D-STAR
Digital Smart Technology for Amateur Radio

D-STAR Introduction
History

• Open protocol developed by the JARL (Japanese Amateur Radio League) under a grant from the Japanese Government
  – Project began about 1999
  – Specification published in 2001
  – Original documents are in Japanese, a subset have been translated into English

Terminology

- **Digital Voice (DV)**
  - 4800 bps data stream real time encoded with
    - 2400 bps voice (AMBE encoded)
    - 1200 bps Forward Error Correction (FEC) for voice
    - 1200 bps data (text messages, GPS, telemetry, etc.)
  - 6.25 kHz. Bandwidth using GMSK

- **Digital Data (DD)**
  - 128 kbps data stream
  - 150 kHz. Bandwidth
  - Possible extensions to other rates and bandwidths
  - E.g. 4800 bps in 6.25 kHz. (not current standard) on repeaters
Terminology

• AMBE
  – Advanced Multi-Band Excitation (AMBE) is a very powerful proprietary speech coding standard developed by Digital Voice Systems, Inc. (From: http://en.wikipedia.org/wiki/Advanced_Multi-Band_Excitation)
  – Converts audio to and from the digital format used in D-Star Digital Voice at 2400 bps with 1200 bps of FEC.

• FEC
  – Forward Error Correction
Implementations

- 2m, 70cm, 23cm Digital Voice mobile/handheld
- Soon: IC-9100 base includes 10m, 6m, 2m, 70cm, 23cm Digital Voice
- 23cm Digital Data
- 10 mbps ATM over 10 ghz.
- GMSK modems (Node Adapters and Soundcards)
- Gateways
The DV Protocol
Common Air Protocol – Techie Stuff

Radio Header

Data

Bit Synchronization
64 bits

Frame Sync
15 bits

Flag 1
8 bits

Flag 2
8 bits

Flag 3
8 bits

Radio ID

P_FCS

Destination Repeater Call
64 bits/8 char

Local Repeater Call
64 bits/8 char

Destination Station Call
64 bits/8 char

This Station Call
64 bits/8 char

This Station Comment
32 bits/4 char

K7LWH  B

K7LWH  C

CQCQCQ

K7VE

JOHN

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The DV Protocol
Common Air Protocol – Techie Stuff

Radio Header  Data
Audio Frame  72 bits  Data Frame  24 bits  Final Data Frame  48 bits

Alternating Audio/Data
FEC on Audio but not on Data
## The DD Protocol

### Common Air Protocol – Techie Stuff

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
<th>Bits/Chars</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radio Header</td>
<td>Length</td>
<td>16 bits</td>
</tr>
<tr>
<td>Ethernet Packet</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bit</td>
<td>Synchronization</td>
<td>64 bits</td>
</tr>
<tr>
<td>Frame Sync</td>
<td>15 bits</td>
<td></td>
</tr>
<tr>
<td>Flag 1</td>
<td>8 bits</td>
<td></td>
</tr>
<tr>
<td>Flag 2</td>
<td>8 bits</td>
<td></td>
</tr>
<tr>
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<td>8 bits</td>
<td></td>
</tr>
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<td>Destination Repeater Call</td>
<td>64 bits/8 char</td>
<td></td>
</tr>
<tr>
<td>Local Repeater Call</td>
<td>64 bits/8 char</td>
<td></td>
</tr>
<tr>
<td>Destination Station Call</td>
<td>64 bits/8 char</td>
<td></td>
</tr>
<tr>
<td>This Station Call</td>
<td>64 bits/8 char</td>
<td></td>
</tr>
<tr>
<td>This Station Comment</td>
<td>32 bits/4 char</td>
<td></td>
</tr>
</tbody>
</table>

- K7LWH G
- K7LWH A
- CQCQCQC
- K7VE
- JOHN

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# The DD Protocol

Common Air Protocol – Techie Stuff

<table>
<thead>
<tr>
<th>Radio Header</th>
<th>Length 16 bits</th>
<th>Ethernet Packet</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAC Src Addr</td>
<td>MAC Dest Addr</td>
<td>Type 16 bits</td>
</tr>
<tr>
<td>48 bits</td>
<td>48 bits</td>
<td>32 bits</td>
</tr>
<tr>
<td>FCS 32 bits</td>
<td>Data Frame 128</td>
<td>TCP/IP or Other</td>
</tr>
<tr>
<td>12000 bits</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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The Internet/Gateway

Icom America Graphic

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Transports

• Backbone
  – D-STAR specification:
    10 mbps data rate, 10.5 mHz. bandwidth, ATM
  – Alternatively: 33 cm, 13 cm and 5 cm
    • using stock or modified Part 15 devices (WiFi/WiMax)
    • Not D-STAR Standard

• Gateway
  – Internet routing of D-Star Repeaters and APs
  – Icom
  – Non-Icom [http://g4ulf.blogspot.com/]
How Does DV Sound?

http://www.w2sjw.com/sounds/Weak Signal D-STAR.mp3

Sound samples courtesy KC5ZRQ
Making a Contact: Simplex

• General Call
  – Your Call: CQCQCQ
  – RPT1:
  – RPT2:
  – My Call: K7VE

• Specific Station
  – Your Call: KZ7ZZZ
  – RPT1:
  – RPT2:
  – My Call: K7VE

• Call Groups
  – 100 groups (00-99)

• General Call
  – Calling CQ
  – Roundtables/Nets
  – Most Common

• Specific Station
  – When other station is using callsign squelch
  – Send Message

• Emergency Override

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Making a Contact: Local Repeater

- **General Call**
  - Your Call: CQCQCQC
  - RPT1: WA7GIE C
  - RPT2: 
  - My Call: K7VE

- **Specific Station**
  - Your Call: KZ7ZZZ
  - RPT1: WA7GIE C
  - RPT2: 
  - My Call: K7VE

- **Call Groups**
  - 100 groups (00-99)

- **General Call**
  - Calling CQ
  - Roundtables/Nets
  - Most Common

- **Specific Station**
  - When other station is using callsign squelch
  - Send Message

- **Emergency Override**
Making a Contact: Zone Repeater

- **General Call**
  - Your Call: CQCQCQC
  - RPT1: WA7GIE C
  - RPT2: WA7GIE B
  - My Call: K7VE

- **Specific Station**
  - Your Call: KZ7ZZZ
  - RPT1: WA7GIE C
  - RPT2: WA7GIE B
  - My Call: K7VE

- **Call Groups**
  - 100 groups (00-99)

- **General Call**
  - Calling CQ
  - Roundtables/Nets
  - Most Common

- **Specific Station**
  - When other station is using callsign squelch
  - Send Message

- **Emergency Override**
Zone Repeater Illustration

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Making a Contact: Gateway

- **General Call**
  - Your Call: /K5TIT
  - RPT1: WA7GIE C
  - RPT2: WA7GIE G
  - My Call: K7VE

- **Specific Station**
  - Your Call: KZ7ZZZ
  - RPT1: WA7GIE C
  - RPT2: WA7GIE G
  - My Call: K7VE

- **General Call Through Gateway**
  - Calling CQ
  - Most like IRLP
  - Be sure to give reverse routing

- **Specific Station Through Gateway**
  - Calling specific Station
  - Don’t need to know other station’s location (City, Repeater, Freq., …)
  - When other station is using callsign squelch
  - Send Message
“Repeaters and Gateways should have club call signs…”
DPLUS Linking

- Created by Robin, AA4RC
- Shim between the Gateway, Network, and Controller
- Acts more like traditional RF linking or IRLP/Echolink
- Conference Bridges
- DV Dongles
- DVAP and DVAR Hotspot
DPLUS Linking Commands

• NW7DR E – Local Gateway Echo Test
• NW7DR I – Local Gateway Status
• WA1XXXBL – Link to WA1XXX Module B
• ........U – Unlink (Gateway or Reflector)
• REF035CL – Link to Reflector 035 Module C (Substitute Local and Remote Callsigns)
D-PRS

- D-STAR – Position Reporting System
- It is not APRS but reports into APRS-IS
- It uses the interleaved data of DV
- Two modes GPS and GPS-A
- Not error corrected
- DO NOT BEACON ON REPEATER!
  Your position is continuously reported every time you key the microphone. You will cause “roger beeps” on everyone’s radios when you beacon
- JFINDU Reporting Example (If WiFi is working)
Interesting Developments

- G4ULF implementation of compatible repeater and gateway - NI-STAR
- Node Adapters
- Radio Kits (Dutch Star in the Netherlands)
- 6M/10M D-STAR (IC-9100 HF/VHF/UHF/SHF Multimode Radio)
- Multi-Trust
- IRCDDDB