



# Bridging the VoIP Islands

White Paper

## **EXECUTIVE SUMMARY**

This paper examines the impact of consumer adoption of Voice over Internet Protocol (VoIP) services as it pertains to the growing need for VoIP Peering solutions to interconnect IP enabled Service Providers (SP). It explains why Multilateral VoIP Peering, facilitated by ENUM, is increasingly a compelling and necessary choice for SPs, MSOs, and other organizations seeking to deliver the full benefits of VoIP to their end customers. It is intended for General Management, Marketing & Product Executives, and all others who wish to better understand the opportunity and implications of VoIP Peering and ENUM for the telephony marketplace.

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# VoIP Adoption and the Need for VoIP Peering

Internet Telephony, or Voice-over-Internet Protocol (VoIP) is in the midst of global wave of mass consumer adoption. With increased broadband availability via cable, fiber and wireless services, it is clear that the decade old promise of VoIP replacing the PSTN is finally underway.

Supported by the increasingly widespread use of the Session Initiation Protocol (SIP), one of the most widely used VoIP signaling protocols, every type of communications provider is migrating towards IP technology. As traditional fixed operators, including large incumbents, are migrating towards next generation networks (NGN) based on IP, mobile operators are working on the specification for their third generation platforms (3GPP IMS) and Cable companies are deploying SIP-based PacketCable solutions. Enterprises large and small are deploying IP-PBXs or hybrid IP/TDM solutions and individual consumers are widely adopting VoIP services from global brands such as Yahoo, Google and Skype.

VoIP makes voice services an application running on the Internet or private IP networks. It allows the rapid deployment of innovative new services and use of networks for multiple service scenarios. While many early implementations of VoIP have essentially been used to replicate the “Plain old telephone service” (POTS) at a lower cost, the future of VoIP phone calls, powered by SIP, will be to provide customers with richer multimedia experiences.

IP communications brings significant cost advantages and a wide range of enhanced services, including high fidelity calls, video conferencing, integrated presence, fixed/mobile convergence (FMC), mobility and new multimedia features that are limited only by the imagination.

However, these features are mostly only feasible when the call starts and finishes on a single network. This is because most VoIP networks today are essentially “Islands” and all calls that go “off net” are sent to the PSTN or VoIP wholesalers for termination. Therefore, if the recipient of the call is on a different network from the person originating the call, then all the advanced features will be lost.

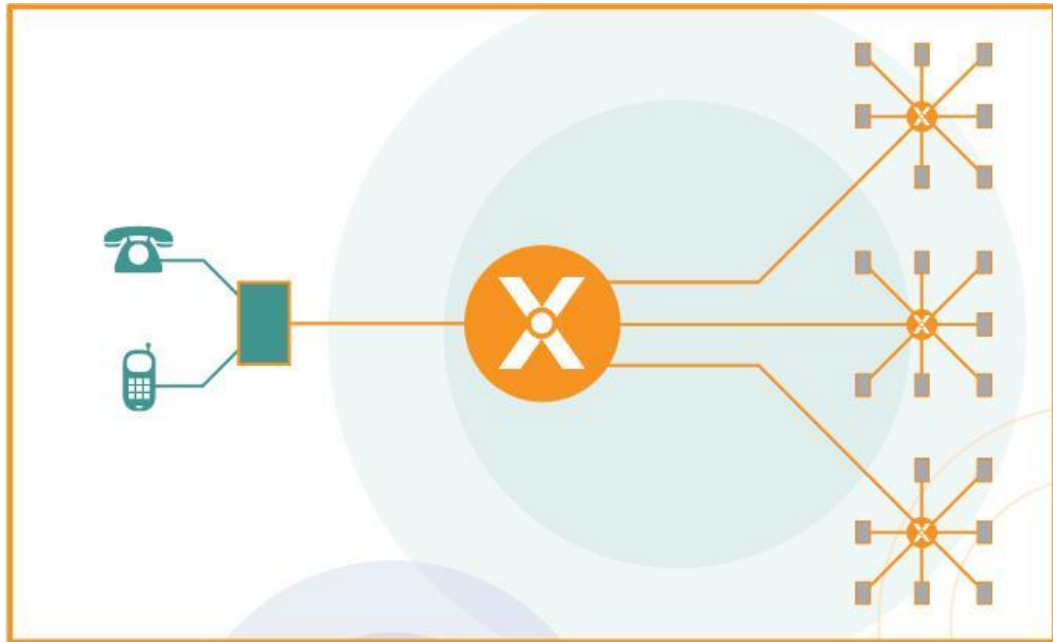
Multi-lateral VoIP Peering is the solution to this problem. By combining Interoperability services with Electronic Number Mapping (ENUM), peering delivers the features, quality & cost benefits and eliminates use of the PSTN as the medium through which calls are delivered between operators.

As more and more types of operators offer VoIP, and more consumers have wired and wireless Broadband connections, peering will become an essential network service that will help connect all the VoIP Islands to another. Peering frees VoIP service providers from the constraints of using the PSTN as the lowest common denominator with respect to the features and value they can offer their customers.

## The Economics of VoIP Peering

While the feature and quality limitations of the PSTN are well understood, there is sometimes confusion around the economics of PSTN interconnects for IP Enabled Service Providers (SPs). Some providers can earn termination revenue on inbound calls, which they will lose for calls delivered via an IP connection. Typically, however, this inbound termination revenue is outweighed by the carrier & termination costs of outbound calls, and so replacing the PSTN represents a net gain. Exceptions to this rule would be where service providers earning termination revenue anticipate substantially more inbound traffic than outbound, and for this reason such providers are only interested in peering relationships that will result in balanced traffic.

## VoIP Adoption and the Need for VoIP Peering



In summary, delivery of calls between SPs via end-to-end IP connectivity, and eliminating the PSTN:

- Enables the preservation of advanced call features such as multimedia calls, high-definition or wideband audio codecs and three way calling
- Avoids the repeated transcoding from VoIP to PSTN and back which degrades call quality
- Avoids the per-minute charges associated with traditional PSTN call routing, resulting in savings on off-net calling
- Reduces capital expenditure and port charges on PSTN gateways

### THE IMPACT OF VOIP ON THE INDUSTRY

It is important to recognize the impact that VoIP is having on the telephony marketplace in order to appreciate the requirements for multi-lateral VoIP peering.

#### Changing Economics: Free & Un-Metered Calling

VoIP transforms voice services into an application, which can share public or private IP networks with other data streams, and radically reduce the cost of operating a network.

The cost for transporting data, regardless of whether it relates to voice calls or any other content, is a small fraction of the equivalent cost charged for PSTN calling, and these costs can be substantially reduced if the public internet is used. A typical VoIP call passing as data over public IP will cost less than \$0.00002 per minute in transport costs, compared to a typical cost of \$0.01 per minute for the same call over the PSTN. This underlying change in the economics

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of delivering calls is leading VoIP operators to offer un-metered calling as part of a subscription package, or even free calling in the case of PC-based VoIP services. Many in the industry expect basic voice calls between most VoIP subscribers will be free in the years ahead.

While consumers will naturally view free global calling as a universal good, there are some risks. The elimination of per-call or per-minute costs will make voice a more attractive advertising/promotion medium than is currently the case, and the absence of clear regulation will likely be exploited by some, leading to large volumes of unwanted and unsolicited calls. SPIT (Spam over internet telephony), the telephony equivalent of SPAM, will increasingly be a problem for consumers unless the industry adopts mechanisms to identify such calls and prevent them from reaching consumers.

Regardless of how consumers pay for calls, the migration away from the PSTN as the main call routing mechanism creates an opportunity to reconsider pricing between service providers. Unlike the PSTN wholesale carrier environment, in which carriers deliver traffic but are never the end destination, call traffic volumes between any two consumer-focused providers, regardless of their respective size, is likely to be well balanced.

For many providers, per-minute or per-call billing arrangements between peers, when call volumes are near balance, generates more work than warranted for the small payment that might result, and so easier to administer fixed pricing or even settlement-free arrangements are becoming more common.

### Changing Business Process: Routing Calls

VoIP provides consumers with the ability to choose their own phone number regardless of their geography. Individuals and businesses can be located in one country and choose to have phone numbers associated with other countries or regions. The efficient routing of calls in a VoIP environment requires a registry of phone numbers mapped to IP addresses, so that an operator can discover the most efficient way to route a call. The ENUM standard was created to solve this requirement.

### Changing Competitive Landscape

Telephony is increasingly a software driven, rather than infrastructure driven, industry. This fundamental change is lowering the barriers to entry, leading to a dramatic increase in the number of telephony service providers which in turn is driving a wave of innovation and creativity. This innovation will bring tremendous benefits to VoIP users, but creates a potential headache for operators who must continuously validate that their systems are interoperable with the systems of other operators to whom they transfer calls.

The implementation of VoIP combined with the explosion of service providers and the availability of free or un-metered calling is giving rise to security concerns that have been less prevalent in a world of fewer dominant in-country players and legacy PSTN infrastructure. VoIP is potentially vulnerable to the same security risks that threaten other network & data systems, including SPIT, identity fraud, and hacking. Unless properly addressed, these security concerns will lead to providers peering only selectively with other operators they trust, and thus limiting the delivery of VoIPs' benefits on a global scale.

# VoIP Adoption and the Need for VoIP Peering

These growing interoperability and security challenges and the dramatic increase in the number of operators will further preclude bi-lateral peering between big operators as a viable solution for delivering calls around the world.

## APPROACHES TO PEERING

### Limitations of Bilateral Peering

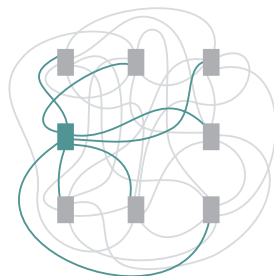
Bi-lateral VoIP peering follows a model similar to a standard PSTN interconnection, where Providers create a separate technical and commercial relationship with every other provider to which they would peer. Bi-lateral peering works reasonably well in the PSTN, an environment with established and stable technical standards, a limited number of participants and simple rules for call routing. By contrast, the emerging VoIP environment is less well suited to bilateral peering.

The continuous evolution of technical ‘standards’ and ongoing innovation in service features (such as video, IM, high-bandwidth audio codecs) raises the burden associated with establishing interoperability between providers. Bi-lateral peering can require the re-certification of interoperability whenever a system is enhanced, increasing operational expenditures for the provider making the change as well as all their peering partners.

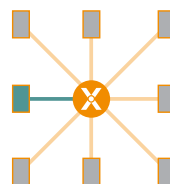
Without a central call-routing registry, bilateral peering requires an exchange of telephone numbers on a daily – even hourly – basis, directly between each pair of peered carriers, so that each can maintain its own registry of call routing information. In addition to the obvious burden of exchanging data in this manner with many peers, this process also introduces security and trust concerns – how do I know that my most trusted data, the list of my customers’ phone numbers, won’t be abused?

These interoperability and trust concerns essentially limit the scalability of bilateral peering. Bilateral peering may be viable for a handful of significant peering relationships, it will not facilitate more universal peering between the many hundreds (and soon to be thousands) of VoIP operators worldwide.

### Bi-lateral Peering



### Multi-lateral (Federation) Peering



*This illustration shows the difficulty in implementing multi bi-lateral peering agreements, as opposed to the ease of multi lateral peering via a peering provider.*

- SP (Service Provider)
- ⊗ Federation/Peering Provider (e.g. XConnect)

# VoIP Adoption and the Need for VoIP Peering

## Opportunity and Challenge of Multilateral Peering

The new paradigm for peering, better suited to the VoIP environment, is that of the multilateral federation, facilitated by a neutral operator. A Federation operator provides any or all of the following services; Physical connectivity, ENUM Directory Management, Signaling Interoperability, Security & Identity services, Media Management and Commercial management.

The multilateral or federated approach to peering creates a 'circle of trust' for central management of key functions, such as:

- Simplifying the interoperability issues by normalizing the protocols used to deliver calls to peered providers
- Insulating service providers from the need to re-certify interoperability with each other on every system upgrade
- Providing an efficient central mechanism for exchanging numbering data

However, because the provision of multilateral peering by a third party can imply less control for member providers over their technical and contractual relationships with other providers, a multilateral solution must also address the following if it is to encourage providers to peer more widely:

- **Peering Policy:** No matter how well security and other issues are addressed, not every provider will want to peer with every other provider connected to a multilateral service. Therefore, some peering policy support is required to allow providers to exercise some control over who they peer with
- **Security & Identity:** A multilateral approach to peering creates the opportunity to address the security issues at a central point in the network, and by doing so remove a key obstacle to the adoption of universal peering between VoIP operators
- **Reporting, Monitoring & Settlement:** Service Providers require information on service usage and performance to manage their businesses, and potentially to facilitate settlement. A multilateral peering federation must provide these supporting services
- **QoS assurances:** To the extent that the multilateral peering provider dictates physical connectivity or otherwise affects call quality (driven by network reliability, latency, jitter etc), it must also offer solutions to achieve targeted QoS levels

## VOIP PEERING VS. IP PEERING

While IP peering is a pre-requisite for VoIP peering, it is not a substitute for VoIP peering. VoIP Peering introduces further specific challenges including:

- Number exchange and query facilities necessary for a service provider to determine when a dialed number belongs to another service provider and to supply associated call routing
- Understanding the VoIP signaling protocol and requirements for interoperability
- Understanding of how to identify, authenticate and secure the call as well as identifying and controlling SPIT

## VoIP Adoption and the Need for VoIP Peering

VoIP peering can be implemented in a manner that is either neutral to the type of physical IP connectivity or that prescribes a particular physical IP peering solution. A preferred physical IP connectivity element is one means to deliver QoS guarantees and is most desirable in a limited geographic context in which VoIP operators can easily access the same physical infrastructure. A logical, or IP-connectivity neutral approach is more desirable when VoIP operators are distributed globally and cannot easily access a common physical infrastructure, though this leaves open the issue of QoS.

### **ENABLING STANDARDS: IETF's, ENUM AND SIP**

#### **IETF**

The Internet Engineering Task Force has been responsible for developing the key standards and protocols that underpin VoIP adoption. The SIPPING working group is responsible for the SIP protocol, the ENUM working group is responsible for ENUM, and the SPEERMINT working group is responsible for developing the standards for VoIP peering, including the role of Federations.

#### **ENUM**

Electronic Number Mapping (ENUM) is a standard devised by the IETF to link phone numbers (in e.164 format) to a Communications Resource (a signaling user agent or border control point identified by a SIP URI or IP address). ENUM Directories store numbers and corresponding URIs or IP addresses in searchable tables so that, for a given dialed number, a service provider can identify whether an end-to-end IP route exists.

As is common with IETF standards, there is ongoing debate about implementation. Although the content of ENUM Directories is well understood, there is debate around how many Directories are required, whether different Directories are linked, and how data is propagated between Directories, if at all. These variations are referred to as Private, Public and Infrastructure ENUM. This paper seeks to describe the behavior of ENUM Directories in the context of peering without prescribing any particular approach.

#### **SIP**

Session Initiation Protocol (SIP) is a protocol and proposed standard for initiating, modifying, and terminating an interactive user session that involves multimedia elements such as voice, video and instant messaging. It is one of the leading signaling protocols for Voice over IP, along with H.323.

# Federated VoIP Peering: The New Paradigm

To recap, there are three main reasons why using the PSTN for interconnection of VoIP networks is wasteful:

1. Voice quality is degraded by repeated transcoding from data to voice and back
2. Advanced features, such as IM, presence and video capabilities are lost during PSTN transit
3. There are per-minute charges to ride on the PSTN network that would not apply to IP-to-IP calls

While VoIP peering can technically be achieved via direct bilateral technical and commercial interconnection relationships between two providers, complete elimination of the PSTN will require each provider to peer with as many other domestic and international providers as possible – preferably all of them. A far more practical solution is multilateral peering based on a Federation model, which will allow a provider to enjoy peering with hundreds of service providers around the world via one secure interconnection.

## IMPLEMENTING MULTILATERAL VOIP PEERING

In order to implement Multilateral Peering, six key issues must be addressed:

1. ENUM Directory Management
2. Peering Policy Management
3. Signaling Interoperability
4. Security & Identity
5. Media Management
6. Reporting & Settlement

### ENUM Directory Management

At the point at which a consumer dials a phone number, their provider must determine whether the dialed number belongs to another VoIP subscriber (of a different provider) and can therefore be routed via end-to-end IP, or whether it must rely upon traditional PSTN routing. This requires the provider to have query access to an ENUM Directory containing the end-subscriber phone numbers & routing information for every provider with which they are peered.

Several aspects of Directory Management design & implementation are fundamental to the desirability of the peering solution as a whole:

1. *Does peering necessarily imply the sharing of sensitive customer numbering data with the peered provider?* Bilateral peering always implies an exchange of data, and so providers must naturally restrict their peering activities to a handful of trusted counterparties. Surprisingly, many multilateral peering implementations also require that data be shared with peered (and potentially competing) provider, a factor that may limit their effectiveness in encouraging more universal peering. *An ideal implementation would ensure that a provider can peer with others without compromising confidentiality of the subscriber data.*

# Federated VoIP Peering: The New Paradigm

2. *Can the Query Interface cope with high call volumes and deliver consistently low latency in response time?* Customer research has indicated that Service Providers prefer a copy of the ENUM **Directory to be deployed inside their own network to ensure the Query Interface is sufficiently fast and reliable.** The problem with such an approach is that a local ENUM directory usually implies that a provider's ENUM data is being openly shared with potential competitors, and so there is an apparent contradiction between maintaining confidentiality of subscriber data and providing a high performance query interface.

Maintaining confidentiality of customer data and delivering a local Query Interface is a key challenge for service providers engaging in peering, both for commercial as well legal reasons bearing in mind the strict requirements regarding data privacy in the European Union and other jurisdictions.

## Peering Policy Management

A multilateral peering solution must still empower providers to determine how widely to peer. Although the ideal is universal and non-discriminatory peering, there are numerous commercial and political reasons why providers might choose to exercise control. The more flexibility in peering policy that a solution offers, the wider the proportion of the providers community it will appeal to.

Ideally a peering solution would include support for the following, each potentially with its own settlement arrangements:

- peering at the individual Provider-Provider level
- peering based on criteria (such as geography, service type etc.)
- federations composed of many providers members, all peered with one another
- the ability to join a federation but apply some exception based logic to avoid peering with specific providers or with providers meeting specific criteria

Service Providers should be able to overlay multiple peering policies or federation memberships to provide them with maximum flexibility.

## Signaling Interoperability

Each successful VoIP call requires Interoperable signaling mechanisms and protocols between operators to initiate service sessions with feature transparency. The peering service provider must facilitate call setup between Providers running different protocols or variants of a single protocol by translating and normalizing the signaling.

Protocols in use within the industry include SIP, H323 and MGCP. Also, because providers use different software platforms to implement their service, there are significant variations even within a given protocol that requires intermediation to ensure interoperability.

# Federated VoIP Peering: The New Paradigm

## Security and Identity

The caller must be fully identified and authenticated to ensure that Caller ID is correct, to correctly handle anonymous calling, and to identify VoIP threats such as SPIT and Caller ID Spoofing.

To prevent SPIT, the peering provider must analyze the behavior of ‘consumers’ making calls and identify suspicious calling patterns. Suspicious calling patterns could include sequential dialing of numbers, numerous calls of similar duration, calls patterns that do not reflect normal consumer behavior etc. Based on these and other attributes a SPIT call can be identified and blocked or diverted to a “junk” voicemail box in a similar manner to which junk emails are handled by many service providers today.

The peering provider should implement standards and requirements for all its providers to ensure that caller ID authentication is achieved so that the caller ID that is being presented is valid and is not being spoofed.

### HOW IMPORTANT IS VOIP SECURITY?

SPIT, the telephony equivalent of SPAM, is rare today because of the costs associated with placing calls and the relative difficulty of generating thousands of calls on an automated basis. The combination of free or un-metered calling with VoIP technology will make voice a more attractive channel for both legitimate and illegitimate businesses seeking to reach consumers.

Underestimating the threat could lead to abuses that threaten the widespread adoption of VoIP by opening up VoIP consumers to high levels of unwanted & fraudulent calls.

Potential dangers include:

- Flooding voice mail with unsolicited messages offering consumers either legitimate services or, more worryingly, illegal or counterfeit goods.
- The likelihood of receiving unwanted calls at inconvenient times – SPIT generators might pay little heed to the time of day when generating automated calls, and indeed may prefer to initiate calls at night in the hope of reaching voicemail rather than having a consumer answer the phone.
- Caller ID Spoofing, where criminals pose as a trusted institution (such as a bank) and solicit valuable or confidential personal data.

VoIP security must ensure that the caller ID is authentic and block criminal callers from posing as a trusted institution.

With current technology, a subscriber cannot simply automatically block and delete unwanted messages but must listen to at least a portion of each message to prevent possibly deleting a valid message embedded among the SPIT. Since most users will not tolerate this inconvenience, SPIT could easily become a VoBB’s worst nightmare with respect to customer retention.

# Federated VoIP Peering: The New Paradigm

## Media Stream (RTP) Management

A peering service need not be tightly coupled with media management, and indeed many providers would prefer that a peering service not interfere with media when this can be avoided. However, for a variety of technical reasons relating to interoperability, it will sometimes be necessary for a peering provider to handle the media.

Where the peering provider does handle media, it is important to discern whether this is for commercial reasons (their billing model may be based on capacity or ports consumed and therefore related to call volumes) and those that do so for technical reasons and only when required to facilitate the peering service. As video and high-bandwidth codecs are adopted more widely by VoIP consumers, Service Providers may prefer a peering provider that only handles the media when absolutely necessary.

## Reporting and Settlement

The opportunity to eliminate the per-minute charges associated with PSTN raises the question of what settlement arrangement should take its place. While many service providers with balanced traffic are happy to enter into settlement free (bill and keep) arrangements, there are situations in which traditional or non-traditional settlement arrangements will be necessary. A peering provider should gather metrics to support per-call and per-minute settlement for voice, video, IM and other content.

## SERVICE DELIVERY

### Necessary Characteristics of a Multilateral Peering Service Provider

1. **Neutrality.** As the service provider it will have access to the customer numbering data contributed by all participating providers, the peering service provider must be trusted by all participating providers not to abuse this information either directly or indirectly. The provider should therefore not itself be a Service Provider nor have preferential relationships with a particular Service Provider(s) that might lead to it compromising this sensitive data.
2. **VoIP Peering Expertise.** The service provider will need skill & experience in the specific challenges presented by VoIP peering outlined earlier.
3. **Security Expertise.** Verifying identity of users and authenticating calls, protecting commercial data and controlling SPIT.
4. **Database Expertise.** The ability to manage an ENUM registry containing hundreds of millions of records, with methodology for provisioning and synchronization of thousands of service providers data.

# Conclusions

Peering will revolutionize not only the VoIP market, but the telecommunications landscape as a whole. While the total number of in-service VoIP devices is still relatively small compared to the range of PSTN numbers, the increasing global availability of broadband is creating a wave of growth in the potential devices reached via IP. For all its promise, there are several important factors that Service Providers must consider when planning for peering. Some of them include:

- **Innovative Services and Pricing Models** – While cost savings is a major driver for the adoption of peering and ENUM, many service providers are finding the support of advanced features such as wide-band codecs and video equally compelling. Service providers that position VoIP solely as a cut-rate version of PSTN services are missing the opportunity to use innovation as the value proposition for their brand.
- **Bi-Lateral vs. Multi-Lateral** – In order to maximize on-net traffic and avoid the PSTN, Providers must peer as widely as possible. The need to peer more widely than in a traditional PSTN environment, and the requirement to cope with multiple standards and rapidly evolving features make bi-lateral peering an unsatisfactory approach. Multi-lateral peering is the preferred route to achieve global peering of disparate VoIP networks.
- **Security** – The move towards free calling, the need to make confidential numbering data externally available, and the potential to abuse VoIP protocols (e.g. via Caller-ID spoofing) are sources of risk to providers. These challenges can be best resolved by a neutral third party that addresses number confidentiality and other security issues as part of their solution.
- **Network Performance** – While a centralized, neutral ENUM registry is attractive from the security perspective, it might lead to unacceptable performance degradation during call setup. Service providers must identify a solution that meets their own performance requirements without compromising the confidentiality and security concerns of their peers.

The advantages of multi-lateral peering based on ENUM are real and achievable today. Providers all around the world are embracing peering in order to enhance their innovative services, reduce operational expenses, increase security and distinguish their brand for their customers.

## About XConnect

XConnect is the world's first and largest provider of VoIP federation-based interconnection services dedicated to connecting VoIP operators and enabling rich multi-media end to end IP communication. Headquartered in London with offices and facilities in USA, Europe and Asia, XConnect is the largest neutral VoIP peering provider for VoIP operators. XConnect's award-winning solutions comprehensively address protocol interoperability, ENUM directory services, and security.

XConnect provides ENUM and peering services to over 100 IP Enabled Service Providers in more than 20 countries enabling IP calls between VoIP end-users. XConnect was recently selected by the cable industry in the Netherlands to operate the first nation-wide VoIP peering solution and recently acquired the European carrier ENUM exchange, e164.info.

XConnect was founded in 2004 by Eli Katz, also co-founder and chairman of the UK's Internet Telephony Service Providers' Association.

