HIPAA-COMPATIBLE WIRELESS COMMUNICATIONS

EMERGENCY DIGITAL VOICE/DATA

DIGITAL

D-STAR

The effectiveness of any voice or data communications system is directly influenced by those it serves. D-STAR is a powerful protocol in the Emergency Communications (EmComm) toolbox that utilizes voice and data for tactical and strategic communications.

Discover a whole new perspective on amateur radio…

- **Deployment Concepts**
- **Practical Applications**
- **Spectrum Usage**

ICOM®

Putting D-STAR to work...

The Three P's of EmComm

Some would say the three P's of EmComm are Planning, Planning, and more Planning. True — planning is extremely important, but equal consideration to Preparation and Practice must be observed. The most well-thought-out plans can make a simple situation a complete disaster without the right execution.

So, how do the three P's tie into D-STAR? Many clubs already include D-STAR as well as other Digital Voice (DV) modes in their EmComm readiness.

Types of EmComm

EmComm can be broken down into two main categories: Tactical and Strategic.

Tactical Communications: Deals with short-term needs or immediate action items to achieve an objective, milestone or goal.

Whether it is to dispatch hotshot crews and aerial water tankers for fire suppression, food deliveries for shelters, or areas requiring immediate medical crews, precision is key here. Unfortunately, inflections in a voice, radio operator experience, or things beyond our control can slow things down. Therefore, to be effective, we must always utilize the three P's and look to new ways to improve.

With the capability of combining voice and data in the same transmission, as well as adding a faster data stream with universal standards such as serial and Ethernet data, D-STAR can greatly increase radio's effectiveness and efficiency.

Strategic Communications: Deals with long-term items and broad of scope needs that do not require an immediate action.

While not as time-sensitive as tactical comms, strategic communication plans and practices address emergency issues. We commonly see strategic comms such as shelter plans and locations, safety warnings and other items that are required for problem solving.

New Technology, New Ways to Communicate

We have become extremely reliant on new technologies, specifically data communications. Data comms (such as text messaging, e-mail, and document transfers) are common in both personal and professional worlds. It is also applicable to comm requirements in times of emergency. New tools to keep the world connected are being developed and adopted.

We as amateur radio operators are seeing our role as general communicators change to IT solution technicians. The amateur radio hobby is being tasked to maintain a level of "connectivity" as technology evolves. A new mantra is "Why say what you can send?" Why not send a photo, text instructions or even a file to better communicate during a critical situation?

In addition to data comms, we also must also focus on technology that enhances voice communications. With digital technology, we see the range and clarity of voice comms improve compared to analog radio.

RF transmissions are affected by environmental and range factors. For analog systems, these interferences and limitations not only disrupt the signal, but directly impact the voice quality on incoming calls. Digital signals, on the other hand, remain clear due to built-in error-correction techniques that reconstitute the voice at nearly its original fidelity throughout most of the RF coverage area.

D-STAR: Let's Get Digital

With all infrastructure supporting analog FM communications, why would anyone want to change or implement digital voice (DV)? Really there are four reasons:

1. Spectrum efficiency
2. Greater range and clarity
3. Routing of voice and data communications
4. Simultaneous data and voice communications

Spectrum Congestion

We all understand the pitfalls of population growth. In many areas, what was once a 10-minute trip across town now takes a half hour! We see a similar congestion issue in amateur radio, but rather than a trip taking longer, we hear, "Sorry, there are no repeater pairs available."

The migration to more efficient modes of communication helps open up repeater pairs. Repeater councils are adopting and implementing new band plans as the ham radio community migrates to address the more efficient DV modes. Tables 1 and 2 on the next page demonstrate how many 6.25kHz digital systems can be deployed in the place of a single analog repeater.

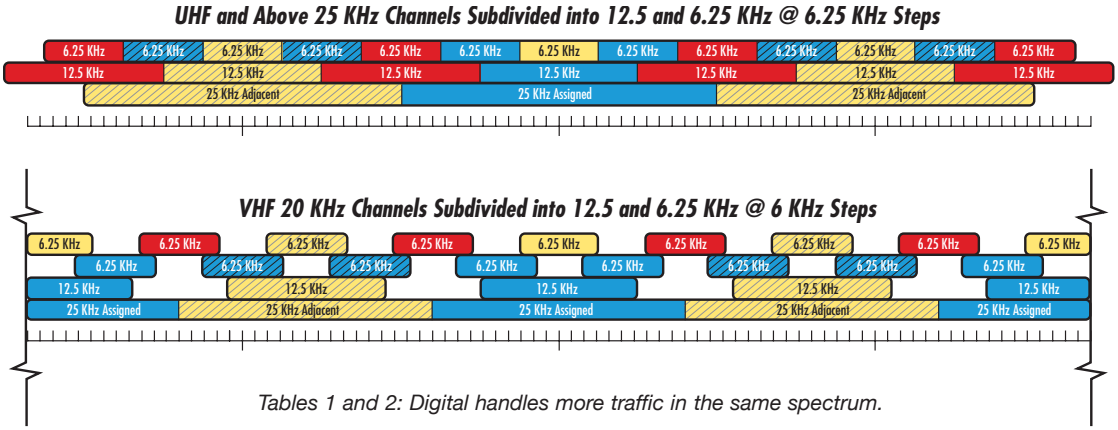
In addition to the increased repeater pairs, the Digital Voice mode increases the number of simplex frequencies that can be used in an emergency. Frequency management becomes more important as we see our roles increase in proportion to the size of the incident and the number of agencies increases.

Frequency Coordination

In many emergency plans, both Amateur Radio Emergency Service (ARES) and Radio Amateur Civil Emergency Service (RACES) members will assist in emergencies. ARES operates under written various MOUs (Memoranda of Understanding) with these "Served Agencies":

- Federal Emergency Management Agency (FEMA)
- American Red Cross
- Salvation Army
- National Weather Service

...during emergencies!



Tables 1 and 2: Digital handles more traffic in the same spectrum.

- Association of Public Safety Communications Officials International, Inc. (APCO)
- National Communications System (NCS)

With so many different entities, you can see why frequency coordination is important!

Many organizations look at a primary and secondary frequency; some will go as far as a third. But what happens in a situation that covers a thousand plus miles, multiple counties, states…even multiple branches of the same organizations? How important does an efficient EmComm plan become?

Multiple agencies will require separate frequencies for their local traffic. However, there are times when communications to coordinate efforts of various counties and agencies will be required.

DV Advantages

VoIP (Voice over IP) technologies such as IRLP and EchoLink® have expanded VHF and UHF global communications. However, utilizing this type of technology has its limitations such as transmission quality. IRLP and EchoLink are both hybrid technologies that deal with analog and digital transmissions. Information that is converted from analog to digital retains the "scratchy" audio that's often associated with analog. With D-STAR, digital information stays in the digital domain — without being encoded and decoded multiple times.

D-STAR also introduced new capabilities for connecting people. Both IRLP and EchoLink® require that if you want to contact a specific person, you have to know where they are! D-STAR allows you to connect to an individual station without knowing the station's location by callsign routing. You can also talk to groups by linking repeaters or reflectors. (A reflector is where multiple repeaters are "conferenced" together.)

Routing and Linking

The magic occurs by adjusting the UR or URCALL field show below. It is recommended to use the repeater callsign with a G in the RPT2 to allow routing or communications with other devices or technologies beyond the local repeater.

Routing to a Station	**Routing to a Repeater**
URCALL = N9JA	UR = /WD4STR B
RPT1 = WX4GPB C (Callsign of the local repeater)	RPT1 = WX4GPB C
RPT2 = WX4GPB G (Callsign sent to gateway for further routing)	RPT2 = WX4GPB G

D-STAR has evolved, allowing third-party applications (such as dplus and D-PRS®) to be utilized on the gateway. These technologies have been added to most D-STAR repeaters, expanding the capabilities of linking to other repeaters or reflectors, and tracking asset locations.

Linking to a Repeater	**Linking to a Reflector**
URCALL = WD4STRBL	UR = REF030CL
(UR field: a user can link their local repeater to another repeater.)	
RPT1 = WX4GPB C (Callsign of the local repeater)	RPT1 = WX4GPB C
RPT2 = WX4GPB G (Callsign sent to gateway for further routing)	RPT2 = WX4GPB G

D-STAR Factoid: *Did you know that a user could select whether their communications are repeated on a single repeater pair, multiple repeater pairs, or to a large group of repeaters on a reflector?*

Simultaneous Voice and Data Communications

In addition to all the routing capabilities of the DV mode, the simultaneous transmission of serial data is possible while operating in the DV mode. While the data rate is not plausible for large data transfers, this feature allows simple serial communications such as keyboard-to-keyboard text messaging to occur on the same infrastructure as the voice communications.

DV Benefits Over Packet Radio

In DV mode, voice and data travel together on one signal and can be used for many data applications including "packet-like" communications. The advantage over Packet Radio is the simple connection between the D-STAR radio and the computer using a single cable, eliminating the TNC and reducing the complexities of configuration errors. Since the voice and data are traveling on the same signal, a separate radio or digipeater is also NOT required, simplifying infrastructure requirements. Additionally, D-STAR provides easy confirmation for data exchange. If an operator can hear you talk, you know they are getting your data.

DV + GPS

While hams have had both voice and position reporting capability for years, D-STAR combines these two communication methods into one seamless system. With D-STAR voice and data on one signal, your GPS position can be sent with every voice transmission. The position data can be sent to the APRS-IS network and used by most GPS applications.

Knowing where your field workers are offers a variety of benefits to dispatchers, supervisors and managers. It also promotes an extra level of safety for field workers as well as faster extradition of any victims being rescued. GPS data is extremely helpful in SAR/USAR activities.

Ham-Brewed Software

Integrating D-STAR Position Reporting System (D-PRS®) information into older existing systems becomes a challenge. Fortunately, several people have stepped up to the challenge and have solved the issues of compatibility with legacy technology.

dplus: dplus is an application that runs on D-STAR repeaters and is used by most D-STAR repeaters around the world. It allows DV Dongles and DV Access Points (DVAP) to access D-STAR repeaters and the D-STAR network. It also expands features of D-STAR repeaters – allowing them to link together one or more repeaters through reflectors, creating flexible networking.

Robin Cutshaw, AA4RC, developed the DV Dongle, DVAP and the dplus software application.

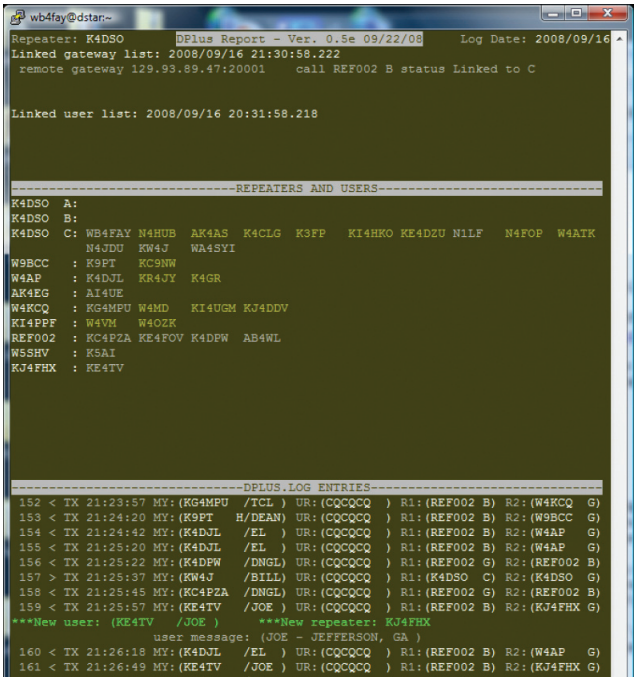
D-PRS Interface/javAPRSSrvr: D-PRS applications allow the use of standard APRS clients to map D-STAR GPS activity. Both applications have the ability to gate the translated D-STAR->APRS packets to APRS-IS where they can be displayed by remote clients or gated to the local APRS frequency.

Pete Loveall, AE5PL, developed several software packages to integrate D-PRS® with APRS®.

Dplusreport: This application displays formatted information obtained from the dplus.log file on the system. This gateway utility helps Net Control Stations (NCS) on D-STAR nets to easily manage and display users checking into the net. This program can provide up to 3 different display sections. Status and warning information include:

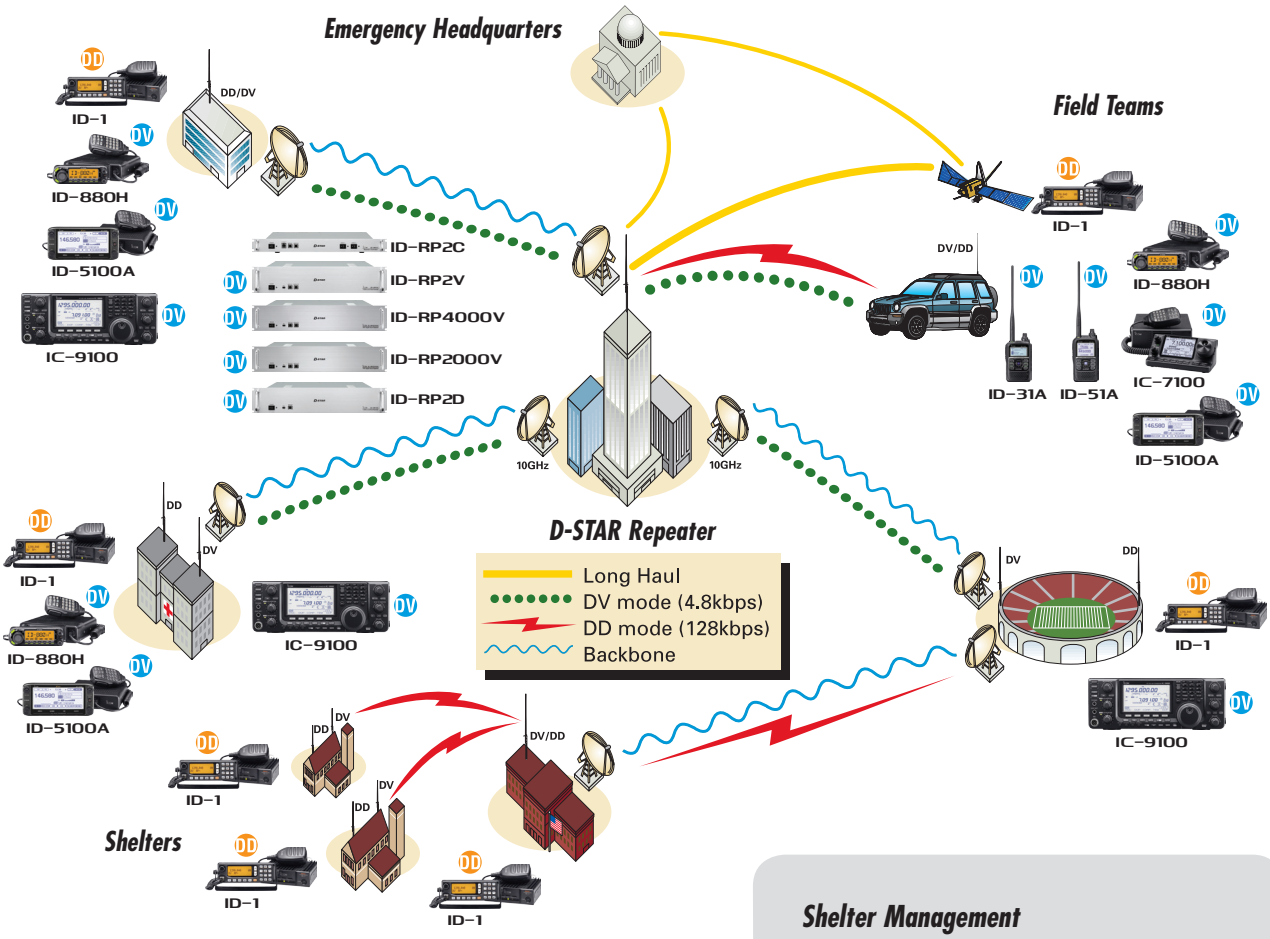
- Current status of active links and DV Dongle, DVAP and hotspot users who are locally connected
- User callsigns are displayed, listed by the local repeater accessed by the station
- Portions of the dplus.log file after it has been processed and reformatted to display a variety of information and assist in troubleshooting programming errors

Ken Adkisson, WB4FAY, developed Dplusreport and MonLink, which runs as a service on the D-STAR gateway.



Dplusreport is available for non-commerical use on D-STAR gateways. Above: Screen shot of Dplusreport interface.

Example System



Shelters

128kbps, 23cm wireless data, allows faster communication over areas of several miles* for Ethernet-based communications while offering secure receive and transmit information.

*Line-of-sight communications.

Shelter Management

Share vital information digitally:

- Inventory such as medical supplies, fuel supplies, food and water availability, bed counts, etc.
- Logistics and coordination
- Staff and schedule

Determine if shelters are filled or empty, require supplies or can spare provisions. Operators should not transmit personal information in the clear, which satisfies HIPAA standards.

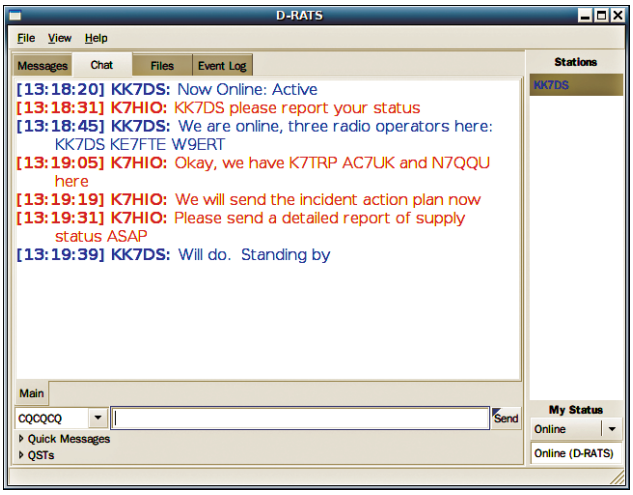
Repeater compatibility chart with Icom digital transceivers

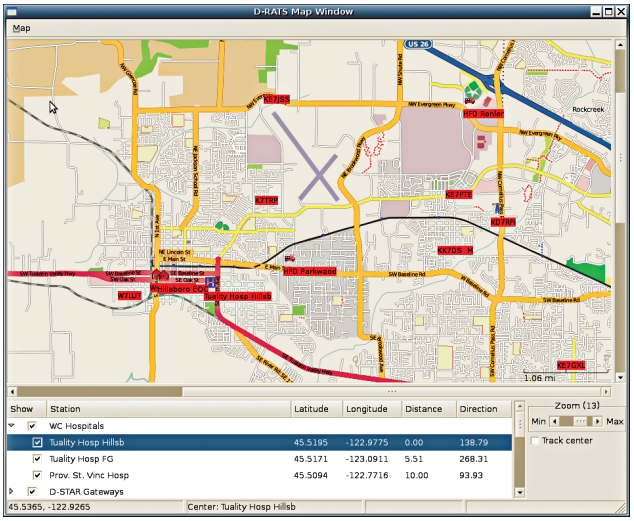
	ID-1	ID-31A	ID-51A	ID-880H	IC-7100	ID-5100A	IC-9100
ID-RP2000V	–	✓	✓	✓	✓	✓	✓
ID-RP4000V	–	✓	✓	✓	✓	✓	✓
ID-RP2V / ID-RP2D	✓	–	–	–	–	–	–

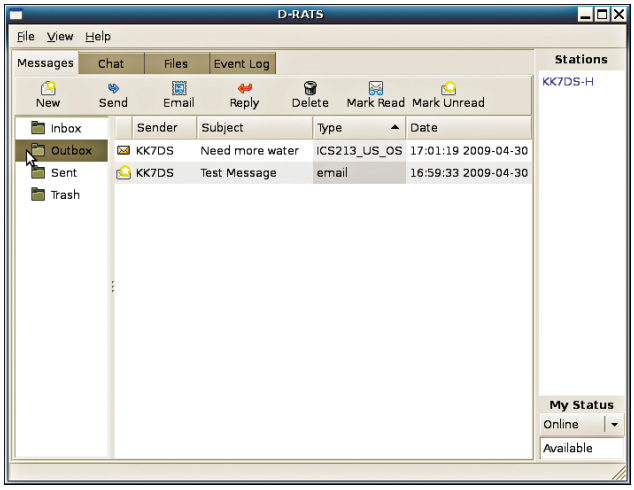
Putting D-STAR to work...

D-RATS: This multi-platform software suite that was developed for first responders. With only a pair of radios (or an entire repeater stack), a variety of data transmission methods are supported including instant message chat, automatic beacon messages, file transfers with error detection, structured forms, GPS position reports and more.

Dan Smith, KK7DS, initially developed D-RATS for the Washington County ARES/RACES group in Oregon.







D-RATS features include but are not limited to (Left to Right): instant message chat, GPS mapping and email portals.

For more information, visit http://www.d-rats.com.

What We Learned

During the introduction of the first D-STAR system in the U.S., K5TIT, a local Dallas, TX amateur radio operator in attendance, asked the question, "Why would I want Internet connectivity in my vehicle?" Hurricane Katrina and other recent natural disasters have helped answer that question.

There is value in being able to show real-time data being generated from the field first responders. The ability to access information from the National Weather Service and other EmComm-related web sites and to send/share e-mail and files with others on the system is incredibly important. Being able to connect to the Internet and to deploy IT systems like fi e, e-mail and chat servers is crucial.

While working out your deployment strategy, there are key things to remember:

- Propagation on 23cm can be tricky. It is truly line-of-sight and does not work around buildings and environmental obstructions.
- As the frequency bandwidth of the digital data (DD) mode is 130 kHz, the total data bandwidth is 128kbps – not per user/connection. Deployment plans with multiple DD systems that cover areas with many users should consider expanding to systems operating different frequencies.
- Unlike the DV modules on a D-STAR system, the 128kbps module, or the DD module, is really an access point. While the DD module is user programmable for the selected frequency, operation is in a half duplex, single frequency. If deployed in a system with the 23cm DV module, or with other DD modules, a pass band filter is highly recommended. This keeps other 23cm transmissions from interfering.

...for you!

D-STAR in Action Around the U.S.

(Dallas, TX) In 2003, Jim McClellan N5MIJ and Bill Moore N5ZPR, became the first D-STAR customers in the U.S. Since then, McCellan, Moore and their club, the Texas Interconnect Team, have expanded their D-STAR presence to the entire Dallas/Fort Worth area. The club hosts critical functions for the D-STAR network including the main D-STAR Trust Server, and a popular web site: www.D-STARUsers.org.

"Simultaneous voice and data [is] a capability unique to the amateur service today, and gives us the opportunity to provide a service not available anywhere else," says McClellan.

(Washington, DC) In 2006, race organizers for the 31st annual Marine Corps Marathon turned to the National Capital Amateur [Radio] Council (NCAC) for race day communications help. D-STAR digital data provided broadband communications support. At 10 to 100 times the bandwidth of previously used packet systems and supporting native TCP/IP applications delivered, AID station performance proved impressive. The D-STAR demo stations became the primary method to manage runner medical info using the native, interactive race web application.

(Georgia, U.S.) Working with the Georgia Emergency Management Agency (GEMA), ARES groups demonstrated the additional capabilities of D-STAR to receive funding for a deployment of D-STAR repeaters across the state. The near statewide coverage has provided new capabilities for GEMA, including transmission of airborne photos from affected locations using the higher speed digital data mode on 1.2 GHz and the ability to create statewide or regional linked repeater networks on an ad-hoc basis. The network has also been integrated into Skywarn® severe weather reporting for the National Weather Service, and with Public Health for emergency communications between hospitals. D-STAR has been included in Emergency Operations Plans for agencies across the state.

(Southeastern U.S.) The Southeastern D-STAR Weather Net connects approximately 50 repeaters across the hurricane, tropical storm and tornado prone Southeastern coast – from Texas to North Carolina – for severe weather reporting and training on a large linked repeater network. The National Hurricane Center, WX4NHC, has added this net to its hurricane reporting resources to add supplementary stations that are reporting "ground truth" from affected areas. Digital voice and predefined forms provide timely and accurate voice and data reporting to WX4NHC.

D-STAR Online Resources

D-STAR Info: http://www.dstarinfo.com
D-STAR Users: http://www.dstarusers.org
D-STAR Videos: http://bit.ly/d-starvideos

Responder Kit Equipment

ID-31A DV
70cm UHF DIGITAL PORTABLE

- 5W output power
- Built-in GPS receiver
- 1252 alphanumeric memory channels

ID-51A DV
2m + 70cm VHF/UHF DUAL BANDER

- 5W output power
- Independent AM/FM receiver
- V/V, U/U, V/U dualwatch

ID-1 DD DV
GO DIGITAL ON 1.2GHz

- Analog, DV and DD modes
- Detached front panel
- PC remote control software included

ID-880H DV
2m + 70cm MOBILE

- 50W output power
- Wideband receiver
- Detachable front panel

IC-7100 DV
HF/6m/2m/70cm TOUCH SCREEN MOBILE

- 100/100/50/35W output power
- Slanted control head
- Detached front panel

ID-5100A DV
2m + 70cm TOUCH SCREEN MOBILE WITH GPS

- 50W output power
- V/U, V/V, U/U Dual Receiver
- DV Dualwatch

IC-9100 DV
HF/6m/2m/70cm/23cm* BASE STATION

- 100/100/100/75/10*W output power
- Remote control capable RS-BA1 software*

**optional*

Frequently Asked Questions & Myths Debunked

D-STAR Q & A

How do I get started?
To learn more about amateur radio, or to find a club in your area, contact the American Radio Relay League (ARRL) at www.arrl.org. Most amateur radio operators will welcome the chance to discuss emergency communications. Free learning tools for existing and potential amateur radio operators can be found online at http://www.hamstudy.org.

What does D-STAR stand for?
"D-STAR" stands for "Digital Smart Technologies for Amateur Radio." It is an open protocol digital communication established by the JARL.

Who can use D-STAR equipment?
Any ham station requires a licensed operator to act as controller. With a controller present at all times and managing the equipment, anyone may use the amateur airwaves.

Who owns and maintains the system?
While anyone may purchase the D-STAR equipment, legally it takes a (ham) to transmit. Hams may purchase D-STAR equipment in cooperation with local or state agencies.

Does D-STAR rely on the Internet?
While connecting repeaters together via the Internet enhances D-STAR capabilities over wide areas, the same voice and data features are available over a local repeater and simplex operation.

What range will the system offer (a "footprint")?
Range always varies due to terrain and antenna height, but 20-40 miles* from the repeater is normal. Due to digital technology, benefits of up to 15% have been experienced over comparable analog systems.

**20-40 miles is a best case measurement, distances will vary based on frequency used and other terrain obstacles. (23cm can easily be only 2-3 miles based on topography)*

Does D-STAR tie-in with P25 (Project 25) interoperability?
Although D-STAR and P25 are both digital protocols, D-STAR only complements agency interoperability. D-STAR is not compatible with P25 mode communications.

How does D-STAR differ from other digital modes?
D-STAR was designed as an open standard for digital voice and data communications specifically for Amateur Radio. Unlike commercial technologies, D-STAR puts the user in control of features such as call routing and flexible repeater linking. As an open protocol, third-party features and applications have been developed to enhance D-STAR operation.

D-STAR Myths

"D-STAR only works on 1.2 GHz."
Low-speed DV D-STAR voice and data works fine at 144 MHz and 440 MHz. 1.2 GHz supports the bandwidth needs of high-speed DD data. Choose the technology that meets your needs.

"There's no difference between D-STAR and packet."
Even D-STAR's lowest speed is competitive with the highest-performance packet systems available. (See page 7 for detailed comparisons.) D-STAR's simultaneous digital voice and data is beyond the capability of any packet technology. High-speed D-STAR systems are ten times faster than the highest packet speeds.

"D-STAR is no different from IRLP or EchoLink®."
All three use the Internet, but the similarities end there. The crucial differences are two-fold. D-STAR systems provide data transmission at up to 128kbps. IRLP and EchoLink do not transfer data at all. D-STAR routes transmissions from repeater to repeater, based on the callsigns included in every data packet. Both IRLP and EchoLink utilize site routing. This is why users must know the repeater information of where they want to talk. D-STAR can use both site and sser routing. User utilizes an individual's callsign and the system will route the call based on the last location where the callsign was heard.

"D-STAR is just a digital party line!"
The ability of D-STAR repeaters to route data and digitized voice worldwide sets it apart from a simple party line. Sophisticated D-STAR controllers and gateways implement modern telecommunications functions in an amateur radio package.

"D-STAR is a replacement for broadband home Internet."
D-STAR can connect a user to the Internet, true, but all of the amateur radio restrictions on commercial activity still remain in place. D-STAR provides the tools for a lot of great amateur innovation, but it's not intended to replace Internet providers.

"I'll be locked into Icom equipment forever."
Icom is the first to implement the JARL (Japan Amateur Radio Protocol) D-STAR protocol, but any manufacturer can implement this protocol. As the D-STAR technology grows, look for other manufacturers to implement this protocol into their products.

As a collective group, amateur radio operators control the direction of the hobby and its relevance (and service) in today's world. Get involved and bring up D-STAR at your next local ham club meeting!

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