
2023-11-19 Centrex

I have always been fascinated by the PABX - the private automatic branch exchange, often shortened to "PBX" in today's world where the "automatic" is implied. (Relatively) modern small and medium business PABXs of the type I like to collect are largely solid-state devices that mount on the wall. Picture a cabinet that's maybe two feet wide, a foot and half tall, and five inches deep. That's a pretty accurate depiction of my Comdial hybrid key/PABX system, recovered from the offices of a bankrupt publisher of Christian home schooling materials.

These types of PABX, now often associated with Panasonic on the small end, are affordable and don't require much maintenance or space. They have their limitations, though, particularly in terms of extension count. Besides, the fact that these compact PABX are available at all is the result of decades of development in electronics.

Not that long ago, PABX were far more complex. Early PBX systems were manual, and hotels were a common example of a business that would have a telephone operator on staff. The first PABX were based on the same basic technology as their contemporary phone switches, using step-by-step switches or even crossbar mechanisms. They no longer required an operator to connect every call, but were still mostly designed with the assumption that an attendant would handle some situations. Moreover, these early PABX were large, expensive, and required regular maintenance. They were often leased from the telephone company, and the rates weren't cheap.

PABX had another key limitation as well: they were specific to a location. Each extension had to be home-run wired to the PABX, easy in a single building but costly at the level of a campus and, especially, with buildings spread around a city. For organizations with distributed buildings like school districts, connecting extensions back to a central PABX could be significantly more expensive than connecting them to the public telephone exchange.

This problem must have been especially common in a city the size of New York, so it's no surprise that New York Telephone was the first to commercialize an alternative approach: Centrex.

Every technology writer must struggle with the temptation to call every managed service in history a precursor to "the Cloud." I am going to do my very best to resist that nagging desire, but it's difficult not to note the similarity between Centrex service and modern cloud PABX solutions. Indeed, Centrex relied on capabilities of telephone exchange equipment that are recognizably similar to mainframe computer concepts like LPARs and virtualization today. But we'll get there in a bit. First, we need to talk about what Centrex is.

I've had it in my mind to write something about Centrex for years, but I've always had a hard time knowing where to start. The facts about Centrex are often rather dry, and the details varied over years of development, making it hard to sum up the capabilities in short. So I hope that you will forgive this somewhat dry post. It covers something that I think is a very important part of telephone history, particularly from the perspective of the computer industry today. It also lists off a lot of boring details. I will try to illustrate with interesting examples everywhere I can. I am indebted, for many things but here especially, to

many members of the Central Office mailing list. They filled in a lot of details that solidified my understanding of Centrex and its variants.

The basic promise of Centrex was this: instead of installing your own PABX, let the telephone company configure their own equipment to provide the features you want to your business phones. A Centrex line is a bit like a normal telephone line, but with all the added capabilities of a business phone system: intercom calling, transfers, attendants, routing and long distance policies, and so on. All of these features were provided by central telephone exchanges, but your lines were partitioned to be interconnected within your business.

Centrex was a huge success. By 1990, a huge range of large institutions had either started their telephone journey with Centrex or transitioned away from a conventional PABX and onto Centrex. It's very likely that you have interacted with a Centrex system before and perhaps not realized. And now, Centrex's days are numbered. Let's look at the details.

Centrex is often explained as a reuse of the existing central office equipment to serve PABX requirements. This isn't entirely incorrect, but it can be misleading. It was not all that unusual for Centrex to rely on equipment installed at the customer site, but operated by the telco. For this reason, it's better to think of Centrex as a managed service than as a "cloud" service, or a Service-as-a-Service, or whatever modern term you might be tempted to apply.

Centrex existed in two major variants: Centrex-CO and Centrex-CU. The CO case, for Central Office, entailed this well-known design of each business telephone line connecting to an existing telco central office, where a switch was configured to provide Centrex features on that line group. CU, for Customer Unit, looks more like a very large PABX. These systems were usually limited to very large customers, who would provide space for the telco to build a new central office on the customer's site. The exchange was located with the customer, but operated by the telco.

These two different categories of service lead to two different categories of customers, with different needs and usage patterns. Centrex-CO appealed to smaller organizations with fewer extensions, but also to larger organizations with extensions spread across a large area. In that case, wiring every extension back to the CO using telco infrastructure was less expensive than installing new wiring to a CU exchange. A prototypical example might be a municipal school district.

Centrex-CU appealed to customers with a large number of extensions grouped in a large building or a campus. In this case it was much less costly to wire extensions to the new CU site than to connect them all over the longer distance to an existing CO. A prototypical Centrex-CU customer might be a university.

Exactly how these systems worked varied greatly from exchange to exchange, but the basic concept is a form of partitioning. Telephone exchanges with support for Centrex service could be configured such that certain lines were grouped together and enabled for Centrex features. The individual lines needed to have access to Centrex-specific capabilities like service codes, but also needed to be properly associated with each other so that internal calling would indeed be internal to the customer. This concept of partitioning telephone switches had several different applications, and Western Electric and other manufacturers continued to enhance it until it reached a very high level of sophistication in digital switches.

Let's look at an example of a Centrex-CO. The State of New Mexico began a contract with Mountain States Telephone and Telegraph [1] for Centrex service in 1964. The new Centrex service replaced 11 manual switchboards distributed around Santa Fe, and included Wide-Area Telephone Service (WATS), a discount arrangement for long-distance calls placed from state offices to exchanges throughout New Mexico. On November 9th, 1964, technicians sent to Santa

Fe by Western Electric completed the cutover at the state capitol complex. Incidentally, the capitol phones of the day were being installed in what is now the Bataan Memorial Building: construction of the Roundhouse, today New Mexico's distinctive state capitol, had just begun that same year.

The Centrex service was estimated to save $12,000 per month in the rental and operation of multiple state exchanges, and the combination of WATS and conference calling service was expected to produce further savings by reducing the need for state employees to travel for meetings. The new system was evidently a success, and lead to a series of minor improvements including a scheme later in 1964 to ensure that the designated official phone number of each state agency would be answered during the state lunch break (noon to 1:15). In 1965, Burns Reinier resigned her job as Chief Operator of the state Centrex to launch a campaign for Secretary of State. Many state employees would probably recognize her voice, but that apparently did not translate to recognition on the ballot, as she lost the Democratic party nomination to the Governor's former secretary.

The late 1960s saw a flurry of newspaper advertisements giving new phone numbers for state and municipal agencies, Albuquerque Public Schools, and universities, as they all consolidated onto the state-run Centrex system. Here we must consider the geographical nature of Centrex: Centrex service operates within a single telephone exchange. To span the gap between the capitol in Santa Fe, state offices and UNM in Albuquerque, NMSU in Las Cruces, and even the State Hospital in Las Vegas (NM), a system of tie lines were installed between Centrex facilities in each city. These tie lines were essentially dedicated long distance trunks leased by the state to connect calls between Centrex exchanges at lower cost than even WATS long-distance service.

This system was not entirely CO-based: in Albuquerque, a Centrex exchange was installed in state-leased space at what was then known as the National Building, 505 Marquette. In the late '60s, 505 Marquette also hosted Telepak, an early private network service from AT&T. It is perhaps a result of this legacy that 505 Marquette houses one of New Mexico's most important network facilities, a large carrier hotel now operated by H5 Data Centers. The installation of the Centrex exchange at 505 Marquette saved a lot of expense on new local loops, since a series of 1960s political and bureaucratic events lead to a concentration of state offices in the new building.

Having made this leap to customer unit systems, let's jump almost 30 years forward to an example of a Centrex-CU installation... one with a number of interesting details. In late 1989, Sandia National Laboratories ended its dependence on the Air Force for telephony services by contracting with AT&T for the installation of a 5ESS telephone exchange. The 5ESS, a digital switch and a rather new one at the time, brought with it not just advanced calling features but something even more compelling to an R&D institution at the time: data networking.

The Sandia installation went nearly all-in on ISDN, the integrated digital telephony and data standard that largely failed to achieve adoption for telephone applications. Besides the digital telephone sets, though, Sandia made full use of the data capabilities of the exchange. Computers connected to the data ports on the ISDN user terminals (the conventional term for the telephone instrument itself in an ISDN network) could make "data calls" over the telephone system to access IBM mainframes and other corporate computing resources... all at a blistering 64 kbps, the speed of an ISDN basic rate interface bearer channel. The ISDN network could even transport video calls, by combining multiple BRIs for 384 kbps aggregate capacity.

The 5ESS was installed on a building on Air Force property near Tech Area 1, and the 5ESS's robust support for remote switch modules was fully leveraged to place an RSM in each Tech Area. The new system required renumbering, always a hassle, but allowed for better matching of Sandia's phone numbers on the public network to phone numbers on the Federal Telecommunications

System or FTS... a CCSA operated for the Federal Government. But we'll talk about that later. The 5ESS was also equipped with ISDN PRI tie lines to a sibling 5ESS at Sandia California in Livermore, providing inexpensive calling and ISDN features between the two sites.

This is a good time to discuss digital Centrex. Traditional telephony, even today in residential settings, uses analog telephones. Business systems, though, made a transition from analog to digital during the '80s and '90s. Digital telephone sets used with business systems provided far easier access to features of the key system, PABX, or Centrex, and with fewer wires. A digital telephone set on one or two telephone pairs could offer multiple voice lines, caller ID, central directory service, busy status indication for other phones, soft keys for pickup groups and other features, even text messaging in some later systems (like my Comdial!). Analog systems often required as many as a half dozen pairs just for a simple configuration like two lines and busy lamp fields; analog "attendant" sets with access to many lines could require a 25-pair Amphenol connector... sometimes even more than one.

Many of these digital systems used proprietary protocols between the switch and telephones. A notable example would be the TCM protocol used by the Nortel Meridian, an extremely popular PABX that can still be found in service in many businesses. Digital telephone sets made the leap to Centrex as well: first by Nortel themselves, who offered a "Meridian Digital Centrex" capability on their DMS-100 exchange switch that supported telephone sets similar to (but not the same as!) ordinary Meridian digital systems. AT&T followed several years later by offering 5ESS-based digital Centrex over ISDN: the same basic capability that could be used for computer applications as well, but with the advantage of full compatibility with AT&T's broader ISDN initiative.

The ISDN user terminals manufactured by Western Electric and, later, Lucent, are distinctive and a good indication that that digital Centrex is in use. They are also lovely examples of the digital telephones of the era, with LCD matrix displays, a bevy of programmable buttons, and pleasing Bellcore distinctive ringing. It is frustrating that the evolution of telephone technology has seemingly made ringtones far worse. We will have to forgive the oddities of the ISDN electrical standard that required an "NT1" network termination device screwed to the bottom of your desk or, more often, underfoot on the floor.

Thinking about these digital phones, let's consider the user experience of Centrex. Centrex was very flexible; there were a large number of options available based on customer preference, and the details varied between the Centrex host switches used in the United States: Western Electric's line from the 5XB to the 5ESS, Nortel's DMS-100 and DMS-10, and occasionally the Siemens EWSD. This all makes it hard to describe Centrex usage succinctly, but I will focus on some particular common features of Centrex.

Like PABXs, most Centrex systems required that a dialing prefix (conventionally nine) be used for an outside line. This was not universal, "assumed nine" could often be enabled at customer request, but it created a number of complications in the dialplan and was best avoided. Centrex systems, because they mostly belonged to larger customers, were more likely than PABXs to offer tie lines or other private routing arrangements, which were often used by dialing calls with a prefix of 8. Like conventional telephone systems, you could dial 0 for the operator, but on traditional large Centrex systems the operator would be an attendant within the Centrex customer organization.

Centrex systems enabled internal calling by extension, much like PABXs. Because of the large size of some Centrex-CU installations in particular you are probably much more likely to encounter five-digit extensions with Centrex than with a PABX. These types of extensions were usually designed by taking several exchange prefixes in a sequence, and using the last digit of the exchange code as the first digit of the extension. For that reason the extensions are often written in a format like 1-2345. A somewhat charming example of this arrangement was the

5ESS-based Centrex-CU at Los Alamos National Laboratories, which spans exchange prefixes 662-667 in the 505 NPA. Since that includes the less desirable exchange prefix 666, it was skipped. Of course, that didn't stop Telnyx from starting to use it more recently. Because of the history of Los Alamos's development, telephones in the town use these same prefixes, generally the lower ones.

With digital telephones, Centrex features are comparatively easy to access, since they can be assigned to buttons on the telephones. With analog systems there are no such convenient buttons, so Centrex features had to be awkwardly bolted on much like advanced features on non-Centrex lines. Many features are activated using vertical service codes starting with *, although in some systems (especially older systems for pulse compatibility) they might be mapped to codes that look more like extensions. Operations that involve interrupting an active call, like transfer or hold, involve flashing the hookswitch... a somewhat antiquated operation now more often achieved with a "flash" button on the telephone, when it's done at all.

Still, some analog Centrex systems used electrical tricks on the pair (similar to many PABX) to provide a message waiting light and even an extra button for common operations.

While Centrex initially appealed mainly to larger customers, improvements in host switch technology and telephone company practices made it an accessible option for small organizations as well. Verizon's "CustoPAK" was an affordable offering that provided Centrex features on up to 30 extensions. These small-scale services were also made more accessible by computerization. Configuration changes to the first crossbar Centrex service required exchange technicians climbing ladders to resolder jumpers. With the genesis of digital switches, telco employees in translation centers read customer requirements and built switch configuration plans. By the '90s, carriers offered modem services that allowed customers to reconfigure their Centrex themselves, and later web-based self-service systems emerged.

So what became of Centrex? Like most aspects of the conventional copper phone network, it is on the way out. Major telephone carriers have mostly removed Centrex service from their tariffs, meaning they are no longer required to offer it. Even in areas where it is present on the tariff it is reportedly hard to obtain. A report from the state of Washington notes that, as a result particularly of CenturyLink removing copper service from its tariffs entirely, CenturyLink has informed the state that it may discontinue Centrex service at any time, subject to six months notice. Six months may seem like a long time but it is a very short period for a state government to replace a statewide telephone system... so we can anticipate some hurried acquisitions in the next couple of years.

Centrex had always interacted with tariffs in curious ways, anyway. Centrex was the impetus behind multiple lawsuits against AT&T on grounds varying from anti-competitive behavior to violations of the finer points of tariff regulation. For the most part AT&T prevailed, but some of these did lead to changes in the way Centrex service was charged. Taxation was a particularly difficult matter. There were excise taxes imposed on telephone service in most cases, but AT&T held that "internal" calls within Centrex customers should not be subject to these taxes due to their similarity to untaxed PABX and key systems. The finer points of this debate varied from state to state, and it made it to the Supreme Court at least once.

Centrex could also have a complex relationship with the financial policies of many institutional customers. Centrex was often paired with services like WATS or tie lines to make long-distance calling more affordable, but this also encouraged employees to make their personal long-distance calls in the office. The struggle of long-distance charge accounting lead not only to lengthy employee "acceptable use" policies that often survive to this day, but also schemes of accounting and authorization codes to track long distance users. Long-distance phone charges by state employees were a perennial minor scandal in New Mexico politics, leading to some sort of audit or investigation every few years. Long-distance

calling was often disabled except for extensions that required it, but you will find stories of public courtesy phones accidentally left with long-distance enabled becoming suddenly popular parts of university buildings.

Today, Centrex is generally being replaced with VoIP solutions. Some of these are fully managed, cloud-based services, analogous to Centrex-CO before them. IP phones bring a rich featureset that leave eccentric dialplans and feature codes mostly forgotten, and federal regulations around the accessibility of 911 have broadly discouraged prefix schemes for outside calls. On the flip side, these types of phone systems make it very difficult to configure dialplan schemes on endpoints, leading office workers to learn a new type of phone oddity: dialing pound after a number to skip the end-of-dialing timeout. This worked on some Centrex systems as well; some things never change.

[1] Later called US West, later called Qwest, now part of CenturyLink, which is now part of Lumen.