D-STAR Basics

TAPR DCC 2011
September 17, 2011
What is the National Capital Region D-STAR Association…?
Local D-STAR repeater groups joining together to promote D-STAR technology

Working together to provide D-STAR coverage in the National Capital Region

Come visit us on Reflectors 025B and 025C!

Participating Groups
- W4HFH (Alexandria)
- N4USI (Bull Run)
- W4OVH (Manassas)
- K4DCA (Reagan National)
- WS4VA (Stafford)
- NV4FM (Tysons Corner)
- W4BBR (Virginia Beach)
National Capital Region D-STAR on the Web

Join us on the web at:
www.ncrdstar.org
• Resources
• News
• Wiki
AN INTRODUCTION TO D-STAR
What is D-STAR?

- D-STAR (Digital Smart Technologies for Amateur Radio)
- Simultaneous digital voice and data
- Packet-based (ready for computers and networks)
- “Digital at the source” – voice quality is not degraded by the communications channel
- Less bandwidth than analog counterparts
- Callsign-based routing architecture
- Stand-alone or gateway-enabled architectures
D-STAR Repeater Allocations

**D-STAR (6.25kHz)**
- 6.25kHz occupied bandwidth
- 10kHz channel spacing

**Analog FM (15kHz)**
- 15kHz occupied bandwidth
- 20kHz channel spacing

D-STAR relieves spectrum crowding!
D-STAR and Analog Repeater Allocations

D-STAR repeaters can be allocated between existing FM repeat
D-STAR and Analog Repeater Allocations

Analog FM (15kHz)  D-STAR (6.25kHz)  D-STAR (6.25kHz)

20kHz spacing

In fact, you can fit two D-STAR repeaters inside the spectrum allocation of just one analog repeater!
D-STAR Specification

- D-STAR is an open protocol – published by Japan Amateur Radio League (JARL)
- Open-source design document
- Google “ARRL DSTAR specification” for more information
D-Star Data Capabilities

- D-STAR offers *both* voice and data or data-only capabilities
- Simultaneous voice and data capabilities
  - Applies to both 2 meters and 70cm
  - Data rate of 1200bps
- High-speed only data
  - Applies to 1.2GHz only
  - Data rate of 128kbps
Four key fields are used in D-STAR routing:

- MY: the ‘source’ callsign (i.e., your callsign)
- UR: the ‘destination’ callsign (or CQCQCQ)
- R1: the repeater your radio is accessing
- R2: the gateway your repeater uses
Callsign Routing – the D-Star Calculator

Programming for talking to N5ITU

YOUR::  N5ITU###
RPT1:  W4OVH###B
RPT2:  W4OVH###G
Set Radio To:  442.5125 MHz Offset +5.0000 MHz

"#" represents a space

N5ITU would:
• Set RPT1 to his local repeater module
• Set RPT2 to his local repeater gateway
• Press the RX->CS button and say Howdy!

The D-STAR trust server ‘finds’ stations at their last known location


Copyright 2009 Ed Woodrick WA4YIH
Callsign Routing – Connecting Repeaters Together

Programming for talking on W4OVH (port DV B) to NV4FM (port DV C)

YOUR:: /NV4FM\*C
RPT1: W4OVH\*\*B
RPT2: W4OVH\*\*G
Set Radio To: 442.5125 MHz Offset +5.0000 MHz
"*" represents a space

Anyone on the NV4FM_C repeater module
Station needs to use the RX->CS button to complete the routing path

This is the original Icom source routing method

Copyright 2009 Ed Woodrick WA4YIH
Callsign Routing – Connecting Repeaters Together

Programming for linking from W4OVH (port DV B) to NV4FM (port DV C)

YOUR:: NV4FM=CL
RPT1: W4OVH=B
RPT2: W4OVH=G
Set Radio To: 442.5125 MHz Offset +5.0000 MHz

“-” represents a space

This uses the Dplus linking method

Copyright 2009 Ed Woodrick WA4YIH
Callsign Routing – Connecting to a Reflector

- ‘Broadcasting’ to anyone on the reflector
- Stations on all connected repeater modules hear each other

Programming for linking from W4OVH (port DV B) to REF025 (port DV C)

YOUR:: REF025CL
RPT1: W4OVH**B
RPT2: W4OVH**G

Set Radio To: 442.5125 MHz Offset +5.0000 MHz

"*" represents a space

This uses the Dplus linking method

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D-STAR Radio Block Diagram

www.kc7key.org/presentations/D-Star%20Hotspot.ppt
D-STAR Architecture

- 2400bps audio
- 1200bps error correction overhead
- 3600bps digital audio channel
- 1200bps data or GPS message
- 4800bps over the air

Microphone

Speaker

Codec
A to D
D to A

Set-up and Control

Voice Encoder Module

FEC Encoder
Block Codes
Convolutional
None

Voice Decoder Module

FEC Decoder
Block Codes
Viterbi
None

AMBE-2020 Vocoder Chip

Communication Channel Link

Wireless
RF
FM
Satellite
Wireline
Modem
Internet
FDDI
ATM

10101010101...
D-STAR Repeaters

- 2m voice and low-speed data
- 440 voice and low-speed data
- 1.2GHz high-speed data
- 1.2GHz voice

- Gateway Computer
- Internet

Repeater controller
Question: What happens if the Internet goes out in an emergency?
Answer: Link local repeaters together over a microwave backbone link!
D-STAR DV Dongle

Access D-STAR radios and repeaters from your computer!

Open-source design platform!
D-STAR DV Access Point

Let's D-STAR radios access the network when repeaters are not available! A simplex ‘digital hotspot’ for D-STAR (similar to a WiFi hotspot)

(20mW output power)

D-STAR Gateway
D-STAR Hotspots

Use your packet-ready analog FM radio to ‘talk’ to DSTAR repeaters and radios

http://w9arp.com/hotspot/
(Satoshi Yasuda, 7M3TJZ/AD6GZ)
Build Your Own D-STAR Repeater

With D-STAR, you can leverage existing analog radio technology

WW6BAY Block Diagram

Conventiona I Analog Technology

New D-STAR Technology

http://www.bay-net.org/ww6bay_dstar.html
Make-shift D-STAR Repeater

D-Star Standalone Repeater Diagram

D-Star DV Radio

FM Analog Radio 9600 Capable Transmitter

GMSK DV Node Adapter

USB

To Radio Data Port

FM Analog Radio 9600 Capable Receiver

Configuration-only Or D-STAR Gateway

Repeater Config Setup

D-Star DV Radio

www.kc7key.org/presentations/D-Star%20Hotspot.ppt
D-STAR Reflectors

- Basically a conference bridge for D-STAR
- Local, regional and world-wide DSTAR connections
- 40+ reflectors currently in existence
- All stations have consistent audio quality!
- Access via repeaters, hotspots, or the Internet (with a DV Dongle)
D-STAR Reflectors

Connect to other D-STAR users – around town or around the world!
D-STAR PROMOTES INNOVATION!
µSmartDigi™

- µSmartDigi™ APRS® Digipeater
- µSmartDigi™ D-Gate™ D-STAR Gateway
- A postage-stamp-sized DSP microcontroller embedded in the TNC-X eliminates the dedicated laptop or PC

D-STAR DPRS and APRS – talking together

http://www.usmartdigi.com/
http://www.tnc-x.com/
D-STAR Digital Voice Transceiver Project

- AMBE 2020 voice compression chip
- ADF7021 single chip VHF RF Transceiver
- 20mW RF output

D-Rats

- A Communications Tool For D-Star
- File transfer capability along with email
- Reflector
- Map display
- Structured forms (templates)
- Winlink 2000 support

http://www.d-rats.com/
Includes form editor to create any form

Only data is sent

Fully printable ICS-213, ARRL Radiogram and NTS Forms included
A simple D-Star keyboard to keyboard chat application for Windows by NJ6N

Connect your computer to your D-Star radio and chat with another ham

http://nj6n.com/dstar/dstar_chat.html
D-StarLet

- A web-based text messaging application using D-Star digital data technology
- Multiple computer support (client/server)

http://dstarlet.ae7q.net/
D-Star TV is Slowscan TV for DStar digital radios
D-Star TV sends images as a compressed jpeg (240x240 pixels)
  - the compression can be adjusted
  - on par with slowscan TV, and as such has about the same transfer rate
Icom ID-1 DD mode (i.e., 128kbps) for streaming video is available

http://www.dstartv.com/
D-STAR and Satellites

D-STAR in space!
Scheduled launch: early 2012

The first D-Star over satellite QSO occurred between Michael, N3UC, FM-18 in Haymarket, Virginia and Robin, AA4RC, EM-73 in Atlanta, Georgia while working AMSAT’s AO-27 microsatellite in 2007

OUFTI-1 Nanosatellite
Universite de Liege -

OUFTI: Orbital Utility For Telecommunication Innovation

The key, innovative feature of OUFTI-1 is the use of the D-STAR amateur-radio digital-communication protocol

This means of radio-communication will be made available to ham-radio operators worldwide. In the future, it will also be used to control space experiments.

http://www.leodium.ulg.ac.be/cmsms/
D-STAR COMPARISONS
## D-STAR vs. FM

<table>
<thead>
<tr>
<th>D-STAR</th>
<th>FM</th>
</tr>
</thead>
<tbody>
<tr>
<td>• 6.25kHz occupied BW</td>
<td>• 15kHz occupied BW</td>
</tr>
<tr>
<td>• 2400bps digital audio</td>
<td>• 1200bps with separate TNC</td>
</tr>
<tr>
<td>• 1200bps digital data</td>
<td>• No forward error correction or</td>
</tr>
<tr>
<td>simultaneously!</td>
<td>interleaver</td>
</tr>
<tr>
<td>• Interleaver/forward error</td>
<td></td>
</tr>
<tr>
<td>correction</td>
<td></td>
</tr>
<tr>
<td>– rate ½ convolutional</td>
<td></td>
</tr>
<tr>
<td>encoder</td>
<td></td>
</tr>
<tr>
<td>• D-STAR radios support</td>
<td></td>
</tr>
<tr>
<td>both digital and analog</td>
<td></td>
</tr>
<tr>
<td>modes</td>
<td></td>
</tr>
</tbody>
</table>

KC5ZRQ tests D-STAR against FM

http://www.w2sjw.com/radio_sounds.html
Is D-STAR like Echolink or IRLP?

<table>
<thead>
<tr>
<th>D-STAR</th>
<th>Echolink and IRLP</th>
</tr>
</thead>
<tbody>
<tr>
<td>• “Digital at the source”</td>
<td>• Echolink and IRLP are analog only</td>
</tr>
<tr>
<td>• Audio quality is <strong>consistent</strong> with any repeater/hotspot configuration</td>
<td>- Must convert to digital before connecting to the Internet</td>
</tr>
<tr>
<td>• DSTAR is not a computer-only application</td>
<td>• Audio quality <strong>varies greatly</strong> with repeater/node configurations</td>
</tr>
<tr>
<td>- But it is computer friendly!</td>
<td>• Echolink and IRLP are inherently computer-based applications</td>
</tr>
</tbody>
</table>
# D-STAR vs. APRS

<table>
<thead>
<tr>
<th><strong>D-STAR</strong></th>
<th><strong>APRS</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>• GPS position data directly sent as part of 1200bps data stream</td>
<td>• TNC required to connect GPS to analog radio</td>
</tr>
<tr>
<td>• Format called DPRS</td>
<td>• Standard APRS format</td>
</tr>
<tr>
<td>• Some radios display position data</td>
<td>• Most radios require a computer display</td>
</tr>
</tbody>
</table>
D-STAR vs. APCO-25

D-STAR
- Uses AMBE vocoder
- Packet-based voice & data
- “flat” architecture
- Any station can connect to any station
  - The way hams operate!

APCO-25 (P25)
- IMBE vocoder (similar to AMBE vocoder)
- Packet-based voice & data
- “tree” architecture
- Tightly structured communications hierarchy
- Developed specifically for local, state and federal public safety communications
Summary of D-STAR Basics

- We’ve only just begun to scratch the surface of digital technology in ham radio
- D-STAR has much to offer ham radio!

Thank you and 73!