

Fusion from the Inside

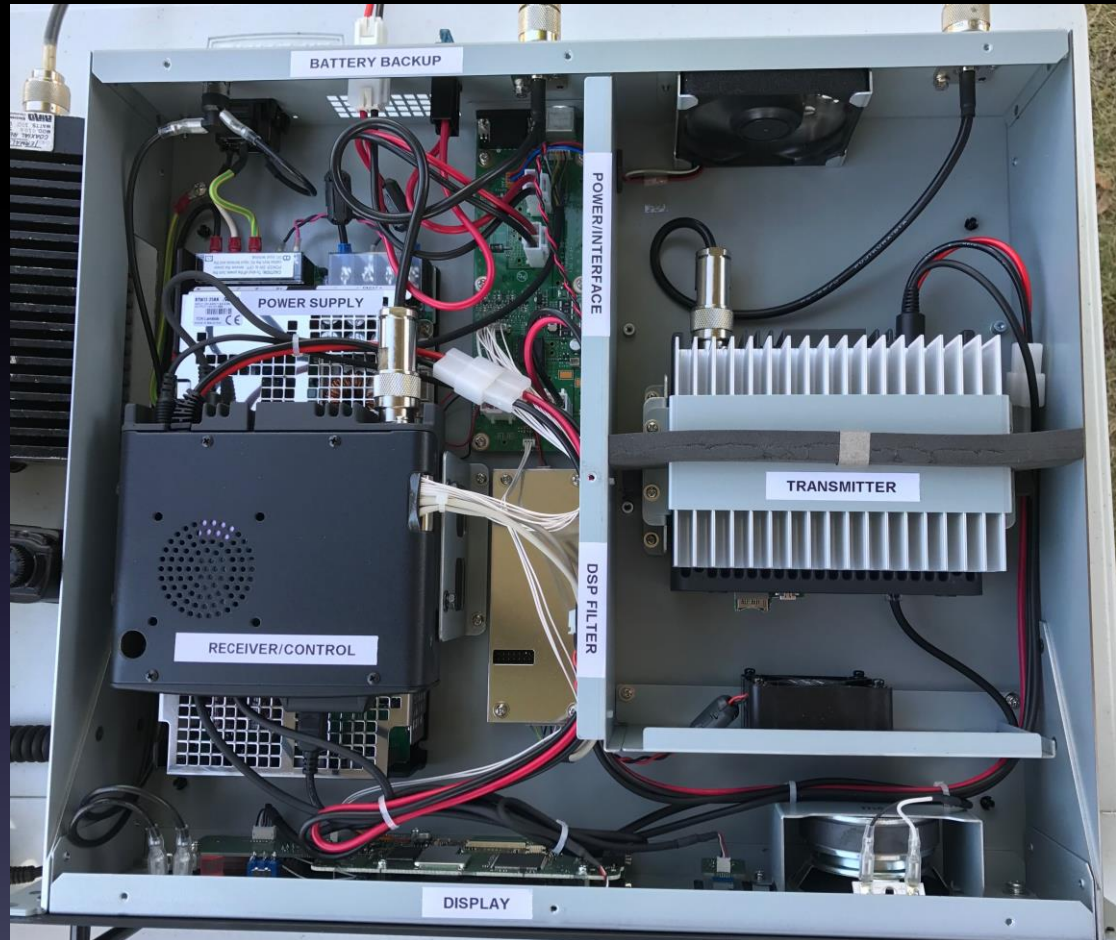
Chris Petersen, K9EQ

TAPR DCC September 15, 2017

Fusion from the Inside

Abstract

- System design
- Broad examination of System Fusion and WiRES-X components
- What the components do and how they interact
- Public information
- Reverse Engineering
- Hams – How we can build on System Fusion for the future



Fusion System Design

- Fit current FM spectral mask
 - Transition from FM to digital
- Use established standards – P25/C4FM
 - And modify for Amateur Radio
- User, Access Point, and Network layers

Fusion Subsystems

- Fusion / C4FM (Built on P25)
 - RF segment
- WiRES-X (Built on WiRES and WiRES II)
 - Networking segment
 - Nodes (Access Point)
 - Simplex access or remote repeater access
 - Repeaters (Access Point)



Network (Internet, RF)



Gateways (WiRES-X, DR-1/2)



Users (FT1/2/70, FTM-100/400/3200/3207, FT-991)



Popularity of Digital Voice

Mode	NA	World	MN	WI	IA	IL
Fusion	1,531	1,796	45	34	28	71
Dstar	1,137	2,174	31	27	7	31
DMR	1,189	1,994	22	28	9	45
P25	254	278	2	7	5	21
NXDN	93	93	2	2	3	3

Data from RepeaterBook.com retrieved 13-Sep-2017
Fusion may support FM and digital to various degrees

Fusion Subsystem

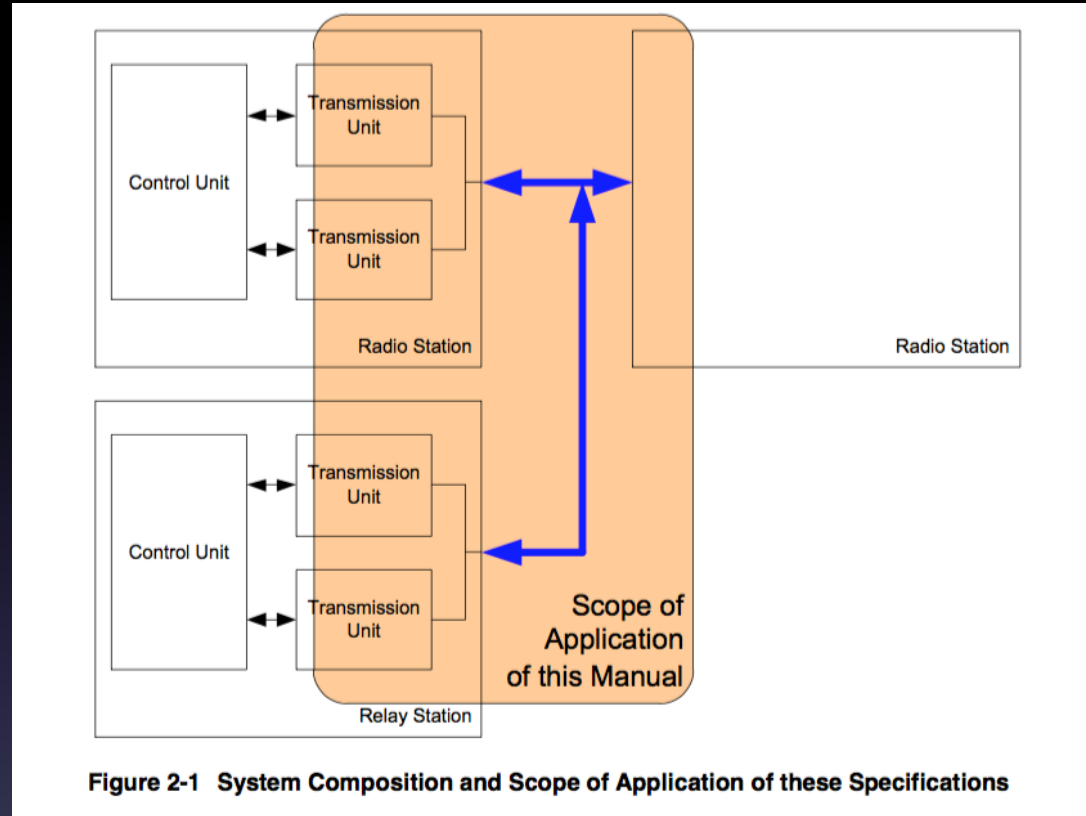
Published Standard

Amateur Radio Digital Standards

Amateur Radio Digital Standards

January 15, 2013 Version 1.0
July 29, 2015 Revision 1.02

YAESU MUSEN CO., LTD.



OTA Modes and Bandwidth

Four modes of operation:

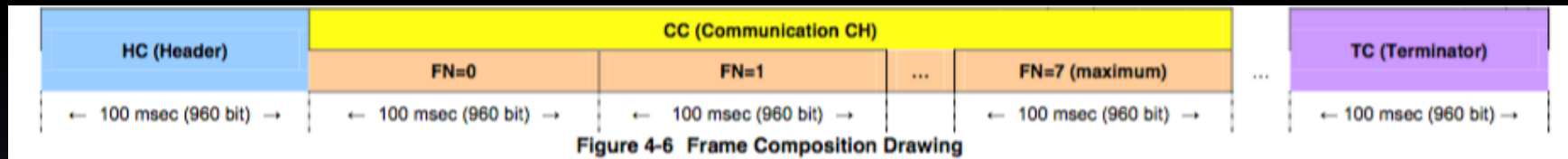
Mode	Voice	FEC	Data
DN1	2,450	1,150	3,600
DN2	2,450	1,150 + 1,800	1,800
VW	4,400	2,800	
DW	7,200		

Table 3-1 C4FM Mapping

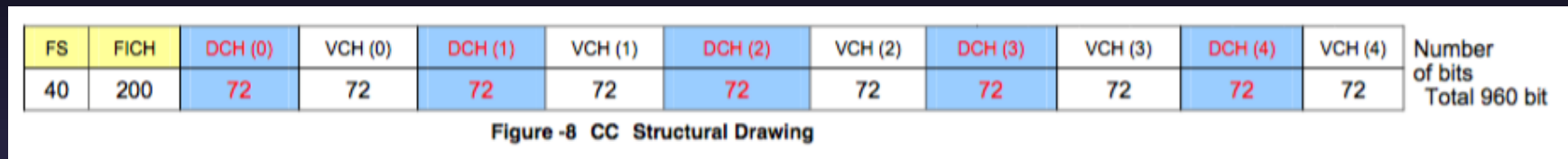
Dibit	Symbol	Frequency Deviations(Wide)	Frequency Deviations(Narrow)
00	+1	+900 Hz	+450 Hz
01	+3	+2700 Hz	+1350 Hz
10	-1	-900 Hz	-450 Hz
11	-3	-2700 Hz	-1350 Hz

OTA Protocol DN Modes

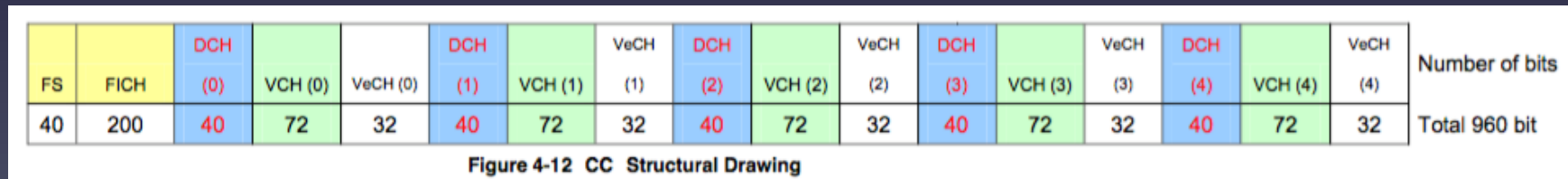
Frame



DN1 3,600bps Data



DN2 1,800bps Data



OTA Protocol VW and DW

VW

The structural drawing of the CC0 (Sub Header CH) actual voice and superimposed data is shown in **Figure 4-21**.

FS	FICH	DCH (0)	DCH (1)	DCH (2)	DCH (3)	DCH (4)	Reserved	VCH (3)	VCH (4)	Number of bits
40	200	72	72	72	72	72	72	144	144	Total 960 bit

Figure 4-21 CC0 Structural Drawing

The structural drawing of the CC actual voice is shown in **Figure 4-22**.

FS	FICH	VCH (0)	VCH (1)	VCH (2)	VCH (3)	VCH (4)	Number of bits
40	200	144	144	144	144	144	Total 960 bit

Figure 4-22 CC Structural Drawing

DW

FS	FICH	DCH-1(0)	DCH-2(0)	DCH-1(1)	DCH-2(1)	DCH-1(2)	DCH-2(2)	DCH-1(3)	DCH-2(3)	DCH-1(4)	DCH-2(4)	Number of bits
40	200	72	72	72	72	72	72	72	72	72	72	Total 960 bit

Figure 4-15 CC Structural Drawing

Note: No FEC on data and no ARQ

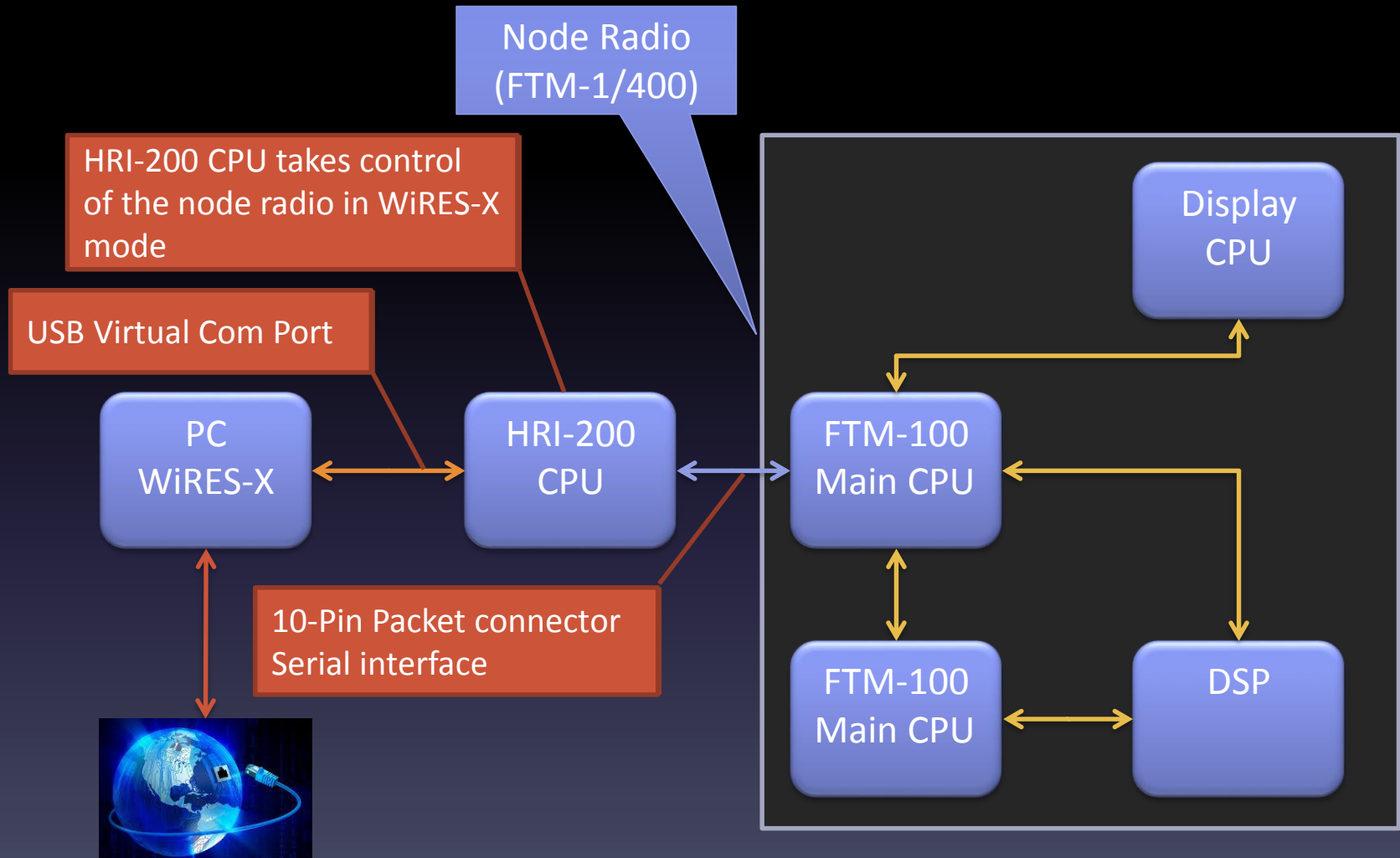
Examine OTA Data

- Use a receiver to demodulate data
- Use software to process the signal
- Example
 - DV4mini
 - DV4RX – Github [G4KLX/DV4RX](#)
 - Build with VS 2017 Community

WiRES-X



WiRES-X Node Interface



Wireshark Network Captures

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	10.8.0.6	180.42.3.130	UDP	123	46100 → 49690 Len=81
2	0.341234	180.42.3.130	10.8.0.6	UDP	1176	49690 → 46100 Len=1134
3	0.449945	10.8.0.6	180.42.3.130	UDP	123	46100 → 49690 Len=81

▶ Frame 1: 123 bytes on wire (984 bits), 123 bytes captured (984 bits) on interface 0

▶ Ethernet II, Src: 00:ff:82:09:1f:6c (00:ff:82:09:1f:6c), Dst: 00:ff:83:09:1f:6c (00:ff:83:09:1f:6c)

▶ Internet Protocol Version 4, Src: 10.8.0.6, Dst: 180.42.3.130

▶ User Datagram Protocol, Src Port: 46100, Dst Port: 49690

▶ Data (81 bytes)

0000	00 ff 83 09 1f 6c 00 ff 82 09 1f 6c 08 00 45 00l.. ..l..E.
0010	00 6d 28 a0 00 00 80 11 50 26 0a 08 00 06 b4 2a	.m(..... P&.....*
0020	03 82 b4 14 c2 1a 00 59 40 d9 40 65 30 36 37 36Y @.e0676
0030	30 30 30 41 30 35 31 38 31 31 31 30 35 30 38 35	000A0518 11105085
0040	4d 32 34 30 35 37 35 30 33 30 38 4b 39 45 51 2d	M2405750 308K9EQ-
0050	4e 44 32 31 37 30 35 30 34 30 37 30 32 42 30 32	ND217050 40702B02
0060	30 30 30 39 30 43 30 30 30 31 31 32 31 31 30 30	00090C00 01121100
0070	31 31 31 36 30 35 30 30 34 31 36	11160500 416

B2313430 .740MHz,
 DSQ:110, 2413466.
 425MHz, D SQ:OFF, 2
 530Lat:N :35 42'
 54" / Longitude:140
 10' 51" / Radius:001k
 m /2B020 02C04000
 0090C000 11221001
 03800FE0 200020D1
 24.26.31 .2030309
 JP7BYD-N D0A05121
 250406JP 7BYD0614
 Sakata-city,Yama
 gata0705 Japan080
 02313430 .760MHz,

.....l.. ..l..E.
q. b..*....
v .r@E0676
 000104IL S6000200
 020D114. 191.3.19
 80309CB- JH1DPC0A
 05121240 406JH1DP
 C0611Sak ura-city
 ,Chiba07 05Japan0
 81E...[.
g... ..

List server request and update

Capture: DMR Not Working

```
0000 00 01 01 80 2d 48 31 38 33 38 33 00 03 00 02 02 .....-H18383.....
0010 00 41 5d fb e8 dd e8 eb 61 bc c7 62 d4 00 ad e2 .A].....a..b....
0020 6b 52 71 0e 25 eb e1 88 49 92 e8 8a 4c a3 86 fc kRq.%...I...L...
0030 47 92 a6 b5 ee 11 b6 2e 43 4e 25 5c 1e ae bf 4c G.....CN%\...L
0040 62 92 9a 45 c1 ea 84 c8 6d 53 cb 16 6d 71 52 53 b..E....mS..mqRS
0050 23 a9 82 01 01 00 e4 43 50 30 30 30 30 30 33 30 #.....CP0000030
0060 42 30 32 31 31 30 33 30 39 4e 30 41 4e 43 2d 42 B02110309N0ANC-B
0070 52 47 30 41 30 35 31 38 33 38 33 44 31 30 31 32 RG0A0518383D1012
0080 44 32 30 31 30 44 33 30 31 30 44 34 30 31 30 44 D2010D3010D4010D
0090 35 30 31 36 44 36 30 31 30 44 37 30 32 30 30 44 5016D6010D70200D
00a0 41 30 41 2a 2a 2a 2a 2a 2a 2a 2a 2a 44 42 30 A0A*****DB0
00b0 41 4b 39 45 51 2f 43 48 52 49 53 44 43 30 41 20 AK9EQ/CHRISDC0A
00c0 20 20 20 20 20 20 20 20 20 44 44 30 41 4e 30 41 DD0AN0A
00d0 4e 43 20 20 20 20 20 44 45 30 35 20 20 20 20 20 NC DE05
00e0 44 46 30 35 31 38 33 38 33 45 30 30 35 32 31 34 DF0518383E005214
00f0 39 33 45 31 30 35 45 35 34 44 44 45 33 30 32 36 93E105E54DDE3026
0100 30 45 34 30 34 32 32 36 32 43 30 31 45 35 46 32 0E4042262C01E5F2
0110 38 35 34 33 35 35 30 35 37 33 31 35 36 37 39 32 8543550573156792
0120 37 37 46 36 43 32 30 31 43 32 30 45 36 30 43 54 77F6C201C20E60CT
0130 35 50 57 31 56 79 27 7f 6c 20 1c 02 02 00 41 99 5PW1Vy'.l....A.
0140 ba 62 69 4f b6 46 17 45 0f ec 9a ab 66 e5 c8 b4 .bi0.F.E....f...
0150 d8 8a ca c7 2d c6 6d 24 47 ac c6 c2 69 6d 13 67 .....-m$G...im.g
0160 9d 0d 9e f3 be 96 36 f5 a3 36 71 cd 32 58 ed 07 .....6..6q.2X..
0170 77 aa 60 8f ca 8d 24 78 52 f5 58 06 51 dc 68 4f w.`...$xR.X.Q.h0
```

```
....V+.18383.....
.A"%.4Ga.'gM#.A
[...tKA.<j...A.:
2.(...2o.FM.....
F2.*...,RR.m...M
#.q....CP0000030
B02110309N0ANC-B
RG0A0518383D1012
D2010D3010D4010D
5016D6010D70200D
A0A*****DB0
AAB3GD DC0A
DD0AN0A
NC DE05
DF0518383E005214
93E105 E3023
0E4042261C0045F2
8...A.9_.P../%N.
...c..T...mI..b..
`d]CZ.....[..5..
Y..\L.....Q...;
.....q
```

WiRES-X Ports

- Ports forwarded to node/room
- Each node is a server
- Every user can create their own Room/reflector
- List Server coordinates connections

Port	Purpose	Destination
46,100	Yaesu List Server	49,690
46,110	Node control	46,110 46,120
46,112	Node voice	
46,114	Room control	
46,120	Room voice	
46,122	News control	46,110 46,122
46,190	Web access	

```

on 4, Src: 50.207.102.150, Dst: 10.8.0.6
Src Port: 46122, Dst Port: 46110
0 ff 83 09 1f 6c 08 00 45 00 .....l.. ...l..E.
5 11 17 e5 32 cf 66 96 0a 08 .@.U..u. ..2.f...
0 2c 34 33 43 50 30 30 30 30 ...*... , 43CP0000
2 30 32 30 39 30 41 30 30 33 033000B0 2090A003
9 33 32 42 30 32 30 30 70521493 2B0200
  
```

```

Src: 50.207.102.150, Dst: 10.8.0.6
Port: 46122, Dst Port: 46112
83 09 1f 6c 08 00 45 00 .....l.. ...l..E.
d9 ac 32 cf 66 96 0a 08 .....u. ..2.f...
b0 cc 43 4f ...*. .. ..CO
  
```

Voice Data Capture

59	6.644078	50.207.102.150	10.8.0.6	UDP	69	46122 → 46110	Len=27
60	6.738918	10.8.0.6	50.207.102.150	UDP	194	46110 → 46120	Len=152
61	6.768873	10.8.0.6	50.207.102.150	UDP	194	46110 → 46120	Len=152
62	6.858878	10.8.0.6	50.207.102.150	UDP	194	46110 → 46120	Len=152
63	6.909074	10.8.0.6	180.42.3.130	UDP	123	46100 → 49690	Len=81
64	6.948860	10.8.0.6	50.207.102.150	UDP	194	46110 → 46120	Len=152
65	7.018842	10.8.0.6	50.207.102.150	UDP	194	46110 → 46120	Len=152

▶ Frame 62: 194 bytes on wire (1552 bits), 194 bytes captured (1552 bits) on interface 0

▶ Ethernet II, Src: 00:ff:82:09:1f:6c (00:ff:82:09:1f:6c), Dst: 00:ff:83:09:1f:6c (00:ff:83:09:1f:6c)

▶ Internet Protocol Version 4, Src: 10.8.0.6, Dst: 50.207.102.150

▶ User Datagram Protocol, Src Port: 46110, Dst Port: 46120

▶ Data (152 bytes)

0000	00 ff 83 09 1f 6c 00 ff 82 09 1f 6c 08 00 45 00l.. ...l..E.
0010	00 b4 2b e2 00 00 80 11 6a e4 0a 08 00 06 32 cf	..+..... j.....2.
0020	66 96 b4 1e b4 28 00 a0 02 90 00 01 00 98 00 90	f....(..
0030	31 38 31 31 31 00 02 00 02 02 00 41 98 a8 5e e1	18111... ...A..^.
0040	58 8f 80 e3 36 8c a6 29 b3 40 61 66 f2 d3 b8 aa	X...6..) .@af....
0050	20 2c c7 ac 22 b9 ae 80 1c 51 aa 1d 57 89 2a d2	,...". .Q..W.*.
0060	75 e1 0c 28 8f 13 3b 99 4f 0d 36 2f ed 54 4d b1	u..(..;. 0.6/.TM.
0070	0a b2 be 26 a5 94 b3 0e 3e 92 da 3a 5d 02 02 00	...&.... >.:]...
0080	41 15 a8 60 1d 59 ac 40 d5 4a b1 a1 1a 6b 40 9c	A..`.Y.@ .J...k@.
0090	58 e2 9c 50 2f 81 db 5e 52 d2 56 ab 80 ef c5 4d	X..P/..^ R.V....M
00a0	53 16 89 cd 1d b2 ce 0a 56 9d 9d 28 52 cf 02 38	S..... V..(R..8
00b0	86 61 ad 96 c7 00 22 ce d6 a7 79 e0 08 b8 79 db	.a....". ..y...y.
00c0	ba 71	.q

WiRES-X Startup – List Server

- Load binary configuration file from fixed URL
- Configuration points to multiple List Servers

(ip.addr eq 192.168.3.126 and ip.addr eq 71.139.254.252) and tcp.port

No.	Time	Source	Destination	Protocol	Length	Info
70	11.876894	192.168.3.126	71.139.254.252	TCP	66	52022 → 80 [SYN] Seq=0 Win=8192 Len=0 MSS=1460 WS=4 SACK_PERM=1
71	11.958547	71.139.254.252	192.168.3.126	TCP	66	80 → 52022 [SYN, ACK] Seq=0 Ack=1 Win=8192 Len=0 MSS=1380 WS=256 SACK_PERM=1
72	11.958809	192.168.3.126	71.139.254.252	TCP	54	52022 → 80 [ACK] Seq=1 Ack=1 Win=66240 Len=0
73	11.960366	192.168.3.126	71.139.254.252	HTTP	175	GET /jp/en/wiresinfo-en/sv/UpdateInfo.bin HTTP/1.1
75	12.042547	71.139.254.252	192.168.3.126	HTTP	752	HTTP/1.1 200 OK (application/octet-stream)
76	12.042788	192.168.3.126	71.139.254.252	TCP	54	52022 → 80 [ACK] Seq=122 Ack=699 Win=65540 Len=0

▶ Frame 73: 175 bytes on wire (1400 bits), 175 bytes captured (1400 bits) on interface 0

▶ Ethernet II, Src: GoodWayI_16:dc:77 (00:50:b6:16:dc:77), Dst: Apple_29:12:a9 (88:1f:a1:29:12:a9)

▶ Internet Protocol Version 4, Src: 192.168.3.126, Dst: 71.139.254.252

▶ Transmission Control Protocol, Src Port: 52022, Dst Port: 80, Seq: 1, Ack: 1, Len: 121

```
0000  88 1f a1 29 12 a9 00 50  b6 16 dc 77 08 00 45 00  ...).P...w..E.
0010  00 a1 5c 3c 40 00 80 06  93 6c c0 a8 03 7e 47 8b  ..\<@... .l...~G.
0020  fe fc cb 36 00 50 0e 2f  bf 0a 39 12 2d c3 50 18  ...6.P./ .9.-.P.
0030  40 b0 de 02 00 00 47 45  54 20 2f 6a 70 2f 65 6e  @.....GE T /jp/en
0040  2f 77 69 72 65 73 69 6e  66 6f 2d 65 6e 2f 73 76  /wiresinfo-en/sv
0050  2f 55 70 64 61 74 65 49  6e 66 6f 2e 62 69 6e 20  /UpdateInfo.bin
0060  48 54 54 50 2f 31 2e 31  0d 0a 55 73 65 72 2d 41  HTTP/1.1 ..User-A
0070  67 65 6e 74 3a 20 57 49  52 45 53 2d 58 0d 0a 48  gent: WI RES-X..H
0080  6f 73 74 3a 20 77 77 77  2e 79 61 65 73 75 2e 63  ost: www.yaesu.c
0090  6f 6d 0d 0a 43 61 63 68  65 2d 43 6f 6e 74 72 6f  om..Cache-Contro
00a0  6c 3a 20 6e 6f 2d 63 61  63 68 65 0d 0a 0d 0a    l: no-cache....
```

WiRES-X Data

Data Type	Description
List Server Hello	TCP to fixed URL
List Server initial response	List of resources (servers), configuration
List Server Request	Connection to List Server
List Server Responses	Rooms, Nodes, descriptions, IP address
Status	Update Node, Room and List Server
Heartbeat	Periodic, still alive
Heartbeat response	Reverse heartbeat
Control information	Tx up/down, connect request, disconnect, etc.
Voice	Analog and Fusion OTA data

WiRES-X Console

The screenshot displays the WiRES-X software interface with the following components:

- Top Menu:** File(F), View(V), Connect(C), Tool(T), Help(H)
- Control Panel:** Includes buttons for NET DIGITAL, ON-AIR, LOCAL, HRI-200, RADIO 1, and MNWIS-FUSION. A status bar shows: User = N2P8R-MATT > ***** (DN: FTM-400D), Uplink = K9EQ (11138).
- Room Information:** Room MNWIS-FUSION(21493) member 39 nodes. Includes Refresh and Close buttons.
- Room Selection Grid:** A grid of buttons for various rooms such as WOMDT-DAY, KE4JD-ND1, NOJOL-ND, etc.
- +C.User ID Table:**

+C.User ID	DTM...	Act	Call/Rm...	City	State	Cou...
AB9DW-ND	11973	IN	AB9DW	Franklin	Wiscons...	US
KA1CNF-ND	30128	IN	KA1CNF	Macedon	New York	US
KA4YMZ-RPT	18506	IN	KA4YMZ	Spencer Mt	North C...	US
KB0GRP-ND	30555	IN	KB0GRP	Inman	Nebraska	US
KB2NGU-RPT	18377	IN	KB2NGU	Brooklyn	New York	US
KC9NSA-RPT	11332	IN	KC9NSA	Round Lake	Illinois	US
- +A.User ID Table:**

+A.User ID	DTM...	CallSign	City	State	Cou...	Freq
-K0STP-	11344	K0STP	Gordonville	Virginia	USA	443
-2E0FTG-	31207	2E0FTG	Hook	Hamps...	UK	
-JE1UDL-	16671	JE1UDL	Takasaki-city	Gunma	Jap...	
-WASSAMU-	19360	JM8JUB	Kamikawa-gun	Hokkaido	Jap...	430
- Room ID Table:**

Room ID	DTM...	-Act	Room name	City	State
ALLJA-CQ-ROOM	20510	161	ALL JA CQ ROOM#1	Yamato-city	Kanaga
AMERICA-LINK	21080	061	America Link Network	Beaumont	Texas
ITALY	27003	046	WIRES-X ITALIA	Cassolnovo	Lomba
MNWIS-FUSION	21493	039	MNWis Fusion Netw...	Lino Lakes	Minnes
CQ-UK	27793	029	CQ-UK	Pudsey	West Y
TSQL0945-ROOM	20945	029	f9lf~fXfPf~f~RD%ai	Koriyama...	Fukush
0382-ROOM	20382	025	WIRES-X0382Room	Nagoya-city	Aichi
FUKUOKA-LINK	20587	021	FUKUOKA-LINK	Fukuoka-city	Fukuok
10M-FM-ROOM-3	20435	018	10M-FM-ROOM-3 #...	Takasaki-city	Gunma
9158-ROOM	29158	016	9158Zi~lf~lfE	Itabashi-ku	Tokyo
POLAND	27784	016	POLAND-room	Lodz	Lodzkie
E-KYUSHU-ROOM	29118	014	CE~aBQSORroom	Miyazaki-city	Miyaza
ITALY NORD	27654	014	ITALY NORD	Subano	Lomba
- Chat Log:**

```

2017/09/13 11:55:18 DL90H-ND(17775) IN. 40 Nodes.
2017/09/13 11:55:29 DL90H-ND(17775) OUT. 39 Nodes.
2017/09/13 11:55:50 List Create Group window list (XML)
2017/09/13 11:55:51 List Create Active ID list (XML)
2017/09/13 11:55:51 List Create Room ID list (XML)
2017/09/13 12:02:21 W6DEN-ND(30609) OUT. 38 Nodes.
2017/09/13 12:03:14 W6DEN-ND(30609) IN. 39 Nodes.

2017/09/18 10:32:12 WOMDT-MV > MNWIS-FUSION : I hate CenturyLink! [EOM] ...d
2017/09/18 10:32:22 WOMDT-MV > MNWIS-FUSION : There, now I feel better.
    
```
- Bottom Panel:** Includes SEND and CLR buttons.

WiRES-X Software Data

- XML/CSV Data

- All Nodes*
- All Rooms*
- Group ID*

- Logs

- Node
- Room
- News

- Other

- Access Log (all transmissions)*
- Diagnostic

- Used by HamOperator.com

WiRES-X Nodes Connected to MNWIS de K9EQ
WiRES-X Room #21493

Updated about every 30 minutes
Number of WiRES-X Nodes Listed: 45
Number of Analog Nodes: 4
Number of Digital Nodes: 35
Number of FCS003-23 Connections: 6

[Courtesy HamOperator.com](http://HamOperator.com)
Report Created: Wed, 13 Sep 2017 18:02:27 Rev. XML=0.8, Python=0.9.3

Do not bookmark this page - it will change. Use HamOperator.com/Fusion/WiRES-X

User ID	ID #	A/D	City	State	Country	Freq	SQL	Comment
KBOGRP-ND	30555	A	Inman	Nebraska	USA			
KF4HR-NC	11019	A	Belhaven	North Carolina	USA			
N0BVE-MPLS	11165	A	Hopkins	Minnesota	USA	145.230MHz-.600MHz	TSQ:114.8Hz	145.230 CHASKA MN PL 114.8
W7ECA-RPT	30406	A	Great Falls	Montana	USA	444.350MHz+5.000MHz	DCS:051	
AB9DW-ND	11973	D	Franklin	Wisconsin	USA	445.550MHz	DSQ:OFF	Dale - Franklin, WI, USA
JATUDE-ND	16082	D	Sendai-city	Miyagi	Japan	430.900MHz	DSQ:OFF	
K5KOY-ND	18250	D	Dallas	Texas	USA	445.525MHz	DSQ:OFF	From the Republic of Texas in DFW
KA1CNF-ND	30128	D	Macedon	New York	USA	147.525MHz	DSQ:OFF	West Waiworth, NY
KA4YMZ-RPT	18506	D	Spencer Mt	North Carolina	USA			
KB2NGU-RPT	18377	D	Brooklyn	New York	USA			
KC9IL-ND	18113	D	Buffalo Grove	Illinois	USA			
KC9NSA-RPT	11332	D	Round Lake Beach	Illinois	USA			
KE4IDF-TOM	30013	D	Dayton	Tennessee	USA			
KE4ID-ND1	30514	D	Hopkinsville	Kentucky	USA			
KI4WXS-RPT	11170	D	Charlotte	North Carolina	USA			
KL4AN-ND	18462	D	Anchorage	Alaska	USA			
KN6LL-ND	30263	D	Jackson	Wyoming	USA			
N0AN-ND	30158	D	Ogden	Iowa	USA			
N0BJN-ND	30012	D	Little Falls	Minnesota	USA			
N0JOL-ND	30092	D	Isanti	Minnesota	USA			

MNWIS Stations Last Heard de K9EQ
WiRES-X Room #21493, Updated about every 30 minutes

Sorted by date/time when the indicated Transmitter ID was heard.
Stations on W0MDT-MV 444.525 are listed as Local
[Courtesy HamOperator.com](http://HamOperator.com) Rev. Python=0.9.3

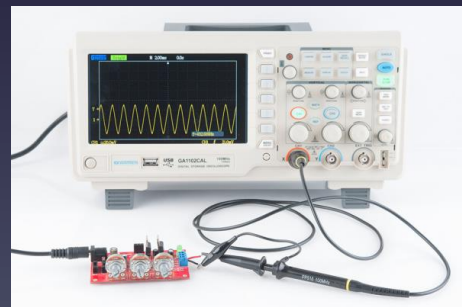
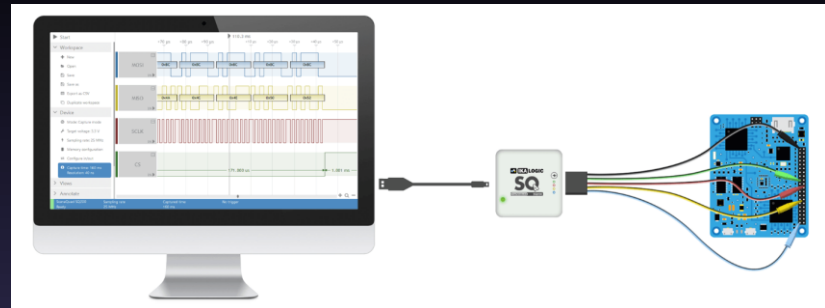
Do not bookmark this page - it will change. Use HamOperator.com/Fusion/WiRES-X

FT1D=12, FT2D=8, FTM-400=40, FTM-100=19, FTM-3200=2, FT70D=3, FT-991=6, Total=90

STATION	CALL	Tx ID	Radio Type	Net or Local	When Heard
W0MTA-MYKL	W0MTA-MYKL	F0Rku	FTM-400	Local	Wed Sep 13 18:00:55 2017
AEORF	AEORF	E0bmb	FT1D	Net	Wed Sep 13 18:00:28 2017
K9EQ/R-075	K9EQ/R-075	E0DoV	FT1D	Local	Wed Sep 13 18:00:09 2017
N9GHP/MIKE	N9GHP/MIKE	F0bDK	FTM-400	Net	Wed Sep 13 17:51:25 2017
KC9IL-WRRN	KC9IL-WRRN	F0oWa	FTM-400	Net	Wed Sep 13 17:51:07 2017
N8XPQ-MIKE	N8XPQ-MIKE	F0pvi	FTM-400	Net	Wed Sep 13 17:45:36 2017
N7GYL	N7GYL	E5KL8	FT2D	Net	Wed Sep 13 17:18:32 2017
KC9RHH	KC9RHH	E0i3y	FT1D	Net	Wed Sep 13 16:57:20 2017
KC9OZA	KC9OZA	E0A1S	FT1D	Net	Wed Sep 13 16:55:07 2017
N0JOL-JOE	N0JOL-JOE	F061a	FTM-400	Net	Wed Sep 13 16:52:36 2017
K0ORKCHUCK	K0ORKCHUCK	E51e8	FT2D	Local	Wed Sep 13 16:51:25 2017
K5KOY-KOY	K5KOY-KOY	E5cO4	FT2D	Net	Wed Sep 13 16:47:31 2017
AD0MI-PETE	AD0MI-PETE	F0Ij4	FTM-400	Net	Wed Sep 13 16:44:34 2017
N1JUX/KEVN	N1JUX/KEVN	F54kT	FTM-100	Net	Wed Sep 13 16:34:22 2017
N0JOL-JOE	N0JOL-JOE			Local	Wed Sep 13 16:30:00 2017
W0GAU GREG	W0GAU GREG	F5NGc	FTM-100	Net	Wed Sep 13 16:17:32 2017
KDOJNQ/BSR	KDOJNQ/BSR	G09DZ	FT-991	Net	Wed Sep 13 15:52:27 2017
KA0FOP-JHN	KA0FOP-JHN	E0fSc	FT1D	Net	Wed Sep 13 15:46:18 2017
N2PSR-MATT	N2PSR-MATT	F0IKx	FTM-400	Local	Wed Sep 13 15:22:06 2017

Analysis Tools

- WireShark
 - Wireshark.org
 - FTDIChip.com
- Scanstudio
 - IKALogic.com
- Oscilloscope



TAPR and Manufacturers

Discussion

- Could TAPR collaborate with manufacturers on projects?
- What should manufacturers do? What should Hams do?
- Is there opportunity to bring digital benefits to a broad range of non-technical users? (I.e., APRS)
- What Digital Voice needs to do (hint: things analog can't do)
- Potential Projects:
 - Diversity reception for repeaters
 - Multisite digital reception
 - Common receive locations for multiple repeaters

Additional Resources

- Saelig.com – Test Equipment
- SparkFun.com, Adafruit.com, Hacktronics.com, SeedStudio.com
- Hackaday.com, DIYHacking.com
- Element14.com
- Tapr.org
- Yaesu Digital Standard (Yaesu.com)
- Github software repositories
- **Fusion Technical Net Monday 7:30 PM Central (0030/0130 UTC) Room #21493, Internet Streaming: HamOperator.com**

73, Chris K9EQ