a routing decision. This enables regional breakout where calls to the visited network are routed there from a regional point close to that destination, and calls back to the home network are onward routed over the IPX. Other international calls are routed as appropriate.

Therefore, a natural role to be played here by the IPX provider involved in VoWiFi roaming will be to transport and terminate this traffic at the highest quality and the lowest cost possible. Different potential business models to be used by IPX providers to achieve this are possible and detailed in the following section of this article.

Usage and quality monitoring/reporting

IPX providers at the centre of the authentication, clearing, billing and media transport, will have visibility of all the key elements constituting the VoWiFi flow. From there, they can easily monitor and report in real-time on customer usage, fraud and network quality.

In some cases, they could also take the necessary actions based on the information

gathered (in the case of fraud for example).

IPX providers could also monitor the voice quality (MOS and R-Factor) of these VoWiFi calls and help determine (in real-time), whether it would be most optimal to move the call (without disruption) to a cellular network or to another WiFi network.

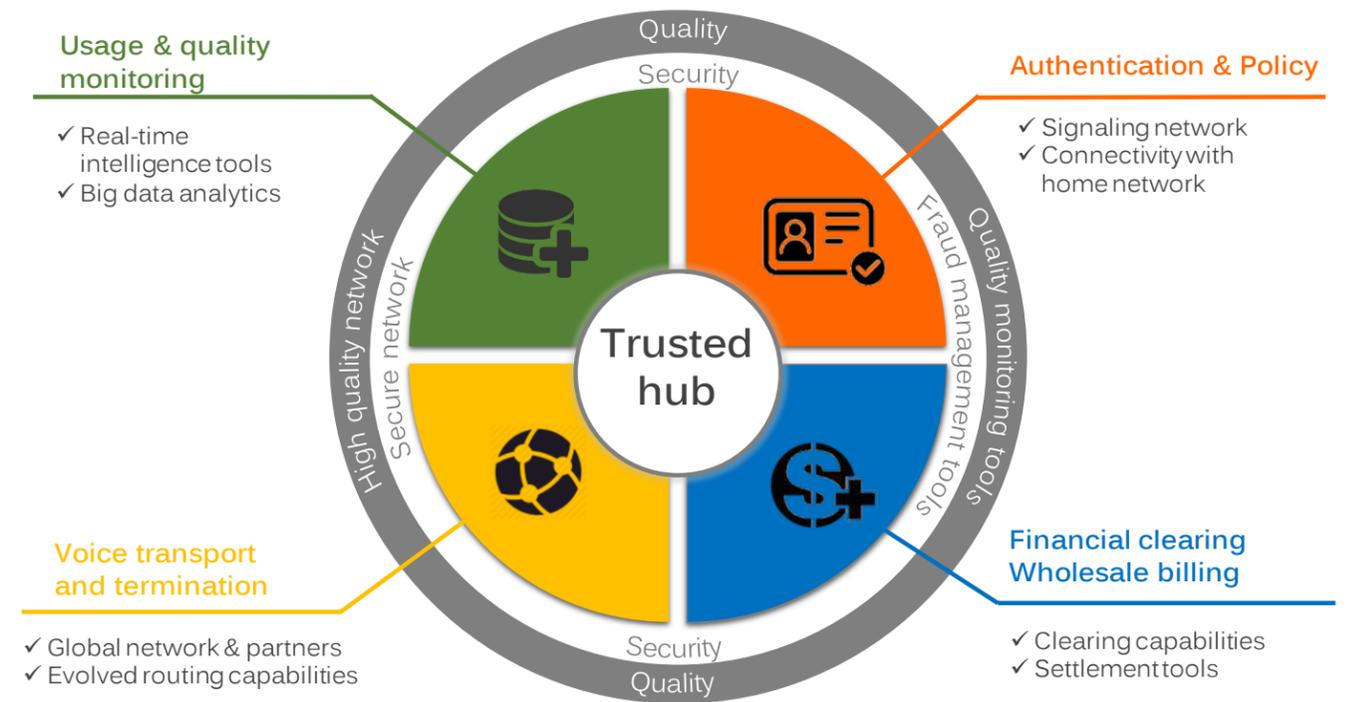
In addition, up to date information on each of the WiFi networks (provider information, location information and SSID) could be kept by the IPX provider on its secure IPX cloud application to be tapped at any time to manage policy around which Access Point to connect to.

Quality and security

In addition, as quality and security have now become an integral part of each of the VoWiFi constituents, IPX providers will need to support each of these functions over high quality and secure networks and systems. Fraud and quality monitoring (as mentioned earlier) are therefore crucial capabilities to add to the mix.

Here again, IPX providers' central location within the VoWiFi roaming environment and the visibility they have of all parts of the communication flow, puts them in a perfect position to achieve this.

Possible roles of IPX providers in VoWiFi Roaming



Source: HOT TELECOM



Trusted hub and deal maker

Finally, a further function that IPX providers could play in the WiFi roaming environment is the role of a trusted hub and deal maker.

By nature, IPX providers are connected to a large number of mobile operators globally, and if they could add to these relationships key global hot spots providers, they could easily bring the two together and enable WiFi roaming (with managed VoWiFi) as a service.

In this case, the IPX providers would be the trusted party in the middle and would enable the commercial and technical side of this type of agreement using a one stop shop business model.

Through this proposition, mobile operators could rapidly deploy WiFi and VoWiFi roaming globally at low risk and low cost. On the other hand, hot spots could then benefit from an expanded pool of customers, almost overnight.

Lastly, IPX providers could use this proposition to add incremental services that are not dependent on the per minute model, helping transition them to the future.

The diagram on the previous page summarizes the possible functions IPX providers could support in VoWiFi roaming, with some of the capabilities they will require to do so.

VOWIFI ROAMING HUB A SOLUTION TO MANY EVILS

In order to enable the functions outlined above, and offer what we call VoWiFi roaming hubbing services, IPX providers will need to play a central role in the whole call flow, not only for authentication, monitoring and accounting, but more importantly for voice hubbing.

VoWiFi normally transits directly from handset to home network and so fulfilling a roaming hub service requires the tunnel to be terminated and the voice calls handled and routed.

In this scenario, the IPX provider is in charge of not only coordinating the Authentication, Monitoring and Clearing / settlement of the WiFi roaming session, they are also more importantly in charge of managing the VoWiFi session itself, routing all the traffic, whether it is terminating in the home network, in the visited network or internationally.

In this case, the traffic is directly routed over the internet from the WiFi hot spot to a regional hub of the IPX provider. From there, the IPX provider terminates the IPsec tunnel, gains authorization and policy from the home network and takes the necessary voice routing decisions to optimize call quality, without the need to route all the traffic back to the home network.

This does require a new network component (which we called the hybrid SBC/PSCF) which is in the process of becoming available from some vendors. This device's main functions are to establish policy for the call (by signaling to the home network) and then handle the SIP signaling and routing decisions necessary to route the call itself.

Therefore, in this case, the traffic destined to the visited network would be routed back (using regional break-out) and the international traffic would be sent from that hub via the IPX itself or other wholesalers. The traffic destined for the home network would be sent over the IPX to the home network's mobile operator.

The benefits of this scenario for mobile operators, compared with the bilateral option



discussed in the previous article include:

- Simplification of some of the operational and commercial functions
- A more regionally appropriate routing of the voice traffic
- Involvement in the rating and settlement of voice calls with other carriers simplifies that function for the home operator
- Potential use of the IPX provider as a trusted deal broker, minimizing the risk, cost and time of implementing VoWiFi roaming globally

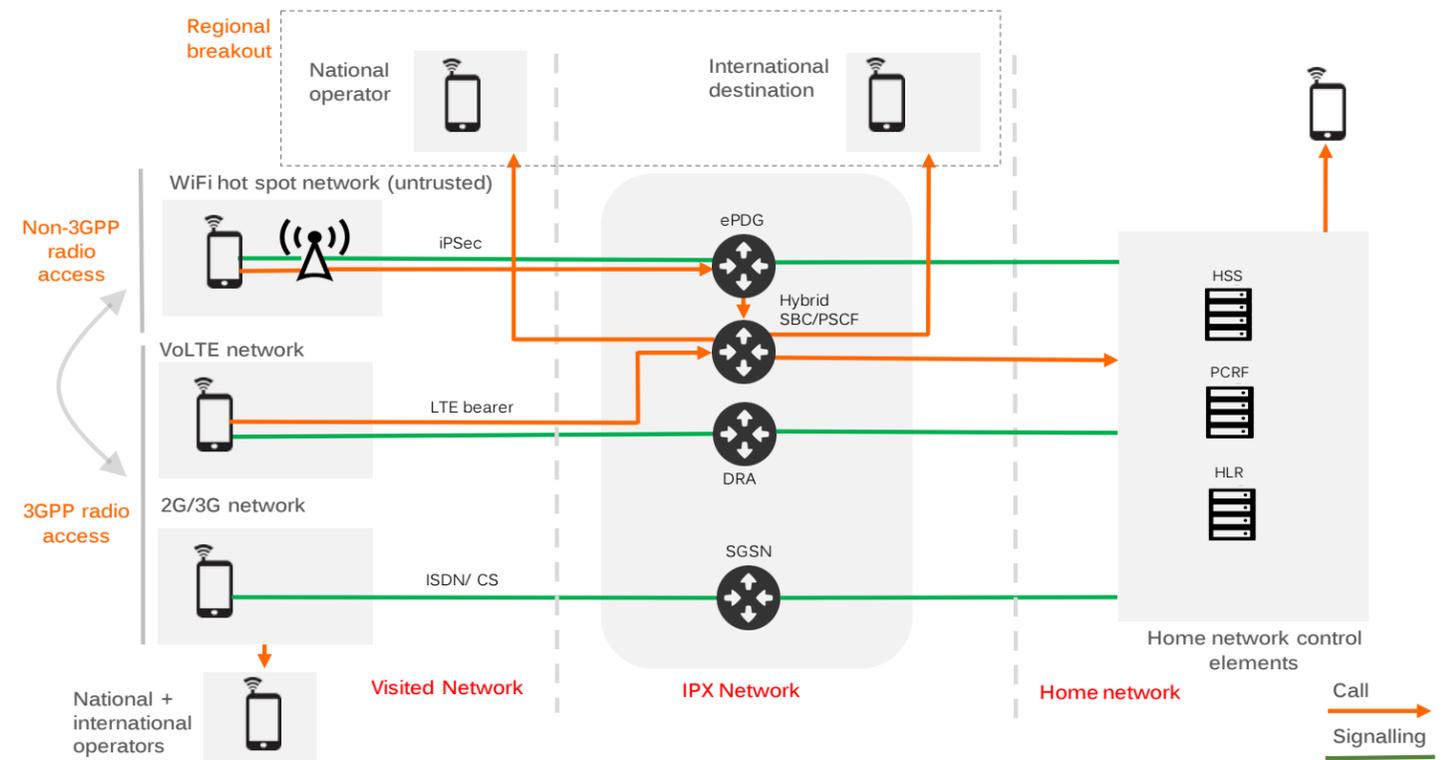
From the IPX providers' point of view, it brings in new traffic that it would not have otherwise

transported: VoWiFi roaming traffic (including the home traffic) that would otherwise have simply been routed out of the home network.

We estimate that on average 30-35% of the roaming traffic is terminated in the visited network, between 50-55% is terminated in the home network and between 10-20% is terminated internationally, this depending on the origin of the roamer and the countries visited of course.

It would therefore be highly beneficial for IPX providers to be in a position where they would transport 100% of the roaming traffic, instead of only 40-55%, if the direct option was implemented by mobile operators.

VoWiFi roaming network architecture – with IPX roaming hub





In addition, with this option, the IPX provider could actually offer a VoWiFi roaming turn-key solutions supporting all the functions a mobile operator needs to offer VoWiFi roaming to its customer, including the relationships with the WiFi hot spots and the intelligent traffic routing.

FUTURE PROOFING YOUR BUSINESS

For IPX providers, playing the role of a VoWiFi roaming hub, would be highly beneficial for a number of reasons.

- Increase the voice roaming traffic it transports (by as much as 50% in some cases)
- Help mobile operators stimulate voice roaming traffic as a whole and fight OTTs
- Enable wholesalers to move above and beyond connectivity / transport towards value added services such as of authentication, clearing, billing and real-time monitoring / reporting
- May generate new sources of revenue (as a deal broker), if offering WiFi and VoWiFi roaming as a service

Nevertheless, this comes with challenges, as to achieve this IPX providers will have to:

- Sustain a global high quality and secure network
- Interconnect with a large number of mobile operators, cablecos and WiFi hot spots to establish a comprehensive global network of WiFi access
- Develop a number of intelligence and big data tools to provide real-time

monitoring and reporting functions to help optimize the quality of service over these diverse access networks

- Provide fraud management tools
- Offer clearing and settlement services

Not all wholesalers or IPX providers will be able to provide such a service, however those who will, will become an integral part of their customers' roaming success and will therefore be one step closer to future proofing their business.



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Isabelle has worked for 22 years in the telecoms industry. Her personal expertise ranges from Int'l Wholesale through to Business Strategy, and Marketing, along with extensive research and global consulting experience.

She has written numerous articles and spoken at many conferences on the challenges of international telecoms evolution in an all-IP world, a subject close to her heart.



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Steve has a lifetime of experience in designing, engineering and operating networks, both domestic and international. With leadership experience in small technology start-ups through to global service providers, he has deep experience in a wide range of products, technologies and geographies.

He has the rare skill of being able to explain complex technical issues in easily understood concepts and uses that extensively in his consulting work with HOT TELECOM.



ABOUT HOT TELECOM

HOT TELECOM is one of the most innovative and creative research and consulting companies, which has been providing International operators and carriers with specialized intelligence and advice for the past 13 years.

We understand the challenges faced by international carriers better than anyone, and have therefore developed a number of research and advisory tools and expertise to mirror these needs, and provide the support any wholesaler requires to survive and thrive in the current environment.

To find out more about what we can do for you and how we can make the difference in your success, contact us and it will be our pleasure to provide you with tailored, real-life solutions that will meet your needs, challenges and objectives.

For more information, please visit: www.hottelecom.com

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ABOUT CATALEYA

Cataleya is a leader in IP networking innovation, with a strong track record in developing and deploying next generation carrier grade session border controllers (SBCs), pushing the envelope in an all IP paradigm.

We develop and deploy intelligent networking technologies for network operators, application service and 4G and LTE based MNOs. We believe that networking technology needs to be simpler, more intuitive and ready to enable an all-IP world.

When a customer chooses Cataleya's technology they gain greater control over their IP network with the operational intelligence to deliver new levels of quality of service and experience.

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ABOUT ORCHID ONE

Orchid One is a next generation session border controller that is specifically developed to address the need for end-to-end quality of service and quality of experience in IP networks. It is an advanced SBC technology that combines multiple network functions and delivers unparalleled visibility into network performance from the transport to application layers.

KEY BENEFITS

- Leading performance
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- Seamless SIP capability



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