

DIGITAL SUBSCRIBER LINE

To provide higher-speed access to the Internet. Digital subscriber line (DSL) technology is one of the most promising for supporting high-speed digital communication over the existing local loops. DSL technology is a set of technologies, each differing in the first letter (ADSL, VDSL, HDSL, and SDSL). The set is often referred to as xDSL, where x can be replaced by A, V, H, or S.

ADSL

The first technology in the set is asymmetric DSL (ADSL). ADSL, like a 56K modem, provides higher speed (bit rate) in the downstream direction (from the Internet to the resident) than in the upstream direction (from the resident to the Internet). That is the reason it is called asymmetric. Unlike the asymmetry in 56K modems, the designers of ADSL specifically divided the available bandwidth of the local loop unevenly for the residential customer. The service is not suitable for business customers who need a large bandwidth in both directions.

Using Existing Local Loops

One interesting point is that ADSL uses the existing local loops. But how does ADSL reach a data rate that was never achieved with traditional modems? The answer is that the twisted-pair local loop is actually capable of handling bandwidths up to 1.1 MHz, but the filter installed at the end office of the telephone company where each local loop terminates limits the bandwidth to 4 kHz (sufficient for voice communication). If the filter is removed, however, the entire 1.1 MHz is available for data and voice communications

Adaptive Technology

Unfortunately, 1.1 MHz is just the theoretical bandwidth of the local loop. Factors such as the distance between the residence and the switching office, the size of the cable, the signaling used, and so on affect the bandwidth. The designers of ADSL technology were aware of this problem and used an adaptive technology that tests the condition and bandwidth availability of the line before settling on a data rate. The data rate of ADSL is not fixed; it changes based on the condition and type of the local loop cable.

Discrete Multitone Technique

The modulation technique that has become standard for ADSL is called the discrete multitone technique (DMT) which combines QAM and FDM. There is no set way that the bandwidth of a system is divided. Each system can decide on its bandwidth division. Typically, an available bandwidth of 1.104 MHz is divided into 256 channels. Each channel uses a bandwidth of 4.312 kHz, as shown in Figure 1, Figure 2 shows how the bandwidth can be divided into the following:

- Voice. Channel 0 is reserved for voice communication.
- Idle. Channels 1 to 5 are not used and provide a gap between voice and data communication

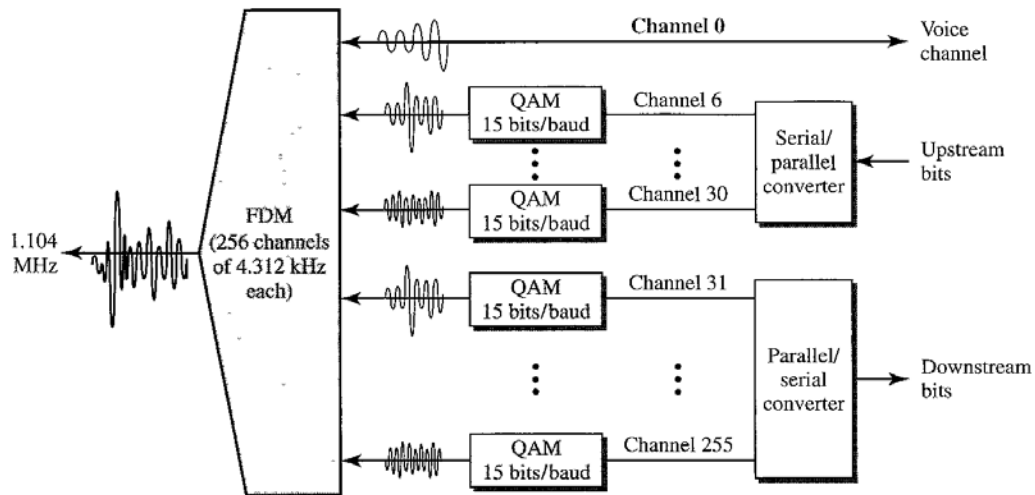
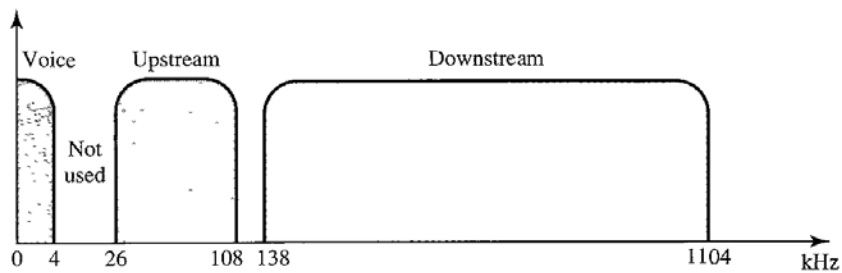


Figure1



- Upstream data and control. Channels 6 to 30 (25 channels) are used for upstream data transfer and control. One channel is for control, and 24 channels are for data transfer. If there are 24 channels, each using 4 kHz (out of 4.312 kHz available) with QAM modulation, we have $24 \times 4000 \times 15$, or a 1.44-Mbps bandwidth, in the upstream direction. However, the data rate is normally below 500 kbps because some of the carriers are deleted at frequencies where the noise level is large. In other words, some of channels may be unused.
- Downstream data and control. Channels 31 to 255 (225 channels) are used for downstream data transfer and control. One channel is for control, and 224 channels are for data. If there are 224 channels, we can achieve up to $224 \times 4000 \times 15$, or 13.4 Mbps. However, the data rate is normally below 8 Mbps because some of the carriers are deleted at frequencies where the noise level is large. In other words, some of channels may be unused.

Customer Site: ADSL Modem

Figure 3 shows an ADSL modem installed at a customer's site. The local loop connects to a splitter which separates voice and data communications. The ADSL modem modulates and demodulates the data, using DMT, and creates downstream and upstream channels.

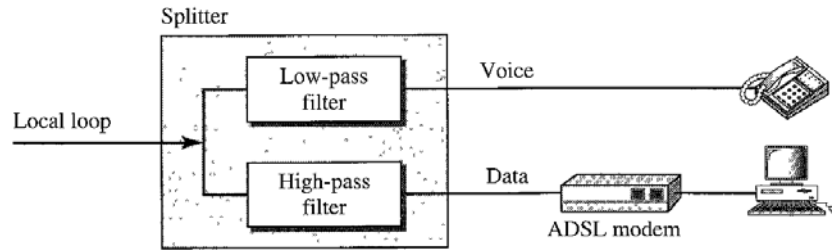


figure 3

Note that the splitter needs to be installed at the customer's premises, normally by a technician from the telephone company. The voice line can use the existing telephone wiring in the house, but the data line needs to be installed by a professional. All this makes the ADSL line expensive. We will see that there is an alternative technology, Universal ADSL (or ADSL Lite).

Telephone Company Site: DSLAM

At the telephone company site, the situation is different. Instead of an ADSL modem, a device called a digital subscriber line access multiplexer (DSLAM) is installed that functions similarly. In addition, it packetizes the data to be sent to the Internet (ISP server). Figure 4 shows the configuration.

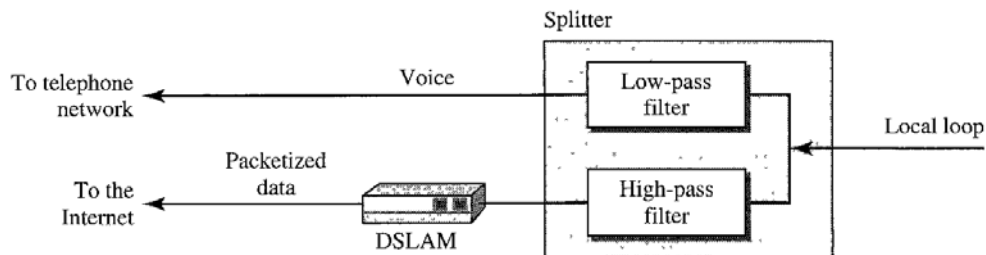


Figure 4

ADSL Lite

The installation of splitters at the border of the premises and the new wiring for the data line can be expensive and impractical enough to dissuade most subscribers. A new version of ADSL technology called ADSL Lite (or Universal ADSL or splitterless ADSL) is available for these subscribers. This technology allows an ADSL Lite modem to be plugged directly into a telephone jack and connected to the computer. The splitting is done at the telephone company. ADSL Lite uses 256 DMT carriers with 8-bit modulation (instead of 15-bit). However, some of the carriers may not be available because errors created by the voice signal might mingle with them. It can provide a maximum downstream data rate of 1.5 Mbps and an upstream data rate of 512 kbps.