The Colliding Worlds of Telephony: Gateways to the Rescue

Introduction

As the entire world seems to be moving to consume cloud-based services, surely there is no space left for legacy, "old fashioned" phones and phone systems? How is it even possible to bring these kinds of systems or services into a modern world architecture based on IP systems or cloud services?
This whitepaper seeks to clarify the role of gateways. What problems they solve, why they are still useful today and the requirements to make any deployment secure and resilient.

Contents

Problem

Before outlining the problem it's worthwhile examining how telecom has evolved over the last century.

In the Beginning

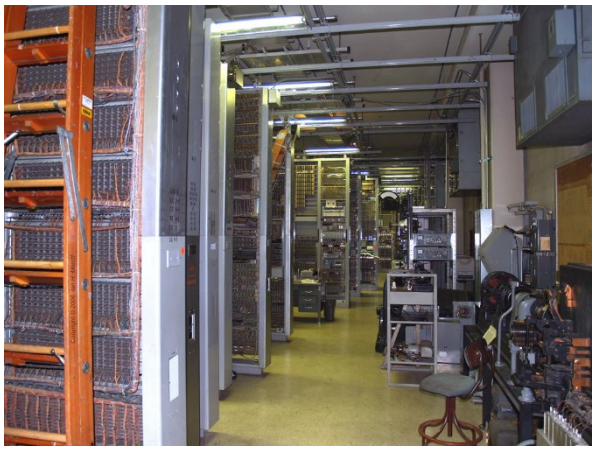
Analogue telephony came first, this is just like the old-style telephone we all had or have at home. Running over two copper wires which connect all the way back to a telephone exchange somewhere. The telephone exchange forms part of the PSTN (Public Switched Telephony Network). Analogue telephony is delivered over copper lines and is controlled with voltages and tones. Analogue telephone lines transmit voice as electrical signals. One phone number is associated with one line and can only handle one conversation at a time.

- Pros
  - Common and well known
  - Reliable
  - The handsets are cheap
  - Ubiquitous
- Cons
  - Basic features
  - Expensive for the service provider

In the analogue world, there are two confusing terms – FXS and FXO that warrant explanation:

- FXS = Foreign eXchange Station
- FXO = Foreign eXchange Office

FXS – Connects to Endpoints



FXO – Connects to the Service Provider

The Digital Age

The fundamental problem with analogue telephony is that a pair of copper wires can only carry one call. For a large office it's very expensive to run and maintain hundreds of pairs of copper wires. Enter ISDN (Integrated Services Digital Network), rising in popularity in the 1980s and 1990s, this provides the ability to place multiple calls over a copper wire. There are two key types:

- BRI – Basic Rate Interface. Also known as ISDN-2. Allows 2 calls over a 2 pair copper wire.
- PRI – Primary Rate Interface. Also known as ISDN-30 or E1. Allows up to 30 calls.

Using ISDN, the amount of copper cables in the ground is vastly reduced and so costs go down. The type of technology used is TDM – Time Division Multiplexing. Again, these connections form part of the PSTN.

Pros

- Reliable
- Rich call information
- At 4 or more lines, it is usually more cost effective than analogue
- Network is already built
- Distance to/from telephone exchange can be long

Cons

- Not practical for low density
- Requires special termination equipment
- Expensive fixed line rental
- PBX requires hardware

IP Takes Over

During the 1990 and early 2000s the internet grew exponentially and became a standard amongst businesses. The key protocol used for all this traffic is IP – Internet Protocol. There are multiple different signalling schemes used. For instance, HTTP to access websites or FTP for file transfer. During the uptake of the internet many businesses ended up with high bandwidth connectivity for data and another connection for voice. What if these could be combined? Well that's what SIP – Session Initiation Protocol – does. SIP is just another IP messaging scheme to carry voice. SIP is the VoIP (Voice over IP) protocol that has become dominant. The early driver for SIP adoption was price. It's much cheaper than renting a digital line or many analogue lines as the provider doesn't have to care for the many kilometres of multiple copper wires in the ground. Over time many more reasons developed like resilience, feature set, ease of support.

Pros

- Very cost effective, no matter the size
- Can use existing network infrastructure
- Tons of features
- PBX can now be purely software

Cons

- Quality can be inconsistent
- Installation and support can be more complex

Most Recently – The Cloud

In the last few years in common with many services, telephony has moved to the cloud. Instead of running a PBX (Private Branch Exchange) on a device at the customer premise, the PBX is now running in the cloud, either as dedicated piece of software or as part of a large multi-tenanted system run by a large network provider or ITSP – Internet Telephony Service Provider.

Pros

- Can be rented, instead of buying PBX hardware
- Can use existing network infrastructure
- Updates carried out by operator
- No expensive maintenance contracts

Cons

- Relies on data connection being good quality
- Can be expensive for larger sites
- Sometimes can lack features

Back to the Problem

With a highly built out network (see the pros of analogue and digital above) and millions of endpoints, it's not practical, cost effective or ecologically sound to simply throw all that equipment away. So, a device is needed to join the worlds of analogue and digital with IP.

Why does this have to be a device and not software? The whole world just wants software these days. Remember that analogue and digital is delivered over dedicated copper lines, and those must be terminated somewhere on a device.

Some examples of where there are still requirements for analogue or digital devices:

- Hotels. Many hotels require telephones in rooms, but don't want to invest in the cabling to bring IP connectivity to each room. So, they keep their old analogue handsets. These days hotel phones are a cost centre, not a profit-making centre where previously calls were charged at a premium.
- Healthcare. Many hospitals or care homes still maintain analogue telephones for ease of use for patients or residents.
- Poor IP Connectivity. In many rural areas it's not practical to acquire a broadband connection of sufficient bandwidth to carry SIP calls. Each SIP calls typically requires about 100kpbs, so 10 calls take 1 megabit of bandwidth.
- Large sites, like factories or railways, where long line lengths make using IP impractical, expensive and possibly unreliable.

Solution

The device required to bridge the analogue and digital worlds is a gateway, also called a VoIP gateway or media gateway.

What Does a Gateway Do?

The gateway is effectively a protocol converter. It converts analogue to IP or digital to IP. Because there are different types of connections for different types of analogue and digital telephony, different types are required, typically:

- Analogue Gateways
  - FXO <-> SIP / PSTN <-> SIP
  - FXS <-> SIP / Telephone <-> SIP
- Digital Gateways
  - PRI <-> SIP
  - BRI <-> SIP

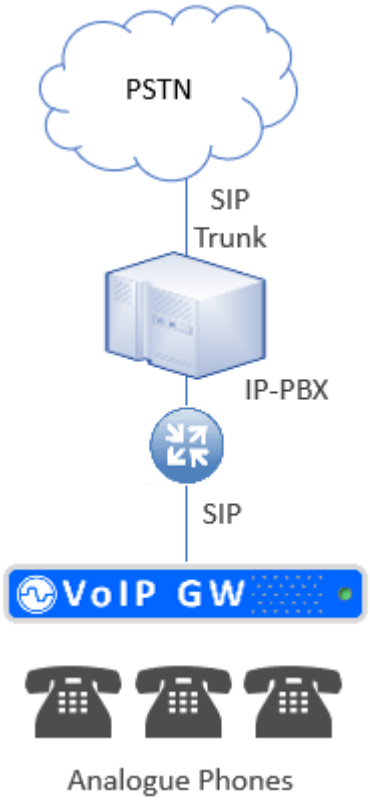
The number of connections supported can also vary by gateway. For instance, in a large hotel it's desirable to look for a gateway that has many FXS connections rather than deploying and managing many, many small gateways.

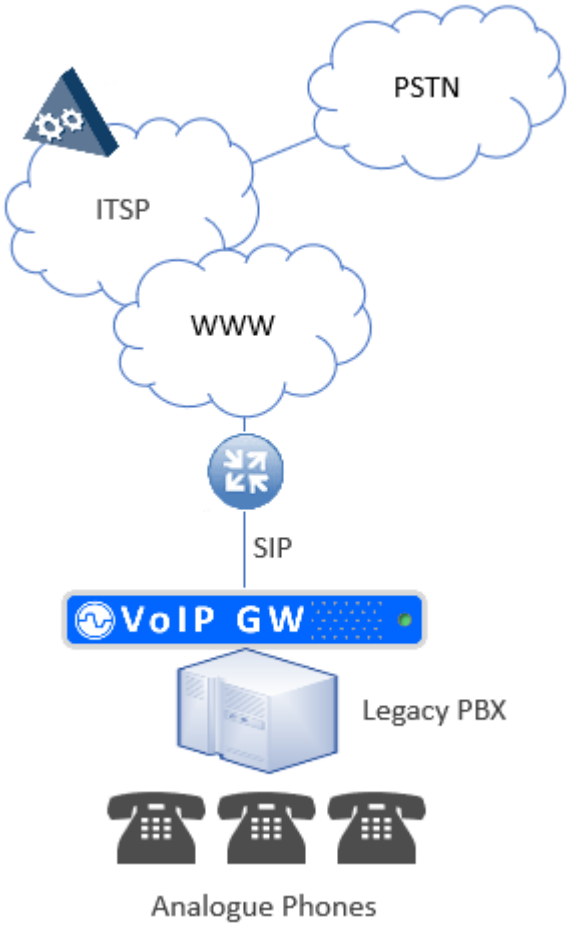
Typical Deployments for Gateways

There are many ways that gateways can be deployed, many outside of the scope of this document. Here the focus is on three key scenarios.

Analogue Connectivity

The purpose of the gateway is to convert the analogue phones so that they appear like an IP phone. The gateway can be connected to an IP-PBX on premise or to an ITSP in the cloud. The gateway will perform all the functions of an IP-phone, like registration, and simple call features like transfer and call forwarding. As far as the ITSP or IP-PBX is concerned there is no difference between an IP-phone and an analogue phone connected to a gateway.





The target market for this application can be divided into two segments, high density and low density. High density can be considered as more than 10 endpoints in a single location.

High density applications:

- Hotels
- Cruise ships
- Care homes
- Military barracks
- Transport

Low density applications:

- FAX machines
- Door entry systems
- Lift phones
- Modems / Franking machines

SIP Trunking

Where a legacy PBX that is fit for purpose is still deployed on premise and operating successfully many advantages can be gained by connecting it to a SIP connection provided by an ITSP. This is generally called SIP trunking.

The advantages of this include:

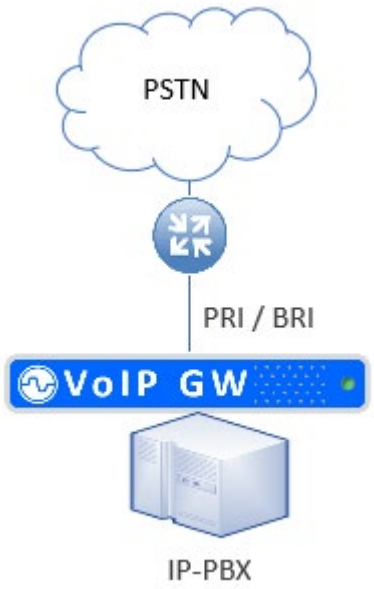
- Cost. It is typically much cheaper to use SIP rather than pay for the rental of ISDN lines. Furthermore, the per-minute call costs are also less expensive.
- Flexibility. When buying ISDN, generally the number of simultaneous calls must be specified at the beginning of the contract. If the number of users changes, up or down, it can be hard to change. With SIP, providing the band width is available, the number of permitted simultaneous calls can be varied easily.
- Contracts. Many ISDN providers lock users to a long-term contract. SIP trunking can be more flexible, allowing for changes in provider if required.
- Disaster Recovery. In the event of total loss of connectivity SIP allows for disaster recovery. For incoming calls, the ITSP can generally reroute calls to an alternative number, like a mobile phone. For outbound calls the gateway can be programmed with alternative routes, either on the IP side or through alternative ISDN or analogue connections.
- Maintaining User Handsets. The handsets on desks don't need to change when using a gateway. No costly recabling, no user retraining.

The target markets for this application are:

- Any of the businesses that are still running ISDN PBXs.

PSTN Connection

In some cases, a business might not have access to a broadband or internet (WAN)connection of sufficient bandwidth to run SIP calls. This rule out the possibility of a hosted system and at this time it would not make sense to buy a legacy PBX when IP-PBXs are relatively low in cost and provide more features. Using an IP-PBX also future proofs the selection as if more bandwidth becomes available the connectivity can be switched to SIP. Coupling an IP-PBX with a gateway to connect over BRI or PRI to the PSTN allows the PBX to use existing connections to the PSTN.



Target markets are the businesses that have no access to enough bandwidth to run SIP calls.

To Cloud or Not to Cloud

In some respects, the gateway can be thought of as a dumb device. It processes calls in both directions, converting from one protocol to the other. Whether it is connected to a service in the cloud or on-premise equipment makes no difference. This is where SIP shines. As above, it's simply another protocol to be treated like any other data protocol. Whether the gateway's calls are routed locally or to the cloud makes no difference. The local PBX or cloud telephony service just sees a SIP trunk in the case of BRI/PRI and a group of IP-phones in the case of analogue.

What About the Risks of Gateways?

Two key risks of deploying gateways are introducing a single point of failure and offering potential extra way to hack the network.

Single Point of Failure

Due to the nature of analogue and digital telephony connections, it's often not practical to provide resilience on these connections. This often leads to the gateway becoming a single point of failure. In the case of analogue, it's possible to connect two gateways but expensive, complex and generally not done. For digital it's a little easier, but still expensive. Fortunately, analogue and ISDN is very reliable and not prone to failure, so most organisations accept the risk that if the gateway or telephony connection were to fail, there might be some loss of service.

Resilience is key.

VoIP Gateways, when implemented properly, can help keep you running when other services fail. Two ways that aren't common but extremely helpful to companies that hope to avoid network downtime are Local Survivability and Physical Fallback.

Local Survivability

What is local survivability? Simply put, local survivability is a feature built into gateways that means that onsite SIP or analogue phones can still get dial tone and make a call even if that site becomes disconnected from the internet. This is sometime called a SIP proxy as it proxies messages between endpoints. When relying heavily on an ITSP (Internet Telephony Service Provider) losing a connection can be catastrophic to some businesses. If the connection is lost, all phones lose service. You lose the ability to:

- Make emergency calls
- Take customer calls
- Make calls between phones
- Make calls to the outside

Physical Fallback

If a port fails, physical fallback means you still have service. This means that if power is lost on a gateway some or all users will still be able to make calls. In the case of analogue, for the cost of a few back-up PSTN lines companies can preserve the ability to make emergency calls even if there is no power at all in the business.
For companies that are looking to future-proof their IT infrastructure, running a mixture of on-premise and cloud infrastructure can bring business benefits including:

- Minimize the impact of physical ISP connection failures
- Minimize the impact of port failure
- Reduced telephony charges
- Lower transition costs
- Seamless integration with existing premise equipment

From a security perspective, how is a gateway different from other devices?

VoIP networks typically have a number of devices in the chain. These may include PCs, Firewalls, Hubs/Routers/Modems, SBCs, and gateways. Unlike these other devices that have routes through them to get to the internet, gateways are not IP to IP devices. With gateways, there's no way through, so there's much less vulnerability.

Hacking through the gateway to gain access to the internal IP network is not really possible, however the other risk is that a hacker gains access to the configuration of the gateway and is then able to reroute their own calls and commit toll fraud. The means to prevent this are similar to other IP based telephony devices:

- Use secure usernames and passwords
- Consider adding a firewall or SBC
- Separate the voice and management interfaces so that the management can be better secured
- Use different access levels for different staff categories
- Use secure protocols like TLS, SSH, HTTPS

What to Look for in a Gateway

There are many gateway manufacturers so it's key to understand the possible feature set that is available to make the best decision.

Line Length

Not every phone is located near to the comms room where a gateway might be situated. Examples could be large buildings where it could be several hundred metres to the phone or perhaps a campus where there might be a gatehouse on the edge of the grounds or an entry phone on a remote entrance. The gateway deployed should be capable of driving the remote phone from potentially multiple kilometres away.

Noise Suppression

Related somewhat to line length is noise suppression. If operating with cable lengths of kilometres, it's possible that noise will be induced on the line from machinery or passing trains or cars. The gateway should be capable of removing any noise on the line so that the voice remains top quality.

Ease of Deployment

Often deploying a gateway is a cost saving measure. It's important that installation is quick and easy, perhaps even done remotely with protocols such as TR-069. Spending a long time deploying negates the initial cost saving endeavour.

Reliability

RMA (Return Merchandise Authorisation) rates need to be low in order to prevent return to site at high expense and therefore eroding any profit from the opportunity. Sending an engineer back to site is very costly and the customer is unlikely to be happy if there has been a break in service.

Support

It's inevitable that at some point something will go wrong or configuration help will be needed. The manufacturer's support organisation should be on-hand, in time zone and ready to help you.

Professional Services

Sometimes an opportunity can be complex and requires system design skills to work up a solution. Having local support, possibly with on-site capabilities, can improve confidence from the customer and ensure the best design is put in place.

Training

Learning more about the product before deploying is crucial. Training, either online or classroom led, can help reduce deployment time and possible recurring visits to site.

Certification

If a particular ITSP or IP-PBX is the target for the gateway, ensuring that this is a tested and certified solution is crucial. This will reduce potential pitfalls later.

Concentration

Concentration is the ratio of possible calls to number of ports supported by the system. For instance, a 50 port FXS gateway may only be capable of driving ringing to 20 of its connected phones. Or perhaps only 15 of the 50 phones will be able to get dial tone at the same time. This may be OK for some deployments like hotels where the ratio of used phones is very low, but in other environments this might not be desirable. For example, in a call centre, all the agents would likely be on the phone at the same time.

Resilience

As covered earlier, being able to route around failure points or busy lines can be crucial.

Dial Plan

The dial plan is the routing engine of the gateway. It determines how the calls progress from one side to the other. Dial plans need to be flexible, easy to program and provide features for seamless connectivity:

- Number Manipulation. Typically adding numbers to the beginning of dialled or calling number. For instance, the user dials a local number but the ITSP requires the full length (likely 11-digit number). It's also useful to manipulate the calling number – perhaps the CEO of a company doesn't want his direct number shared so it should be overwritten.

- Port Selection. Routing calls to a specific port, and sometimes to a specific ISDN channel can be very powerful.

Product Portfolio

Choosing a manufacturer with a wide range of gateway models means that engineers only have to be trained on single platform. For instance, low and high-density analogue, multiple density BRI, multiple density PRI and potentially a mix of all 4.

Single Platform

Assuming a range of different gateway types are required, it's desirable that all the models use the same type of configuration interface – preferable web driven (not requiring dedicated programs) and similar across the range.

What to look for – Summary

It's clear from the examination above that there are two categories to look out for when choosing a gateway. The first is the feature set of the gateway – port count, management interface, etc. This should be easy to measure against the product data sheet. The second is more touch-feely. The helpfulness of the company, the quality of the product. Remember that a low up-front cost can quickly be eroded by spending time, money and resources on having to return to site to repair or replace or losing valuable time trying to contact a remote support department.

Conclusion

Gateways have been developed and required since the advent of Voice Over IP. About 20 years later there is still strong requirement for the gateway, but a lack of education on their capabilities and lack of knowledge that the old telecoms world can be easily integrated to the IP and cloud space. The availability of high-quality internet connectivity, fibre to the curb, ethernet final mile is driving the adoption of cloud and hence the requirement to connect diverse devices. Additionally, our habits, using our own mobile in a hotel room, means that there are many instances where it's not cost effective to remove all the legacy infrastructure. The gateway has many more years of life left in it still.