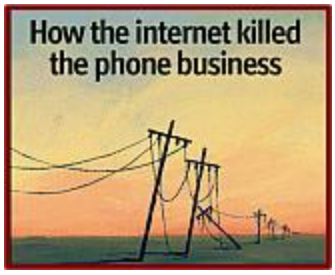
Telecom



Since the advent of the Internet and wireless communications, telecom companies have experienced drastic changes. (See The Economist, How the internet killed the phone business and Slate Magazine, What's really killing the land-line telephone business.) Affected are the traditional home phone connections (landlines). Shrinking revenues caused by fierce competition and the loss of monopoly status, lower prices, cellphone use and a declining customer base have forced mergers and acquisitions. These mergers in turn often require the integration of different types of phone switches, network elements and software, adding maintenance and support costs to already strained budgets. All of this has resulted in massive lay-offs and early retirement of skilled personnel. Employees with higher pay, more vacation and higher medical expenses are replaced by fewer, younger workers with knowledge incompatible with the legacy systems and networks which are left behind.

One of the legacy systems is the network that handles the billing of landline phone calls. Neither the phone switches nor the network itself use TCP/IP.

Other examples of legacy systems include the public or private X.25 data networks, networks handling directory assistance and maintenance and support, and specialized networks, such as British Telecom's RedCare Burglary Alarm system.

CDR Billing Networks

Telecom companies create revenues by charging for phone or data services. To make a charge, every successful phone call causes a Call Detail Record (CDR) to be written to a disk file (or magnetic tape) at a phone switch near the customer. These phone switches are highly specialized computers and are distributed throughout the telecom company's service area. The number of switches depends on the size of the geographical area, the number and types of customers, and the type of phone switch.

The process of invoicing customers requires these CDRs to be electronically transferred to a centralized computer (collector) at the telecom company's billing department. To avoid an overflow of the allocated disk space and possible loss of billable CDRs, the frequency of collection times has to be high enough to accommodate the transfer of all the CDRs created at peak time. The electronic transfer is done via a synchronous interface at the legacy switch that normally uses the X.25 protocol.

In 1976, the International Telegraph and Telephone Consultative Committee (CCITT) companies introduced the X.25 protocol as **Recommendation for Packet Switching Data Networks (PSDN)**. X.25 is a point-to-multipoint network protocol, but telecom companies often use point-to-point

connections between phone switches and collectors. Swisscom used, and the German Telekom still uses, X.25 over ISDN B-channel to connect to Siemens EWSD, Ericsson AXE and Alcactel S12 switches. AT&T (formerly Pacific Bell) uses X.25 over ISDN D-Channel on their Lucent 5ESS switches. Many telecoms still use dial-up modems or direct CSU/DSU connections.

Other than X.25, file transfer protocols lacked a common standard. Consequently, most switch manufacturers adopted X.25 as their interface. For example, in the U.S. the BellCore BX.25 and its subset AMATPS is often used by Lucent 5ESS switches and by NEC Japan. Nortel (Canada) uses XFER, AFT (Automatic File Transfer) and AFT/EIU. Most European switch manufacturers use FTAM: Siemens (EWSD), Alcatel (S12) and Ericsson (AXE). Ericsson also uses MTP, very similar to Nortel's AFT (down to the error messages). There is no fixed rule regarding who is using what, and where it should be used. For example, in the U.S., Siemens uses AMATPS for the EWSD switch, while in Russia, Alcatel-Lucent uses FTAM on the 5ESS switch.

The Lucent 5ESS also supports an ISDN BRI 0B+D interface, where X.25 uses LAPD as underlying link layer. Motorola EMX2500, a cellular phone switch, manufactured by then DSC Dallas for Motorola, uses LAPB (the X.25 link layer) as the underlying layer for their DAS protocol. This solution makes a lot of sense for non-multiplexed, point-to-point connections.

There are also some older protocols still in use by "pre-historic" switches. Nortel DMS-10 and Siemens Carlson/Stromberg still use 3780 BSC and HDLC/NRM (IBM SDLC Link protocol). These are half duplex protocols, using a vintage collection of Bell 208B modems, with signal turn-around timers nobody knows anything about anymore.

Legacy Data Networks

In addition to providing phone services, most telecom companies provided (and some still provide) their customers access to Public or Private X.25 Data Networks (PDN) also known as Packet Switched Data Networks (PSDN). Created in the mid-1970s, they were an economic alternative to leased line or dial-up connections and to IBM's Systems Network Architecture (SNA). X.25 PDNs used point-to-multipoint connections or virtual circuits (VC), and for each VC the network guaranteed that data packets entering the network were leaving the network in the same sequence and were error-free.

This was the time when more affordable mini-computers made inroads into the mainframe dominance of time sharing applications dominated by IBM. Mainframes or even minis were expensive and had the processing power and memory to provide host services to multiple remote branch offices. These branches often used clusters of dumb terminals connected to terminal controllers or later to X.25 PADs. The terminals had little processing power and limited memory. Using modems or acoustic couplers, digital data were modulated into analog data and transmitted over leased line or dial-up (often noisy) phone connections provided by the phone companies.

Today the situation is reversed. Computer systems at the branches are very powerful, with plenty of memory and storage. TCP/IP networks, such as the Internet, are digital, very fast, often based on fiber and wireless technology and are nearly error-free. If an error is detected, it will be corrected by the end-points, not by the network. Where still in use, analog phone connections are now digitized using the same network as data such as e-mail, SMS, FTP, web traffic, voice and video.

Frame Relay, a derivative of ISDN LAPD, was an interim step, taking advantage of nearly error-free digital network connections. It omitted the error handling used by X.25. Frame Relay, like X.25, a point-to-multipoint network, was much cheaper and faster than X.25. Frame Relay Annex G allowed X.25 users to utilize the cheaper Frame Relay network. It was also used for inter-company voice connections.

With the rise of the Internet, X.25 networks and X.25 leased lines through Public Switched Telephone Networks (PSTN)are now considered legacy networks. Even ISDN and Frame Relay networks are approaching that state. The cost to maintain and support legacy networks is mounting. Most of the technical people who had the knowledge are gone. Documentation is difficult to find, sketchy, or just incorrect. There are no longer any X.25 PSDNs in the U.S., and we know from Swisscom that they will decommission their X.25 PDN as well. Frame Relay may still be used, but as an underlying protocol for TCP/IP.

For telecoms to be viable, they have to offer Internet or intranet (dedicated or private network) services. The obvious solution for the telecom companies and their customers using legacy data networks is to replace them with an Internet/intranet solution. Unfortunately for the telecom companies and their customers, that is not a trivial undertaking.

Similar to the telecoms with their own CDR billing and legacy phone switches, it is often the legacy host (mainframe) whose X.25 interface cannot be changed. The application is usually monolithic and includes a proprietary interface into a third party X.25 protocol stack and synchronous adapter. It is likely that none of the parties who developed the application, the X.25 protocol software and the synchronous adapter are still around. Source code, often written in COBOL, PL/1, IBM Assembler or DB2, and documentation are unlikely to be available or are in a questionable state. Modifying the application is therefore extremely difficult and risky. The *status quo* seems to be the most convenient option.

Because terminal clusters at the branch offices were simpler, they were later replaced by PC/LAN technology. A dedicated PC functioned as an X.25-to-LAN (Novell IPX, NetBIOS) gateway serving multiple LAN workstations that emulated terminals. Branch offices are more numerous now, and the best solution would be to eliminate the synchronous interfaces altogether. This is not always possible, however, since in banking networks, ATMs still use synchronous X.25 or BSC interfaces.