



Multi Protocol Digital Networks

Introduction, Overview and further
development

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- ▶ 1. digital modes: differences and commonalities
- ▶ 2. digital modes: infrastructure
 - ▶ 2.1 vendor specific
 - ▶ 2.1.1 DPLUS
 - ▶ 2.1.2 WIRES-X
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 - ▶ 2.2.1 Connect Plus Overview
 - ▶ 2.2.2 Why CCS7?
 - ▶ 2.2.3 Structure of the CCS7 number
 - ▶ 2.2.4 How CCS numbers are assigned
 - ▶ 2.2.5 CCS7 databases

Agenda

- ▶ 2.2.6 Reflector systems
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 - ▶ 2.2.6.2 DMR Plus
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1. Digital Modes: differences and commonalities

Amateur Digital Voice Systems

Format Feature	P25 Phase II	DMR	DSTAR	FUSION	NXDN/IDAS
Operating Band	VHF, UHF, 700/800	70cm primary, 2m, 33cm,	2m, 70cm, 33cm	2m, 70cm	70cm primary, 2m, 33cm
Dual Band	Yes	No	Yes	Yes	No
Battery Life	40% longer	40% longer	Normal	Normal	20% longer
Dual Time Slot	Yes	Yes	No	No	N/A
Range	20-25% over wideband analog	20-25% over wideband analog	20-25% over wideband analog	20-25% over wideband analog	20-25% over wideband analog
Manufacturer specific	No	No	Yes, ICOM	Yes, Yaesu	Yes, Kenwood, Ritron/ICOM
Number of Manufacturers	>6	25+	1	1	2/1



1. Digital Modes: differences and commonalities

Amateur Digital Voice Systems

Format Feature	P25 Phase II	DMR	DSTAR	FUSION	NXDN/IDAS
Protocol	TDMA (Phase I was FDMA)	TDMA/4FSK	GMSK	FDMA/C4FM	FDMA
Vocoder	AMBE+2 Vocoder	AMBE+2 Vocoder	AMBE Vocoder	AMBE+2 Vocoder	AMBE+2 Vocoder
Forward Error Correction	Yes	Yes	No	No	Yes/Yes
Spatial Efficiency	12.5khz (dual 6.25khz slots)	12.5khz (dual 6.25khz slots)	6.25khz	12.5khz	6.25khz/12.5khz
Adopted Worldwide Standard	Yes, Public Safety	Yes, Commercial and Amateur	Yes, Amateur only	No, Amateur Use Only	No
No of Amateur Repeaters in the US	170	623	1100	219	52



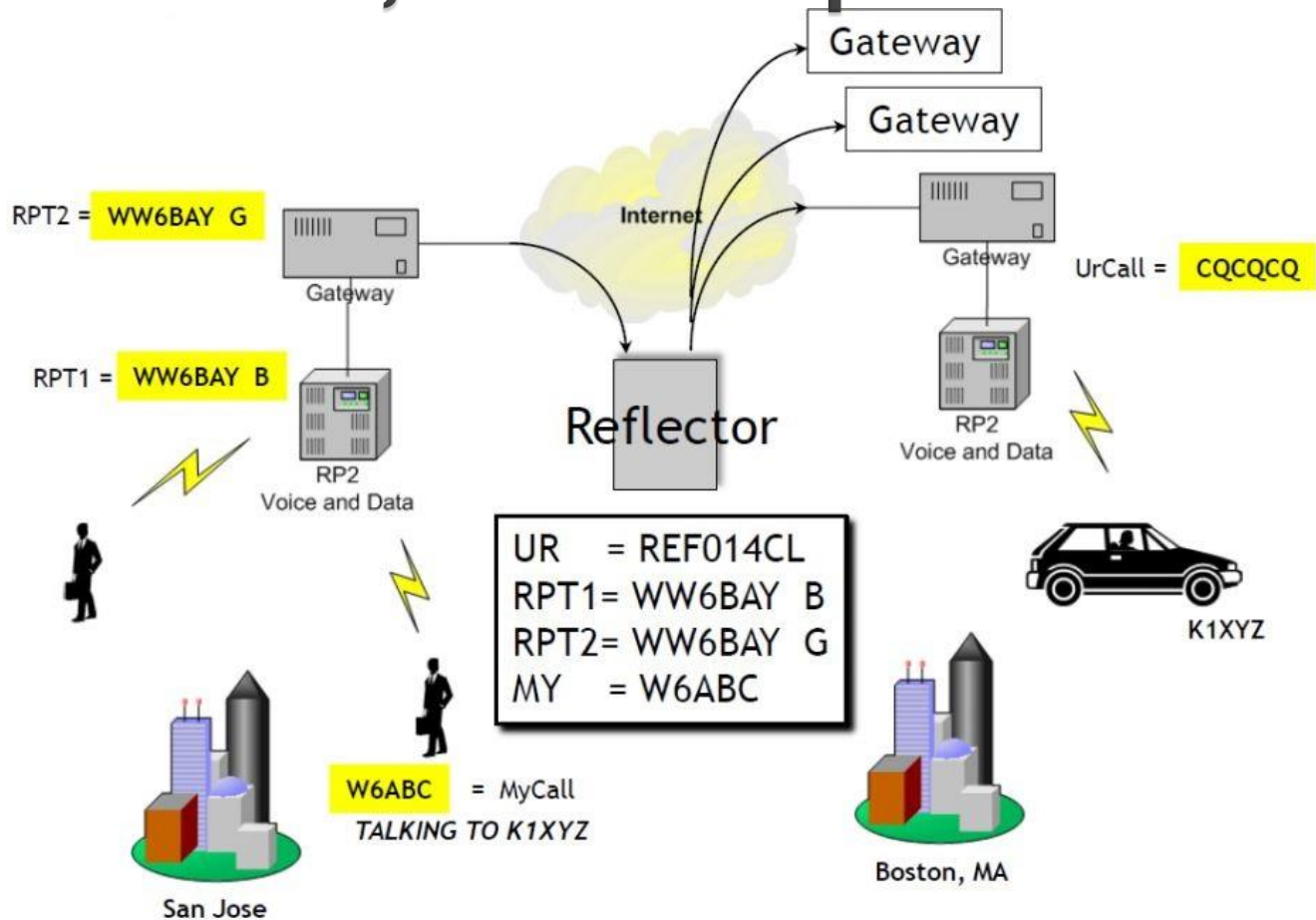
2. Digital modes:

- ▶ Network Infrastructure

2.1 vendor specific

- ▶ D-Plus
- ▶ WIRES-X

2.1.1 D-Plus, ICOM specific



Slide courtesy George Zafiropoulos KJ6VU

2.1.2 WIRES-X, YAESU specific

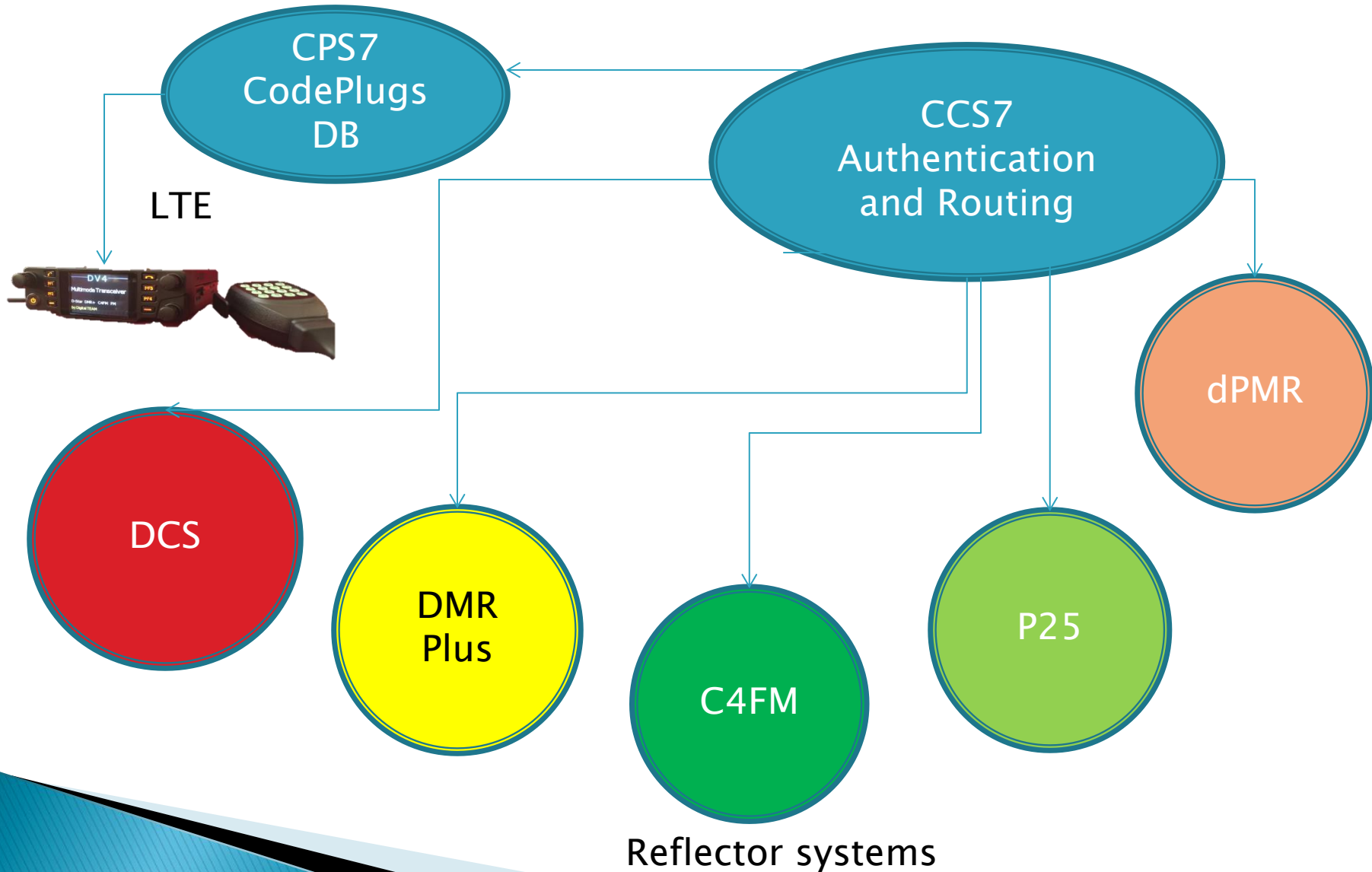
Every node PC is a reflector
Needs external radio and PC
Many Japanese Stations



2.2 vendor independent

- ▶ XREFLECTOR
- ▶ CONNECT Plus
 - DCS Plus
 - DMR Plus
 - dPMR Plus
 - P25 Plus
 - C4FM Plus

2.2.1 Connect Plus Overview



2.2.2 why CCS7?

- ▶ Other than D-Star all other digital systems do not work with call signs!

The DMR-Header has 3 bytes in the air interface as an address space

00 00 00 bis FF FF FF,

This represents a decimal number range between 0 bis 16 777 215 or, without special coding, (in ASCII) 3 characters.

A public data base correlates the call signs with these numbers

Based on „MCC“ Standard / [ITU-T Recommendation E.212](#)

(MCC = „Mobile Country Code“)
(http://en.wikipedia.org/wiki/Mobile_country_code)

2.2.3 Structure of the CCS7 number

- ▶ Hierarchically structured numbering system:
 - 1: Test Networks
 - 2: Europe
 - 3: North–America
 - 4: Asia
 - 5: Australia, New Zealand, Philippines etc.
 - 6: Africa
 - 7: South Amerika
 - 9: World Wide

2.2.3 Structure of the CCS7 number

- ▶ Hierarchically structured numbering system:

- ▶ Examples:

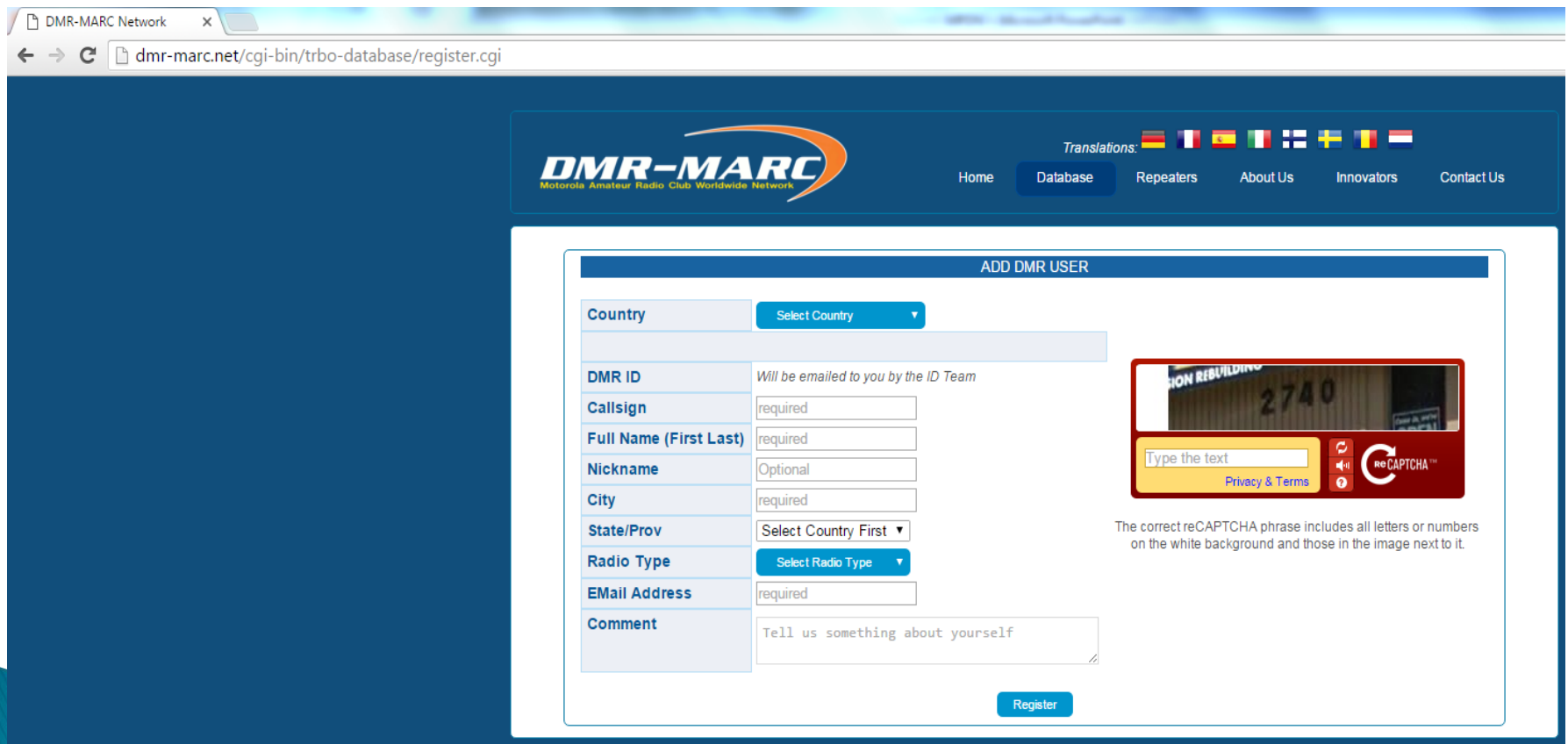
- ▶ 310–317 USA
- ▶ 204: Netherlands
- ▶ 228: Switzerland
- ▶ 232: Austria
- ▶ 234/235: United Kingdom
- ▶ 238: Denmark
- ▶ 262: Germany

- ▶ 311 2528 = Uli, AG0X

262 7506 = Uli, DH6SAB

2.2.4 How are CCS7 numbers assigned?

- ▶ To provide a common “phonebook” the DMR–MARC server assigns the numbers which are then synchronized with the D–Connect CCS7 servers:



The screenshot shows a web browser window with the URL `dmr-marc.net/cgi-bin/trbo-database/register.cgi`. The page features the DMR-MARC logo and navigation links: Home, Database, Repeaters, About Us, Innovators, and Contact Us. A language selection menu is visible with flags for Spanish, French, German, Italian, Danish, Swedish, and Japanese.

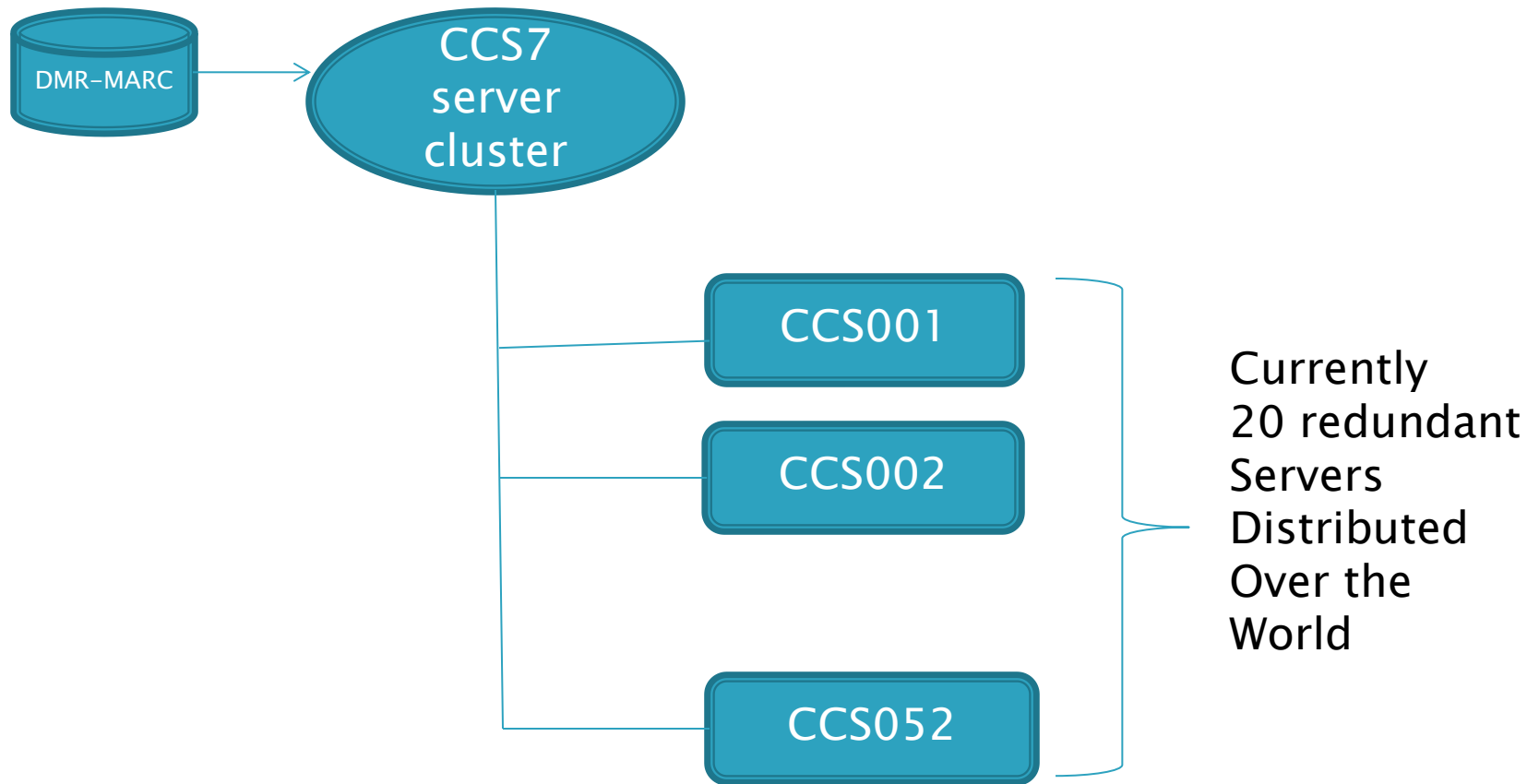
The main content area is titled "ADD DMR USER" and contains a registration form with the following fields:

Field	Requirement/Options
Country	Select Country (dropdown)
DMR ID	Will be emailed to you by the ID Team
Callsign	required
Full Name (First Last)	required
Nickname	Optional
City	required
State/Prov	Select Country First (dropdown)
Radio Type	Select Radio Type (dropdown)
E-Mail Address	required
Comment	Tell us something about yourself

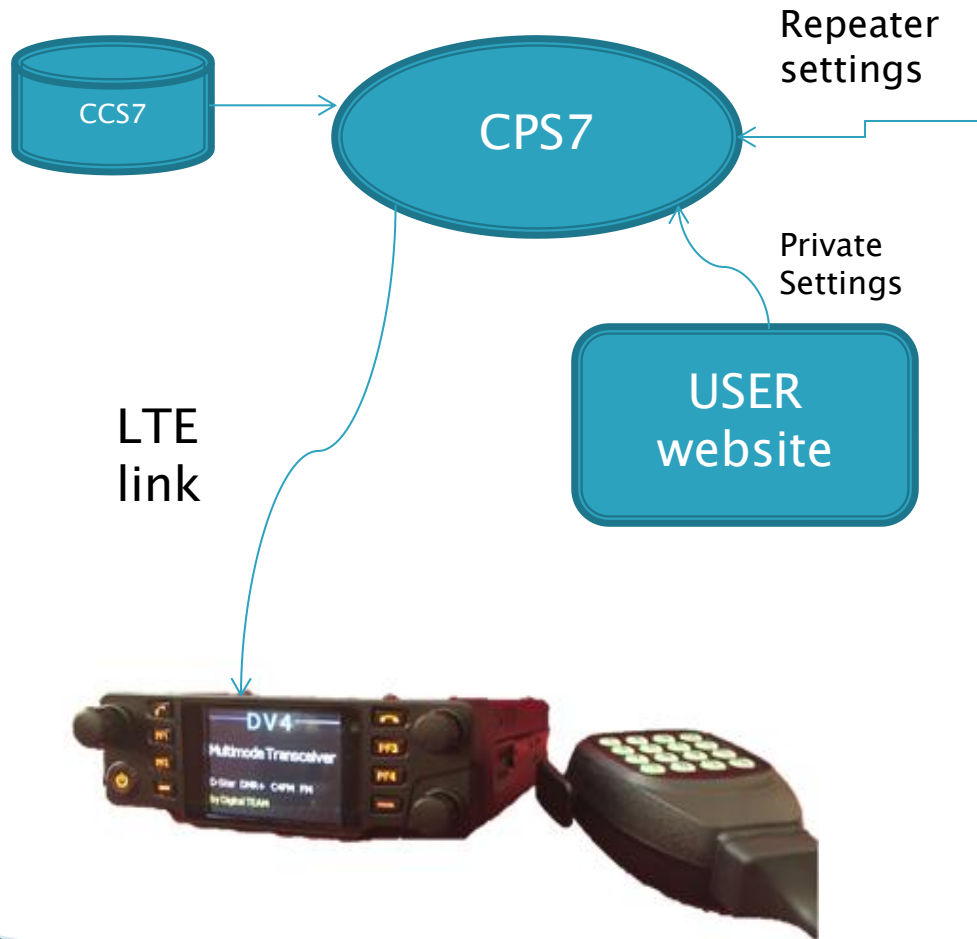
To the right of the form is a reCAPTCHA widget. The image shows a building with the number "2740" and the text "ION REBUILDING". Below the image is a text input field with the placeholder "Type the text" and a "Privacy & Terms" link. Below the reCAPTCHA is the instruction: "The correct reCAPTCHA phrase includes all letters or numbers on the white background and those in the image next to it."

A "Register" button is located at the bottom right of the form.

2.2.5 CCS7 data bases



2.2.5.1 CPS7 data base



Digital Amateur Radio Registration System

Sysop-Page

Home SysopArea Change password You are logged in Log-out (AG0X)

DMR Repeater Registration

Repeater ID:	311256
Repeater Call/SID:	AB4NP
Repeater Callsign:	AB4NP
License Call:	
Admin Callsign:	AG0X
Admin First Name:	Uli
Admin Surname:	Aitvater
Email Address:	uli@aitvater.com
Country:	United States
Repeater location:	Naples
Zip code:	
Latitude (+ North/ - South):	decimal: 26.126234 - or -
Longitude (+ East/ - West):	decimal: -81.727877 - or -
Transmit Frequency in MHz:	449.87500
+/- Repeater offset in MHz:	-5.000
Antenna height Above Ground Level (m):	100
Antenna gain (dBi):	2
Losses (dB):	2
TX power (W):	50
Mixed Mode analogue/digital:	off / on
Color-code / systemcode:	1
DMRplus-Features:	off / on

Only supported by Hytera repeaters and DMRplus-AB/rdg!

DMRplus

Options:		
TS1 Group1	311	(default: 311 = Own Country)
TS1 Group2	1	(default: 1 = Worldwide)
TS1 Group3	262	(default: Language Region)
TS1 Group4	0	
TS1 Group5	0	
TS2 Start Reflector	4639 USA - Nationwide	
TS2 Reflector Rerlink Time	60	
TS2 Link control by users	off / on	

Savechanges / Checkchanges / Returnwithout changes

Distributed
Over the
World

2.2.6 reflector systems

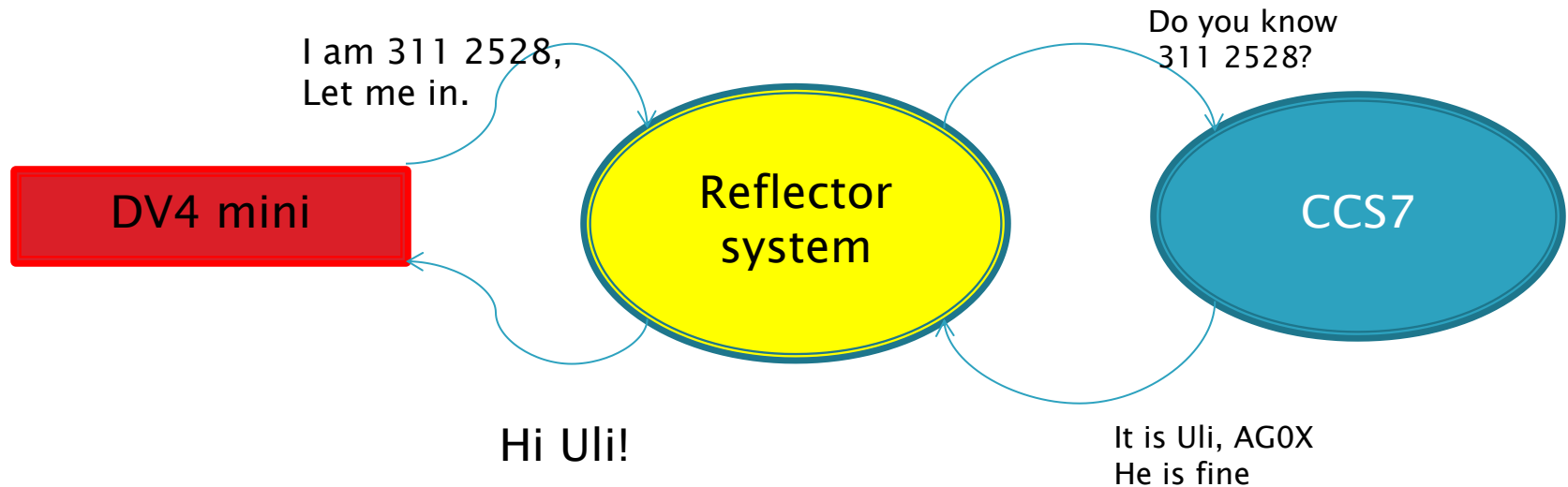
- ▶ What happens when I push these buttons?

The screenshot shows the DV4mini Control Panel software interface. The window title is "DV4mini Control Panel (Stick ID: F5-08-6F V201.64 @ 127.0.0.1)". The interface is divided into several sections:

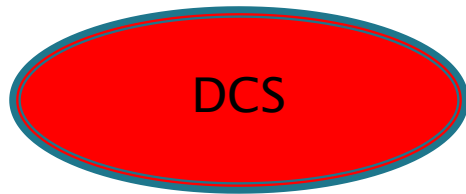
- Personal Settings:** DMR/CCS7 ID: 3112528, Hotspot Callsign AG0X: D, Location (City): Naples, FL, QTH Locator: EL96CE, Internet Data Quality: (checked).
- DV4mini Settings:** A red box highlights the mode selection options: D-Star, C4FM, DMR+, P25, and DPMR (experimental). Below this is a Power slider set to 12mW and RX-QRG: 433.42518 MHz, TX-QRG: 433.42518 MHz, SIMPLEX.
- DMR-PLUS:** 4639 USA - Nationwide. A list of reflector IDs (4600-4640) is shown with 4639 selected. Below the list are buttons for TS1 and TS2, and a "CONNECT" button.
- Info:** A text area showing "disconnected" and "connected to 4640".
- S-Meter:** -84 dBm.
- Log:** A list of system messages including "Set Reflector:4640", "LOGIN #3112528/AG0X 4640 20160128 to Master:[75.151.47.162]", "set RX / TX qrg: 433425180 / 433425180", "set mode: DMR", "Set Dongle ID:#3112528/AG0X", "Online: MASTER USA-Florida 3112 uli@altvater.com 9.2x 13915", "set RX / TX qrg: 433425180 / 433425180", and "from Reflector: RX SLOT=2 GROUP=9 REF_ID=#4640".
- Status Bar:** "connected to 4640 CCS7" and "4640: 4640 USA - Area 0".

2.2.6 reflector systems

- ▶ What happens when I push these buttons?



2.2.6.1 DCS (D-Star)



33 reflector
Systems
With
26 rooms
each

DMRplus DCS006 CCS7 Security Mode ON | Reflector System 7 Status and Control

DCS006 Reflector System

Group	User on GROUP	Repeater on GROUP	Online 34
World Wide	User	Repeater	
USA Preferred channel	User	Repeater	14
USA Alternate channel	User	Repeater	
USA Fusion test	User	Repeater	
USA DMR test	User	Repeater	
Available	User	Repeater	
Dv-Mega	User	Repeater	
Dstar Contest 1	User	Repeater	
Dstar Contest 2	User	Repeater	
Dstar Contest 3	User	Repeater	
USA California	User	Repeater	
USA Texas	User	Repeater	
USA New York	User	Repeater	
USA Florida	User	Repeater	
Available	User	Repeater	
Available	User	Repeater	
Quadnet	User	Repeater	2
USA Colorado	User	Repeater	11
Minnesota	User	Repeater	1
Available	User	Repeater	
USA Iowa	User	Repeater	
USA Iowa	User	Repeater	1
Ragchew channel	User	Repeater	1
USA Bilingual EN/SP	User	Repeater	4
Emergency Comm	User	Repeater	
Echo USA	User	Repeater	

Germany
DCS001

User

Repeater

Group Info

World Wide
DCS002

User

Repeater

Group Info

Switzerland
DCS003

User

Repeater

Group Info

Denmark
DCS004

User

Repeater

Group Info

Great Britain
DCS005

User

Repeater

Group Info

United States of America
DCS006

User

Repeater

Group Info

Netherlands
DCS007

User

Repeater

Group Info

Italy
DCS008

User

Repeater

v1.7 | DCS Server v12.7_64Bit

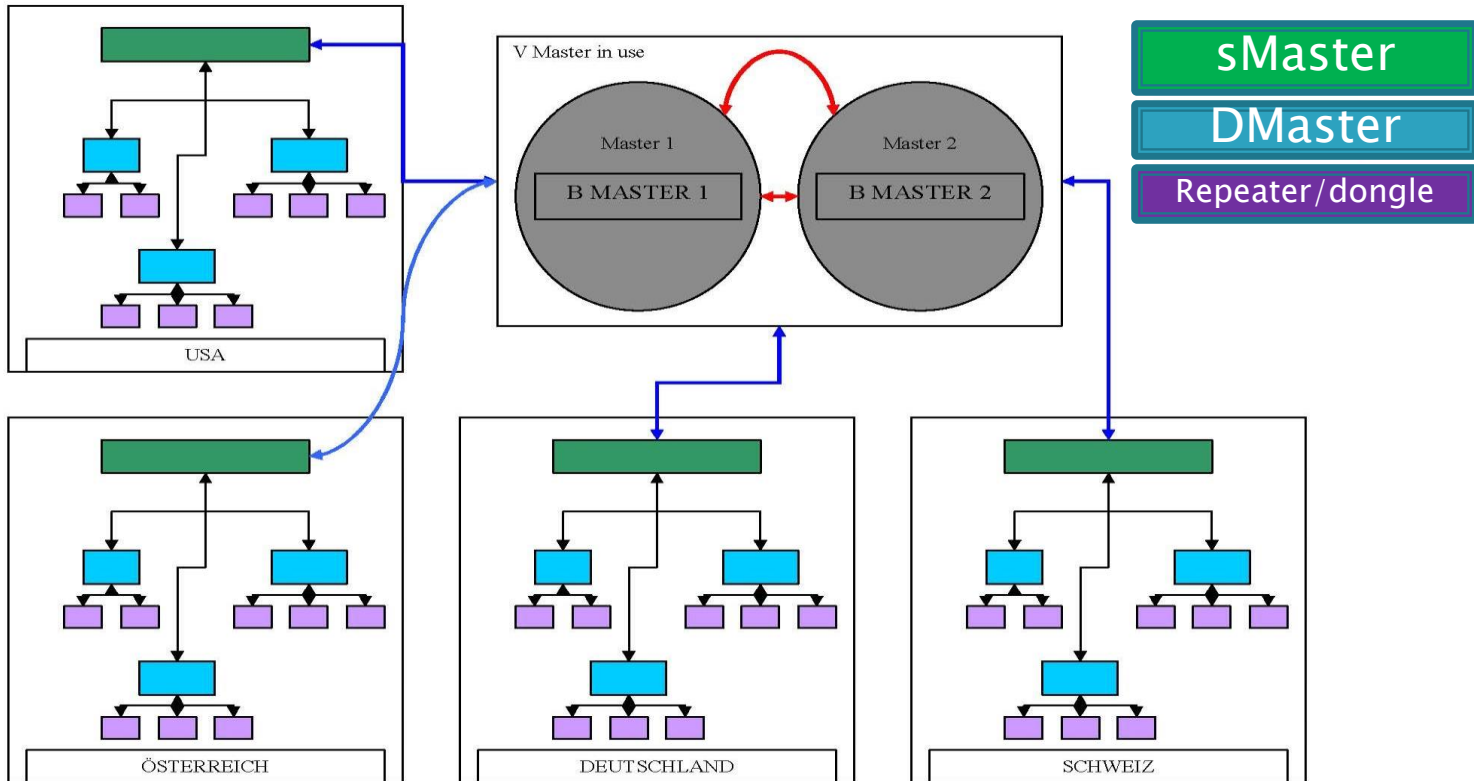
URCALL

- DCS006AL
- DCS006BL
- DCS006CL
- DCS006DL
- DCS006EL
- DCS006FL
- DCS006GL
- DCS006HL
- DCS006IL
- DCS006JL
- DCS006KL
- DCS006LL
- DCS006ML
- DCS006NL
- DCS006OL
- DCS006PL
- DCS006QL
- DCS006RL
- DCS006SL
- DCS006TL
- DCS006UL
- DCS006VL
- DCS006WL
- DCS006XL
- DCS006YL
- DCS006ZL

Z

D626

2.2.6.2 DMR Plus



2.2.6.3 dPMR

▶ Experimental System

x-NET LCD001 Dashboard Reflector Status and Control					
dPMR Reflector System by DG1HT/DJ0ABR					
Status System v0.1 LCS Server v0.1_64Bit					
HOME	Nr.	CALL	Last Heard	Name	Group
	1	PA3DPS	1 h 32 m 13 s	ECHO	99
USER	2	M1DAZ	1 h 59 m 24 s	ECHO	99
	3	DG6FAX	6 h 15 m 5 s	in use	09
INFO	4	DF4UD	12 h 12 m 40 s	ECHO	99
	5	K4IGZ	22 h 26 m 16 s	ECHO	99
	6	DO2STA	1 d 3 h 46 m 14 s	in use	09
	7	DO2JZ	1 d 6 h 13 m 46 s	in use	09
	8	N4VBR	1 d 8 h 14 m 1 s	ECHO	99
	9	DL3MX	1 d 15 h 57 m 20 s	in use	09
	10	EA7IYR	2 d 14 h 56 s	ECHO	99
	11	DO7WO	3 d 5 h 32 m 17 s	in use	09
	12	DM1ER	3 d 9 h 32 m 13 s	in use	09
	13	OK1MSU	3 d 16 h 4 m 14 s	ECHO	99
	14	K4LKL	4 d 2 h 12 m 34 s	ECHO	99
	15	DF200	6 d 3 h 9 m 56 s	ECHO	99
	16	M6LSJ	6 d 6 h 6 m 52 s	in use	09
	17	M0RDC	7 d 34 m 32 s	in use	09
	18	DG2DAD	8 d 12 h 11 m 47 s	Deutschland	01
	19	DB0KX	9 d 4 h 59 m 30 s	in use	09
	20	IU5AVW	10 d 23 h 24 m 59 s	ECHO	99
	21	DG1FBA	11 d 15 h 27 m 22 s	ECHO	99
	22	PD0ADC	13 d 4 h 30 m 23 s	ECHO	99
	23	DH0PAT	18 d 14 h 4 m 51 s	in use	06
	24	OE1KBC	19 d 5 h 2 m 37 s	ECHO	99
	25	DO1PBH	19 d 5 h 40 m 12 s	in use	09
	26	DD1KJ	22 d 23 h 26 m 14 s	in use	05
	27	N3NJI	24 d 1 h 4 m 38 s	in use	06
	28	DJ3OW	24 d 7 h 38 m 54 s	ECHO	99
	29	VA3DRM	24 d 17 h 15 m 53 s	ECHO	99
	30	W1RZO	25 d 2 h 14 m 52 s	Deutschland	01
	31	M3OPW	25 d 7 h 33 m 38 s	ECHO	99
	32	M0VTM	26 d 2 h 11 m 43 s	ECHO	99
	33	PD0BEL	28 d 13 h 6 m 16 s	Repeater	00
	34	IW8ELN	30 d 47 m	in use	05
	35	M1BCB	30 d 1 h 51 m 14 s	ECHO	99
	36	OZ3HLF	31 d 8 h 6 m 12 s	Deutschland	01
	37	DB0ZAV	31 d 9 h 1 m 57 s	in use	87

2.2.6.4 C4FM (YAESU Fusion)

- ▶ 2 reflector systems with 100 room each:
- ▶ FCS001 / FCS002

DMRplus FCS002 Dashboard | Reflector Status and Control

Fusion Reflector System by DG1HT Status System v0.1 | FCS Server v0.1_64Bit

HOME	Group	Group Nr	DTMF
	TALK USA1	00	A200
USER	TALK USA2	01	A201
	Alabama	02	A202
INFO	Alaska	03	A203
	Arizona	04	A204
	Arkansas	05	A205
	California	06	A206
	Colorado	07	A207
	Connecticut	08	A208
	Delaware	09	A209
	Florida	10	A210
	Georgia	11	A211
	Hawaii	12	A212
	Idaho	13	A213
	Illinois	14	A214
	Indiana	15	A215
	Iowa	16	A216
	Kansas	17	A217
	Louisiana	18	A218
	Maine	19	A219
	Maryland	20	A220
	Massachusetts	21	A221
	Michigan	22	A222
	Minnesota	23	A223
	Mississippi	24	A224
	Missouri	25	A225
	Montana	26	A226
	Nebraska	27	A227
	Nevada	28	A228
	New Hampshire	29	A229
	New Jersey	30	A230
	New Mexico	31	A231
	New York	32	A232
	North Carolina	33	A233
	North Dakota	34	A234
	Ohio	35	A235
	Oklahoma	36	A236

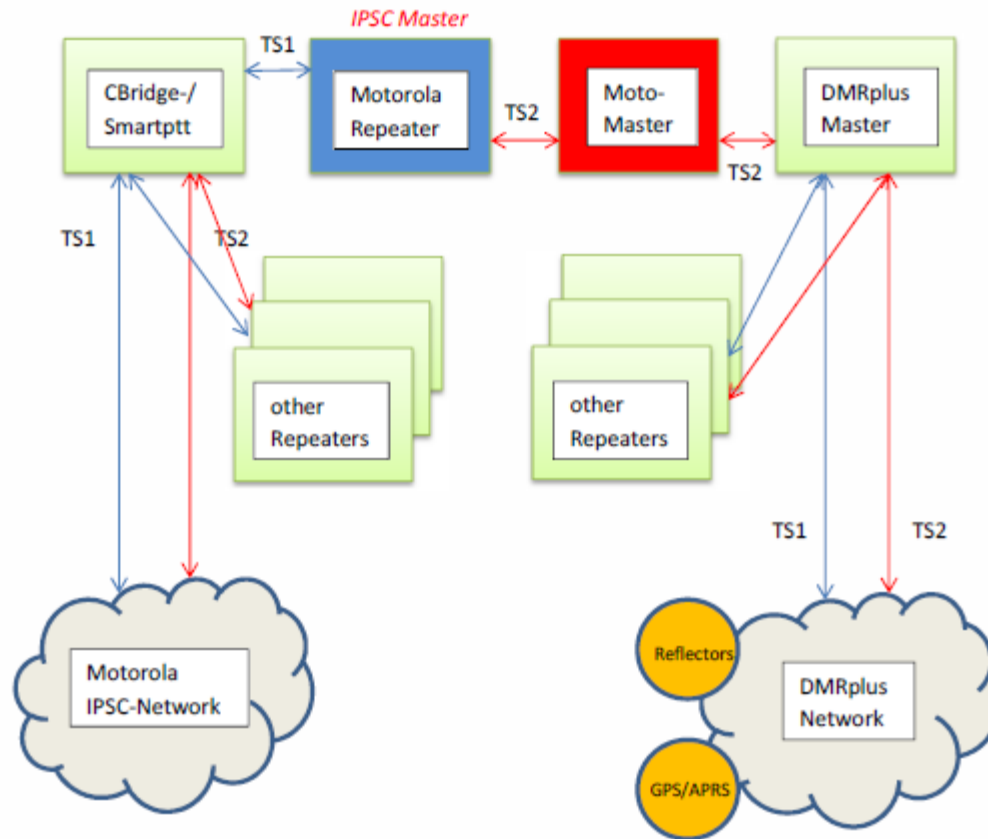
2.2.6.5 APCO25 (P25)

- ▶ 1 reflector system with a second one in Los Angeles currently being installed.

x-NET PCS001 Dashboard Reflector Status and Control					
P25 Reflector System by DG1HT/DJ0ABR					
Status System v0.1 PCS Server v0.1_64Bit					
HOME	Nr.	CALL	Last Heard	Name	Group
	1	G4TUZ	16 s	in use	06
USER	2	NC5P	45 s	in use	06
	3	N8GY	1 m 57 s	in use	06
INFO	4	WY8E	4 m 29 s	in use	06
	5	G0UZZ	7 m 47 s	in use	06
	6	N2UFQ	8 m 41 s	in use	06
	7	KH2PM	31 m 50 s	in use	06
	8	G0YNM	35 m 2 s	in use	06
	9	DO3DL	56 m 27 s	Repeater	00
	10	DL5DAE	1 h 11 m 27 s	Repeater	00
	11	DF1VB	2 h 13 m 39 s	in use	06
	12	DL1BH	3 h 26 m 37 s	Repeater	00
	13	WH6FM	5 h 18 m 56 s	in use	06
	14	G0VBJ	10 h 21 m 4 s	in use	06
	15	VE6EN	12 h 5 m 47 s	in use	06
	16	DL2FDL	12 h 59 m 15 s	Repeater	00
	17	W8RW	18 h 28 m 15 s	in use	40
	18	VK4TUX	18 h 39 m 56 s	in use	06
	19	G7EPL	1 d 11 h 43 m 31 s	in use	06
	20	K8ARW	1 d 17 h 41 m 49 s	in use	40
	21	NF9K	1 d 19 h 46 m 25 s	in use	06
	22	N6VYT	1 d 21 h 56 m 22 s	in use	06
	23	NS2B	1 d 23 h 6 m 11 s	in use	06
	24	W1MSG	2 d 59 s	in use	06
	25	N2LBT	2 d 2 h 41 m 32 s	in use	06
	26	DG4LX	2 d 5 h 33 m 34 s	in use	50
	27	KN5UPS	2 d 6 h 29 m 46 s	in use	05
	28	K8UH	2 d 7 h 50 m 49 s	in use	06
	29	K1LNX	2 d 10 h 42 m 49 s	in use	69
	30	WB4JGI	2 d 19 h 43 m 41 s	in use	69
	31	KC7NP	3 d 2 h 1 m 11 s	Repeater	00
	32	KJ4SHL	3 d 2 h 28 m 45 s	in use	06
	33	KG5EEL	3 d 4 h 42 m 9 s	in use	06
	34	W1KFR	3 d 6 h 49 m 56 s	ECHO	99
	35	DL2OAM	3 d 7 h 18 m 41 s	Deutschland	01
	36	HB9EMQ	3 d 12 h 39 m 30 s	in use	06
	37	AK4EG	3 d 12 h 43 m 34 s	Deutschland	01

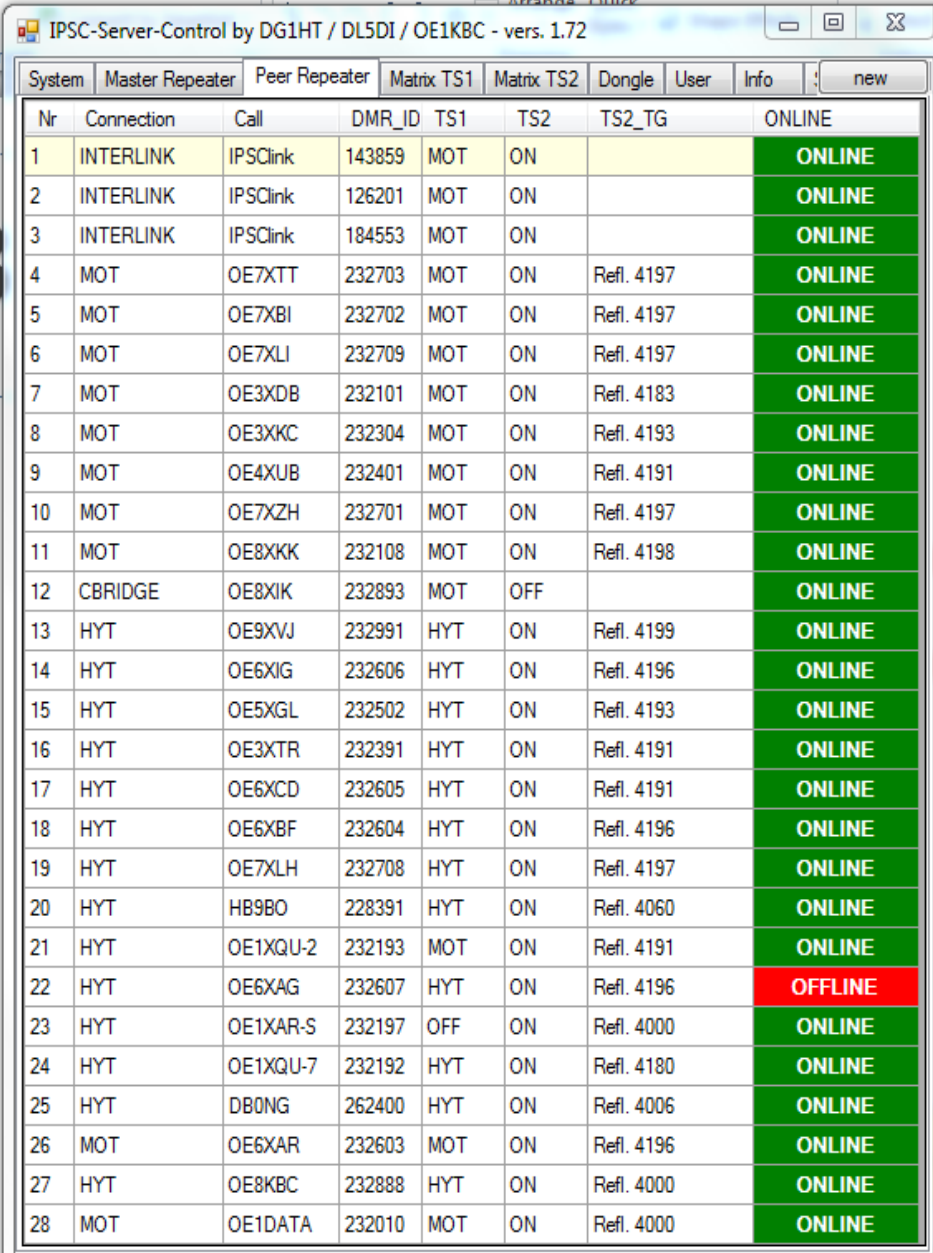
2.3 bridging

▶ MotoTrbo/Hytera



2.3 bridging

▶ MotoTrbo / Hytera



The screenshot shows a software window titled "IPSC-Server-Control by DG1HT / DL5DI / OE1KBC - vers. 1.72". The window contains a table with columns for System, Master Repeater, Peer Repeater, Matrix TS1, Matrix TS2, Dongle, User, Info, and a status column labeled "new". The table lists 28 rows of system connections, each with a number (Nr), connection type, call name, DMR_ID, TS1, TS2, TS2_TG, and an ONLINE/OFFLINE status.

Nr	Connection	Call	DMR_ID	TS1	TS2	TS2_TG	ONLINE
1	INTERLINK	IPSClink	143859	MOT	ON		ONLINE
2	INTERLINK	IPSClink	126201	MOT	ON		ONLINE
3	INTERLINK	IPSClink	184553	MOT	ON		ONLINE
4	MOT	OE7XTT	232703	MOT	ON	Ref. 4197	ONLINE
5	MOT	OE7XBI	232702	MOT	ON	Ref. 4197	ONLINE
6	MOT	OE7XLI	232709	MOT	ON	Ref. 4197	ONLINE
7	MOT	OE3XDB	232101	MOT	ON	Ref. 4183	ONLINE
8	MOT	OE3XKC	232304	MOT	ON	Ref. 4193	ONLINE
9	MOT	OE4XUB	232401	MOT	ON	Ref. 4191	ONLINE
10	MOT	OE7XZH	232701	MOT	ON	Ref. 4197	ONLINE
11	MOT	OE8XKK	232108	MOT	ON	Ref. 4198	ONLINE
12	CBRIDGE	OE8XIK	232893	MOT	OFF		ONLINE
13	HYT	OE9XVJ	232991	HYT	ON	Ref. 4199	ONLINE
14	HYT	OE6XIG	232606	HYT	ON	Ref. 4196	ONLINE
15	HYT	OE5XGL	232502	HYT	ON	Ref. 4193	ONLINE
16	HYT	OE3XTR	232391	HYT	ON	Ref. 4191	ONLINE
17	HYT	OE6XCD	232605	HYT	ON	Ref. 4191	ONLINE
18	HYT	OE6XBF	232604	HYT	ON	Ref. 4196	ONLINE
19	HYT	OE7XLH	232708	HYT	ON	Ref. 4197	ONLINE
20	HYT	HB9BO	228391	HYT	ON	Ref. 4060	ONLINE
21	HYT	OE1XQU-2	232193	MOT	ON	Ref. 4191	ONLINE
22	HYT	OE6XAG	232607	HYT	ON	Ref. 4196	OFFLINE
23	HYT	OE1XAR-S	232197	OFF	ON	Ref. 4000	ONLINE
24	HYT	OE1XQU-7	232192	HYT	ON	Ref. 4180	ONLINE
25	HYT	DB0NG	262400	HYT	ON	Ref. 4006	ONLINE
26	MOT	OE6XAR	232603	MOT	ON	Ref. 4196	ONLINE
27	HYT	OE8KBC	232888	HYT	ON	Ref. 4000	ONLINE
28	MOT	OE1DATA	232010	MOT	ON	Ref. 4000	ONLINE

3. Hardware



3.1 hardware optimized for multiprotocol networks



Torsten, DG1HT

3.1.1 DVRPTR1-3



3.1.2 DV4 mini: first all mode dongle with 70cm transceiver



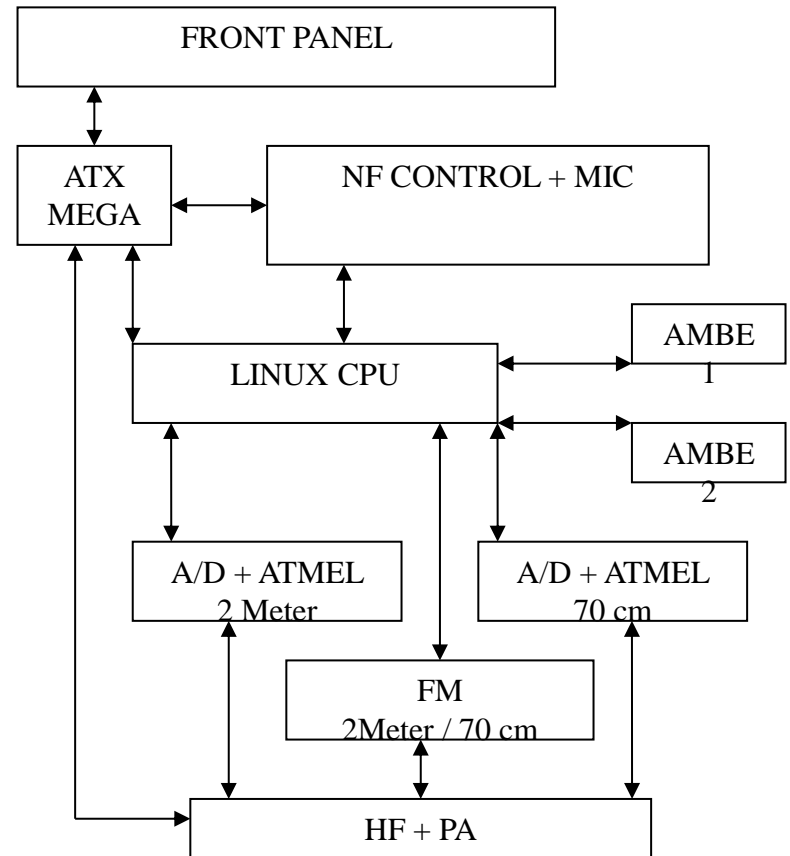
3.1.3 DV4 home: stand alone all mode with transcoding and wireless



3.1.4 DV4mobile: all digital protocol mobile transceiver for 144/222/440MHz



- D-Star
- C4FM
- DMRplus
- dPMR
- P25
- LTE
- Code plug in the cloud



3.2.5 DV4 mobile at Ham Radio



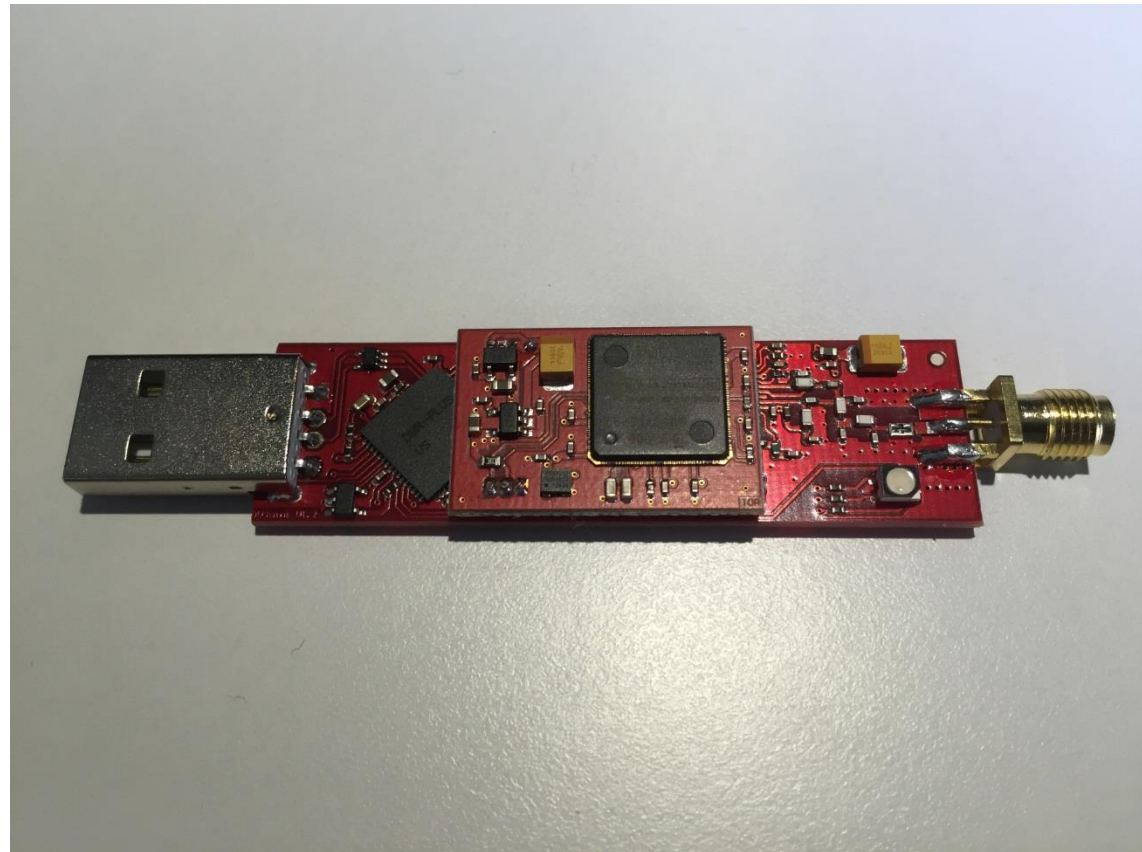
3.2.6 DV4 mobile at Ham Radio



3.2.7 DV4mobile at Ham Radio



3.1.8 DV4 AMBE



3.3. IPSC2

DMRplus IPSC 2 Link-Control

DMRplus IPSC 2 eine in C++ programmierte Software-Lösung welche HF-Repeater für DMR-Umsetzer verschiedener Hersteller zu einem Netzwerk zusammenfassen kann.

- Repeater/Dongle Registrierung Master & Peer Connections
 - HYTERA
 - MOTOROLA
 - MMDVM
 - DV4mini Dongle
- Interlink Verbindungen um dezentrale eigenständige und hierarchische Verbindungsmodelle aufzubauen
 - CBridge, SmartPTT
 - IPSC 2 InterLink
- Verwaltung der Verbindungen
 - Nach Sprechgruppen oder Reflektoren
 - Sprechgruppen OnDemand
 - Repeater / Sprechgruppenmatrix
 - Matrixgesteuerte Haltezeit für TG
 - Interlinkmatrix
- Verbindung zu LastHeard Applikationen
- SYSOP IPSC-Control-Center
- SYSOP Audio Kontrolle ohne HF
- HTTP IPSC-Control-Pages (Dashboard)

Design und Programmierung
 Torsten DG1HT, Hans-Jürgen DL5DI, Kurt OE1KBC
 Informationen: ipcs2@ham-dmr.de

3.4 Horkheimer Award at Ham Radio Friedrichshafen



3.5 Horkheimer Award at Ham Radio Friedrichshafen



DG8FAC

DH1HT

AG0X

DG1SW

KF4DX

Questions?