

1. Discussion

The following discussion outlines some of the alternatives for an office telephone system.

1.1 Connections with the PSTN (Public Switched Telephone Network)

The connection with the telephone company usually takes two forms. The first is where each line has its own pair of wires. The second is where the talk circuits are multiplexed onto two pairs of wires.

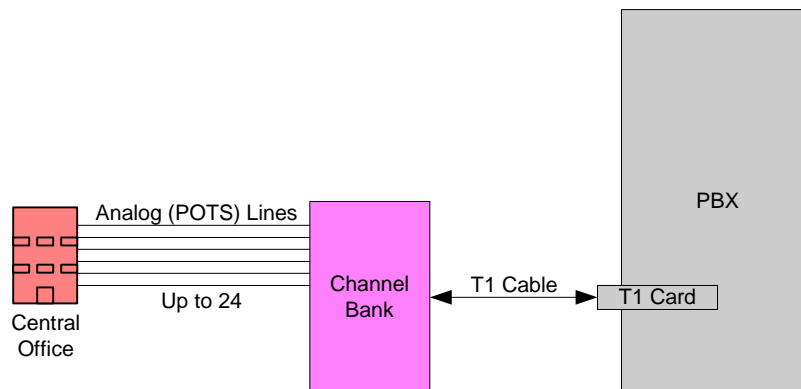
The traditional telephone line is an analog line. Sometimes called a POTS (Plain Old Telephone Service) line, it is the type of line you have coming into your home. A POTS line typically connects with an analog telephone set.

A fax machine also has an analog interface and connects with a POTS line.

1.1.1 Multiple Analog (POTS) Lines

An office of any size typically has several POTS lines attached to a key or PBX system. Even though the telephone sets connected to the PBX system might be “digital”, the POTS connections with the central office is still analog.

The proposed PBX system will connect with existing POTS lines by using a channel bank device. A channel bank multiplexes up to 24 analog circuits onto one T1 (digital) circuit. This T1 circuit then connects with a T1 PCI interface card on the PBX server.



This diagram doesn't show the PBX extensions. Analog telephone sets could also connect to the same channel bank (up to a maximum of 24.)

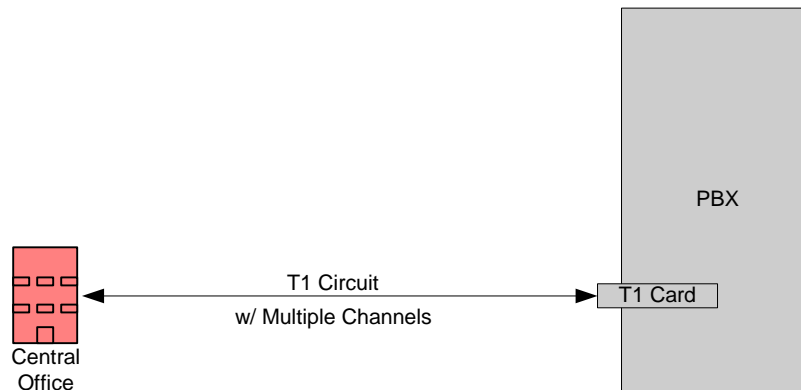
1.1.2 T1 (Digital) Circuit

With a T1 connection, the talk circuits are multiplexed onto two pairs of wires, one pair for transmitting and the other for receiving. Each T1 connection may have up to 24 56Kbps channels or 23 64Kbps channels for a total data rate of 1.544Mbps (some bandwidth is required for signalling.)

A T1 circuit may be “fractional”, that is, not using all 24 channels. It is typically more cost effective (when compared with POTS lines) to have a fractional T1 circuit when the number of voice circuits is greater than about six.

A T1 circuit may be “integrated”, that is, having some voice channels and some data channels. The advantage of an integrated T1 is that one connection can be used to supply an office with both voice circuits and Internet access. Also, a channel bank device is not required for a T1 circuit.

The proposed system will connect with one or more T1 circuits by using a T1 PCI interface card on the PBX server.

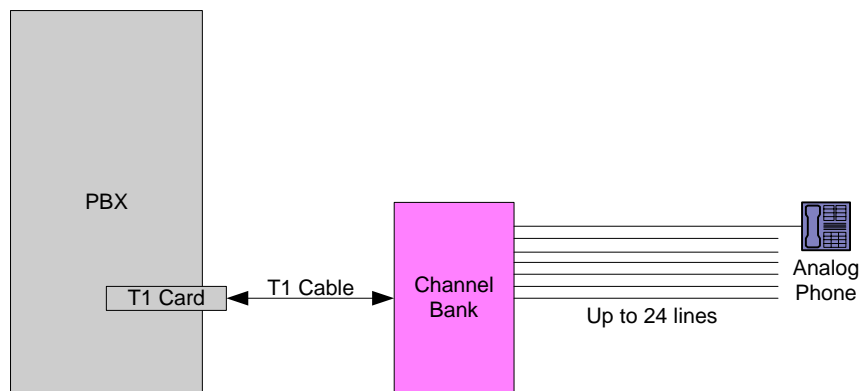


1.2 Connections with the Local Telephone Sets

There are several types of office telephone sets that can be used with the proposed PBX system: analog, SIP, and “softphones”.

1.2.1 Analog Sets

The proposed PBX system will connect with analog telephone sets (called “extension” sets) by using a channel bank device. A channel bank multiplexes up to 24 analog circuits onto one T1 circuit. This T1 circuit then connects with a T1 PCI interface card on the PBX server.



The same channel bank that is used to connect with the incoming POTS lines can also connect with the office telephone sets. The maximum number of analog interfaces on a channel bank is 24, and more than one channel bank device can be utilized.

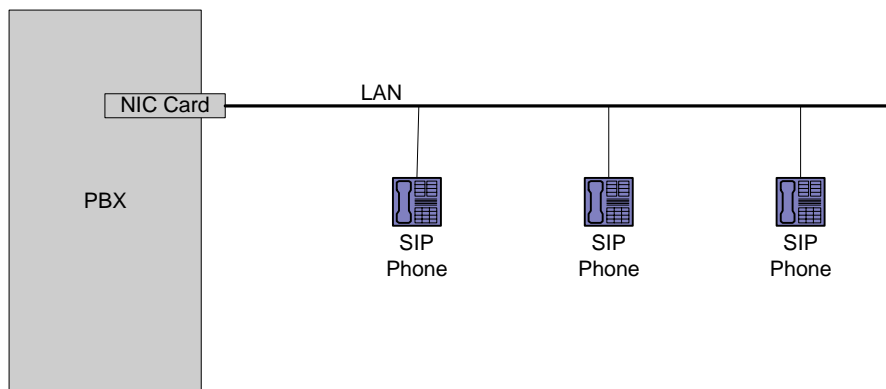
1.2.2 SIP Telephone Sets

The VoIP (Voice over Internet Protocol) technology takes a speaker’s voice, digitizes it, packetizes the digitised voice into data packets, and sends the packet stream over the LAN (or WAN) to the receiving device. The receiving device takes the incoming packet stream, extracts the digitized voice, converts it to an analog signal, and plays it to the listener.

The VoIP stream uses LAN (or WAN) wiring and not telephone wiring. Using SIP telephones on different LAN segments, callers can make calls within the enterprise. Using SIP telephones in different cities, callers can make calls over the Internet.

The proposed PBX system will act as a gateway for SIP telephones. A distant caller, using a SIP phone connected to the Internet, can call into the proposed PBX system and connect with any local extension. Likewise, a local caller can call a distant SIP phone that is connected to the Internet.

After the PBX completes setting-up a call with SIP phones at each end, the phones can then establish a direct connection between the two phones, thus unloading the call overhead from the PBX system.



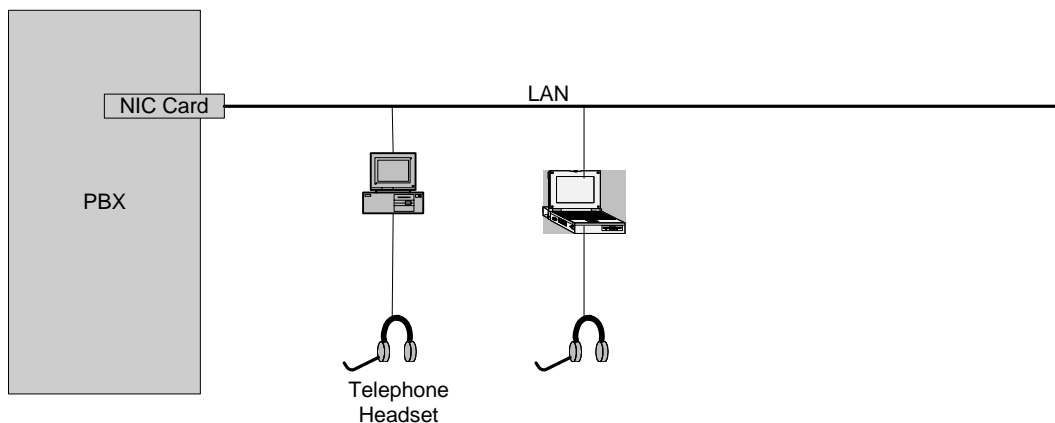
There are many SIP phones on the market. One low-cost phone is the Grandstream BudgeTone 102. This phone has two LAN jacks—one for the incoming LAN connection and one for the PC connection. This phone retails for about \$85.

At the other end of the price spectrum is the Cisco 7960. It retails for about \$300+ and a \$150 license fee. There is also a \$700+ Cisco cell phone that will make a VoIP call if it detects a WiFi connection that it can use.

1.2.3 Softphones on the PC

In addition to SIP, there is a similar protocol called IAX. This protocol, native to the proposed PBX system, is a computer-to-computer protocol for voice calls.

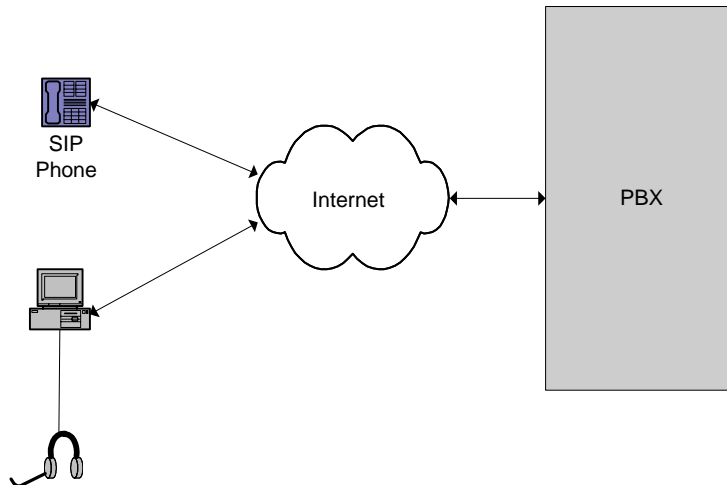
A “softphone” is a computer program that performs the IAX encoding and decoding of a voice conversation. The softphone utilizes a headset (or handset) that is plugged into the PC’s sound card or USB port. The softphone program performs the same functions as a SIP phone except that it doesn’t utilize a physical telephone set—an IAX connection is established between the user’s PC and the proposed PBX server.



There are several open source softphone programs available for download. Diax, IAXComm, and IaxPhone operate quite well with the proposed PBX system. With an existing PC or laptop, the softphone is a zero-cost option.

1.3 Internet-connected Phones

The SIP hardphones and IAX softphones may also be used wherever there is a broadband Internet connection:



Employees with a broadband Internet connection at a remote location would have the same PBX functionality as local employees.

The PBX system incorporates firewall software that protects it from malicious attacks originating on the Internet.

1.4 Local Calling

Local calls will, in most cases, remain with the PSTN (Public Switched Telephone Network.) Your company will probably want to retain some or all circuits to the local telephone company (as opposed to an all-Internet solution.) One reason is that your company's telephone number is already known by its customers, and changing or removing that number would be problematic.

The other reason to maintain a connection with the PSTN is that there should always be access to the local 911 service, even during an extended power failure.

N.B. If it is decided to install a T1 from a CLEC (Competitive Local Exchange Carrier) the existing telephone number(s) can now be ported over to the new T1 service.

1.5 Long Distance Calling

In the past, all long distance calling utilized the PSTN. In recent years the per-minute charges have come down, but they are still about 10¢/minute. Some LECs (Local Exchange Carriers) offer lower rates.

In a VoIP environment, however, long distance calling can bypass the PSTN long distance network. Examples of bypassing the long distance network are:

- Inter-office "trunk" with two of the proposed PBX systems in different offices: the PBX software establishes an IAX connection between the two systems allowing

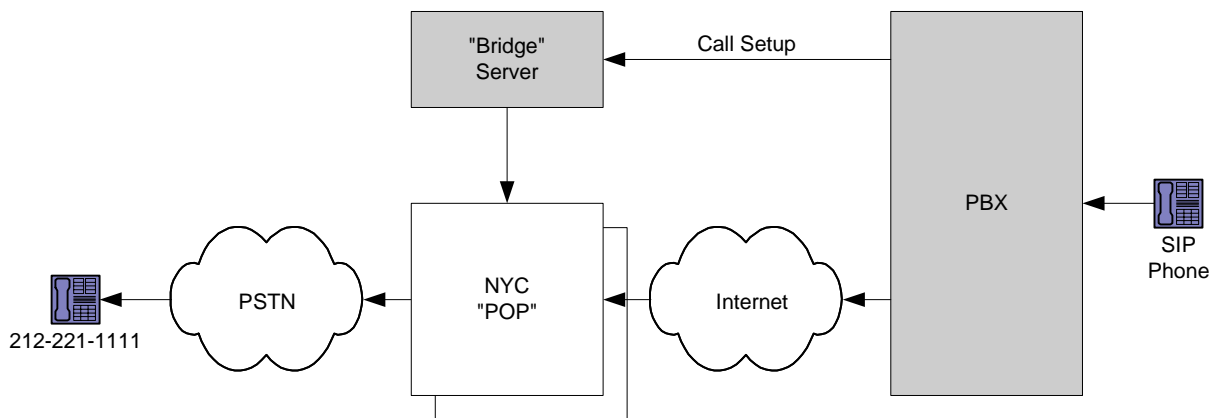
extensions on one PBX to be “local” to the other PBX. A caller at a distant office, calling someone in the Evergreen, CO office, would use this facility to make a call to an extension on the other PBX.

- A road warrior or home worker with a broadband connection: the remote worker would use a headset and a PC (or laptop) to establish an IAX connection with the Evergreen, CO office’s PBX. The remote user could then have the same PBX functionality as a local extension at the office.
- A remote caller with a SIP phone and a broadband Internet connection calls the office PBX to establish a call with a local extension.

1.5.1 Outbound Long Distance Calls to PSTN Telephones

There are several firms that offer a VoIP to PSTN “bridge”. These firms have POPs (Points of Presence) in major cities.

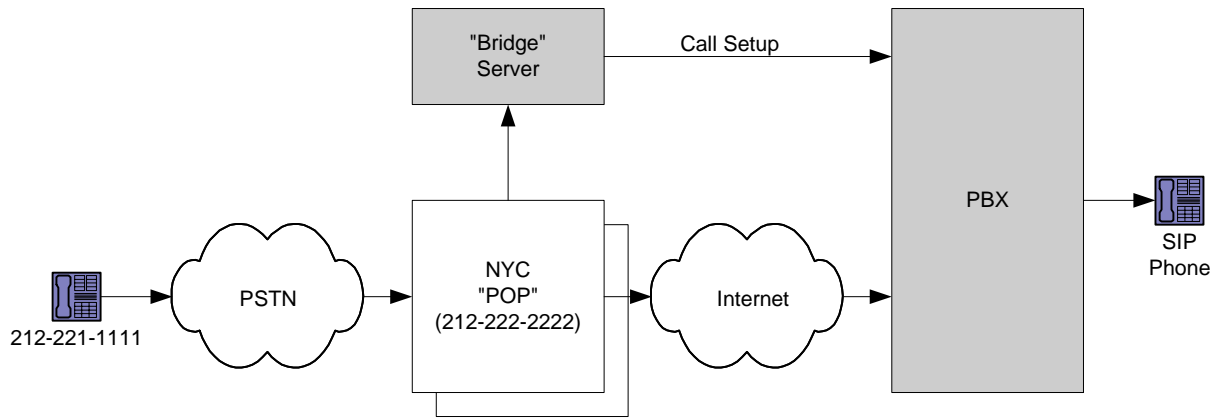
To call a distant telephone number, the proposed PBX will be configured to utilize one of these firms to complete its long distance calls. A user dialling 8-1-212-221-1111, as an example, would be connected with the “bridge” server, which would connect the call between the proposed PBX and its “POP” in New York City and then complete the call on a local PSTN line.



Two popular “bridge” firms are VoicePulse and Nufone. VoicePulse’s domestic long distance rate is 2.95¢/minute, and the Nufone rate is 2.9¢/minute. International rates are a little higher.

1.5.2 Inbound Long Distance Calls from PSTN Telephones

Most “bridge” firms offer DID (Direct Inward Dial) telephone numbers in major cities. If your company has large call volumes from New York City, as an example, a NYC DID (say 212-222-2222) number would be purchased from the “bridge” firm. When a NYC caller dialled this (local) number, the bridge firm would establish an IAX connection between its NYC POP and the proposed PBX system.



Both VoicePulse and Nufone offer DID numbers in selected cities. Both vendors charge about \$8/month for a DID number.