



**WELCOME ALL!  
TO**

**A LOOK INTO D-STAR BASICS**

**RON MILIONE PH.D. W2TAP**

**[WWW.LIMARC.ORG](http://WWW.LIMARC.ORG)**

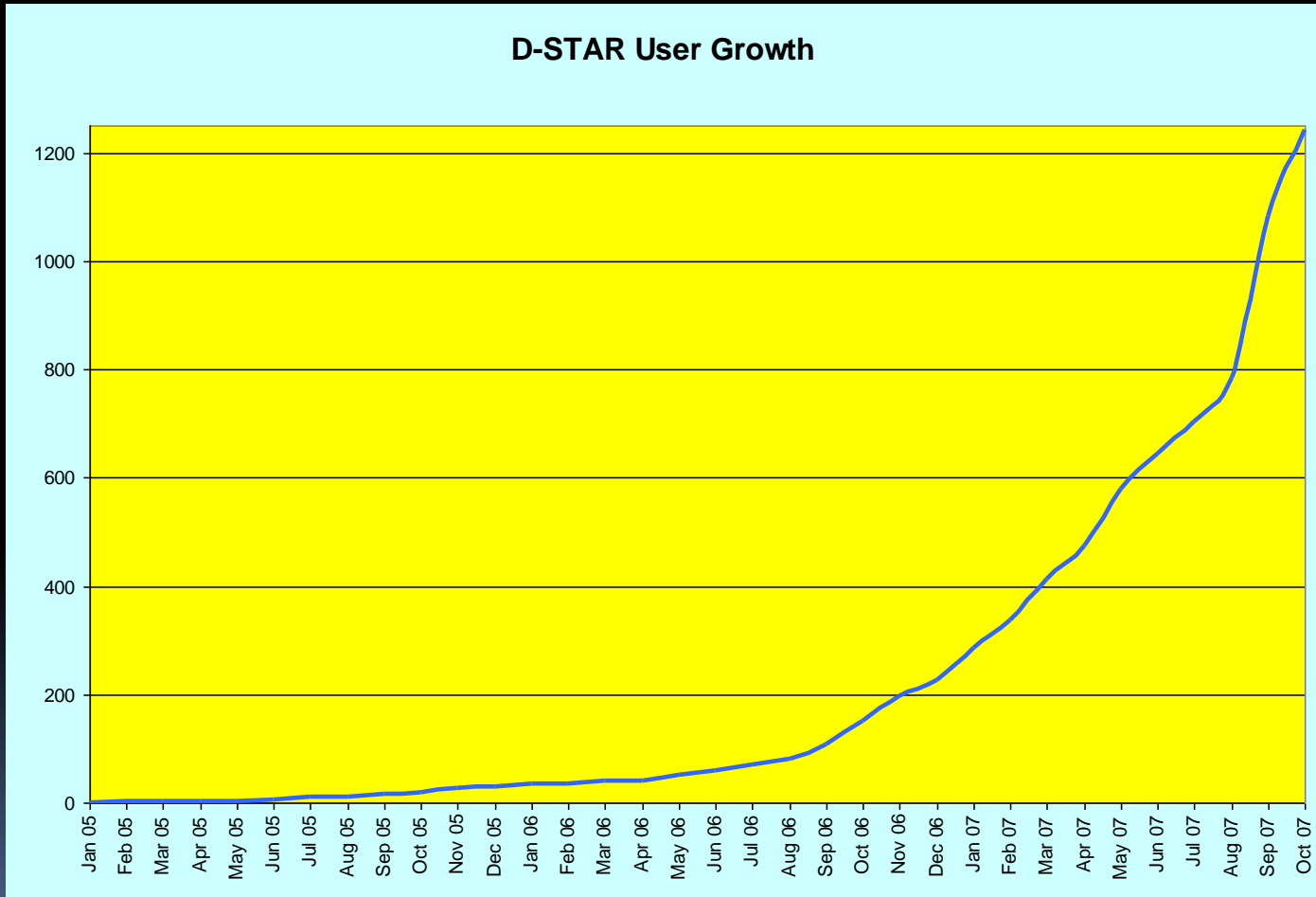
# INTRODUCTION TO D-STAR \*\*\*\*\*

*DIGITAL SMART TECHNOLOGY  
FOR AMATEUR RADIO*

# Brief history of D-Star

- **August, 2003** First ID1's purchased
- **December, 2003** "ICOM Days" at Texas Towers
  - RP1 Repeater system installed for demo
  - First D-Star repeater in country
- **February, 2005** Installation of first 2 Internet Gateways
- **Dayton, 2005** RP2/ID1 Promotion from ICOM
- **Dayton, 2006** Release of RP2000V, RP4000V  
*FRRL* and *NSRC* installation efforts begin
  
- **February, 2007** *FRRL* joins Gateway network as system #12
- **Dayton, 2007** **D-STAR** Homebrew radio, Dongle announced
- **October, 2007** Consolidated D-STAR Network
- **November, 2007** 100<sup>th</sup> Gateway system and over 2,000 users

# Growth through October, 2007



# What is D-STAR ?

- D-STAR 1200 Mhz started with the ID-1



# What is D-STAR ?

- D-STAR 1200 Mhz started with the ID-1
  - D-STAR is actually *Two different modes*
    - Wide DIGITAL DATA DD – 125 KHz
    - Narrow DIGITAL VOICE DV - 6.25 KHz
    - Narrow DV mode also has 1200 Baud included



- The ID-1 also has traditional NBFM capability

# What is D-STAR ?

- D-STAR 440 and 144 Mhz
- ONE mode DV
  - Narrow DIGITAL VOICE DV - 6.25 KHz
  - Narrow DV mode also has 1200 Baud included but this capability is different than the High Speed Digital Data available for 1200 Mhz
- Wide DIGITAL DATA DD – 125 KHz is too wide for use on 2 meters and is not available for 440

# What is D-STAR ?

- D-STAR 440 and 144 Mhz
- DV DIGITAL VOICE
  - This DIGITAL VOICE mode is what the majority of us think of when we refer to as "***D-STAR***"
  - ***DV*** is the 4800 baud 0.5GMSK mode
  - We will come back to the topic of high speed ***DIGITAL DATA*** or ***DD D-Star***.
  - The ***DD*** or High speed wide mode is 128 Kb/s



# What is D-STAR

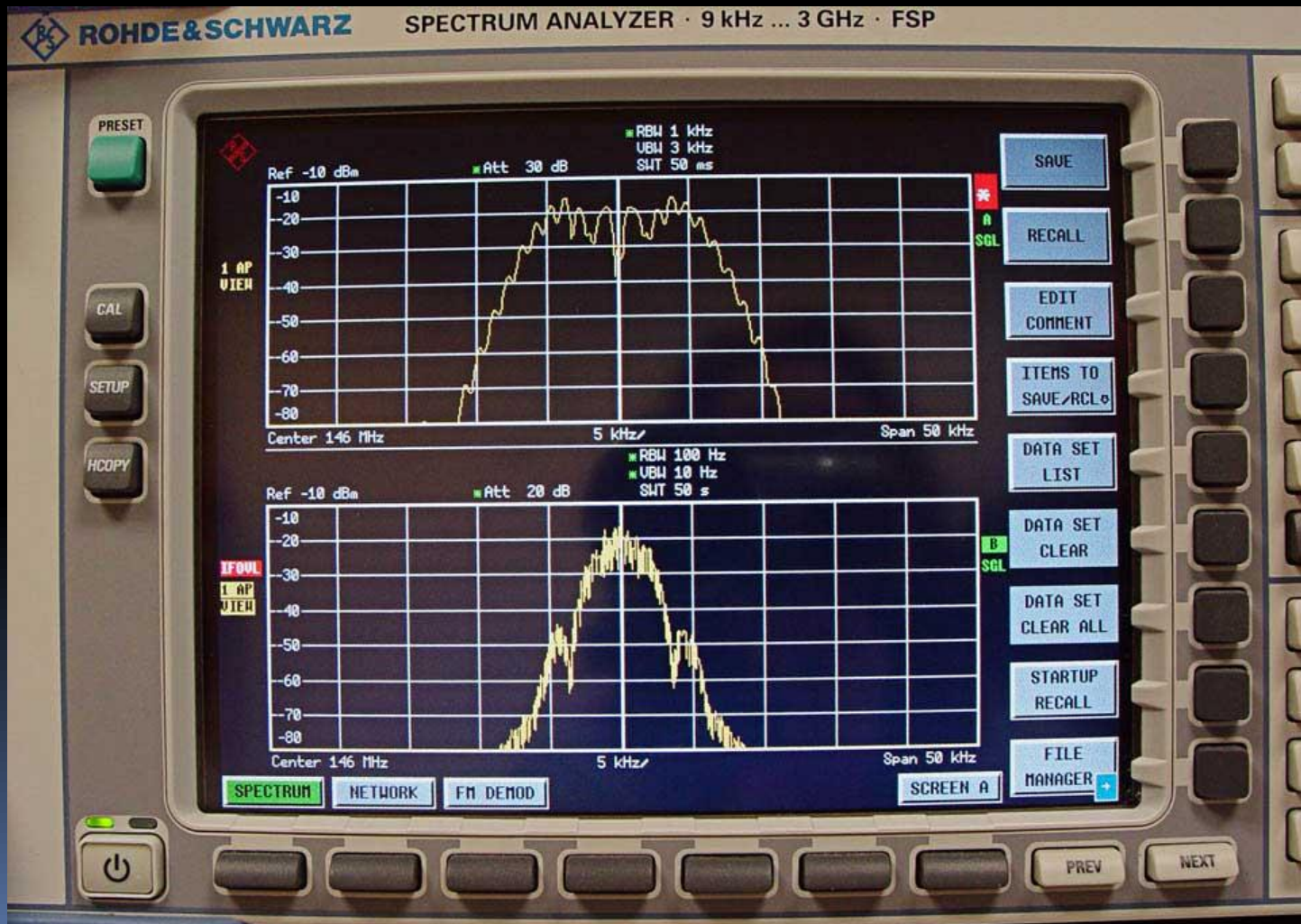
**The radio emission is 0.5 GMSK**

**Gaussian Minimum Shift Keying**

4800 Baud data rate of the radio channel

- Includes voice encoded at 2400 Baud rate
- Includes addressing (callsigns) for routing
- Includes FEC – forward error correction 990 Baud
- Includes 1200 Baud digital data payload

# D-STAR Spectral Efficiency



How is D-Star  
Similar to FM Operation?

**D-STAR BASICS**

# Similar to FM

- **Channelized frequencies by convention**
- **Range is about 15 – 20% more than FM**
- **Operation is on VHF / UHF**
  - Mobile and Portable operation
  - Power levels 5-50 watts normal
  - Actual coverage depends on terrain
  - Demodulators can receive only one signal at a time, there is a capture effect at play

# Similar to FM

- **Every station can demodulate all D-Star transmissions**
- **Nothing is “scrambled”**
- **A station which presents a properly formatted signal to a repeater input will be repeated**
  - User registration is only required for gateway operation, not for normal repeater use
  - A “double” will cause loss of intelligibility

How is D-Star  
Different from FM Operation?

**D-STAR BASICS**

# Different from FM

- **The D-Star format combines**
  - 2400 BAUD VOICE STREAM
  - 1200 BAUD SLOW DATA STREAM
  - 900 BAUD Forward Error Correction – FEC
  - Routing information in the form of FOUR CALLSIGNS
    - THE ORIGINATION MYCALL e.g. W2TAP
    - THE DESTINATION URCALL e.g. WA2CDL
    - THE FIRST ROUTING RPTC<sub>1</sub>
    - THE NEXT ROUTING RPTC<sub>2</sub>

# Different from FM

- **The D-Star format combines**
  - Additional ID on the MYCALL of 4 characters
    - The MYCALL will look like "W2TAP \_\_\_ / Ron\_"
    - The "/Ron\_" portion is not used for routing
  - 15 Character transmitted user message separate from the 1200 Baud data stream
  - GPS NEMA code Lat/Long information
    - ICOM 2820 has optional internal GPS-Rx
    - ICOM IC-92AD has optional GPS-Rx in microphone
    - IC-91AD and ID-800 can be fed NEMA-0184 stream from standard GPS receiver



# Different from FM

- **FOUR CALLSIGNS**

- THE ORIGINATION      MYCALL e.g. W2TAP
- THE DESTINATION      URCALL e.g. WA2CDL
- THE FIRST ROUTING    RPTC<sub>1</sub>
- THE NEXT ROUTING    RPTC<sub>2</sub>
  - The callsign is 7 characters long
  - The 8<sup>th</sup> position of the call denotes the PORT for repeater systems

It is Different from FM

How do we get the *CALLSIGNS*  
into the radio?

# Front Panel Programming

*Push the  
Menu/Lock  
Button*

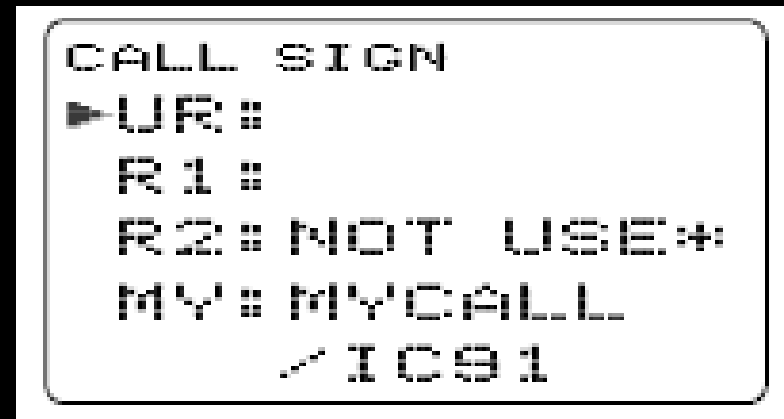
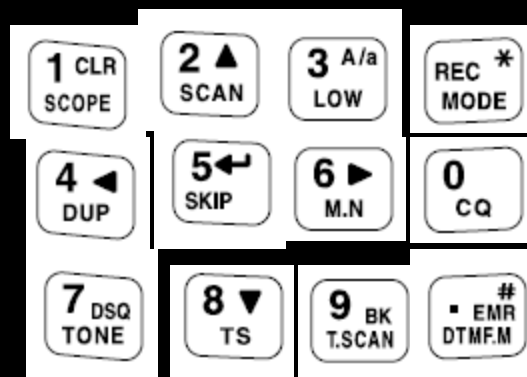


```
***** MENU *****  
RX CALL S  
MESSAGE/POS  
DV VOICE M  
▶SET MODE  
DV SET MODE
```

*When the Digital Board UT-121 is installed OR if the IC-91 was an IC-91AD when it was manufactured THEN the top Menu will read "CALL SIGN" selecting this choice will then display the CALL SIGN menu*

```
CALL SIGN  
▶UR:  
R1:  
R2: NOT USE*  
MY: MYCALL  
/IC91
```

# Front Panel Programming



***TO Navigate the MENU use the up/down and left/right arrow keys***

***When EDITING a field, the character to be changed will be a flashing BLOCK....the character can be changed with the up/down (2 & 8 keys) OR with the upper small frequency selector knob, navigation in the editing field is manipulated with the left/right (4 & 6 keys).***

***At any time the editing is complete – the RETURN (#5) key can be pressed***

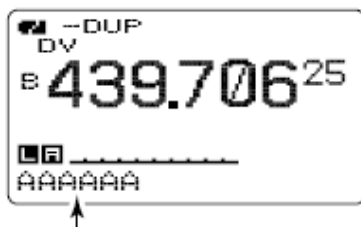
# INSTANT Programming

## ◆ One-touch reply using the call record

The stored call signs in the call record can be used to the call.

- ① After receiving a call, push and hold [RX→CS](CALL) for 1 sec.

Or, while pushing and holding [RX→CS](CALL), rotate [DIAL] to select the desired call sign record.



The received call sign is displayed while pushing and holding [CALL/RX→CS] when [DIAL] is rotated while [CALL/RX→CS] is pushed.

- Set your own call sign (MY) in advance. (p. 34)
  - The call sign stored in “CALLER” is stored as “UR,” “RXRPT1” is stored as “R2” and “RXRPT2” is stored as “R1.”
  - Error beeps sound when a call sign is received incorrectly, and no call sign is set in this case.
- ② Push [PTT] to transmit; release to receive.

### **Important!**

Setting call signs with the “One-touch reply using the call record” operation as at left are for temporary operation only. Therefore, the set call signs will be overwritten when another call record is used to set call signs.

- Never saved into a call sign memory.

If you want to save the set call signs, see “Copying the call record contents into call sign memory” (p. 50) for details.

### ✓ For your information

When a call specifying your call sign is received, the call signs of the calling station and the repeater it is using can be used for operation automatically.

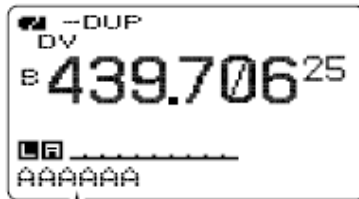
- When “RX call sign auto write” (p. 93) is set to “AUTO,” the station call sign in “CALLER” is set to “UR” automatically.
- When “Repeater call sign auto write” (p. 93) is set to “AUTO,” the stored station call sign in “RXRPT1” is stored as “R2” and “RXRPT2” is stored as “R1” automatically.

# INSTANT Programming

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omatically.

# Different from FM

- **CALLSIGNS**
  - The station's call is up to **7 Characters** long
    - By definition the MYCALL must be the legal callsign of the originating station
  - The **8<sup>th</sup> Character** of a callsign is the **PORT** of a D-Star Repeater
    - The Ports are by convention
      - **A** is **1200 Mhz** or **BLANK** is routed as an "A"
      - **B** is **440 Mhz**
      - **C** is **144 Mhz**
      - **G** is the **GATEWAY COMPUTER** use only in RPTC2

# Different from FM

- **FOUR CALLSIGNS**
- For local simplex Operation
  - THE ORIGINATION    **MYCALL**    **W<sub>2</sub>TAP**
  - THE DESTINATION    **URCALL**    **CQCQCQ**
  - THE FIRST ROUTING    **RPTC<sub>1</sub>**    **not used**
  - THE NEXT ROUTING    **RPTC<sub>2</sub>**    **not used**
    - The callsign is 7 characters long
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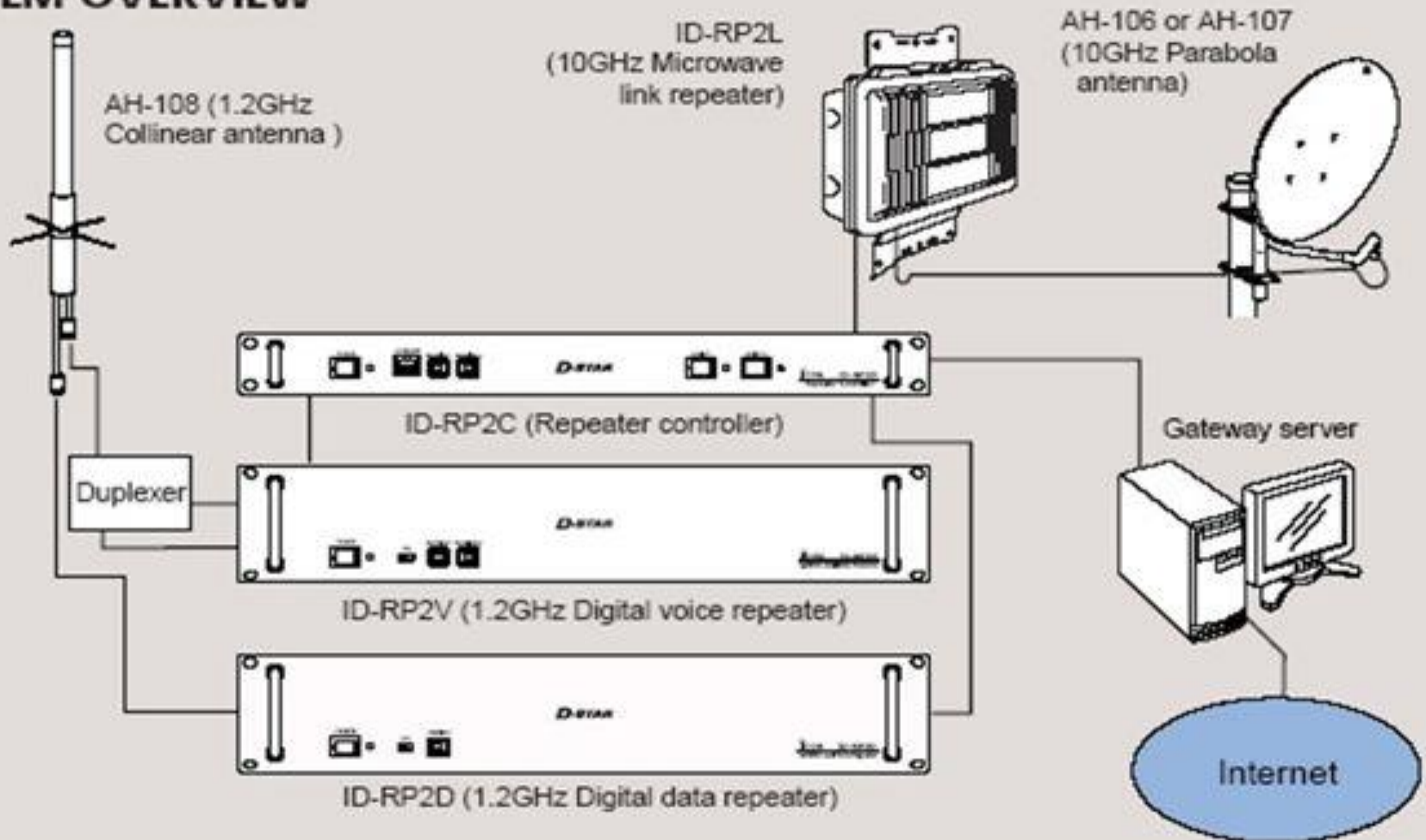


# Routing

## D-STAR BASICS

# What is Routing?

## SYSTEM OVERVIEW



# What is Routing?

- **Gateway system**

- Is a computer running Linux that interfaces the repeater controller to the distant D-Dstar repeater's gateway.
- *The gateway system functions as a specialized router for the 4800 baud D-Star data streams*

# What is Routing?

- **Gateway system**

- *A single **Gateway** system serves all repeater "ports" within one D-Star system*
- *D-star systems usually have 144, 440 and 1200 Mhz **DV** – Digital Voice Systems*
- *.The gateway will also route high speed data to and from the **DD** - High Speed Digital Data Systems at the 128 kb/s data rate !!!*

# W2KPQ FRRL Selden, NY

Shown for example only not realistic!

Blue Box – WRT-54G  
Linux PC – Gateway

D-Star Controller

2 Meter DV Repeater  
440Mhz DV Repeater

Cavities & Duplexer



# How is Traffic routed?

- Gateway system
  - **Associates** the user's callsign with a discrete IP number within the gateway system
    - Accomplished by user registration
  - **Associates** distant repeater callsigns with discrete IP number within the system
    - Assigned when the gateway system is commissioned

# How is Traffic routed?

- **Gateway system**

- *The IP numbers used in routing are **NEVER** needed beyond the inner workings of the gateway system*
- *All that is needed are the **CALLSIGNS** which are available to the user's "front panel"*

# Gateway Routing

- Gateway system
  - *Tracks* each user's callsign last location
  - *Routes* traffic for that user to the last known repeater and port



# What is Routing?

- Two Routing Methods
  - Site Routing
    - *Where* you want to talk
      - Specific *System/Gateway* and *Port*
  - User Routing
    - *Who* you want to talk
      - Specific *User*

# Site Routing

## ■ Callsign of the System

- W2TAP: Huntington, NY
- W2KPQ: Selden, NY
- W4DOC: Atlanta, GA
- K6MDD: Mt. Diablo, CA
- N7IH: Bellevue, WA (ICOM America HQ)
- G7ICM: ICOM UK
- VK8RAD: Darwin, Australia

## ■ Callsign Programming

- MYCALL = W2TAP
- RPT 1 = W2KPQ---B
- RPT 2 = K6MDD---G
- URCALL = /VK8RADB

## • Results

- My call would be routed from the W2KPQ repeater, over the gateway, and come out on the UHF module in Darwin Australia

# User Routing

## ■ Callsign of the System

- W2TAP: Batavia, IL
- K5TIT: Dallas, TX
- W4DOC: Atlanta, GA
- K6MDD: Mt. Diablo, CA
- N7IH: Bellevue, WA (ICOM America HQ)
- G7ICM: ICOM UK
- VK8RAD: Darwin, Australia

## ■ Callsign Programming

- MYCALL = W2TAP
- RPT 1 = W9CEQ---B
- RPT 2 = W9CEQ---G
- URCALL = N5MIJ

## • Results

- W9XA's voice and data communications would be routed from the N7IH repeater, over the gateway, and come out on the *last RF module* N5MIJ used in Dallas, TX

# User Routing

- HOW DO YOU KNOW WHERE WA<sub>2</sub>CDL is?
- <http://www.dstarusers.org>



**Your Source for D-Star DIGITAL Information!**

**142 Unique callsigns heard in the last 24 hours**

- Home
- Last Heard
- JFindU D-Star Maps
- Repeater Directory
- D-Star Solutions
- Joining The Network

[\[Click here to disable refresh\]](#)

Current Time is 08/23/2007 15:18:37 UTC

Callsign	Time Heard	Reporting Node	
VE3EI	08/23/07 15:17:25 UTC	VE3YYZ C 2 Meters	Toronto, Cn
K6IXA	08/23/07 15:12:08 UTC	W6HHD A 1.2GHz	Atwater, Ca
WA6YTD	08/23/07 15:11:55 UTC	K6MDD C 2 Meters	Mt. Diablo, Ca
G4TKR	08/23/07 15:04:40 UTC	GB7IC B 440 MHz	ICOM UK
K9SGK	08/23/07 15:03:12 UTC	W9ICE B 440 MHz	Indianapolis, In
WA4MZE	08/23/07 14:58:59 UTC	KI4SAZ C 2 Meters	Magnolia Springs, Al
N9FNX	08/23/07 14:49:06 UTC	W9CEQ B 440 MHz	Batavia, Il
NJ6N 2	08/23/07 14:43:42 UTC	K6SOA A 1.2GHz	Laguna Beach, Ca
KI4PB	08/23/07 14:43:19 UTC	KI4SAZ C 2 Meters	Magnolia Springs, Al
W4MD	08/23/07 14:41:33 UTC	W4KCQ C 2 Meters	Tuscaloosa, Al
WA4SYI	08/23/07 14:41:10 UTC	KI4PPF C 2 Meters	Huntsville, Al
KE4ROC 5	08/23/07 14:33:24 UTC	KI4PPF C 2 Meters	Huntsville, Al
K6WL	08/23/07 14:31:51 UTC	K6MDD B 440 MHz	Mt. Diablo, Ca
KI6PR	08/23/07 14:24:24 UTC	W6HHD C 2 Meters	Atwater, Ca
W9GF	08/23/07 14:18:56 UTC	K5TIT C 2 Meters	Dallas, Tx
W2XAB	08/23/07 14:17:28 UTC	W4DOC C 2 Meters	Atlanta, Ga
KG4VPV	08/23/07 14:16:28 UTC	K5TIT B 440 MHz	Dallas, Tx
G8PPQ	08/23/07 14:15:14 UTC	GB7IC B 440 MHz	ICOM UK
KI6FQR	08/23/07 14:08:54 UTC	K6MDD B 440 MHz	Mt. Diablo, Ca



# User Routing

- HOW DO YOU KNOW WHERE W<sub>2</sub>TAP is?
- <http://www.dstarusers.org>

# User Routing (Fun Stuff)

- **Goal**

- To talk to as many D-STAR users as possible.

- **User Callsigns**

- W<sub>2</sub>TAP: Huntington, N.Y.
- KJ<sub>4</sub>VO: Atlanta, GA
- W<sub>4</sub>OZK: Huntsville, AL
- K6BIV: Mt. Diablo, CA
- N<sub>9</sub>JA: Bellevue, WA
- VK8HF: Darwin, Australia

- **Callsign Programming**

- MYCALL = W<sub>2</sub>TAP
- RPT 1 = W<sub>9</sub>CEQ---B
- RPT 2 = W<sub>9</sub>CEQ---G
- URCALL = N<sub>5</sub>MIJ

**Then**

- URCALL = KJ<sub>4</sub>VO

**Then**

- URCALL = K6BIV

**Then**

- URCALL = VH8HF

- **Result**

- Both Voice and Data Communications routed to the appropriate recipient! Note – the 1200 baud data stream is carried along with the voice payload.....

# Route with the system controller

- **Goal**

- To talk to friends on another band, same system.

- **System Configuration**

- 23cm DV                      Port A
- 23cm DD                     Port A
- 70cm DV                     Port B
- 2m DV                        Port C

- **Callsign Programming**

- ▣ MYCALL = W2TAP
- ▣ RPT 1 = NS9RC---B
- ▣ RPT 2 = NS9RC---A
- ▣ URCALL = CQCQCQ

- **Result**

- Both Voice and Data Communications routed to NS9RC Port A, which is 1200 Mhz!



# User Routing (More Fun Stuff)

- **PROBLEM**

- W2TAP travels TOO much
  - How do we keep regular contact?

- **W2TAP Travel Schedule**

- Monday: Huntington, NY
- Tuesday: Atlanta, GA
- Wednesday: Tuscaloosa, AL
- Thursday: San Francisco, CA
- Friday: Bellevue, WA

- **Callsign Programming**

- MYCALL = W2TAP
- RPT 1 = W9CEO \_\_ B
- RPT 2 = W9CEO \_\_ G
- URCALL = N9JA

- **Result**

- Both Voice and Data Communications routed to the appropriate recipient regardless of location!

# What is D-STAR ?

- JARL's Open Protocol
  - Japanese Amateur Radio League
  - Goal
    - Advancement of the hobby
    - Spectrum Efficiency
    - Experiment with Voice and Data

# 8 Characters (A reminder)

- EVERY CALLSIGN FIELD will have 8 characters!
  - The 8<sup>th</sup> character is a port designator for the *System/Gateway* fields (RPT 1 or RPT 2)
    - **NOTE:** IF left blank, the system assumes PORT A is used!
  - **DO NOT** use a letter or number in the 8<sup>th</sup> position in the *USER* callsign.

# Thanks

