D-STAR Review & Final Exam

Summary

This lesson consists of a selection of items from the review sections of Lessons #1 - #9. The Final Exam consists of twenty questions selected from the individual lesson exams.

D-STAR Review

Lesson #1 - Introduction

D-STAR is a public communications standard owned by JARL.

D-STAR is an open system - any equipment complying with the published standard can use the system.

D-STAR applies to a communications system's air link and the repeater-to-repeater gateway interface.

D-STAR specifies the type of codec that performs digitization of analog signals.

Digital data is transmitted by the D-STAR system without modification.

The D-STAR gateway interface may use with the Internet or radio links.

Lesson #2 - D-STAR Characteristics

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**.

D-STAR's DV mode combines digitized voice and digital data signals.

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.

D-STAR uses AMBE at 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.

AMBE adds information to the voice data that allows the receiving codec to correct errors introduced during transmission.

D-STAR's DV mode carries 8-bit digital data at 1200 bps and uses a three-wire RS-232 or USB 1.1 interface.

D-STAR's DV and DD modes require the sender and receiver to perform flow control by using special data characters. This is called software flow control.

FCC bandwidth and data-rate regulations permit D-STAR DV signals to be transmitted on any VHF or UHF band.

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 DD mode data interface is an Ethernet bridge between two fixed network addresses. The physical connection is a standard RJ-45 jack.

The net data rate of DD mode is comparable to or better than a high-speed dial-up Internet connection.

FCC regulations restrict high-speed data signals like D-STAR DD to the 902 MHz and higher bands.

Gateways communicate over the D-STAR backbone using the Asynchronous Transfer Mode (ATM) protocol at up to 10 Mbps.

Lesson #3 - D-STAR Protocol Basics

D-STAR packets consist of a *header* segment and a *data* segment.

Data segments are sometimes referred to as *payloads*.

The header segment contains information about the packet the receiving device needs to process the data, whether that means reading and acting on the data or just forwarding it on to another receiver elsewhere in the system.

The header and other information added to the original set of data creates packet overhead. It is most efficient to send the maximum amount of data in each packet.

Protocol overhead refers to the time it takes for a packet's receiver to process and acknowledge the packet. D-STAR does not incur protocol overhead.

D-STAR encapsulates data formatted according to the AMBE and Ethernet protocols.

The header segment is the same for both the DV and DD packets.

Sync frames are unique patterns of bits that the receiver can use to unambiguously determine that a packet is beginning.

The bits in the control flag bytes are used to direct the processing of the packet.

Identification fields carry information about the origin and destination of the packet and the data it carries.

Error detection codes such as checksums are used to detect transmission errors. These only tell the receiver that the data is damaged, but not how. D-STAR uses a checksum to protect the header data and the DD packet includes a checksum as part of the Ethernet data payload.

Error correcting codes contain information about the payload data. Because the codes are sent with the data to enable correction at the receiver, they are called Forward Error Correcting or FEC codes. FEC codes contain enough extra information for the receiver to repair most damage. D-STAR includes FEC codes in the AMBE 2020 digitized voice data.

Digital data sent via DV packets is not protected by error detection or correction.

Lesson #4 - D-STAR Network Operation

Each D-STAR packet can carry up to four different call signs. The types of call signs are:

- Own Call Sign - the call sign of the user making the transmission
- Counterpart Call Sign - the call sign of the station the user wishes to or is in contact with
- Sender Repeater Call Sign - the repeater and specific module (A-D) through which the user intends to communicate
- Receiver Repeater Call Sign - the repeater and specific module (A-D) through which the station identified by Counterpart Call Sign will communicate

All D-STAR transmissions not over an Internet link are public and can be monitored by anyone, just as on analog repeaters. There are no "private conversations" on the D-STAR network.

D-STAR call signs of users or repeaters may be up to 8 characters long.

If the character string "CQCQCQ" is present in the Counterpart Call Sign field, it indicates that the calling station wishes to talk to any station.

D-STAR suffix characters are separated from the call by spaces and must be in the 8th position of the call sign.

Each D-STAR repeater can have up to four modules that handle voice or data, each identified by a letter; A, B, C or D. By adding the module identifier after a repeater call sign, the packets are routed only to that module.

D-STAR repeater modules can be linked into zones.

A D-STAR gateway is the Internet connection for a D-STAR repeater.

A D-STAR Zone consists of all of the repeater modules that share a common gateway.

The slash character "/" added before a repeater call sign indicates that the information in the packet is to be distributed to all repeaters in the zone of which that repeater is a member.

Adding a "G" to a repeater call sign indicates that the communication is to take

place via the repeater's gateway.

The D-STAR registry is a database of user call signs registered on the D-STAR network by repeater system operators. Each D-STAR gateway has a copy of that database, which is maintained by several D-STAR **trusted servers** located around the world. Each D-STAR repeater gateway database is updated a number of times each day.

Each time a registered user transmits via a D-STAR repeater, the user's location is updated in the master registry where it will be provided to all D-STAR gateways.

Lesson #5 - D-STAR Radios

To determine which is the best radio for an application, the first step is to understand what the requirements are:

- Is DD mode operation required (high-speed data)? If so, the only radio supporting DD mode is the ID-1.
- Is dual-band operation required?
- Is high-power required?
- If data is to be transmitted, what data interface does the computer have?

Key items to remember when choosing the right D-STAR technology:

- High-speed data (DD mode) can only be sent on the bands above 70 cm.
- Error correction for low-speed data (DV mode) is the responsibility of the data communications programs used to exchange data.
- RS-232 interfaces for D-STAR data do not provide data flow control hardware signals, such as RTS or CTS.
- Higher power radios will result in stronger signal strengths and fewer data transmission errors.
- If data is to be transmitted while in motion, higher frequencies will result in fewer transmission errors, improving the net data exchange rate.

D-STAR radios may all have slightly different labels, keys, and sequences of operation, but under the surface they all use the same sets of D-STAR information.

Multiple memories are available for MY CALL SIGN if the radio is shared by more than one operator or if you frequently operate away from home or with a club call sign.

D-STAR radios can take advantage of the information contained in each packet to provide functions based on the data.

- AUTO REPLY - automatically reads all of the calls in the received

packet and sets the radio to reply correctly without any call sign entry being required.

- BREAK IN - allows you to enter a conversation if the stations are using CALL SIGN SQUELCH (see next item)
- CALL SIGN SQUELCH - mutes the receiver output audio unless packets addressed to MY CALL SIGN are received
- EMR - enables full audio output whenever an EMR call is received
- RX CALL SIGN AUTO WRITE - temporarily stores the call sign of the calling station
- RPT CALL SIGN AUTO WRITE - temporarily stores the call sign of the repeaters used by the calling station

The squelch function of digital radios does not function the same way as for an analog radio. Instead of "opening" the squelch to hear unmodulated white noise, the squelch selects between DCS (Digitally Coded Squelch), CSS (Call Sign Squelch), and no squelch.

D-STAR supports the exchange of short text messages, similar to Internet Messaging (IM) or a mobile phone's Short Messaging Service (SMS).

Low-speed data transmission in the PTT mode does not occur until the PTT switch is closed on the radio or at the microphone jack (either by a microphone or an external circuit). While PTT is closed, the radio transmits whatever data it receives. In AUTO mode data is transmitted as soon it is sent to the data interface.

Lesson #6 - D-STAR Local Use

You do not have to enter any call signs for the radio to receive D-STAR packets. Once your radio is tuned to an active channel frequency, you can hear every conversation.

A D-STAR radio is silent until D-STAR packets are received, then the decoded digital voice will be heard over the speaker as long as the signal is strong enough to receive the packets properly.

When CSS is turned ON and a call sign entered, the radio will remain silent until D-STAR packets containing the specified call sign are received.

All digital information is carried by the D-STAR packet as "plain text."

To make a transmission not directed to any specific station, use the special text string "CQCQCQ".

The presence of call signs in D-STAR packets lets the radio acquire them automatically.

D-STAR uses the EMR function to alert all stations within range that an urgent or emergency situation exists. This function depends on the value of Bit 3 of the Flag 1 control byte of the D-STAR header.

A transmission can be directed to a specific station by storing that station's call sign in the Counterpart Call Sign field.

To use a D-STAR repeater, you must store the repeater's call sign in the Sender Repeater Call Sign field.

In a D-STAR zone, a call or transmission can be relayed to the entire zone by adding a slash character "/" before the repeater's call sign.

Lesson #7 - D-STAR Gateway Use

The D-STAR gateway is not a "thing", but rather a "connection." The gateway is software that runs on a PC connected to the controller of a D-STAR repeater.

The D-STAR gateway only sends digitized signals to other repeaters when directed to do so by the information in a received D-STAR packet.

The only time you will hear a signal from a remote D-STAR system is when the station that generates the signal directs the gateway to send it to your repeater or repeater zone.

D-STAR packets not being relayed to other repeaters aren't handled by the gateway and so will not be heard elsewhere.

Adding a "G" to a repeater call in the Receiver Repeater Call Sign field tells the D-STAR repeater to send the transmission via the gateway.

The "G" must be in the 8th available space in the call sign.

D-STAR repeaters can support up to four radio modules.

Each module is assigned a unique letter identifier; A, B, C, or D.

If you do not specify a module, the controller will default to repeating your signal on the same band on which it was received.

If the module you specify operates on a different band, you will then be operating cross-band!

If you choose to specify the module the station you are calling must be listening on that band.

Lesson #8 - D-STAR Repeater

At a minimum, a D-STAR repeater must have a controller and at least one module.

The repeater consisting of a controller, module, and RF link can provide all of the D-STAR network services.

Each repeater must have a unique call sign for the repeater, such a club call sign.

One ID-RP2C repeater controller is required for each D-STAR repeater. Modules can not function without a controller.

D-STAR repeater modules perform the same functions as do transmitters and receivers in an analog repeater system.

A separate antenna connection is required for each module.

The modules process only D-STAR digital signals. An analog signal on a D-STAR module's input frequency is not demodulated or retransmitted.

Each module is connected to the controller at a separate port. There are four module ports on the controller and each can be connected to a DD or DV module.

The controller is configured via an Ethernet connection to a Windows-based PC running the ID-RP2C controller configuration software.

Each controller port must be configured to connect to a specific type of repeater module. The modules must be physically connected to Port 1 to 4 on the controller in exactly the same order as shown on this screen.

Each repeater module must be assigned a module identification letter. This letter allows D-STAR users to select a specific module within a repeater.

If the controller is to be attached to a gateway, that function must be enabled during configuration.

The D-STAR repeater module's control and programming is done using a USB interface on the module. There are two USB ports on each repeater module; one for the transmit (TX) frequency and the other for the receive (RX) frequency.

Lesson #9 - D-STAR Gateway Configuration

The D-STAR gateway must be assigned a fixed or static IP address and be provided with a broadband Internet connection, such as those provided by a DSL or cable connection.

Icom's gateway software is a proprietary, licensed vendor product, and can not be copied, shared or re-distributed. It is not part of the open D-STAR protocol.

The gateway software is hosted by a Linux®-based PC based on the Fedora? Core 3 or Fedora Core 4 version of Linux.

The host PC must have two Ethernet ports, eth0 and eth1. Eth0 is configured as a LAN port and will be connected to the router. Eth1 is configured to connect to the ID-RP2C controller. Both ports will have static IP addresses.

The gateway server must be physically located at the repeater due to latency requirements.

The local D-STAR database is named dstar.local.db and is maintained on the gateway PC.

Several trust servers, such as USRoot, are maintained around the world to the D-STAR network. You can also use your own private trust server to create your own D-STAR network. Any PC running the D-STAR gateway software can be configured to be a trust server to create your own private network.

Once your gateway is up and running, it will synchronize itself with the rest of the D-STAR network. The easiest way to see if it synchronized is to look at the **dstar.local.db** file for a list of other D-STAR gateway call signs and IP addresses.

D-STAR gateway database files are updated / merged automatically with the trust server and all the other gateways on the network at least once a day.

Any user can operate locally on a D-STAR repeater, with or without their call sign in the registry.

Only users that have been added to the gateway registry are allowed to cross the D-STAR gateway and access the D-STAR network. Once a user is added to the D-STAR gateway, they have gateway rights via any D-STAR gateway that is configured to use the same trust server.

The Icom test D-STAR system is provided to allow gateway administrators to test their system before "going live." To go live on the full D-STAR network, it is necessary to "kill & clean" the gateway so that the D-STAR databases will be downloaded from the trust servers.

Click "Next" to continue...