Multi Protocol Digital Networks

Introduction, Overview and further development

AG0X/DG1HT
Uli /Torsten

Agenda

- 1. digital modes: differences and commonalities
- 2. digital modes: infrastructure
- 2.1 vendor specific
- 2.1.1 DPLUS
- 2.1.2 WIRES-X
- 2.2 vendor independent
- 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
- 2.2.6.3 dPMR
- 2.2.6.4 C4FM (Fusion)
- 2.2.6.5 APCO P25
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- 3. Hardware
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- 3.1.2 DV4mini
- 3.1.3 DV4home
- 3.1.4 DV4mobile: all digital protocol mobile transceiver for 144/222/440MHz
- 3.1.4 more multiprotocol devices
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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

DMR
DIGITAL MOBILE RADIO ASSOCIATION

Courtesy Ken Bryant, K1DMR

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

DMR
DIGITAL MOBILE RADIO ASSOCIATION

Courtesy Ken Bryant, K1DMR

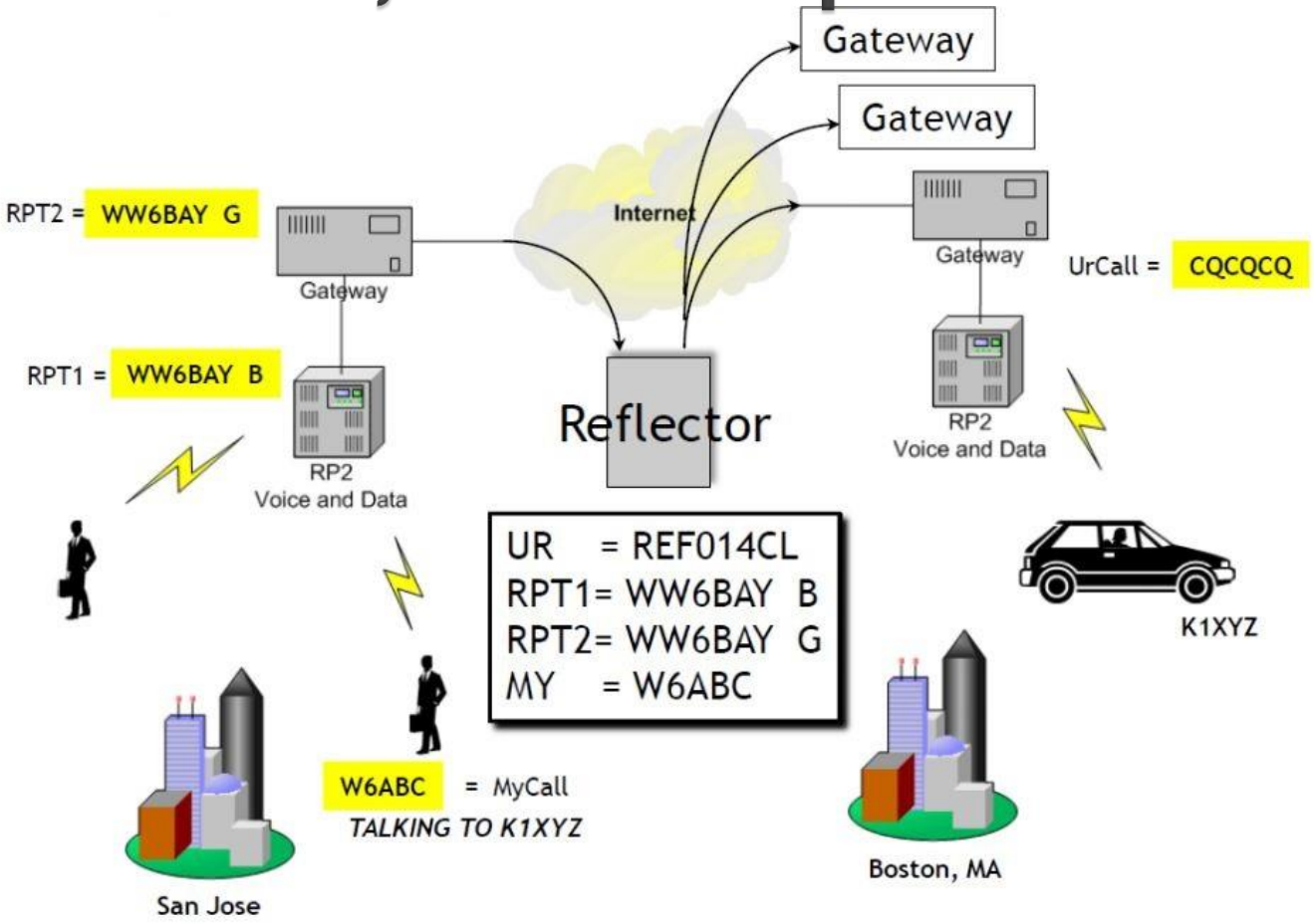
2.Digital modes:

- Network Infrastructure

2.1 vendor specific

- D-Plus
- WIRES-X

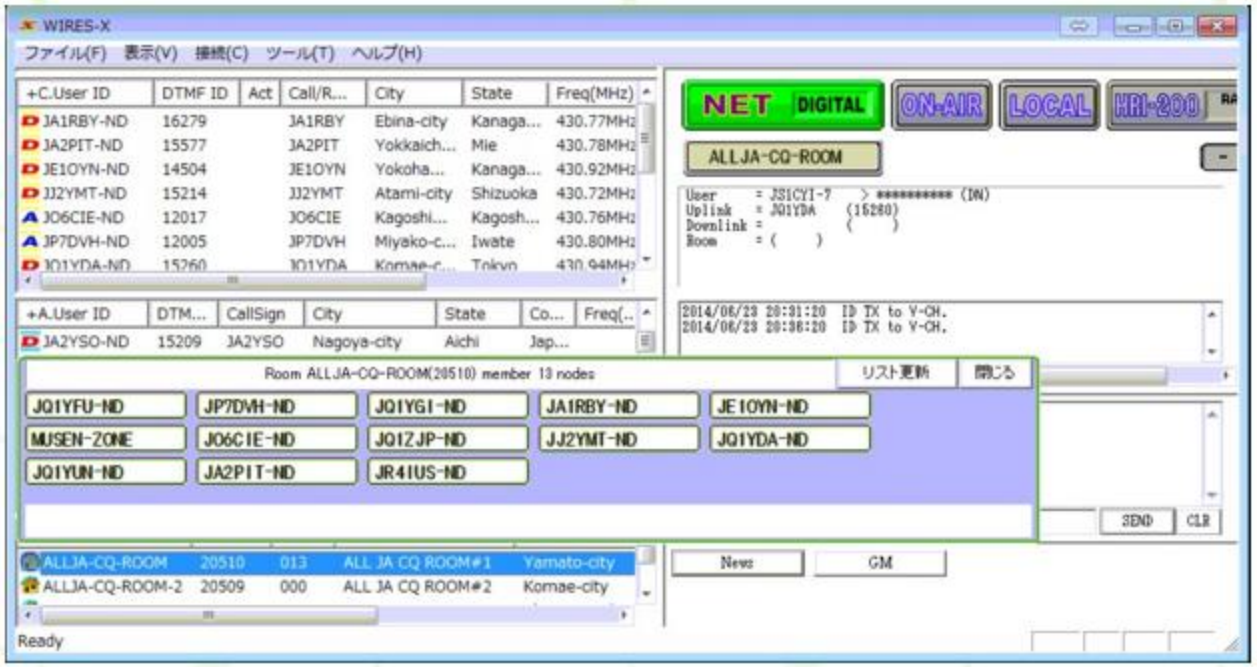
2.1.1 D-Plus, ICOM specific



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

CPS7
CodePlugs
DB

CCS7
Authentication
and Routing

LTE

dPMR

DCS

DMR
Plus

C4FM

P25

Reflector systems

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

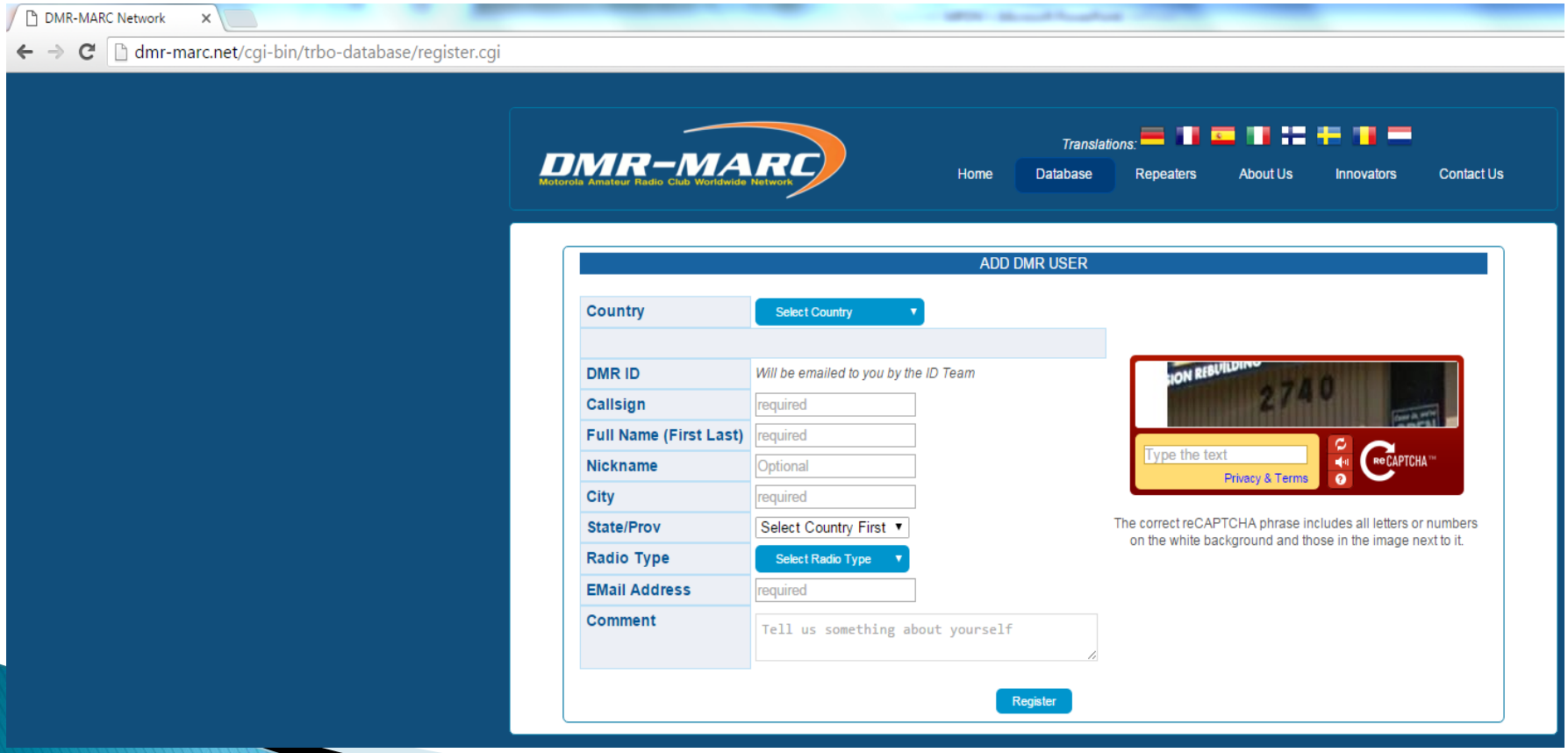
- Hierarchically structured numbering system:
- Examples:

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

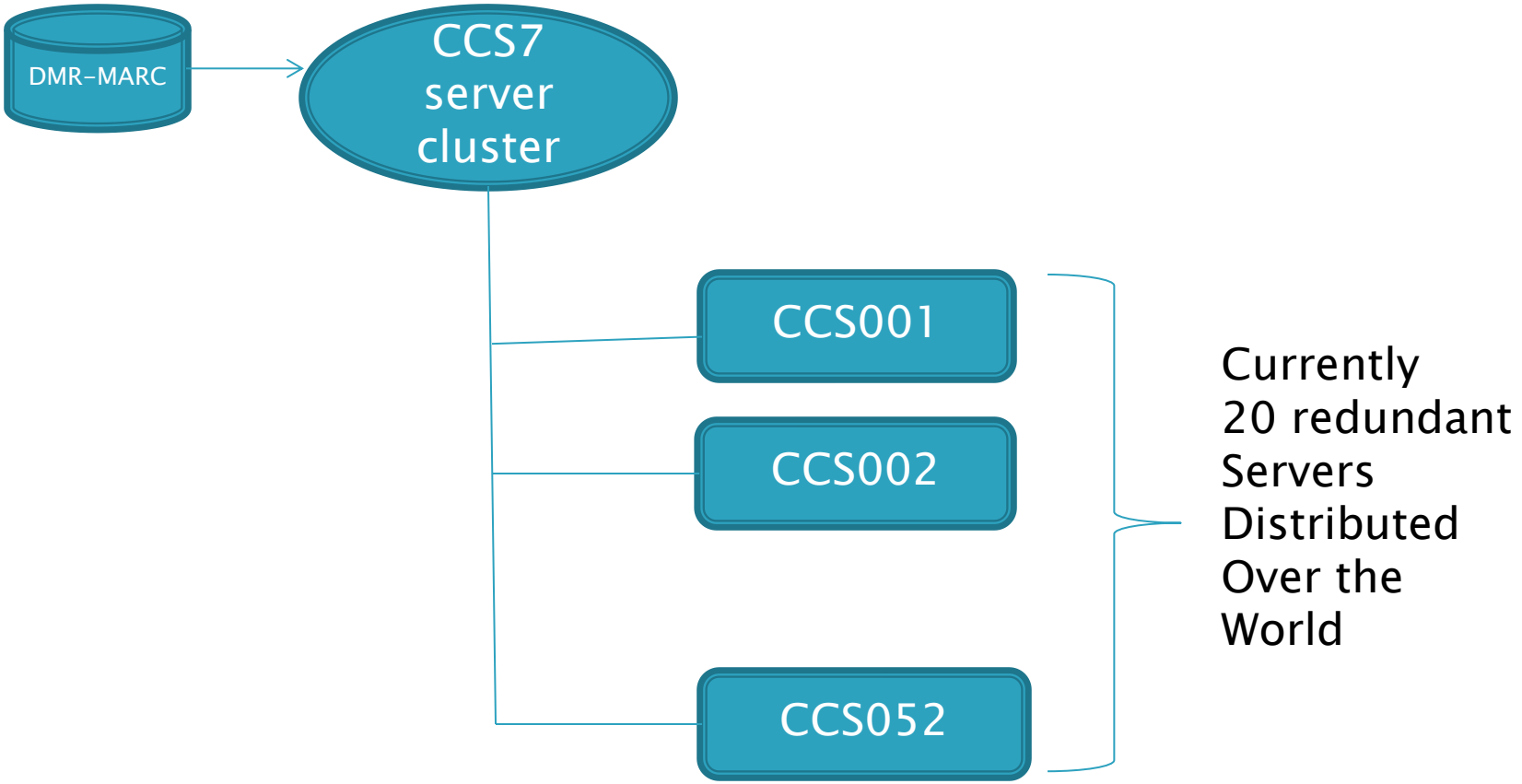
- 311 2528 = Uli, AG0X
- 262 7506 = Uli, DH6SAB

2.2.4 How are CCS7 numbers assigned?

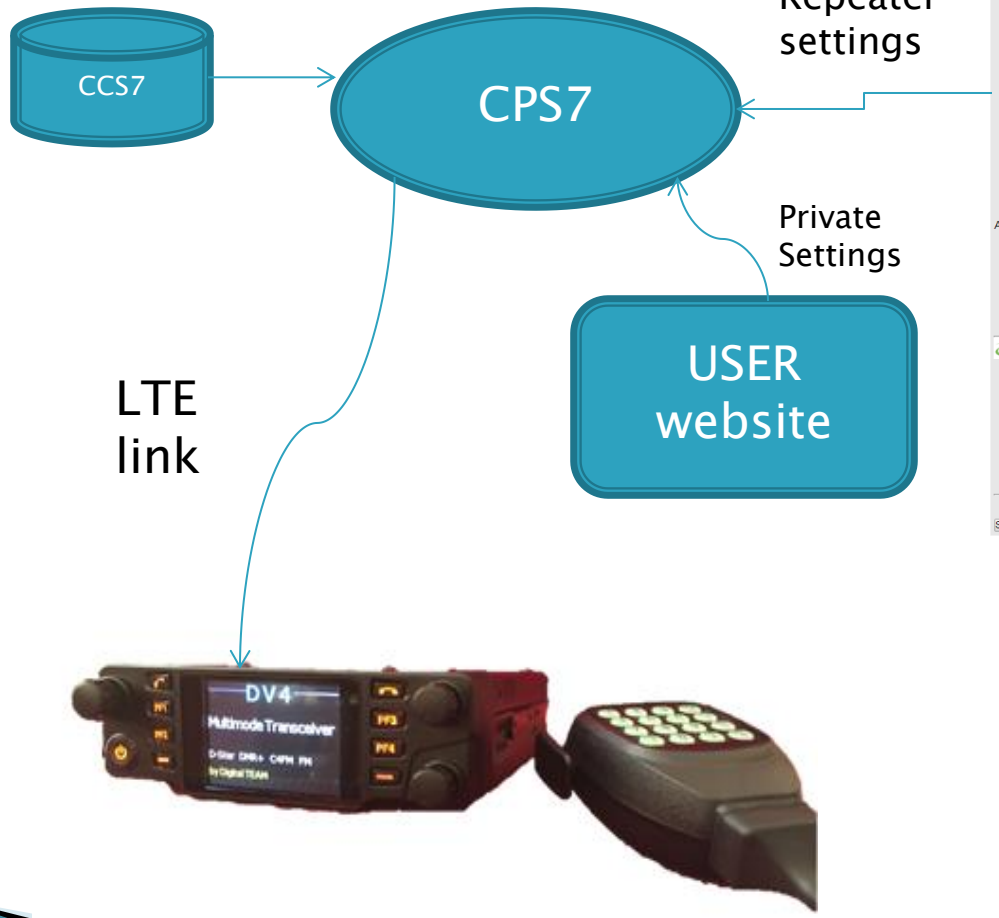
- To provide a common “phonebook” the DMR-MARC server assigns the numbers which are then synchronized with the D-Connect CCS7 servers:



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/SSID:	AB4NP
Repeater Callsign:	AB4NP
Licensee Call:	
Admin Callsign:	AG0X
Admin First Name:	Uli
Admin Surname:	Altvater
Email Address:	uli@altvater.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
Antenne 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-MBridge!

DMRplus

Options:

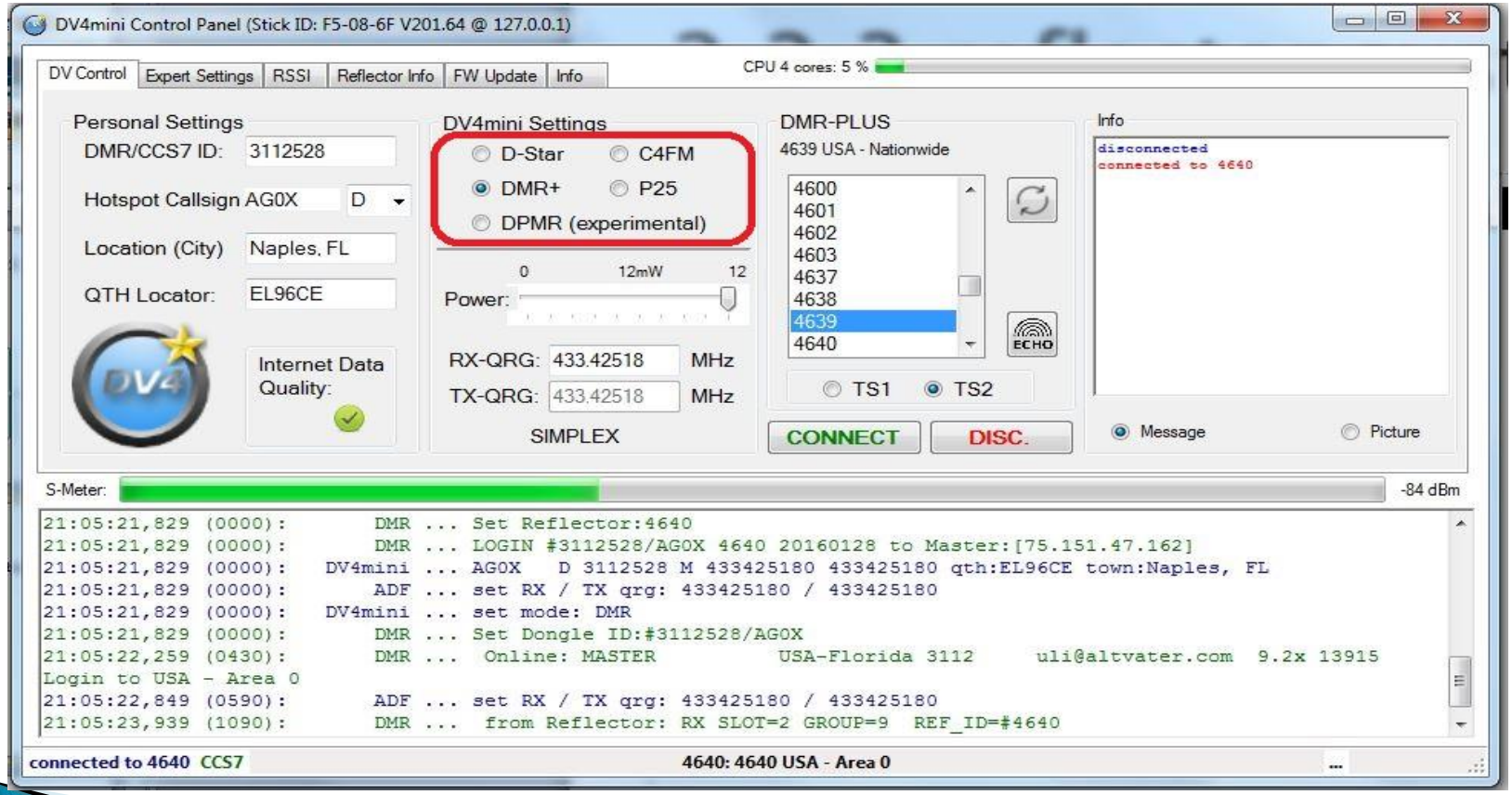
TS1 Group1	311	(default: 311 = 'Own Country')
TS1 Group2	1	(default: 1 = 'Worldwide')
TS1 Group3	262	(default: 'Language Region')
TS1 Group4	0	
TS1 Group5	0	
TS2 Start Reflector	4639 USA - Nationwide	
TS2 Reflector Relink Time	60	
TS2 Link control by users	off / on	

Save changes / Check changes / Return without changes

Distributed Over the World

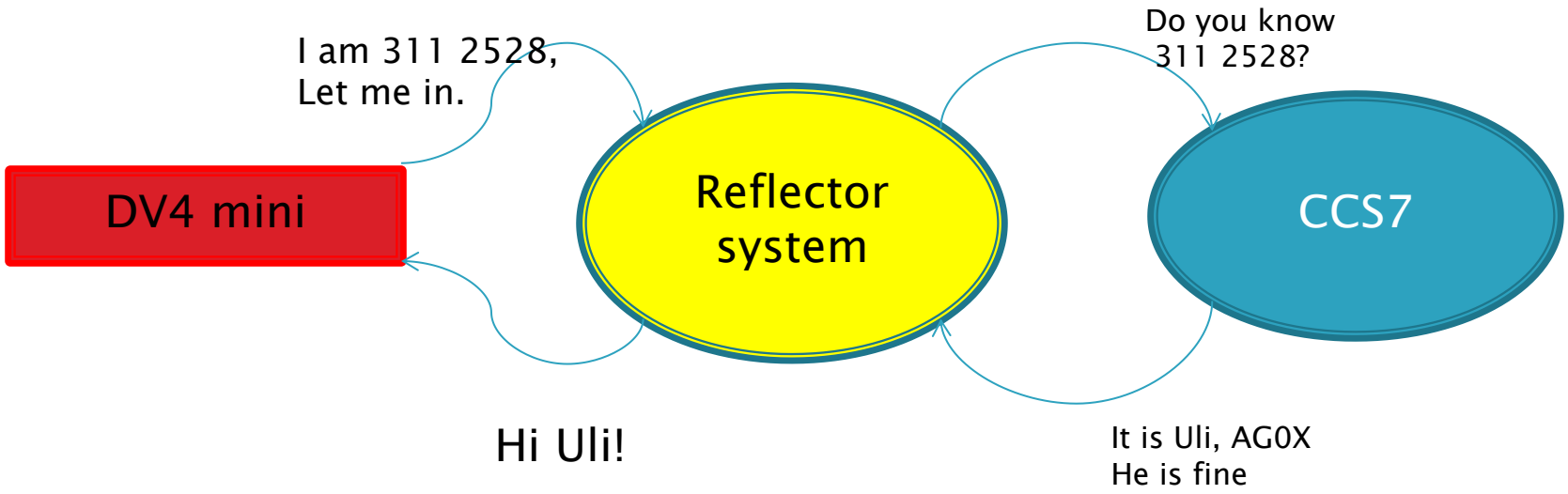
2.2.6 reflector systems

- What happens when I push these buttons?



2.2.6 reflector systems

- What happens when I push these buttons?



2.2.6.1 DCS (D-Star)

DCS

33 reflector Systems With 26 rooms each

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

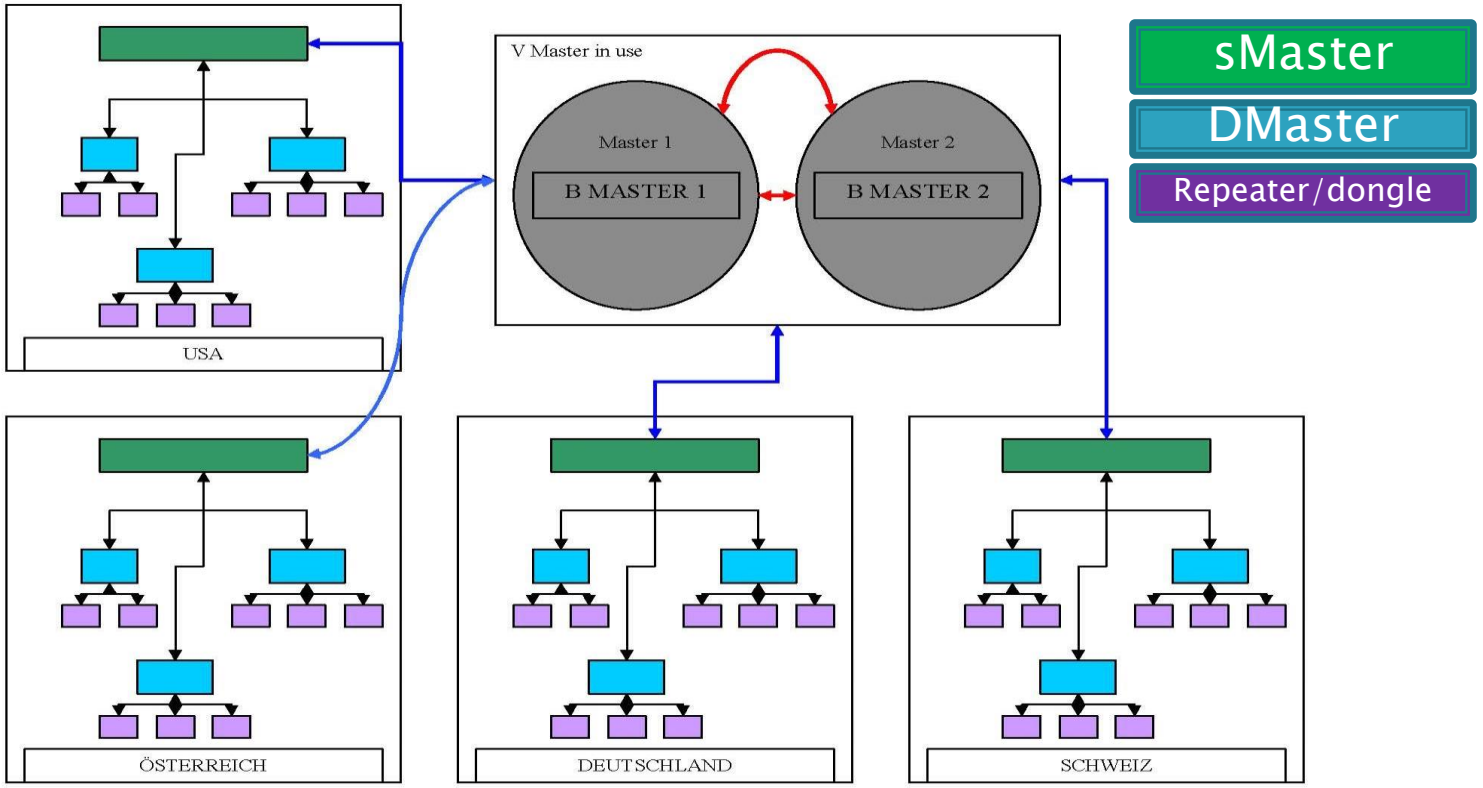
DMRplus DCS006 CCS7 Security Mode ON | Reflector System 7 Status and Control

DCS006 Reflector System

v1.7 | DCS Server v12.7_64Bit

Group	User on GROUP	Repeater on GROUP	Online 34		URCALL
World Wide	User	Repeater			DCS006AL
USA Preferred channel	User	Repeater	14		DCS006BL
USA Alternate channel	User	Repeater			DCS006CL
USA Fusion test	User	Repeater			DCS006DL
USA DMR test	User	Repeater			DCS006EL
Available	User	Repeater			DCS006FL
Dv-Mega	User	Repeater			DCS006GL
Dstar Contest 1	User	Repeater			DCS006HL
Dstar Contest 2	User	Repeater			DCS006IL
Dstar Contest 3	User	Repeater			DCS006JL
USA California	User	Repeater			DCS006KL
USA Texas	User	Repeater			DCS006LL
USA New York	User	Repeater			DCS006ML
USA Florida	User	Repeater			DCS006NL
Available	User	Repeater			DCS006OL
Available	User	Repeater			DCS006PL
Quadnet	User	Repeater	2		DCS006QL
USA Colorado	User	Repeater	11		DCS006RL
Minnesota	User	Repeater	1		DCS006SL
Available	User	Repeater			DCS006TL
USA Iowa	User	Repeater			DCS006UL
USA Iowa	User	Repeater	1		DCS006VL
Ragchew channel	User	Repeater	1		DCS006WL
USA Blingual EN/SP	User	Repeater	4		DCS006XL
Emergency Comm	User	Repeater			DCS006YL
Echo USA	User	Repeater		Z D626	DCS006ZL

2.2.6.2 DMR Plus



Kurt OE1KBC / Torsten DG1HT

2.2.6.3 dPMR

- Experimental System

x-NET LCD001 Dashboard | Reflector Status and Control

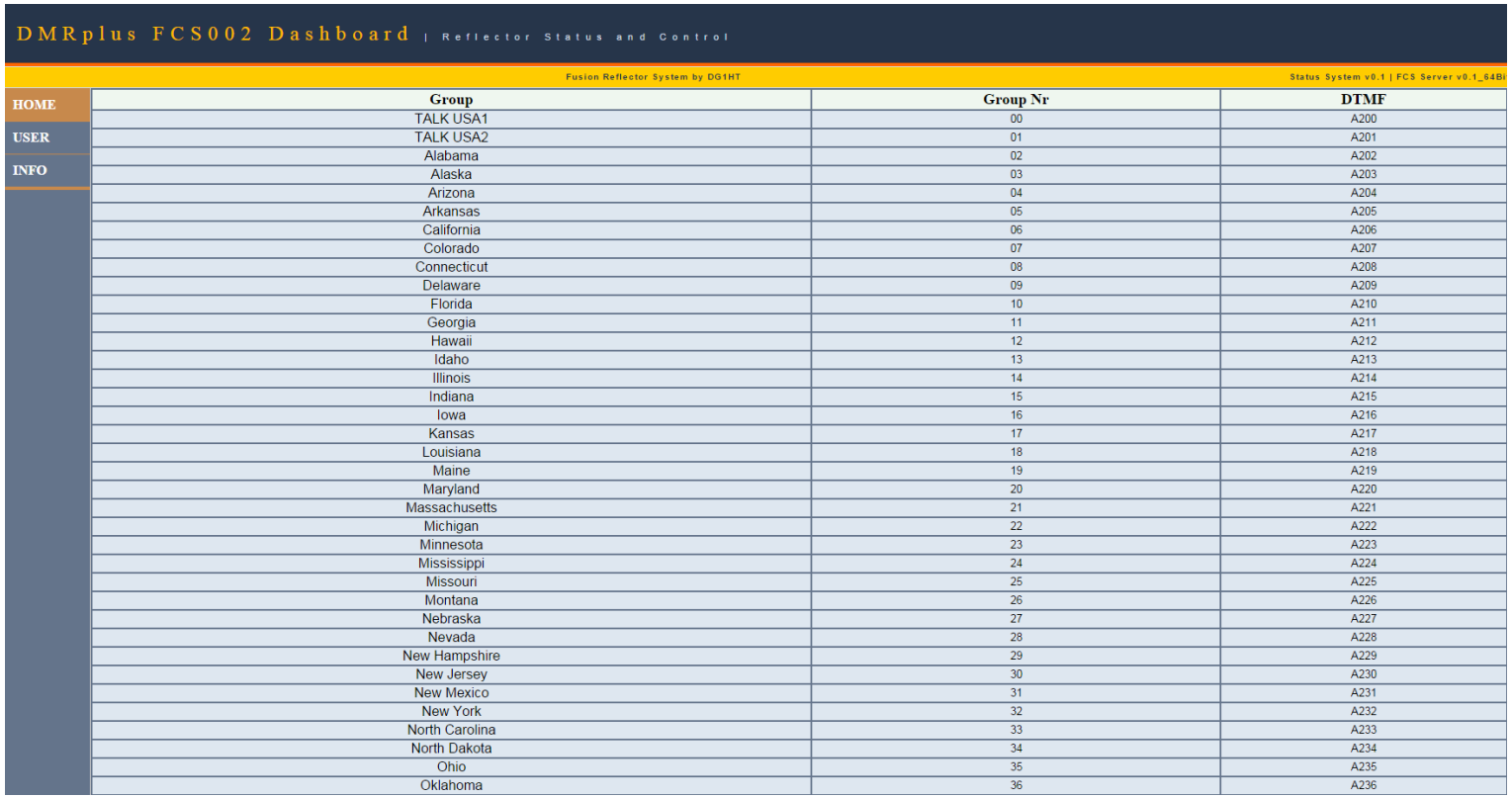
dPMR Reflector System by DG1HT/DJ0ABR — Status System v0.1 | LCS Server v0.1_64Bit

HOME
USER
INFO

Nr.	CALL	Last Heard	Name	Group
1	PA3DPS	1 h 32 m 13 s	ECHO	99
2	M1DAZ	1 h 59 m 24 s	ECHO	99
3	DG6FAX	6 h 15 m 5 s	in use	09
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	DF2OO	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_64Bi

HOME
USER
INFO

Group	Group Nr	DTMF
TALK USA1	00	A200
TALK USA2	01	A201
Alabama	02	A202
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

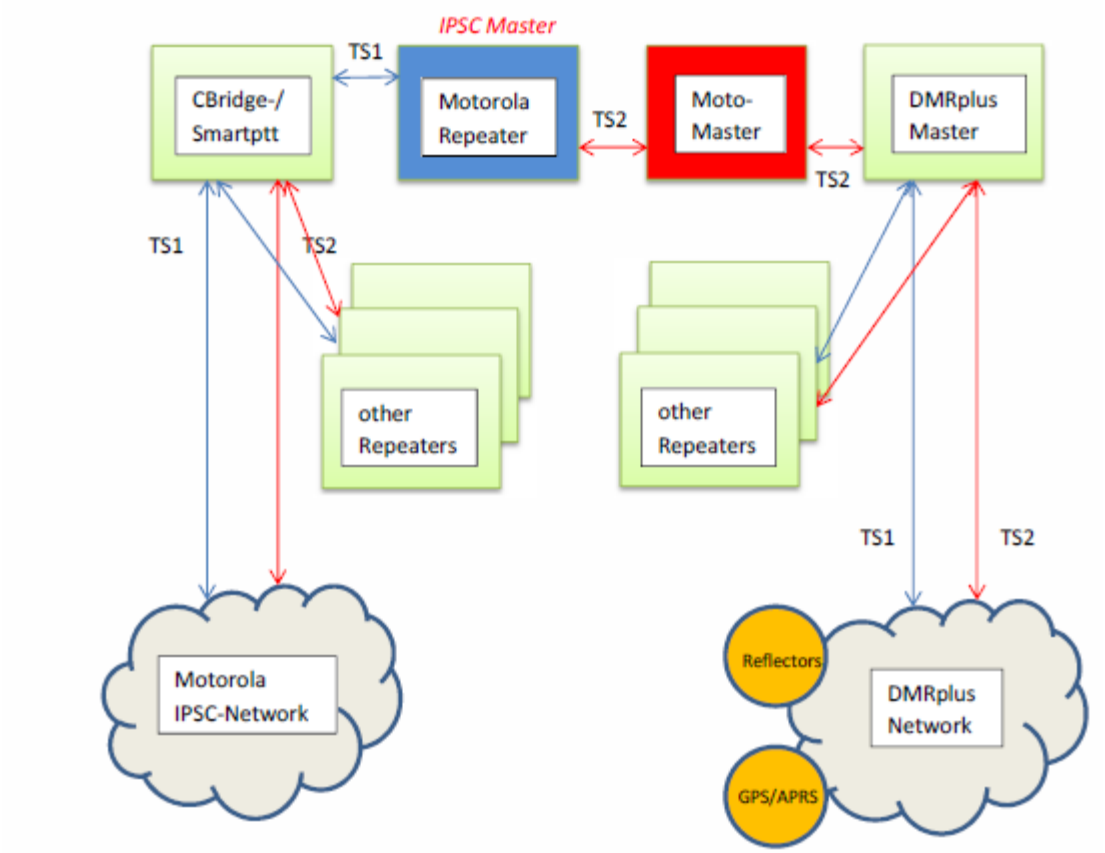
P25 Reflector System by DG1HT/DJ0ABR — Status System v0.1 | PCS Server v0.1_64Bi

HOME
USER
INFO

Nr.	CALL	Last Heard	Name	Group
1	G4TUZ	16 s	in use	06
2	NC5P	45 s	in use	06
3	N8GY	1 m 57 s	in use	06
4	WY8E	4 m 29 s	in use	06
5	G0UZJ	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	G6VBJ	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

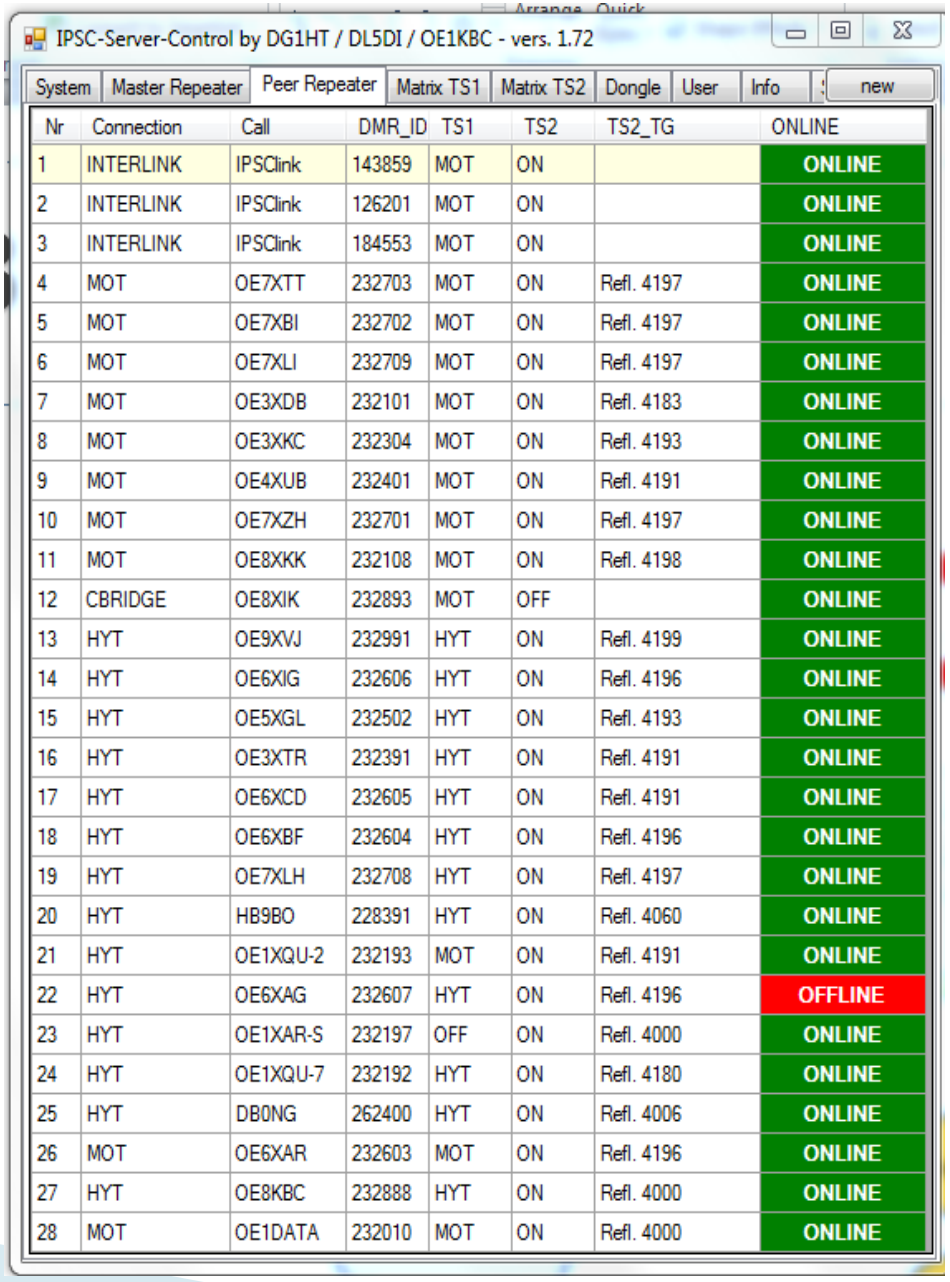
2.3 bridging

- MotoTrbo/Hytera



2.3 bridging

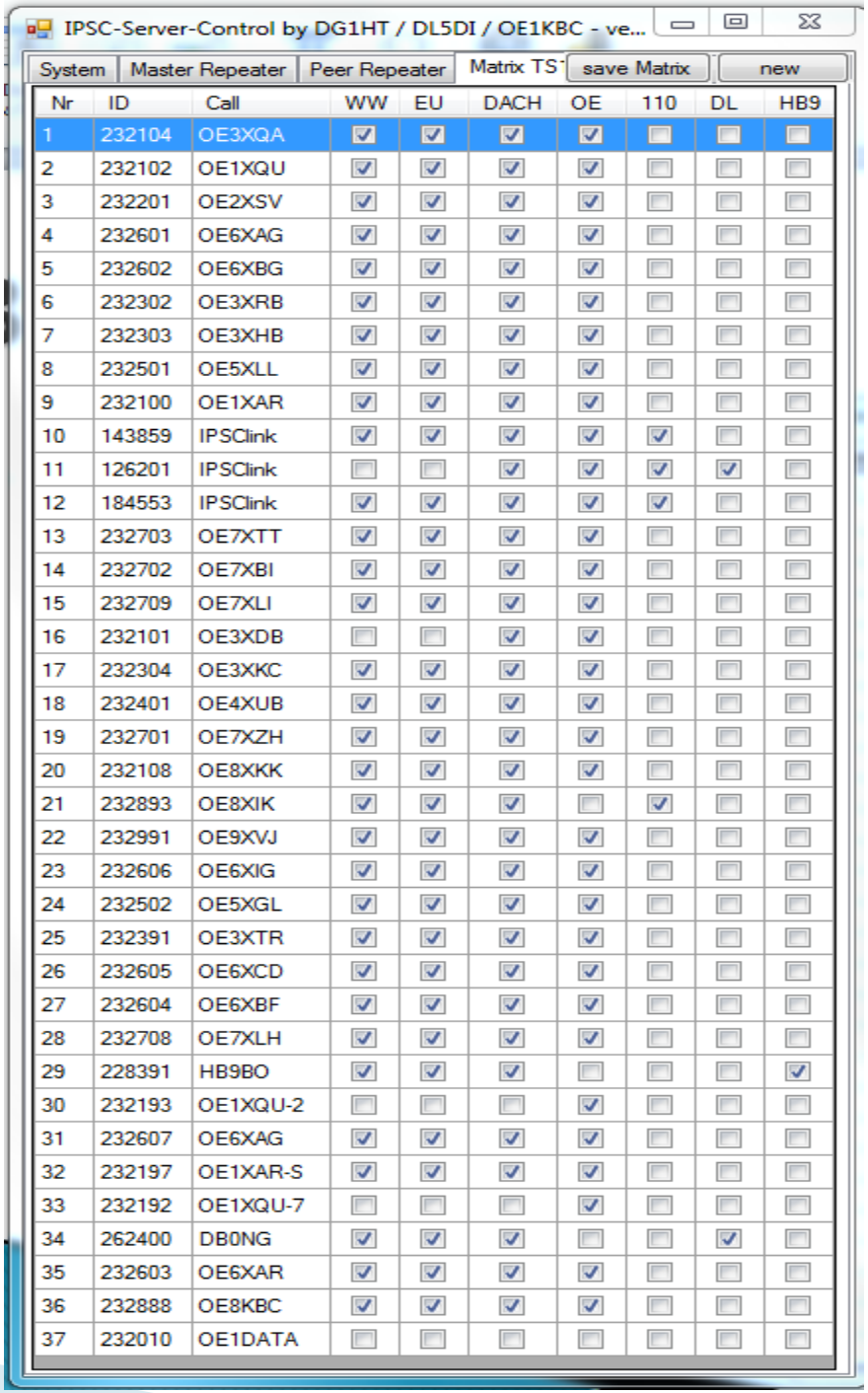
- MotoTrbo/Hytera



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

2.3 bridging

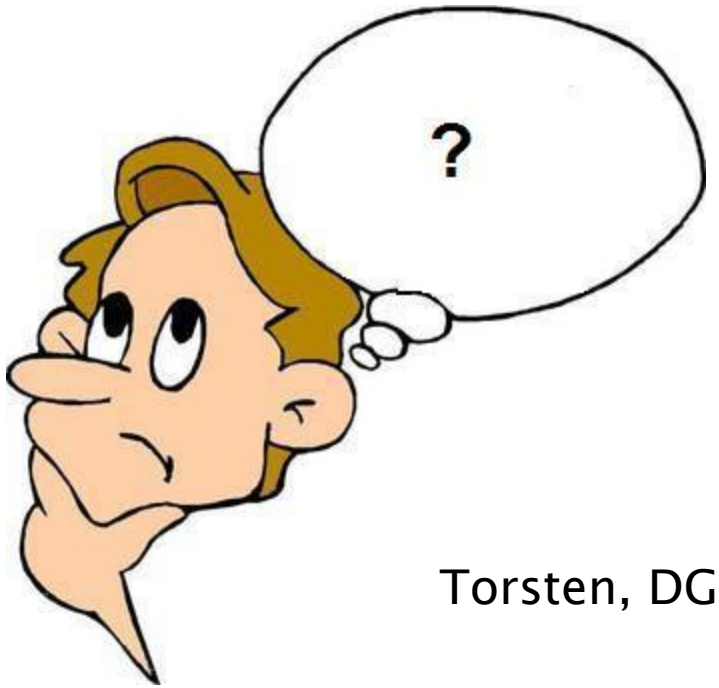
- MotoTrbo/Hytera



Nr	ID	Call	WW	EU	DACH	OE	110	DL	HB9
1	232104	OE3XQA	☑	☑	☑	☑	☐	☐	☐
2	232102	OE1XQU	☑	☑	☑	☑	☐	☐	☐
3	232201	OE2XSV	☑	☑	☑	☑	☐	☐	☐
4	232601	OE6XAG	☑	☑	☑	☑	☐	☐	☐
5	232602	OE6XBG	☑	☑	☑	☑	☐	☐	☐
6	232302	OE3XRB	☑	☑	☑	☑	☐	☐	☐
7	232303	OE3XHB	☑	☑	☑	☑	☐	☐	☐
8	232501	OE5XLL	☑	☑	☑	☑	☐	☐	☐
9	232100	OE1XAR	☑	☑	☑	☑	☐	☐	☐
10	143859	IPSClink	☑	☑	☑	☑	☑	☐	☐
11	126201	IPSClink	☐	☐	☑	☑	☑	☑	☐
12	184553	IPSClink	☑	☑	☑	☑	☑	☐	☐
13	232703	OE7XTT	☑	☑	☑	☑	☐	☐	☐
14	232702	OE7XBI	☑	☑	☑	☑	☐	☐	☐
15	232709	OE7XLI	☑	☑	☑	☑	☐	☐	☐
16	232101	OE3XDB	☐	☐	☑	☑	☐	☐	☐
17	232304	OE3XKC	☑	☑	☑	☑	☐	☐	☐
18	232401	OE4XUB	☑	☑	☑	☑	☐	☐	☐
19	232701	OE7XZH	☑	☑	☑	☑	☐	☐	☐
20	232108	OE8XKK	☑	☑	☑	☑	☐	☐	☐
21	232893	OE8XIK	☑	☑	☑	☐	☑	☐	☐
22	232991	OE9XVJ	☑	☑	☑	☑	☐	☐	☐
23	232606	OE6XIG	☑	☑	☑	☑	☐	☐	☐
24	232502	OE5XGL	☑	☑	☑	☑	☐	☐	☐
25	232391	OE3XTR	☑	☑	☑	☑	☐	☐	☐
26	232605	OE6XCD	☑	☑	☑	☑	☐	☐	☐
27	232604	OE6XBF	☑	☑	☑	☑	☐	☐	☐
28	232708	OE7XLH	☑	☑	☑	☑	☐	☐	☐
29	228391	HB9BO	☑	☑	☑	☐	☐	☐	☑
30	232193	OE1XQU-2	☐	☐	☐	☑	☐	☐	☐
31	232607	OE6XAG	☑	☑	☑	☑	☐	☐	☐
32	232197	OE1XAR-S	☑	☑	☑	☑	☐	☐	☐
33	232192	OE1XQU-7	☐	☐	☐	☑	☐	☐	☐
34	262400	DB0NG	☑	☑	☑	☐	☐	☑	☐
35	232603	OE6XAR	☑	☑	☑	☑	☐	☐	☐
36	232888	OE8KBC	☑	☑	☑	☑	☐	☐	☐
37	232010	OE1DATA	☐	☐	☐	☐	☐	☐	☐

3. Hardware

3.1 hardware optimized for multiprotocol networks



Torsten, DG1HT

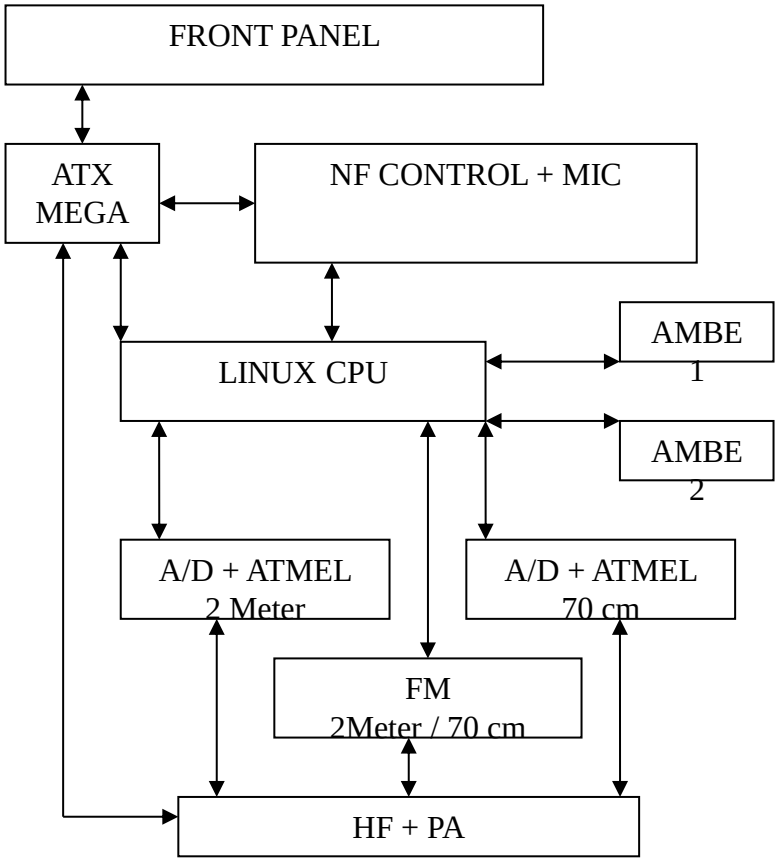
3.1.1 DVRPTR1-3

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

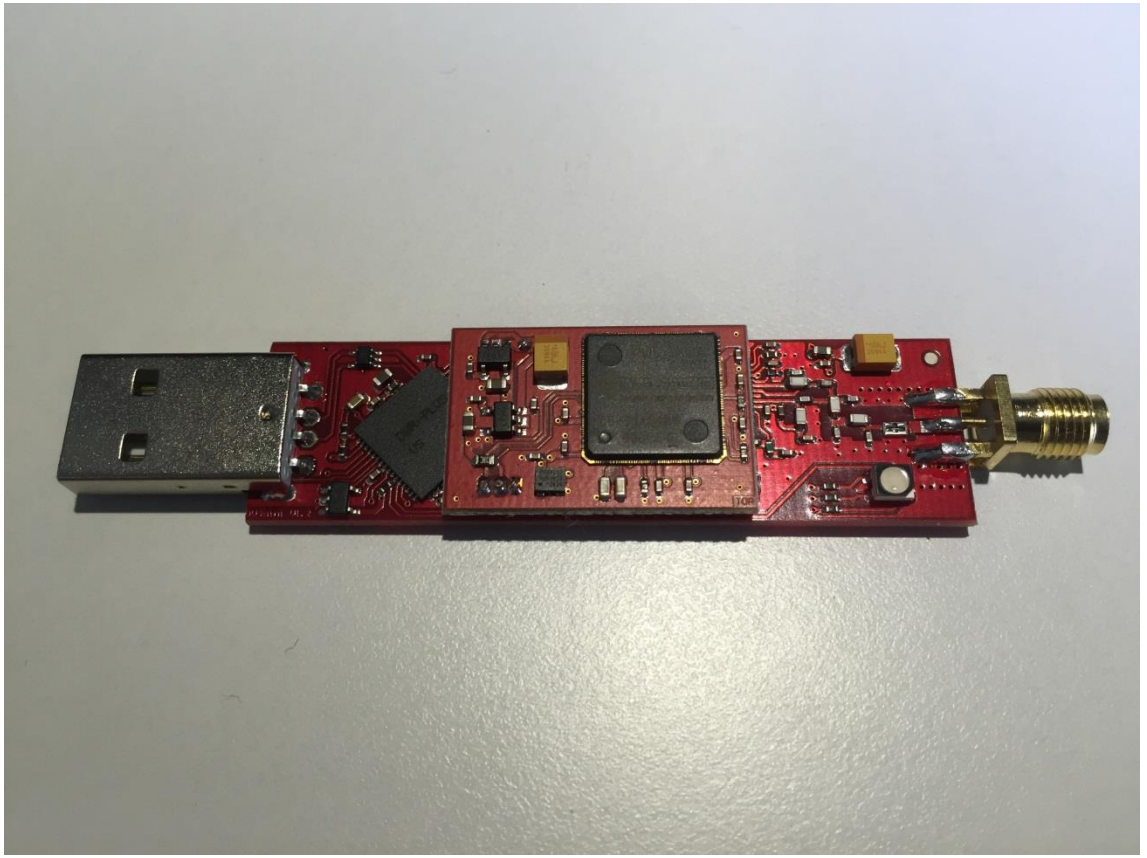


3.2.5 DV4 mobile at Ham Radio

3.2.6 DV4 mobile at Ham Radio

3.2.7DV4mobile 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
HAMNET an der HAM RADIO
(eine Dienstleistung der SWISS-ARTG)
Amateurfunk

3.4 Horkheimer Award at Ham Radio Friedrichshafen

3.5 Horkheimer Award at Ham Radio Friedrichshafen

DG8FAC DG1HT AG0X DG1SW KF4DX

Questions?