

D-STAR Characteristics

Summary

In this lesson the student is introduced to D-STAR terminology and the D-STAR system definitions. The different types of D-STAR communications, voice and data, are presented and compared. The student is made aware of regulations that place constraints on the frequencies where D-STAR signals can be transmitted. Finally, some common misconceptions about intended applications of D-STAR are discussed.

What D-STAR Is

Just as for any other communication system, one can become quite confused or reach the wrong conclusions if the right terms and definitions are not used when discussing or planning a D-STAR system. That's why this lesson is devoted to a review of important terms and ideas.

D-STAR's Modes

The D-STAR system carries digitized voice and digital data, but does the job in two different ways. There is a combined voice-and-data mode (**DV**), and a high-speed data-only stream (DD). From the perspective of the D-STAR user, data and voice are carried at different rates and managed in different ways, but over the air, they are contained in **packets**.

You may be familiar with the packet radio AX.25 **protocol** that governs the exchange of data between TNCs (Terminal Node Controllers) or the Ethernet protocol that is used by home and business computer networks. The D-STAR protocol is similar, using many of the same techniques.

Digital Voice and Low-Speed Data (DV)

Mobile phone systems and Voice-Over-Internet Protocol (VOIP) phone technologies, such as Skype, convert the speaker's voice to a stream of digital data so that it can be sent to the destination over computer networks. The type of digitization used must be the same as the speaker and receiver, so D-STAR requires that a specific codec be used.

Digital Voice

The D-STAR codec digitizes voice by using the AMBE 2020 codec. AMBE stands for Advanced Multiple Band Encoding and 2020 designates the particular variation used by D-STAR. (Detailed technical information about AMBE 2020 is available at <http://www.dvsinc.com/products/a2020.htm>).

AMBE can digitize voice at several different rates. The D-STAR system uses a 2.4k bits per second (bps) rate which gives a good compromise between intelligibility and the speed at which data must be transmitted via the radio link. In addition, AMBE adds information to the voice data that allows the receiving codec to correct errors introduced during transmission. (The process of error correction will be covered in the next lesson.) The net result is that the digitized voice stream carries data at a rate of 3.6 kbps.

Low-Speed Data

Along with the digitized voice data, D-STAR's DV mode can also carry 8-bit digital data at

1200 bps. The data is not modified in any way as it is carried along with the voice stream and delivered to the receiving user.

Radios that support DV voice and data present an RS-232 or USB 1.1 interface to the user as shown in **Figure 2-1**. (The RS-232 interface is restricted to Rx, Tx, and ground - a "three-wire" connection.) Any computer terminal or program that can exchange data over those types of interfaces can use D-STAR's DV mode capabilities as a "radio cable." Figure 2-1 shows the data interfaces for both DV and DD mode connections.

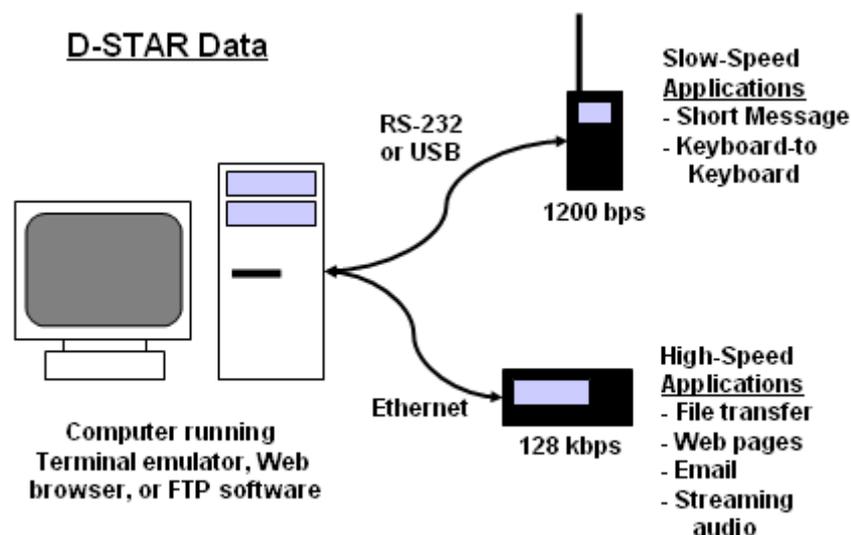


Figure 2-1

Because D-STAR's DV mode handles the digital without any modifications, it is up to the equipment or programs that are exchanging data to manage its flow. For example, if one system is busy and can't accept data, it must be able to signal the sending system to stop sending data and then start again when ready again. This process is called **flow control**. D-STAR requires the sender and receiver to perform flow control by using special data characters. This is called software flow control.

Table 2.1 - Comparison of DV Mode and Packet Radio

Feature	D-STAR DV	AX.25 Packet
Voice Codec	2.4k bps AMBE	None
Data Speed	1200 bps	1200 - 9600 bps
Data Format	8-bit ASCII	7-bit ASCII
Data Interface	RS-232 or USB 1.0	RS-232
Bandwidth	6.25 kHz	25 kHz
Frequency	Any VHF/UHF band	Any VHF/UHF band

Table 2.1 illustrates some important differences between D-STAR's DV mode and packet radio. Most obvious is that packet does not support voice in any form. High-speed packet can also reach 9600 bps. However, the bandwidth of a D-STAR signal is much smaller than that of an FM packet signal. Because of the low bandwidth, FCC bandwidth and data-rate regulations permit D-STAR DV signals to be transmitted on any VHF or UHF band. (See FCC regulations Part 97.305 and 97.307 for restrictions on bandwidth and signaling rates for data signals.)

High-Speed Data (DD)

D-STAR's high-speed data mode is called D-STAR **DD**. In this mode, the voice signal is dropped and the packets are dedicated completely to digital data. The packets sent across the air link at a **raw data rate** of 128k bps, but since that includes the packet header and the delay between packets, the **net data rate** is somewhat lower. (Sending data while in motion will further reduce the rate.) As with the DV mode, data is transmitted without modification so flow control is left to the users on each end. Radios supporting DD mode communications may also support DV mode.

Users connect to a radio supporting DD mode with an Ethernet interface via the usual RJ-45 modular jack found on computer networking equipment. (See **Figure 2-1**) The DD mode interface looks to computer equipment just like a customary network connection. Specifically, the DD mode interface is an Ethernet "bridge" between a pair of fixed network addresses. This allows Web browsers and other Internet software to run normally, as if they were connected to standard computer network.

The net data rate of DD mode is comparable to or better than a high-speed dial-up Internet connection. Voice transmission using DD mode connections can be effected by digitizing the voice separately and transmitting it as a stream of data via D-STAR. (Since DD mode just treats the digitized voice as data, any codec may be used.) Any streaming media mode that will run over dial-up Internet will likely perform well over D-STAR, as well.

Table 2.2 - Comparison of DD Mode and Packet Radio

Feature	D-STAR DD	AX.25 Packet
Data Format	8-bit ASCII	7-bit ASCII
Data Speed	128k bps (raw)	1200 - 9600 bps
Bandwidth	130 kHz	25 kHz
Data Interface	Ethernet bridge	RS-232
Frequency	902 MHz and higher	Any VHF/UHF band

DD mode data outperforms high-speed packet radio by a considerable margin, although with a substantially higher bandwidth. FCC regulations restrict high-speed data signals like D-STAR DD to the 902 MHz and higher bands.

D-STAR Backbone

The "invisible" mode of D-STAR is the system backbone with which repeater systems are connected together. Backbone connections can be made by any combination of Internet (a broadband connection is required) or radio links. Users do not use the backbone directly, it is only used by the D-STAR repeater gateways.

Gateways communicate over the D-STAR backbone using the Asynchronous Transfer Mode (ATM) protocol. (Detailed information on ATM is available at http://en.wikipedia.org/wiki/Asynchronous_Transfer_Mode.) The backbone operates at data rates of up to 10 Mbps, depending on the connection available. If the radio link backbone is used, signal bandwidth can be as high at 10.5 MHz, so these links are restricted to the amateur microwave bands. (Icom currently provides a 10.7 GHz microwave point to point radio link.)

What D-STAR is Not

It is also important to understand what D-STAR systems can not or may not do, due to both technical and regulatory restrictions.

Amateur Mobile Phone

D-STAR uses many techniques that are derived from or seem similar to those of the mobile phone systems and the Internet. Nevertheless, D-STAR does not create a "Ham Radio Cell Phone" or an "Amateur Internet." Most importantly, D-STAR communications are public and can be monitored by anyone with a D-STAR radio.

Streaming media are also quite constrained by D-STAR's limited data rate. Anyone expecting to watch video or download music via a D-STAR DD mode connection will likely be disappointed. D-STAR supports reasonable amateur requirements, but is not a replacement for broadband Internet connections.

The intent of D-STAR is to provide amateurs with state-of-the-art digital communications to support traditional amateur communications and foster the development of new applications suitable for amateur radio.

Commercial Content

Hams using D-STAR's DD mode can certainly connect to the Internet, send-and-receive email, use FTP servers, and so forth. Nevertheless, the FCC's prohibition against using amateur radio for commercial purposes still applies. This means that D-STAR users and system owners must be vigilant in keeping the many commercial aspects of the Internet off of the D-STAR system. For example, accessing your club's Web site may be OK, but reading a commercial newspaper's home page is not.

Click the "Review" button to review the topics covered in this lesson. When you are ready, click "Next" to continue...