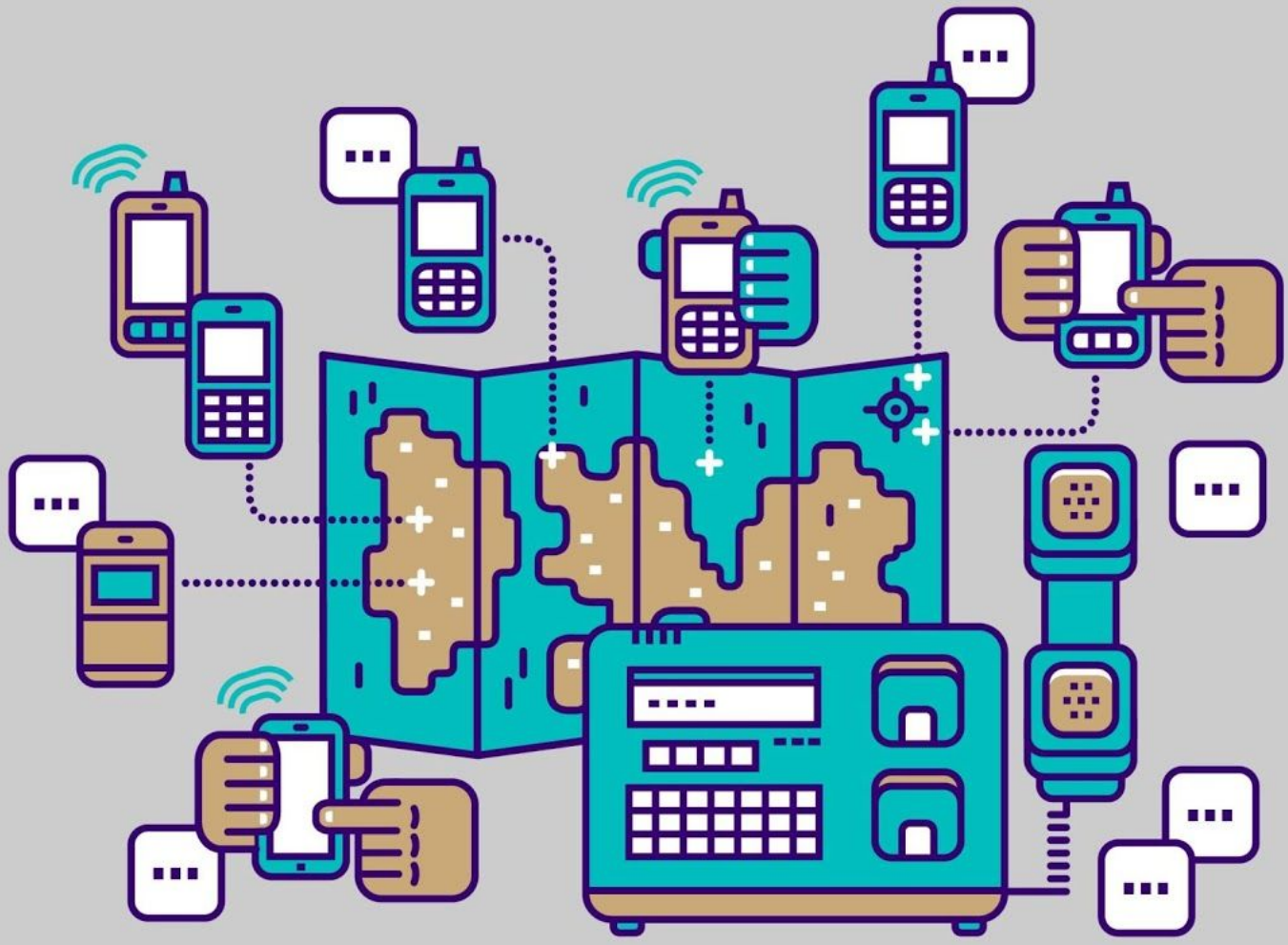
PBX



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1 Introduction

PBX, or private branch exchange is an internal telephone exchange that serves one particular organization, as opposed to a common telephone carrier or a telephone company that provides services for several businesses or the general public. PBXs are also known as PABX (private automatic branch exchange), EPABX (electronic private automatic branch exchange), IP PBX (internet protocol private branch exchange), business phone system and even unified communication system. A PBX functions as the core switching system for telephone calls within a business. PBX systems not only handle internal communication traffic within an organization, but also act as a gatekeeper for communication requests to and from the outside world.

2 History

Before PBXs were introduced, key systems existed, which were more cumbersome than PBX systems. An incoming call was answered by an operator who manually connected the call to the right person or department extension. Similarly, outgoing calls were handled by routing them to the operator who then manually connected the call to an available public switched telephone network (PSTN) trunk.

In a key system, the station user could control the calls manually by selecting the outgoing lines, but a PBX has automatic selection of outgoing lines similar to that of a PSTN. As the technology evolved, manual operators were replaced by electromechanical and later electronic systems for managing access to external lines. Thus, outgoing calls from an extension could be dialed directly in a PBX system. Today, pure key systems have virtually disappeared from the market, although hybrid systems, which combine the best of both worlds, still exist.

When PBXs were introduced, their primary advantage was the cost savings on internal communications within an organization. The original purpose of the PBX system was to provide shared access to limited telephony resources. So instead of having individual PSTN lines for each telephone within an organization, a business could use a small set of trunks to interconnect a larger set of end-point devices. By completely handling the circuit switching, PBXs allowed organizations to save on charges levied by the PSTN provider. Soon, PBX equipment started offering value added services that were not available on the PSTN network. These included closed caller groups, call forwarding, and extension dialing. Additional features were added to route incoming calls automatically, allowing active calls to be transferred between stations and permitting or denying calls based on various rules. Adjunct systems were added for voice messaging, call queuing, multi-party conferencing, and other value added services. In the nineties, traditional PBX systems started being replaced by integrated services digital network (ISDN) PBX systems as they started offering additional features such as caller ID, conference calling, and call forwarding.

2.1 Current Trends

Today, analog and proprietary digital phones are being replaced by standards-based IP phones. The massive growth of data networks and the increased focus of companies on their core competence led to the development of VoIP PBX (also known as IP PBX) and hosted PBX. As the technological know-how of packet switching improved, companies started exploring ways in which packet switched networks that were being used for data could be utilized for voice calls as well. The spread of the Internet made the concept even more viable and thus VoIP PBX gained popularity.

Historically, PBX equipment was an expensive proposition and only large organizations could afford it. Today, the drop in hardware prices combined with open source telephony software projects have made PBX systems affordable to large and small businesses alike. The open source projects offer great flexibility and are feature rich. This has lowered the entry barriers for new entrants in the market, as the open source software allows customization of the core functions of

the PBX itself. There are also consumer size PBX systems on the market, which provide several features of full-fledged PBX equipment at a fraction of its cost.

As small companies increasingly outsource their network and infrastructure management, hosted PBXs gain traction. In a hosted environment, the PBX is located at the service provider premises. The hosted PBX is managed by the service provider and the call management services are delivered via the Internet or a private network. This is good for small businesses, as they are saved the hassle of investing and maintaining expensive PBX equipment.

3 Technology

A private branch exchange not only connects all the internal communication equipment of a private organization (usually one with a large number of staff and high amount of call transfers and internal calls, such as a contact center), but it also connects these to the public switched telephone network via trunk lines.

The communication equipment in an organization can range from telephones to fax machines, modems and so on; hence, the term 'extension' is used to refer to any endpoint on the PBX network.

3.1 System Components

There are two key components in a traditional PBX: trunks and stations. A trunk or a line is a connection to the external PSTN, which is established with the help of a telephone company. A station is an endpoint device, which can be a telephone, a fax machine, a modem, or even a credit card terminal. Other components of PBX systems include the internal switching network, a microcontroller for controlling the equipment, a UPS system, logic cards, power cards that aid PBX operation, and a console or switchboard that allows an operator to control inbound calls.

3.2 Key Features and Functions of a PBX

Typically, a PBX system performs the following call processing functions:

- Establish circuits between the two communication endpoints by mapping a dialed number to a physical end point such as a telephone or a fax machine
- Maintain the connection established as long as it is necessary by channeling voice signals between the two end points
- Disconnect the connection once the user requirement is met
- Provide information (such as metering of calls) for MIS and reporting purposes

Some of the key features that are included in a modern day PBX are listed below:

- **VoIP Compatibility**: As VoIP increasingly replaces legacy PSTN lines, it becomes essential that the PBX can support IP stations and IP trunks.
- **Support for Remote Workers**: Today, most organizations will have at least a few remote workers who would be spending their work hours away from the main office premises. Therefore, it is essential that the PBX offers features that support mobile working such as remote IP extensions, fixed/mobile convergence and Find Me/Follow Me features.
- **Voice Message and Conferencing Support**: The more that communication mechanisms become integrated, it is necessary that the PBX equipment supports voicemail. As

teleconferencing replaces business travel, PBX equipment needs to support multi-party conferences and not just three-way calling.

- **Customized Reports**: PBX equipment should be able to offer customized reports for reporting basic call history.

In addition to these basic functions, manufacturers have started offering several value added features in an effort to differentiate themselves in a tough market. Key features that are commonly available in a good PBX system include auto-attendant, auto dialing, ACD queueing, dynamic agent handling, distributed call routing, easy to use web-based interface, customizable on-hold handling including custom greetings, automated ring back, call accounting, call blocking, call waiting, call transfer, call forwarding, and easy access to the company directory. In addition, the system should be easily scalable as the business grows and should be reliable with downtimes within acceptable limits. Advanced PBX systems also offer several high-end features such as Direct Inward System Access, Interactive Voice Response, Voice Mail, Skill Based Routing, real time monitoring of call queues, and geographical call distribution. The range of features offered by a PBX system varies in proportion to the price of the equipment. The additional features are offered either through hardware or software upgrades. In some cases, add-on modules are required for additional features. Automatic Call Distribution is one of the more expensive features that are available in a PBX system and products with ACD usually come at a premium to those that don't have it.

3.3 Operations

A PBX device is a piece of wall-mounted or rack-mounted hardware with a patch panel for connection to internal and PSTN telephone lines. In software PBX systems, a personal computer controls the PBX operation and connectivity is provided with the help of adapter cards and add-on software modules.

The operations of a PBX system are fairly straightforward. An inbound call from outside the organization is routed through the PSTN to company-specific lines. The PBX system answers the call with a custom message, plays a menu of options to the caller, and based on the inputs received, will route the call to an appropriate extension or a holding queue. Some organizations choose to route the call to a receptionist or an operator who then forwards the call to the relevant extension. At the extension, if the call is not answered, then it is transferred to the voicemail for the extension. In the case of calls which are not meant for an individual, but for a specific department (such as calls to the support or sales team in a contact center), callers are routed to a holding queue and are connected to whichever agent is available next. However, low-end PBX systems do not offer this feature. Some systems have a less sophisticated 'hunt group' feature, where a list of pre-fixed phone numbers are tried and the line that is available is connected to the caller. The flip side of a hunt group is that the order in which the PBX attempts to connect the calls is pre-determined and the first extension in the list is usually overburdened with calls, as the calls are passed on to the next extensions only in the event that the first extension is 'busy'. Yet another drawback of a hunt group

is the large time taken to respond to an inbound call, as each extension is tried in turn to identify one that is available.

Higher end PBX systems with Automatic Call Distribution (ACD) queues handle call distribution more efficiently by keeping track of call volumes per agent and idle time of each agent. Inbound calls are distributed to the free agent who has the highest idle time, thus ensuring that calls are distributed evenly and answered with the minimum wait time for the caller.

3.4 Interface Standards

There are several interfaces for connecting the extensions to the PBX. These range from Plain Old Telephone Service (POTS), which is the most common system, to proprietary protocols defined by vendors that allow only specific devices to be connected to the PBX, to DECT (for connecting cordless phones) and IP protocols (such as H.323 and SIP) for VoIP devices.

Similar to the protocol used for connecting extensions to the PBX, the interfaces for connecting PBXs to each other also vary. If the PBX system has equipment from multiple manufacturers then there is a need for a standard protocol for connecting the different PBXs in the organization. Commonly used interface standards include ISDN PRI, QSIG, DPNSS and IP based protocols such as H.323, SIP and IAX which can handle both voice and multimedia (video calls, for example).

Finally, the internal PBXs are connected to external trunk lines using POTS, ISDN or RBS protocols. The POTS protocol is cheap and effective for small systems; however, it may not be able to detect an incoming call while attempting an outgoing call. ISDN is the most popular digital standard for fixed telephony devices and most medium to large sized companies use this protocol. RBS or Robbed Bit Signaling delivers 24 digital circuits over a four-wire interface. In addition to these, IP protocols such as H.323, SIP, MGCP, and Inter-Asterisk eXchange protocols are also supported by some service providers.

Data from the PBX can be collected using a serial interface, a network port, or in a file format. The call records from the PBX are called CIL, SMDR or CDR. The serial interface was historically used to print call records to a serial printer. The network port is used to connect an external application to the TCP or UDP port to which the PBX streams information.

4 Types of PBX

4.1 Hosted PBX

A hosted PBX system delivers PBX functionality as a service over the PSTN. It was first introduced commercially by a company called Virtual PBX™ in 1997. Hosted PBX systems are feature rich and can provide all the features of a premise-based PBX system at a fraction of its cost. Instead of investing in PBX equipment and incurring a high upfront cost, users would contract for PBX services from a hosted service provider and pay-per-use or a work within a subscription model.

4.2 Mobile PBX

As mobile devices such as cellular handsets and smartphones become part of everyday work, mobile PBXs with the capability of handling both fixed line phone and mobile devices as extensions are gaining popularity. A mobile PBX system is usually a hosted PBX service, but it differs from a normal hosted PBX solution, which can only forward data or calls to mobile devices. In the case of a mobile PBX, the functionality available in the mobile device is used to provide PBX features – either using the buttons and keys (hardware) or by running custom applications (software) in the device. A mobile PBX can also offer extension identifiers for each handset, allowing a mobile device to dial another device in the network using an extension shortcut, instead of using the PSTN services.

4.3 Software PBX

A software PBX operates similar to that of a premise-based hardware PBX except that there are no hardware equipment associated with the PBX. Instead, the features are provided through software running on a PC or a computer. Though some vendors, refer to this as a hosted PBX (as the PBX logic is 'hosted' on a computer and not hard coded on hardware), it is not a hosted service. Software PBXs are generally more difficult to configure and use and are not as feature rich as either a premise-based PBX system or a hosted solution.

4.4 VoIP PBX

VoIP PBX devices are identical to software PBXs, but they rely on network protocols and wires to deliver the calls. VoIP PBXs use PBX software to route calls within the business network to IP telephones and hardware to connect to the external PSTN.

4.5 Hosted VoIP PBX

This hosted PBX solution relies on VoIP technology. As with a normal hosted PBX, a hosting service provided provides the PBX functionality from outside the premises of the company. Inbound calls are answered at the hosting site and routed to extensions in the company premise via the internet. Today, this technology is at its nascent stage and there are problems with respect to call quality, data security, and reliability. Call quality and reliability are much better for PSTN networks than the

internet. VoIP systems also increase vulnerability of the network to security breaches. However, once these problems are effectively addressed, this shall be the solution of the future.

5 Comparison of Standard PBX Equipment to a Hosted PBX Solution

5.1 Strengths of Standard PBX Equipment

There are several advantages of using standard PBX equipment:

1. Mature Technology: PBX hardware has been around for several decades now, and it has all the advantages of a mature technology.

2. Cost Savings: By sharing the cost of incoming phone lines across multiple extensions, organizations can derive cost savings by moving into a PBX system. In addition, the capital costs incurred can be amortized and depreciated over the life of the system.

3. Feature Rich: Almost any feature that can be thought of in the telecommunications space can be made available as a part of a PBX system or as an add-on, provided customers are willing to pay the price for it.

5.2 Weaknesses of Standard PBX Equipment

A premise-based standard PBX network has the following weaknesses:

1. Costs: The biggest problem with a standard PBX system is the high up-front costs incurred to get the system running. The typical cost of a PBX system including the cost of equipment, installation charges, and wiring charges can range anywhere from $500 to $2,000 per user. In fact, very low-end systems may not offer even the basic features required for the business and can be very restrictive when it comes to scalability. As a result, several smaller businesses continue to use individual phone lines for their employees.

The other major cost element for a standard PBX installation is the cost of ongoing support and maintenance. As the functionality increases, the need for highly trained staff to maintain the PBX equipment and the software, install system upgrades, and monitor usage patterns also increases. Typically, organizations incur about 12% of the up-front cost of the PBX installation as support and maintenance expenses on an annual basis.

2. Scalability: As with most telecommunication devices based on hardware infrastructure and software, lack of flexibility to scale is a key concern area for PBX equipment as well. Most PBX hardware has limitations when it comes to adding internal extensions or external lines. This is more so in the case of low-end PBX equipment. As a result, small businesses on an aggressive growth path are often forced to over-invest in the equipment in order to handle increasing call volumes. Otherwise, they will be forced to discard the equipment and invest in new hardware when the business grows. Industry surveys indicate that most small businesses overhaul their PBX system at least once in two years to handle business growth. In both cases, it is a loss-loss situation, and thus standard PBX equipment in a premise-based installation is not the ideal solution for a small and growing business.

3. Flexibility: Most standard PBX equipment also lacks the flexibility to add on new features. While almost any telecommunication functionality can be made available as part of the PBX system, often these features are not available in a modular structure, forcing businesses to invest in new systems in order to benefit from additional features. Even in the case of a modular structure where features can be added on later, the costs of such add-ons are significantly higher than purchasing them as a bundled product along with the original purchase.

4. Adaptability: As the business environment continues to evolve at a rapid pace, it is important that supporting technologies such as the PBX system are quick to adapt to the changing realities. Originally, PBX equipment was designed to address the needs of a central office where employees are located. Today's business environment caters to the needs of the mobile workforce and the traditional PBX equipment is not capable of addressing this new scenario. Increasingly, business users want the flexibility to receive calls on multiple numbers – their cellular phones when they travel, an alternate phone when they work out of a branch office, or even a home phone when they telecommute. The basic PBX architecture is designed for routing calls inside a pre-wired central office, and routing calls back to a different phone is difficult and often more clumsy than the call forwarding or follow-me features of a hosted service.

As cost rationalization becomes the norm in a recessionary economy, companies are moving to a completely distributed workforce in an attempt to save office infrastructure costs. The concept of virtual office is now being embraced by not just small businesses, but even by large service organizations. For such distributed virtual offices, it is difficult to use standard PBX equipment and it may not be a cost effective option.

5.3 Strengths of Hosted PBX

Hosted PBX systems have several advantages over traditional premise based PBX systems. There are several models of hosted PBX services in the marketplace today. An organization needs to do a detailed analysis of the features it needs and compare it with the features being offered in order to identify the right solution at the right price. Some of the key advantages of hosted PBX solutions are listed below:

1. Lower Up-Front and Support Costs: There is no capital expense for availing a hosted PBX service, making it an ideal choice for small companies or companies on a tight budget. Today, even larger firms that have outgrown their PBX installations, consider hosted solutions as the option of choice instead of upgrading the equipment and incurring further capital costs. A high-end feature rich PBX system can be quite complex to manage and would require expensive skill sets. With a hosted PBX solution, the day-to-day management and maintenance of the equipment is handled by the service provider, thus freeing the organization from the hassle of managing additional headcount and monitoring up time and redundancy requirements.

2. Call Routing Flexibility: One of the inherent advantages of a hosted PBX solution is the flexibility to route calls to any equipment across the globe rather than only to extensions that are physically connected to the in-house PBX. This call routing flexibility has encouraged the widespread use of a virtual office model in industries such as contact centers, which are focused on reducing operating costs without compromising on service levels and agent efficiencies.

3. Scalability: Small organizations with premise based PBX systems often spend a lot of money buying equipment that is not easily scalable and that they quickly outgrow. Some others end up buying PBX equipment with a larger capacity in anticipation of future growth, paying more than they currently require. Hosted PBX services offer the best value for the money as they can be easily scaled up or down without additional effort on the organization's part. This way, companies can pay for only what they need, without incurring any penalty for not planning for the future.

4. Call Capacity: Hosted PBX services typically handle multiple companies and are able to exploit the economies of scale to offer better services to each of their clients. A hosted PBX system will normally have far more lines than is required for the company's needs. If the service provider can manage capacity efficiently, then callers will never have to hear a busy signal. This is a huge boost to the customer satisfaction levels of the company. On the other hand, a hardware PBX system can only handle as many calls as the number of physical incoming lines in the network leading to a loss of customer satisfaction and even potential revenue.

5. Feature Rich: Today, all PBX features are available in both premise-based systems as well as hosted systems. However, the same set of features will be much more affordable in a hosted PBX system than in a premise-based system. Additional incremental costs for features are very low in a hosted PBX service, thus users are able to get the most value for money for their PBX solution. A hosted PBX service provider will be able to provide all the functionality of a hardware PBX (which can cost hundreds of thousands of dollars) for a very small monthly fee, thereby allowing even small businesses to benefit from a feature rich solution.

6. Redundancy: A hosted PBX service will incorporate redundant components for fault tolerance and multiple systems for automatic fail-over. Replicating this model in a premise-based system can be very expensive. As the hosted service provider would share the costs across a large number of clients, the redundancy becomes more affordable. In a hosted PBX environment, no single component failure can bring the system down, and even if an entire PBX system fails, the fail-over mechanism ensures a smooth roll over into another system.

7. Distributed Administration: A well-designed hosted PBX service allows end users to manage their own extensions, giving them flexibility and administrative control. Agents in a contact center, for example, are able to schedule their breaks by logging in and out of ACD queues,

change their contact number while travelling, and configure system options to suit their individual requirements while keeping in mind the overall contact center key performance indicators (KPIs). In a premise based PBX system, much of this functionality resides only with the system administrator and any change in an agent's schedule will have to be centrally managed. So, a lot of time and effort is wasted on the scheduling process.

5.4 Weaknesses of Hosted PBX

While hosted PBX services have many advantages, there are inherent disadvantages as well. Some key features are usually difficult (though not impossible) to find in a hosted service environment. These include Automatic Call Distribution (not just hunt groups), flexible company directories, real time monitoring and reporting capabilities, and call transfers between extensions.

In a hosted PBX service, dialing between extensions can be quite problematic. In a premise-based PBX system, employees can easily dial each other without having to go into the public telephone network, through an 'intercom' kind of function. In a hosted environment, employees are usually geographically distributed – an end user can be inside the office premise, or anywhere else in the world. This means that calls between employees are typically routed by dialing their number directly or by dialing the hosted service provider and then selecting the extension. This is because the PBX is now functioning on the PSTN and not on the office premises. While high-end hosted services have resolved this problem, transferring calls between extensions is still an issue with low cost hosted service providers.

5.5 When to Choose a Hosted PBX System

There are pros and cons for hosted PBX systems as well as centralized PBX systems and the choice depends on the needs of the contact center. For example, if the contact center has a distributed workforce, then a hosted PBX is a better choice than a centralized PBX. However, if all the agents are physically located on the same premises, then a premise-based PBX could be a better option. Other factors favoring a premise-based PBX system include a steady anticipated call volume for the next few years, a large sized company, availability of budgets (if the contact center can afford high up-front costs, so as to minimize running costs) and the availability of skills (if there is a team to maintain the PBX in-house).

For contact centers and organizations with a virtual workforce or with telecommuting employees, a hosted PBX system may be a better choice. Hosted PBX systems also allow organizations with budgetary constraints to benefit from the advantages of a PBX without incurring the high up-front costs associated with a state-of-the-art premise-based system. Thus, a hosted PBX system is the ideal choice for a small company or one that is on an aggressive growth path. It is also a good choice when the organization wants to focus on its core competency and does not want to set up an in-house team for maintaining the PBX system. Hosted PBXs offer better fault tolerance and system reliability, and make high-end features such as ACD queuing available at a reasonable budget.

In short, a hosted PBX is clearly a better choice for a small company with a distributed workforce and a limited budget for capital expenditure. When a well-established company has centrally

located employees, a low growth rate, and a predominant focus on minimizing call costs, then a hardware PBX is a financially savvy option.

6 Key Players in the Industry

According to a recent report from Infonetics Research, the global PBX market in 2012 totaled $8.1 billion. The global recession has affected the enterprise telephony industry as well. Sales figures of PBX equipment have dropped by 4% compared to 2011, as organizations reduce their technology budgets in an attempt to cut costs wherever possible. Moreover, the primary driver for PBX equipment is the creation of new business or the expansion of current business. Thus, any downturn in the economy directly affects the growth of the PBX equipment market.

Major players in the PBX-KTS equipment market include Cisco, the market leaders globally, followed by Avaya and Nortel. Other significant contributors include 3Com, Aastra, AudioCodes, Alcatel-Lucent, Dialogic, Mitel, NEC, Quintum, Samsung, ShoreTel, Siemens, Tadiran, Toshiba, and Vertical.

The right PBX system can be a powerful tool for contact centers, helping to improve key metrics such as productivity, customer satisfaction, and operational costs.

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