WHITE PAPER

PBX SYSTEMS FOR VOICE-OVER-IP
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INTRODUCTION

Small-to-medium business communications market is undergoing a considerable flux as a result of major ongoing changes in the technology of core networking infrastructure. Voice communications have been migrating from time-based to packet-based switching. A typical enterprise today includes all of the following ingredients for telephony purposes:

- A core communications switching system, commonly known as Private Branch Exchange (PBX) that provides dial tone, call setup functions, and other call processing features
- A management system to support fault and configuration operations
- A call accounting system to analyze call detail records for the purpose of generating billing records
- A voice messaging system

The enterprise demands have grown to include automated attendants, paging systems, and voice announcers. Organizations, with focus on customer service, now rely on an Automatic Call Distributor (ACD) system and an Interactive Voice Response (IVR) system.

Today, a PBX system boasts hundreds of features that could be customized for several industries such as hospitality, services, and finance. It is worth noting here that some great features are unique to special categories of customers and may even be used by only one subscriber per small enterprise. This document is intended for the telecommunication manager or voice-and-data network manager who is considering upgrading his/her telephony network into the IP realm.

1. PRIVATE BRANCH EXCHANGE

The Private Branch Exchange, commonly known as PBX, is an exchange that serves a particular business operation. It operates in a similar fashion to a carrier’s Public Switched Telephone Network (PSTN). A PBX makes connections among the individual peripherals and connects these to the PSTN via trunk lines. These peripherals could be telephones, fax machines, or modems. All peripherals are referred to as extensions, the end point of the PBX branch. PBXs select the outgoing line automatically while in some instances could allow a user to select an outgoing line. The growth of data networks and awareness of the benefits of packet switching led the PBX into the IP core domain. The IP suite has evolved to carry voice packets as well as data packets. The internet became a global delivery system leading to the development of the Voice-over-IP (VoIP) PBX. The basic function of a PBX system remained: allow in-house calling between extensions and enable routing for outside calls.

COMPONENTS

Several components are necessary for a complete PBX system:

- Exchange: The brain of the PBX system and is where the bulk of the application and operation is concentrated. Positron provides a PBX that operates as a SIP call server enabling SIP registration and SIP routing. Positron’s PBX also plays an RTP proxy role.
- Gateway: The component that connects the internal network to the outside world. It serves as call router from the exchange to the PSTN. Positron provides a PBX with integrated PSTN gateway functionality.
- Handsets: The actual telephones used with a PBX system. These are usually designed with an increased set of features that are compatible with the PBX system. Handsets enable users to dial extensions, connect to outside lines, utilize paging, and access a variety of features available with a system. Positron’s PBX systems are interoperable with a host of handsets from various market vendors, allowing for lower total cost.
PBX FUNCTIONS

PBX functions have evolved over recent years. Many of the functions today are an enhancement of original functions of a key telephone system (KTS). Some other functions were carried on from a hybrid key phone system. Other functions were inherited from TDM-based PBX systems. The list below is a summary of main categories of PBX features that were turned into de-facto functions.

- Call setup, tear down, and maintenance: a PBX provides the signaling required to establish a call between endpoints by utilizing signaling protocols such as Session Initiation Protocol (SIP). During the call, SIP messages are exchanged between the participating endpoints to maintain the status of the call. Upon the request of an endpoint, SIP messages are exchanged to tear down the call. Several SIP elements participate in the execution of a call. Positron’s IP PBX encompasses all of the required SIP elements for call execution. Many of Positron’s IP PBX call features shall be described at a later stage in this document.

- Call accounting: This function has become increasingly in demand in recent years. An IP PBX from Positron has the capacity to monitor or intervene in a call. It can also generate call data records (CDR), which could become useful in customer billing in applications, such as law offices and hospitality.

- Call distribution and routing: A PBX can take part in a call distribution for incoming calls, route selection for outgoing calls, and addressing a user group for incoming calls. Positron’s IP PBX offers a rich list of call management.

- Messaging: Positron’s PBX systems offer many message features such as voice mail, voice-to-email, and shared message boxes. Refer to a Positron product manual for more info.

- Interactive response: today IVR is a must have in a PBX system. IVR is a technology that allows a system to interact with human input through either voice recognition or keypad inputs. Positron’s IVR system can respond with pre-recorded or dynamically generated audio messages. It can also transition a call depending on a user’s input. The advantage of an IVR system is handling volume calls and performing auto-attendance.

INTERFACES

EXTENSION INTERFACES

There are several interface types that could connect a PBX to an extension:

- POTS (plain old telephone service) interface, a two-wire RJ11 interface used in most any standard phone. A Foreign eXchange Station (FXS) is a telephone interface that provides a dial tone and ringing voltage to a standard analog phone.

- IP over Ethernet interface running SIP or H.323 protocols

- Proprietary interface that defines a manufacturer protocol. It allows the PBX to connect to only vendor-specific handsets, while presenting more proprietary feature offering.

- DECT (Digital Enhanced Cordless Telecommunications) interface for cordless communication

Positron’s IP PBX systems offer two FXS interfaces for the purpose of connecting a fax or analog phone. It also offers several Ethernet interfaces to communicate flexibly with a Local Area Network (LAN) environment.

TRUNK INTERFACES

A trunk is the interface that connects the gateway part of the PBX system to the service provider. There are several trunk interfaces in deployment today.

- POTS analog interface, a two-wire RJ11 interface used in most any standard phone. A Foreign Exchange Office (FXO) is a telephone interface that receives POTS. It generates the off-hook/on-hook indications at the FXS’s end of a telephone circuit. A PBX could have several POTS FXO ports to connect to a PSTN. Positron’s PBX offers up to 12 FXO ports which could be configured according to outgoing and incoming rules.
ISDN PRI interface which runs over T1 (or E1). ISDN allows digital transmission of voice and data over ordinary telephone copper wires. ISDN usually offers better voice quality than an analog line can provide. Positron offers products with up to four T1 (or E1) interfaces. Positron also offers products with fractional T1 (or E1) interfaces.

- Ethernet interface running SIP (or IAX) or H.323 protocols that connect to Voice and Video over-IP providers.

**TOTAL COST FOR PBX**

The total cost of ownership (TCO) of a PBX system varies depending on the scope and features included in the system. There are often service charges involved when adding or altering extensions, upgrading systems, or otherwise changing the operational parameters of a PBX system. These charges can vary greatly depending on the service provider and manufacturer. Positron provides a PBX system with lowest TCO in the market.

2. **TODAY’S TELEPHONY ENVIRONMENT**

The business telephony environment today leans toward a conversion of protocols where the internet protocol dominates the scene of communications. Deploying a telephony network, an enterprise can take advantage of the universality of the internet protocol to achieve a convergence in topology where voice and data communication elements share the same medium of transport, Ethernet. Whether it is a phone, a server, or a computer, all are identified in the same fashion on a local enterprise network. A trunk type is selected to connect the gateway to the service provider according to a pre-selected service type that usually determines the cost and quality of service.
3. **PBX SYSTEMS CLASSIFICATION**

Some significant differences in PBX design and function across the spectrum of product offerings lead to a classification of PBX systems. This classification is the natural tendency to label the products. The three major categories are based on call control and switching platforms:

- **TDM/PCM circuit-switched PBX system** is a system with a proprietary common control complex and internal circuit switch network. This type is synonymous to a traditional PBX system.

- **Converged PBX system** is an integrated circuit and packet-switched system. It has a proprietary common control complex. It contains an internal circuit-switched network and integrated gateway interfaces to support IP peripherals connected directly to an external LAN or Wide Area Network (WAN). In this context, a traditional PCM-based phone and an IP-based phone can be supported.

- **Client-server IP packet-switched PBX system** is based on a client-server design consisting of a telephony server that uses a LAN/WAN infrastructure for call control and signaling operations. A circuit-switched network is not included as part of the standard system design.

This document shall assume the designation IP PBX, as developed by Positron, to define a client-server packet-switched PBX system in distinction to a “converged PBX system”.

4. **PBX SYSTEM PRICING CONSIDERATIONS**

Pricing is the most prevalent among all customer purchase criteria. Every PBX system, TDM or IP or converged, has its own price point, and few customer configurations are identical. Price comparison between different PBX system types is configuration dependent. If the configuration is defined, there are several pricing model assumptions regardless of system model.

- IP phones are priced higher than a digital telephone with comparable capabilities.

- If an IP PBX design is implemented, analog stations and PSTN trunk circuit connections become more expensive because gateways are required – gateways are more expensive than the traditional port circuit cards.

- Introducing IP gateways to a TDM/PCM PBX system is more expensive than adding the traditional port circuit cards.

- Emergency power costs are greater for an IP PBX design because there is more distributed hardware equipment such as call server, database servers, LAN switches, routers, and desktop terminals.

- The cost for incrementing IP ports on a pre-existing converged PBX is greater than a client-server design because the converged system requires port circuit cards.

- Cabling costs for a green field application are less for an IP- PBX than for a converged design.

- Upgrading a TDM/PCM circuit-switched PBX to a converged system by adding few IP ports might be more cost effective than replacing the entire system with a client-server IP PBX system. However, if a significant number of IP ports are required, the cost of a client-server design is likely less expensive. The only significant variable cost is that of IP phones.

**IP PBX SYSTEM PRICING**

- IP PBX designs are priced lower than converged solutions. Converged solutions require mandatory increase of IP port requirements.

- IP PBX designs are optimal for green field environments because the newly installed LAN and WAN infrastructure can be initially designed with voice-grade quality of service. Also, a single cabling system can be installed for all media communications.
5. **MAKING THE CASE FOR IP PBX SYSTEMS**

**CUSTOMER SOLUTION CHARACTERISTICS**

An IP PBX is likely to be the standard design platform of the future for enterprise communication systems. The benefits to customers who select an IP PBX exceed the drawbacks. Looking back at the earlier pricing discussion, the upfront capital investment for a client-server design is favorable for customer solutions with the following characteristics:

- Green field environment
- Large percentage of IP peripherals including telephone instruments
- Remote location requirements with limited port capacity
- PBX performance requirements with limited port capacity

**PERFORMANCE VALUE OF AN IP PBX**

**CONVERGED NETWORK**

Packet-switched LANs today carry telephone-generated voice communications in addition to computer system data traffic. From the perspective of a data communications network designer, the telephone is viewed as just another client, and voice features and functions are just other applications supported by a LAN-based server. LAN bandwidth capacity continues to increase. This means more point-to-point video communications traffic will be carried between desktops, and there is a decreasing dependence on larger, more expensive, room-based videoconferencing systems. A converged network where voice, video, and data are all sharing one transmission medium is the main driver for the emergence of an IP PBX.

**UNIVERSALITY OF THE TRANSPORT PROTOCOL**

The internet protocol, IP, is used everywhere today. IP control and transmission is the standard for data communications networks. The concept of a LAN and WAN is a fact of network operation across all industry sectors. The client-server communication model is a dominant mechanism. For a customer searching for an IP PBX system solution, the current data networking infrastructure is favorable.

**NETWORK BANDWIDTH**

Now that IP has become the transport mechanism to carry both voice and data, using the same communications network for both traffic types reduces overall bandwidth requirements. The two traffic streams could be interleaved and QoS levels can be engineered and programmed to satisfy real-time voice communications requirements. As customers migrate from circuit-switched to packet-switched communications, there will be cost savings and increased network efficiency due to economies of scale. Cost savings are attributed to off-premise communications because PSTN trunk carrier facility requirements are reduced with the introduction of IP.

**SIMPLIFIED MANAGEMENT**

The primary elements on an IP PBX, IP phones and call servers, are indistinguishable to a data network management system. All voice system management is performed from the data network management workstation. A single management system costs less to operate and is more easily administered than separate phone systems for voice and data communications.

**RAPID DEPLOYMENT**

An IP PBX lends itself well to rapid deployment of new technology because there are fewer hardware elements in the system architecture than a traditional PBX. It is far easier to implement a technology upgrade for an IP PBX because there are hardly any proprietary switching elements. Newer applications can be implemented through a software upgrade or an optional applications server. Migration between IP PBX server types is easier and less disruptive due to the client-server nature of the design.
DISTRIBUTED NETWORK DESIGN
The client-server scheme of an IP PBX defines a distributed network design. A single telephony call server can support premises and off-premises IP stations. Premise stations can be distributed across a campus. Multiple server designs can be programmed to support redundant emergency call processing. Servers can be collocated or distributed. LAN and WAN concepts alleviate the prospects of a single point of failure.

HIGHLY SCALABLE
IP PBX client-server design has the potential to be highly scalable because IP telephones are easily added to the system using an Ethernet medium. Port capacity can be expanded through the addition of servers. A customer can continually add switches and routers to the LAN and WAN infrastructure resulting in virtually boundless switching and transport limits.

6. POSITRON’S IP PBX SYSTEM – ATTRIBUTES AND ADVANTAGES

CLASSIFIED ATTRIBUTES
An IP packet-switched PBX system, commonly referred to as an IP PBX system, uses telephony-over-IP to support some or all control or voice communications signaling. Positron offers a family of IP PBX systems with the following classified attributes:

- LAN-connected telephony server that provides call signaling control to peripherals and stores the software feature program for feature/function provisioning operations
- LAN-based control signaling of IP peripherals (stations and/or trunk circuits) with an integrated gateway function port circuit card
- Ethernet-switched support of ‘IP peripheral’ to ‘IP peripheral’ calls that would involve no circuit-switched connections. Voice communications signals are carried across the LAN infrastructure between IP peripherals.
- Ethernet-switched support of ‘non-IP peripheral’ to ‘IP peripheral’ calls. An example of this call type is a call connection between a traditional analog or digital telephone and an IP telephone. Voice communication signals are carried across the LAN infrastructure to gateways interfacing to non-IP communication equipment.

Note that a circuit-switched PBX system based on a traditional common control complex that supports IP peripherals using an external gateway and/or gatekeeper network element would not qualify as an IP PBX.

BENEFITS AND ADVANTAGES OF A POSITRON IP PBX
There are several important reasons why a customer may decide to implement an IP PBX system from Positron.

LEVERAGE EXISTING INVESTMENT IN IP INFRASTRUCTURE
Enterprises have made large investments in LAN and WAN infrastructure over the past decade or so, mainly to embrace the growing demands of data networks. This investment has exceeded by far traditional circuit-switched voice communication systems. Using a single network infrastructure for both voice and data communications instead of the traditional two-network approach offers customers the advantage of reduced upfront capital expenditure and ongoing maintenance expenses. This also allows for simplified installation and management operations.
REDUCED CAPITAL EXPENDITURE

Although the current market price for an IP PBX system may not always be less than that of a circuit-switched PBX system, the projected cost curve favors the IP PBX system. Prices of IP phones are in continuous decline as product levels increase. Many of the equipment cost components of a circuit-switched PBX system are eliminated in a telephony-over-IP environment. The cost of a telephony server is less than existing traditional common control complexes in TDM/PCM systems. Using an existing data communications network to support voice networking requirements across multiple customer locations may significantly reduce telecommunications service expenses. WAN-based trunk connections require less bandwidth because of voice compression techniques and packet routing network configurations. Fewer trunk circuits mean reduced expenses. Optical fiber networks have grown, which makes bandwidth a non-issue for voice communications. Positron offers a compelling cost curve for an IP PBX in comparison to the current market offering. A Positron IP PBX interoperates with virtually any IP phone in the market allowing for low cost on phones and peripherals.

REDUCED OPERATING EXPENSES

Operations, administration and maintenance (OA&M) expenses are often greater than equipment and service costs because of personnel expenses. Although the price curve for equipment is declining, the OA&M cost is always on the rise. One way to reduce OA&M is by reducing personnel requirements. Positron IP PBX allows for a simple maintenance approach and a centralized approach to telephony-over-IP by closing down the gap between voice and data networks.

SIMPLIFIED SYSTEM CONFIGURATION AND EXPANSION

The technical advantage of telephony-over-IP using a Positron system is the ease of adding station users and supporting dispersed geographic locations to an existing system configuration. The distributed capabilities of Positron’s IP PBX can reduce the need for multiple systems in a network environment.

LAN and WAN infrastructure is ubiquitous in a sense that remote individual IP station users do not require local PBX common equipment to interface to the voice communications system. Using the LAN and WAN to support remote carrier requirements for station users with one premise or across multiple premises eliminates the need for dedicated circuit switched trunk links for signaling and communication.

It is simpler and more cost effective to add stations and port carriers using the LAN and WAN infrastructure; hence, the underlying technology of an IP PBX system offers configuration scalability. IP phones, for example, can use existing Ethernet data ports to connect into the voice communications network. The need for wiring dedicated to voice-only communications is eliminated by using an IP PBX from Positron.

CONFORMANCE TO STANDARDS

Other than ISDN BRI telephones, all digital PCM-based telephones are proprietary to a unique PBX system. TDM circuit-switched PBXs were traditionally designed to use proprietary signaling protocols and the operating systems of these PBXs were proprietary and closed to third-party software. Positron’s IP PBX system, however, is designed to conform to SIP and H.323, both of which are published call control signaling protocol standards. Both standards can support third-party phones for basic call operations and feature operation.

CLIENT-SERVER DESIGN

Positron’s IP PBX uses a client-server model that is a distributed application that partitions tasks between services and service requesters. This client-server design adheres to standard protocols and allows customers to use less proprietary hardware and more off-the-shelf system components such as third-party servers running telephony call processing and management software. LAN switches from a variety of suppliers provide the switching function for call connections.
ENTERPRISE-WIDE APPLICATION SUPPORT
Positron’s IP PBX behaves as a centralized telephony call server which can support several geographically dispersed locations. The same functions and applications available at one location can be provided across the enterprise network without replicating expensive processing equipment. This centralized system management and messaging saves money. In addition, the IP support of Positron’s PBX allows for cost efficiency.

WIDE AVAILABILITY OF APPLICATIONS AND STATION FEATURES
Positron’s IP PBX system supports an array of new desktop and system features and applications not available with traditional circuit switched PBX systems. IP telephones today support many features not available on traditional digital telephones. IP softphones are also equipped with integrated computer telephony features without dedicated desktop instruments.

Positron’s IP PBX system provides station user mobility and flexibility in accessing the communications network. Each IP station automatically identifies itself to the PBX system when it attempts to establish a connection, regardless of its location or method of connection. The PBX can identify the identity of the station using Dynamic Host Control Protocol (DHCP) and it can allow the user to access system features and functions.

7. POSITRON’S G-SERIES IP PBX
Positron Telecommunication Systems develops and markets sophisticated VoIP equipment for enterprise communication. Backed by the technology leadership of Positron, Positron Telecommunication Systems introduces a complete PBX system that is easy to use and manage. Positron’s highly scalable IP PBX phone system makes communications easier and more cost effective for small businesses. IP PBX systems are relatively out of reach for many small businesses due to high cost, therefore Positron makes this technology affordable for the small-to-medium size business, by leveraging the flexibility, performance, and cost savings made available by voice-over-IP. The G-series family of phone systems is highly programmable and offers an array of advanced features driven by Positron’s enthusiasm to provide the end-user with a remarkable experience. Positron’s IP PBX merges communications within one customer peripheral element. The G-series IP PBX handles the switching and connecting of both VoIP calls and analog telephone calls, allowing customers to select whichever solution is best suited for their needs. With the G-series phone system, separate networks are no longer necessary for voice and data communications.