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PSTN Access for Your Contact Center

Telephone Lines

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PSTN Access for your Contact Center

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All too often, public switched telephone network (PSTN) access is simply ordered, with little or no thought as to how it dovetails with business objectives. However, there are many techniques and options available to set up your PSTN access arrangements. The ultimate goal of PSTN access engineering is to provide adequate (in terms of capacity), reliable and cost effective transport for telephone calls between the public telephone network and your premise.

PSTN Access Sizing

"Adequate" means that the bandwidth (or in voice parlance, the number of simultaneous two-way voice communication channels) is big enough to ensure that callers get through to your call center. It is impossible to put in enough trunks (see **Table 1 – Glossary**) to ensure 100 percent of inbound calls get into your automatic call distributor (ACD) at will. Disasters, marketing and dozens of other factors can drive unanticipated traffic loads into your center.

The most common measure/metric used for access sizing is blockage rates. When call center executives say they have a 5 percent blockage rate, they usually mean that 5 percent of callers receive a busy signal over the reporting period. When sizing PSTN access, however, engineers usually use a Grade of Service (GOS). A 5 percent GOS means that during the busy hour of the busy day of the busy month, 5 percent of callers receive a busy signal.

This should result in a very small number of busy signals over the reporting period - and those only occurring during the busiest hours of the planning period.
Busy signals are difficult to measure. All ACDs have All Trunks Busy (ATB) reports. But be careful when examining ATB reports, because they only record the number of times or the percent of time all trunks are busy. To get a better picture of the busy signal situation, it is necessary to go to the local exchange carriers (LEC) and interexchange carrier (IXC).

IXCs can readily supply a blocked call report and it can usually be counted upon to be accurate. LECs, on the other hand, usually don't charge on a call-by-call basis like the IXCs so it is much more difficult to get this report from a LEC. The report must be requested in advance, and the ILEC will collect the information on the specified lines for the specified period of time. Even then, the analyst should inspect the results carefully for accuracy.

However, these blocked call reports provide only limited help in assessing the true loss of demand experienced because of network blockage. To drill deeper, you'll need good analyst with some basic database programming skills. This person can do an originating-phone-number sort to identify, out of all the blocked calls, how many came from unique callers. This will help you produce a report that takes into account the propensity of callers to redial repeatedly until they finally reach a customer service representative (CSR). The above discussion on analyzing busy signals and caller retry behavior demonstrates the folly of under-trunking — i.e., not providing enough telephone trunk access. Undertrunking hides the true demand, and, as such, will make it difficult to justify realistic staffing requirements to senior managers.

A common tactic used by call center managers is to take telephone trunks in and out of service to manage service level, preferring to give callers a busy signal rather than a low service level. This is a legitimate strategy in known understaffing situations or in marketing promotions that serve only to garner attention rather than offer any true sale or service (the $99 round trip air fare around the world, for example) But this practice should be used sparingly. When done purposefully to improve service level, the call center manager must let senior management know they are engaging in this practice because it can be perceived as dishonest. This is especially true if a bonus is paid out on service level goals.

Access Configuration

One of the most common mistakes made in access engineering is provisioning multiple trunk groups to the toll free carrier. In practice, a call center only needs one trunk group to an IXC. If there is a large administrative function in the building, there may be an argument for having separate outbound toll and inbound toll-free trunk groups to ensure outbound capacity remains available at all times. ISDN trunks can be configured to reserve a specified amount of capacity for outbound service, thus eliminating the need for the separate in and out trunk groups.

In many call centers, the policy is that each new phone number, client or product added to the center receives its own telephone lines. The rationale for this practice is either reserved capacity, cost allocation or reporting. standard feature on all ACDs, and even the most basic reporting package can report on DNIS signaling.

In truth, there is no justification for this approach, and segmented trunks are highly inefficient. Callers can be receiving busy signals on one trunk group while circuits sit idle in other trunk groups. Dialed Number Identification Service (DNIS), which reports the phone number that the caller dialed, is a Most ACDs can be configured to place maximums on simultaneous calls on any DNIS number, and ISDN allows even more control over capacity allocation.

Traffic Engineering

So how many telephone trunks are required for a given number of CSRs? Old adages such as "one and a half telephone lines per CSR" oversimplify line sizing. The basic metrics required to determine line size are:

- Number of calls
- Length of time a call occupies a circuit.

Together these yield a total base demand for access service. As noted earlier, this is usually calculated for the busiest hour over the planning period. To account for the random arrival of calls, this is applied to a statistical model to ascertain the number of trunks required for the call center.

ATHT = Ring time + Talk time + Forced announcements + Queue Time

So the number of calls is simple enough. But point #2 above, "Average Trunk Holding Time" (ATHT) is a bit more complex and is defined as:
Talk time and forced announcements (automated attendants are included in this) are straight forward, but ring time and queue time require some thought.

Ring Time — Ring time is usually between zero and 12 seconds. Ring time can be set on the ACD to allow as many ring cycles as desired (a ring cycle usually lasts six seconds — two of ringing and four of silence. The "Ring Cycle" is also the name of a German opera that lasts 16 hours and seems even longer.)

It is unwise to set the ring time to zero, because callers will feel obligated to tell the CSRs that they did not hear any ring tones, thereby increasing talk time. Trunks provisioned as ISDN (discussed later, see glossary) have no ring time, in that ring signaling is done on the D-channel. Traditional T1s then should be sized with about six seconds of ring time (again, check your switch setting for this). ISDN PRIs should be sized with zero ring time included in the ATHT metric.

Queue Time — Queue time is a difficult metric to quantify. Goals are fine, but it is necessary to engineer to reality. Also, there can be a philosophical discussion as to how much queue time should be allowed based on whether the call center is a revenue center or not. The theory is: In a revenue center, you want callers to hold on as long as possible to reach a CSR, so as to capture as much revenue as possible. That said, one would never use predictive queuing (see glossary) in a revenue center, because predictive queuing tends to increase “abandon early on” in the queue. In contrast, callers who don't know how long the queue is, combined with snappy on-hold music and messages, can hold quite long without realizing how much time has passed.

In short, a revenue center should significantly over-trunk to limit the amount of lost revenue. Proper staffing is the first remedy, of course. But it isn’t possible or economical to never be understaffed. So there will always be periods of time where queues are longer than desired.

The cost of telephone trunks is trivial in comparison to the potential revenue lost. Some simple math will demonstrate that the increased revenue resulting from increased queue time can pay for the incremental line and per-minute charges.

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Let’s say that an additional T1/PRI will allow a center to handle an additional 100 calls in an hour. That T1/PRI will cost, say, $1,000 per month. If the net revenue per call is $100, only 10 additional sales are needed to justify the additional access service. If the customer buy rate is 10 percent, the additional costs can be recovered in a single hour. The center will capture additional calls and revenue in more than a single hour, so the benefits seem obvious.

On the service side, there is no revenue to drive over-trunking. However, it is a well-understood phenomenon that talk time begins to increase as queue time passes a certain threshold. Callers begin to complain about the wait. This drives up both access line costs and personnel costs. In effect, you pay extra to deliver bad service. It is this threshold queue length that service call centers want to use as their queue time in the calculation of ATHT.

Statistical Modeling

The decision to use Poisson, Erlang B, Extended Erlang B or some simulation model is the subject of much academic debate. It is, however, academic. As you engineer to better and better service, these models approach one another. If you are engineering for, say, a 5-percent GOS in the busy hour of the year, there will be little difference in results between the various engineering approaches. Because Extended Erlang B accounts for retry behavior, in theory, it might be an appropriate model for an inbound call center.
But again, in this world of T1 and PRI high-capacity digital services that come in 24- and 23-voice-connection increments respectively, it rarely matters. Most engineers use Erlang B because MS Excel add-ins are readily available and they generally round up to the next full T1/PRI.

In short, access is cheap. Error on the side of over capacity. It is easy to take circuits out of service, but difficult and time consuming to add circuits.

Reliability

High-capacity digital access services are highly reliable. There are, however, very few call centers that have not experienced an access failure in the last 24 months. While the probability for disaster is small, the impact of a PSTN access failure is devastating. So spending some time developing contingency plans is worth the effort. (Switched access service is not discussed here because it is uncommon and expensive, even for the smallest operations.)

A call center reaches the PSTN via either a local (LEC) or a long distance (IXC) service, or both. The most common arrangement, especially in large cities, is to have a set of trunks for local service and a separate set for long distance. A center almost always has some local service for administrative purposes, most often Direct Inward Dial (DID)/Direct Outward Dial (DOD), that lets administrative personnel have their own phone number without having to dedicate specific lines to reach individuals.

When setting up access to the public network, DNIS numbers from the IXC should be selected so that they match numbers in the DID range assigned by the LEC. The DID lines can then be subscribed to local-line toll-free service (switched toll-free service) from the IXC, and this sets up a disaster recovery plan for certain types of disasters (specifically IXC POP failures). This is inexpensive and every center should have this arrangement. The local lines can transport toll-free calls in the event of certain kinds of disasters without any reprogramming of the ACD.

Route Diversity

The next step up the PSTN contingency planning ladder is diverse routing to the PSTN cloud. In **Figure 1**, the central office is the point of access into the local telephone network (LEC). The Point of Presence (POP) is the point of access into the long distance network (IXC).
There are many single points of failure in trying to obtain diverse routes to these offices, and diverse routes can be more successfully achieved in large cities.

Figure 1 shows four possible configurations. (These configurations are accurate for IP Telephony access alternatives as well as traditional voice access designs) If you order "total service" access from your IXC, the likely configuration will look like "A" in the figure. Although the circuit passes through the LEC central office, no switching occurs there and the trunk is dedicated to you from your premise to the IXC's POP. This access arrangement is a single point of failure from end to end.

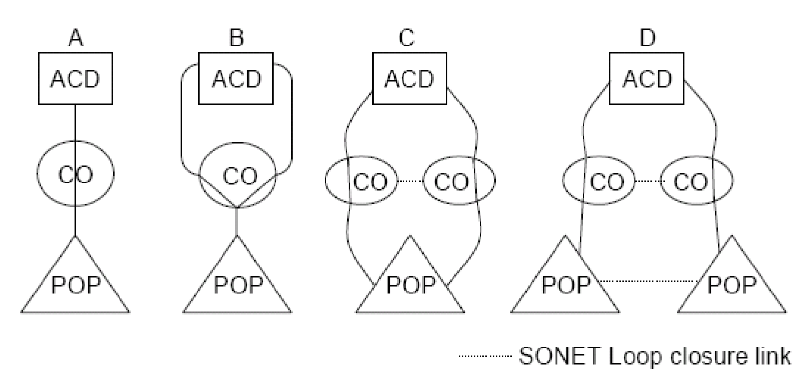
Option B is an improvement, but can be difficult to achieve. In small towns, it is not uncommon for there to only be a single central office servicing the entire town. In these cases, LEC right-of-way often extends radially from the central office like the spokes of a wheel. There may be two exits from the building in different places, but the paths converge under a manhole cover right outside the building. If that's the situation, there is little merit to paying for diverse building entrances, unless the facility itself and the land around it are undergoing heavy construction.
On the other hand, if there happen to be two fully diverse paths all the way from the call center to the central office, the LEC will assess "special construction" charges to connect the two routes.

It is common for a company to locate its call centers in medium-size towns where there will be multiple LEC central offices, but a single IXC POP. In this case, it is very likely diverse paths can be found (although there will still likely be a "special construction" charge from the LEC). In this case, there will be full redundancy all the way back to the POP (Option C).

Most IXCs have what is known as N - 1 failure recovery mechanisms. Should the local POP fail, they take the call back one office in the hierarchy and attempt to complete it from there. It's in this type of failure that the shared DNIS/DID arrangement pays off, as the IXC can use the local lines to terminate the calls from the distant switch. This design becomes highly reliable and can be cost effective (discussed later).

Finally, the most robust access design is one where the diverse paths go all the way to separate IXC POPs (Option D).

Figure 1 – Access Design Alternatives



The IXC access is split between the POPs so at least half of your high capacity access remains in service in the event of a failure. The remaining half would be completed on the toll-free subscribed lines.

While Option D is the most robust, it is not terribly common in practice. First, dual POPs are only available in large cities, and even then, the second POP can be quite far away, dramatically increasing the cost of access. Second, with the N - 1 recovery mechanisms, an Option C design can recover a significant amount of bandwidth and keep a center running.

The size of your center, value of your calls and size of your budget will drive how elaborate an access design you want to build. Any revenue center should have as robust an access arrangement as possible. Tech support and service operations will have to determine how callers will react to not being able to reach you. One medical equipment manufacturer's service call center takes calls from surgeons while operating; clearly, even though not a revenue center, this center has very robust access arrangements.

Cost Effective

Generally speaking, access to the PSTN is cheap. Access rarely makes up even as much as 5 percent of a contact center's operating budget. For medium-to-large operations, however, saving just a few percentage points can fund staff positions or needed technology.

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The cost of access is usually charged to the IT group's budget, and, unless billed back to the contact center, the manager often never knows what he or she is paying. The contact center manager should understand both the design and costs associated with PSTN access so he or she can make intelligent operational tradeoffs. This is especially true when benchmarking against other centers. The PSTN access investment for the call center usually dwarfs that for administrative needs, and benchmarking metrics should include the cost of access in any "cost per" metric.

As mentioned, it's seldom a good idea to skimp on access bandwidth. For a 300-to-500-chair and larger operation, a T3 (which provides as much bandwidth as 28 T1s) is not out of line at all, especially for revenue centers. There can be significant tariff savings associated with a T3 access configuration.

Obviously, a configuration such as pictured in **Figure 1**, Options C and D becomes difficult or impossible with all of your access lines being transported along a single copper path. For this reason, most centers considering T3 technology will choose optical fiber SONET rings, which can be configured as shown in Options C and D. In most cases, this requires a special contract with the local telephone company. Option C changes by closing the fiber loop between the two central offices.

When engineering a fiber-access arrangement, there are several nuances. Most often, the LEC will place a fiber mux (a FLM 150 for example) on the premise, so make sure the equipment room has adequate floor space and power. And not all central offices support fiber. This can drive a need to route to a more distant central office and thus increases costs.

Also, make sure to understand where the de-multiplexing from T3 to T1 occurs. If you're buying a T3 service only, a M13 mux is required to perform this function. If you are buying T1s carried over T3, the LEC places the M13 into the fiber mux and they take care of it (for a monthly charge).

T3 service can either be carried over copper or fiber. Most often, a SONET fiber access arrangement looks like Option C or D, i.e., with an additional connection between the two LEC COs. The inherent resiliency of the SONET ring is highly desirable when dealing with T3 services because everything is riding on a single connection.

Total Service vs. Customer Provided Access

The IXCs can provide one-stop shopping when it comes to access. This is called "total service" access and runs about $25 per T1/PRI. The IXC works with the LEC to acquire the links between the local central office and the premise. The LEC bills the IXC which, in turn, bills you. Most importantly, the IXC takes sole ownership for access and billing. If anything goes wrong, you only have to look as far as your IXC for help.

While this single point of contact is desirable, it most often limits the design to Option A. If the center requires any enhanced reliability, the Customer Provided Access (CPA) route will be required.

Choosing the CPA route places the burden of design and trouble shooting on you — but don't be afraid. CPA is very common in the call center industry, and both the LECs and IXCs have resources that can help, and your corporate IT group will almost always have existing relationships with both. This exercise, however, is best handled formally with detailed project planning. The project team should consist of a telephony person from your IT staff and an account rep and access engineer from both the LEC and IXC.

Other Considerations

A variety of control signaling occurs between the network and the ACD, including ring, answer supervision, user data and network transfer. The information about the call and the control signaling can occur either "in-band" or "out-of-band." Ever since the invention of the telephone, control signaling has occurred "in-band." This means that a single communication path carries the voice call and the control signaling. Generally speaking, you cannot send control signals and talk at the same time. So your voice paths are occupied while this signaling occurs.

If you are old enough, you might remember, when making a long distance call, hearing the in-band signaling as your call was set up across the country. If the other end was busy, that network capacity was needlessly occupied during that set-up time and the telephone company could not bill you for it.

At some point, the phone companies built separate, dedicated signaling networks that took all of that set-up and all other network signaling out of the voice channel. Now, this network, called signaling system 7 (SS7), sets up the voice path virtually. When everything is ready and the other end is not busy, SS7 instantaneously sets up the call. This keeps the voice bandwidth free for voice calls and provides for much quicker call set-up.

> ISDN provides a separate D (for data) signaling channel for call control and user information.

This out-of-band signaling is extended to the call center premise through ISDN. ISDN provides a separate D (for data) signaling channel for call control and user information. This D channel occupies a full 64kbps channel, and an ISDN PRI has 23 voice channels, with the 24th channel used for the D channel. ISDN is a protocol that rides on top of a traditional T1, so usually, you order a T1 and pay extra for ISDN provisioning. There is also a charge for each D channel you use.

ISDN D channels can be shared across PRIs to increase the capacity and reduce the D channel charges from the IXC. Using NFAS (non-facility associated signaling) allows a single D channel to control multiple PRI interfaces. A backup D channel is recommended for reliability purposes.

Support for NFAS varies from ACD to ACD. Some ACDs require a D channel for every PRI; some will allow one D channel and one back-up D channel pair to support as many as eight PRIs. The actual number of PRIs supported by a primary and backup D channel pair will depend on whether DNIS and ANI are to be signaled in- or out-of-band. Some IXCs don't allow a choice, requiring ANI to be signaled out-of-band on the D channel. Almost all IXCs allow DNIS to be signaled in-band.

The network carries a lot of information about the caller in the signals delivered to the ACD. Automatic Number Identification (ANI) and DNIS are familiar to most call center managers.

DNIS is free and is a very useful tool. Not only can unique DNIS numbers be assigned to each toll-free number for the purpose of DNIS routing to queues in the ACD, it is possible to assign multiple DNIS numbers to a single phone number based on area code and/or area code and exchange. Thus with DNIS signaling, it is possible to encode quite a bit of geographical information into the network signaling associated with the call.

ANI, on the other hand, is not free. Depending on contractual arrangements with the IXC, ANI can cost anywhere from a half a cent to a penny per call. Furthermore, ANI's practical value is limited, since most CTI screen pop applications already use an IVR or automated attendant to collect account or other personal information to identify the caller. The "hit rate," or percent of times a caller is accurately identified by ANI, can be much too low to make using ANI worthwhile for many operations. There are exceptions, of course, such as credit card security validations and other situations where the caller most frequently calls from their home or phone number "of record."

Many times a call center finds they are paying for ANI and not using it. Make sure ANI is used if you are paying for it. These costs can mount up to quite a sum over time.

The local telephone companies have similar features in their DID and CLID services. These are typically charged on a monthly recurring basis and not per call. DID and CLID are signaled exactly the same way as DNIS and ANI and can be set up in the ACD the same way.

IP-Telephony

Many IXCs have started offering IP connectivity to their voice networks. IP-telephony is the clear direction voice communications will be taking in the future. IP-PBXs are already being successfully deployed.

IP access to the public network is not widespread for call center applications. Most IP access offerings simply place IP-to-TDM voice converters at both ends of the connection.

The contact center manager and engineer should stay abreast of developments, however. IP call centers will be mainstream sooner than most people think.

Conclusion

Provisioning voice communications access to the public switched telephone network is a much more complex engineering exercise than most managers understand.

Adequate capacity, reliability and cost effectiveness can help establish a path for the engineer to navigate through all the decisions required for a successful, robust access infrastructure deployment. While carrier consulting or "total service" is a viable option, do not completely abdicate responsibility for design and engineering decisions without careful considerations of your business objectives and customer needs.

Many times a call center finds they are paying for ANI and not using it. Make sure ANI is used if you are paying for it. These costs can mount up to quite a sum over time.

Table 1 – Glossary

ANI	Automatic Number Identification is the phone number the caller is calling from
ATHT	Average Trunk Holding Time is the amount of time, on average, a trunk is occupied during a call
Circuits	Communications paths between equipment devices
CLEC	Competitive LEC. Local service providers competing against the ILEC
CLID	Calling Line ID is equivalent to ANI in that it provides the telephone system with the phone number the caller is calling from
CO	Central Office. The first point of entry into the local network
CPA	Customer Provided Access. End user designs and manages access to IXC services
CTI	Computer Telephony Integration allows telephone systems and computers to work together and coordinate functions between the two systems.
DID	Direct Inward Dialing - Allows administrative staff to share trunk capacity and have direct lines without requiring dedicated lines to each phone
DNIS	Dialed Number Identification Service provides the phone number the caller dialed
DOD	Direct Outward Dialing - Allows administrative to share outbound local resources
ILEC	Incumbent LEC. Typically the traditional Bell service provider or the LEC who has dominated the local calling market since divestiture
ISDN	Integrated Services Digital Network — Advanced protocol providing out of band signaling for the connection between the Central Office and the business premise
IVR	Interactive Voice Response
IXC	Inter Exchange Carrier. Commonly known as the long distance companies, responsible for transporting calls across LATAs
LATA	Local Access and Transport Area. Defines the geographic boundaries where a LEC and transport calls totally within their own system. When a call crosses LATA boundaries, the call typically must be passed to an IXC for transport to a distant LATA
LEC	Local Exchange Carrier. Business entity responsible for transporting local calls and toll calls within the LATA boundaries
Line	Communications paths typically connecting a switch to a telephone instrument
Line side	Refers to those circuits connecting inward from the switch to the telephone instruments
POP	Point of Presence is the first point of entry into the long distance network
Predictive Queuing	A CTI capability that can announce predictive wait times to callers in queue
PRI	Primary Rate Interface — The ISDN offering providing 23 voice channels and 1 data channel
PSTN	Public Switched Telephone Network. The nation's voice communication infrastructure. Sometimes referred to as “the cloud”
SONET	Synchronous Optical Network. A high capacity fiber optic connection
T1	High speed, high capacity digital communications path running at 1.544 mbps providing 24 voice channels
Trunk side	Refers to those circuits connecting from the switch to the outside PSTN
Trunks	Circuits typically reserved for business customers connecting switch to switch. Usually a shared communications path

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Searching for the "Perfect "CRM

What would you do differently if you knew you had a valuable customer on the line?

Operationalizing customer intelligence is a key factor in migrating the customer contact center from a cost/ service oriented operation to a profit/ loyalty oriented operation. Customer service managers should be able to discuss customer defection saves, service to sales conversions, cross & up sell ratios, and what the center is doing to increase customer satisfaction and loyalty with senior management.

Searching for the "Perfect" CRM

For many years, contact center managers have been searching for the perfect tool to support customer service delivery. Unfortunately, the customer contact center is often not always the primary focus of a corporate CRM effort. Field force management, e-mail, customer analytics and back office integration are many times the focus of CRM projects and the contact center is almost an afterthought. Although the contact center is frequently the primary point of interface a corporation has with their customers, the contact center is very often not represented in the selection of a CRM package.

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About the Author

Ike Mitchell is a Contact Center specialist with in-depth knowledge of process re-engineering, customer service and technology. He has focused on both the technical and human sides of contact center management. His experience includes assessing and avoiding business risks, planning technology assets, and managing large projects. Mr. Mitchell has extensive industry experience and has provided consulting services in over 100 contact centers covering multiple applications, sizes, technologies and industries.

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