Digital Mobile Radio (DMR) Fundamentals

Agenda

- Introductions
- What is driving DMR Radio?
- What benefits does DMR provide?
- What is DMR modulation scheme?
- Basic DMR functions
  - Zones
  - Color Codes
  - Roaming
  - Simplex
  - Talk Groups
  - C-Bridge

What's Driving Digital Radio?

- SPECTRUM!
  - United States FCC is running out of spectrum due to the explosion of wireless technologies and has instituted a mandate.
  - By January 1, 2013, licensees must migrate their two way radio systems from 25 kHz (wideband) to 12.5 kHz (narrowband) channel bandwidth or radio technology that achieves equivalent efficiency
- Who's required by FCC Narrow Banding?
  - All Public Safety and Industrial/Business licensees in the 150-174 MHz (VHF) and 421-512 MHz (UHF) bands
- Amateur Radio has taken advantage of this newer technology known generically as Digital Mobile Radio.

Digital Mobile Radio (DMR)

- Digital mobile radio (DMR)
  - Open digital radio standard
  - Professional Mobile Radio (PMR) users
- Specified in the European Telecommunications Standards Institute (ETSI) Standard (ETSI TS 102 361-1, 2, 3 &4)
- The standard was first published in 2005 and has been widely adopted by radio manufacturers and users.[2]
- Products built to the DMR standard also comply with the U.S. Federal Communications Commission (FCC) mandates in the United States for the use and certification of 12.5 kHz and 6.25 kHz narrowband technology for systems covered by Part 90 regulations.

Digital Mobile Radio (DMR)

- Designed as a low cost entry level radio system for commercial use, consequently DMR *is not* classed as a mission critical or critical communications platform.

- A situation further compounded by vendors introducing proprietary standards over and above the limited ETSI DMR standards list and nulling interoperability between different vendor offerings.

- DMR provides voice, data and other supplementary services.

- DMR is a two-slot, time division multiple access (TDMA) system offering voice, data and a range of other features and applications.

- The specification covers the RF frequency range 30 MHz to 1 GHz and uses 4 state/level FSK constant envelope modulation.

References
1) ETSI. "DMR Standard Overview". ETSI. Retrieved 22 March 2012.
2) David, Taylor. "DMR Market Report". Analysis Mason. Retrieved 22 March 2012.
3) http://www.dmrassociation.com. Missing or empty |title= (help)
4) "DMR Equipment Manufacturers & Product Showcase".
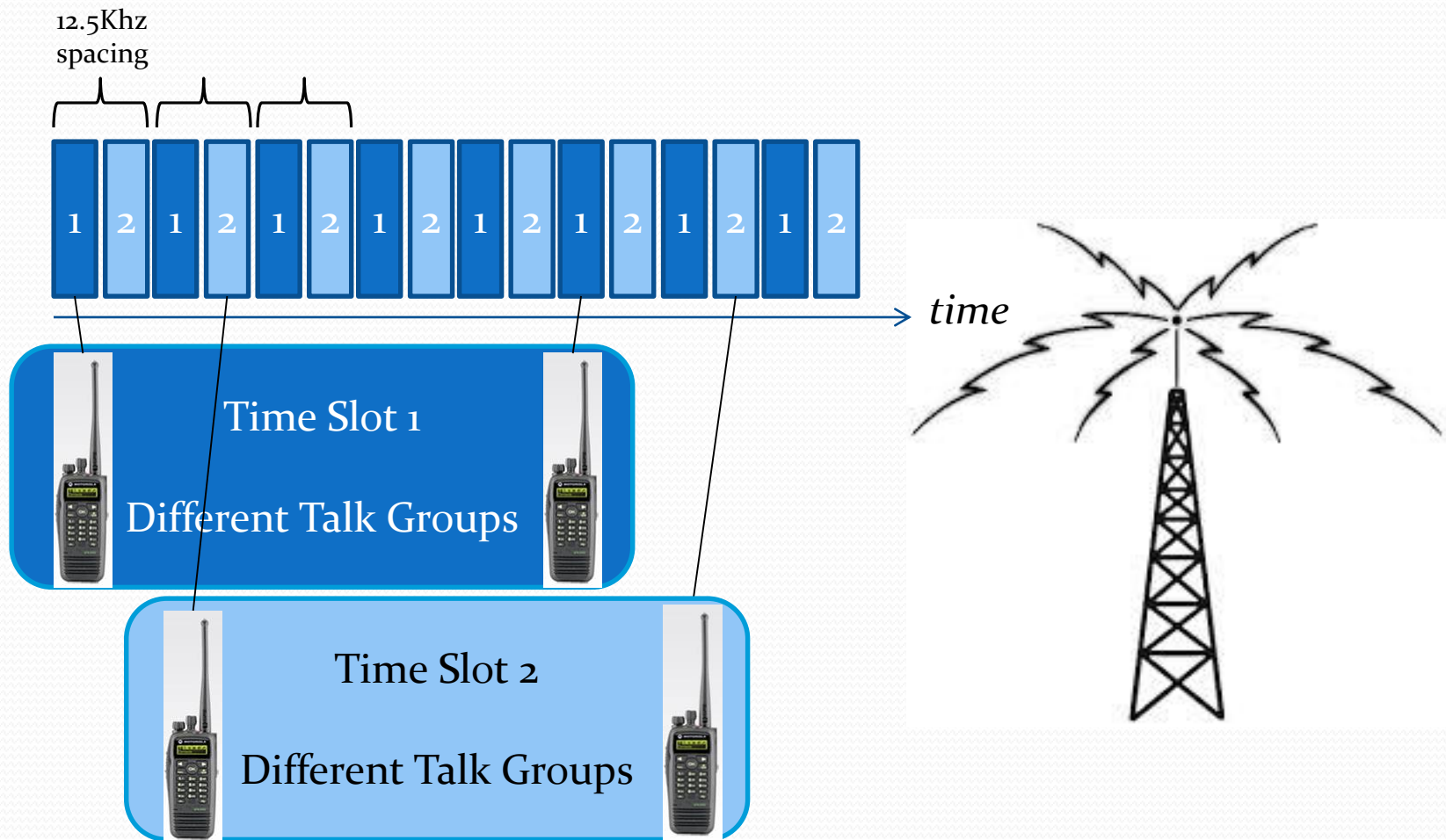5) http://dmrassociation.org/?page_id=339. Missing or empty |title= (help)

DMR Benefits

- Two (2) simultaneous conversations from single repeater transmitter

- Improved audio performance over analog FM

- More efficient use of RF spectrum
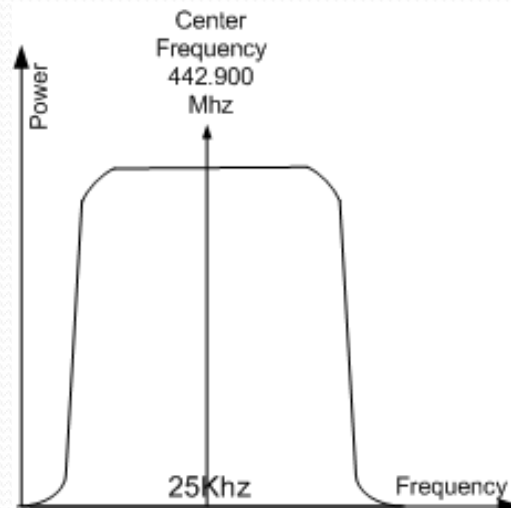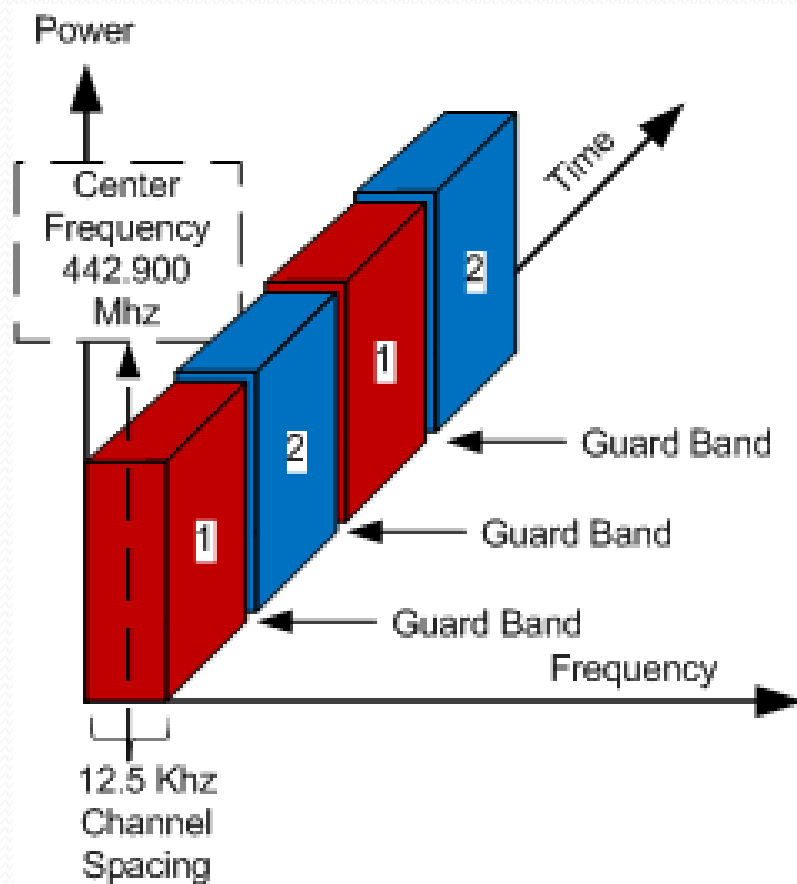
- Less power consumption than FM

* **Suppliers**
Tait Communications, Fylde Micro, Selex, Motorola, Hytera, Vertex Standard, Kenwood and Icom
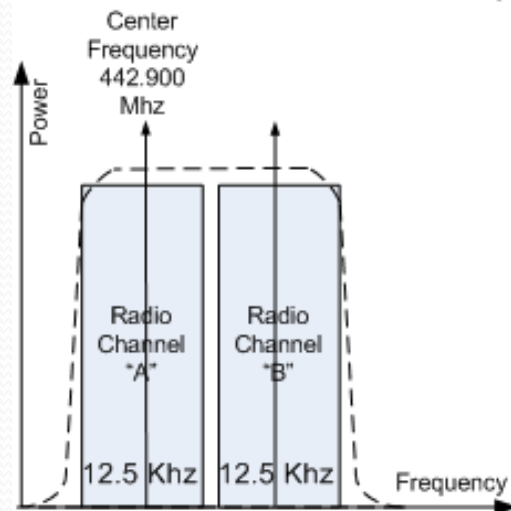
Two Conversations/Transmitter

12.5Khz spacing

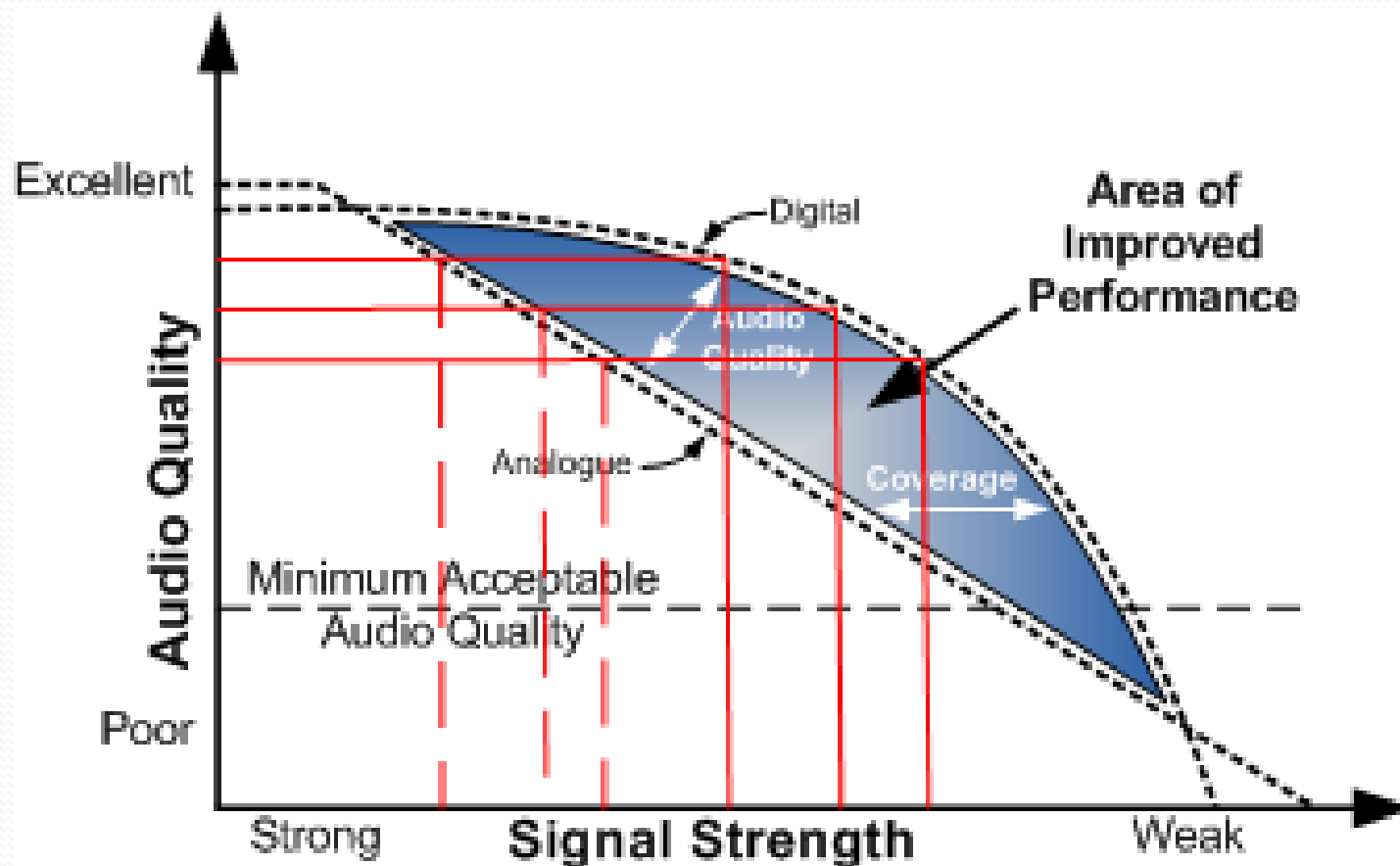| 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 |

time

Time Slot 1

Different Talk Groups

Time Slot 2

Different Talk Groups

Efficient Radio Spectrum

1 - Analog Repeater 25Khz, 1 conversation

1 - DMR Repeater 12.5Khz, 2 Time Slots or conversations per DMR Repeater

Total Efficiencies: 4 Voice DMR conversations for 1 analog conversation

Improved Voice Performance

Zones, Color Codes

- **Zones** – User DMR radios support Zones, a Zone is just a grouping of individual channels. Some model radios may limit the number of channels per Zone and the number of Zones allowed.

- **Color Codes** – DMR repeaters use Color Codes (CC) much like analog repeaters use CTCSS or DCS.
  - To access a repeater you must program your radio to use the same CC as the repeater. There are 16 different CCs (CC0-CC15).
  - The use of Color Codes is not optional on DMR systems. If your Color Code is not set correctly, you will not be able to access the repeater.
  - The only real purpose of using different Color Codes is when multiple repeaters operating on the same frequency have overlapping coverage areas.

Reference: John S. Burningham, W2XAB

Roaming

- Roaming is designed to have your radio automatically select the best channel if your current channel's Receive Signal Strength Indicator (RSSI) falls below a defined level as you move throughout the coverage area of a group of repeaters that carry the same talk groups on the same time slots.

- You should select channels that have the same time slot and receive groups configured; if you do not, roaming may not work correctly.

- Repeaters can be configured to transmit beacons at predefined intervals of inactivity so roamers will be on the correct channel, without the repeater beacons roaming will still work but the radio will only change channels if it hears a repeater.

Reference: John S. Burningham, W2XAB

Simplex

- Direct or point to point communications between users
- Amateurs typically use dedicated simplex channels so as not to interfere with repeaters.
- The amateur DMR community has published a list of recommended simplex frequencies to be used instead of operating simplex on repeater outputs:
  - UHF 1) 441.000 2) 446.500 3) 446.075 4) 433.450
  - VHF 1) 145.790 2) 145.510
    - [Use TG99 / CC1 / TS1 /Admit Criteria: Always / In Call Criteria: TX or Always]
- Do not use 146.520 or 446.000; they are the national analog simplex channels.

Reference: John S. Burningham, W2XAB

Talk Groups

- A method for groups of users to share a time slot (one-to-many) without distracting and disrupting other users of the time slot.
- It should be noted that only one talk group can be using a time slot at a time.
- If your radio is not programmed to listen to a talk group, you will not hear that talk group's traffic.
- There are talk groups implemented for individual states and regional on many networks.
- Some talk groups are available all the time, only at preprogrammed times, or require a local user to PTT on the talk group to activate for a period of time.
- Since only one talk group can be active at a time on a time slot, many systems will disable other talk groups when a local user is active on a different talk group on the time slot.
- Be ham friendly and try to use talk groups that tie up the fewest number of repeaters if you are going to have a long QSO.

Reference: John S. Burningham, W2XAB

C - Bridge ™

- To interconnect DMR Repeaters via the internet
- One of the repeaters (or a c-Bridge™) serves as a Master and the other repeaters as Peers
- Any traffic on originating on one of the interconnected repeaters is relayed over the IP network to each of the other repeaters.
- The c-Bridge™ allows for the management of talk groups on an always-on, scheduled, or on-demand (Push To Talk) basis. <u>Not all talk groups will be available on all repeaters.</u>
- Local talk groups have priority over other PTT talk groups.*
- The c-Bridge™ also supports the interconnection of non-DMR audio sources utilizing an optional USB analog dongle and vocoder module.

* Chicagoland Control Center C-Bridge Programmed

Reference: John S. Burningham, W2XAB
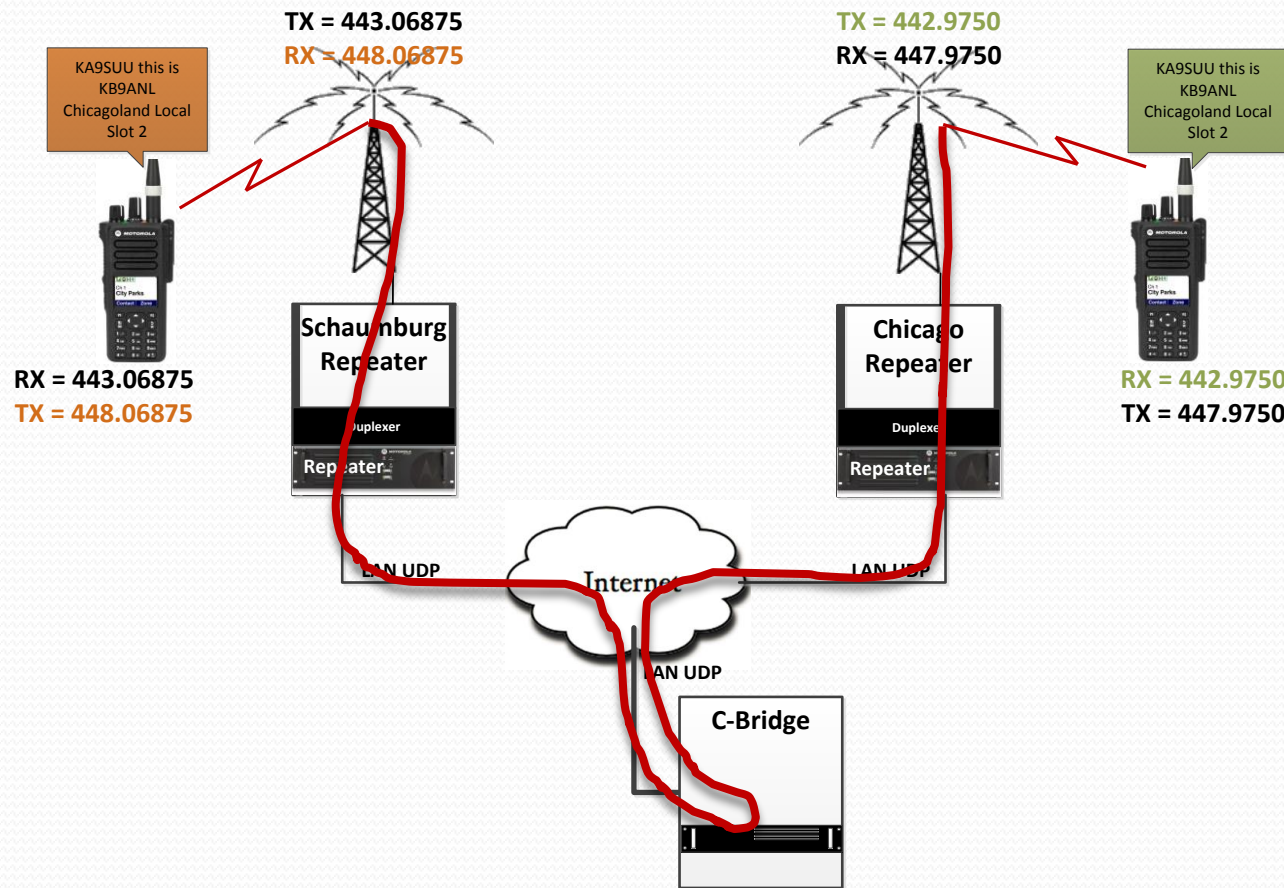
Illustration shows how the C-Bridge connects multiple repeaters together.

Chicagoland Control Center Talk Groups

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Chicagoland Control Center
Talk Group Resource Usage

Talk Group Resource Usage
(estimates depending on outside connections)

Talk Group Name	Timeslot	Number	Source	# Areas involved	est. # Rptrs keyed
Parrot 2	2	9998	DMRX	testing single site	1
Audio Test 2	2	9999	DMRX	testing single site	1
TAC1 2	2	8951	DMRX	Site to Site	2 or more
TAC310 2	2	310	DMRX	Site to Site	2 or more
TAC311 2	2	311	DMRX	Site to Site	2 or more
TAC 312 1	1	312	K4USD	Site to Site	2 or more
TAC 313 1	1	313	K4USD	Site to Site	2 or more
TAC 314 1	1	314	K4USD	Site to Site	2 or more
TAC 315 1	1	315	K4USD	Site to Site	2 or more
TAC 316 1	1	316	K4USD	Site to Site	2 or more
TAC 317 1	1	317	K4USD	Site to Site	2 or more
TAC 318 1	1	318	K4USD	Site to Site	2 or more
TAC 319 1	1	319	DMRX	Site to Site	2 or more
UA English 1	1	113	MARC	Site to Site	2 or more
UA English 2	2	123	MARC	Site to Site	2 or more
Wisconsin 1	1	3155	ChicagoLand	ChicagoLand	7
Illinois 1	1	3117	ChicagoLand	ChicagoLand	20
Local 1	1	3181	ChicagoLand	ChicagoLand	40
Local 2	2	3166	ChicagoLand	ChicagoLand	40
MidWest 2	2	3169	MARC	Midwest Region	>200
Comm 1	1	3777215	DMRX	Nationwide	>200
Comm 2	2	3777216	DMRX	Nationwide	>200
Bridge 2	2	3100	DMRX	Nationwide	>300
NA 2	2	3	MARC	Nationwide	>500
WWe 2	2	13	MARC	Worldwide	>700
WW 2	2	1	MARC	Worldwide	>700
California 1	1	3106	DMRX	Statewide	n/a

California 1	1	3106	DMRX	Statewide	n/a
Florida 1	1	3112	BM	Statewide	n/a
Georgia 1	1	3113	DMRX	Statewide	n/a
Indiana 1	1	3118	BM	Statewide	n/a
Iowa 1	1	3119	BM	Statewide	n/a
Kentucky 1	1	3121	DMRX	Statewide	n/a
Maryland 1	1	3124	BM	Statewide	n/a
Massachusetts 1	1	3125	DMRX	Statewide	n/a
Michigan 1	1	3126	DMRX	Statewide	n/a
Minnesota 1	1	3127	K4USD	Statewide	n/a
Ohio 1	1	3139	DMRX	Statewide	n/a
Pennsylvania 1	1	3142	DMRX	Statewide	n/a
Tennessee 1	1	3147	BM	Statewide	n/a
Dallas Local 1	1	2	LoneStar	n/a	n/a
Texas 1	1	3148	LoneStar	Statewide	n/a
Virginia 1	1	3151	BM	Statewide	n/a
Washington 1	1	3153	BM	Statewide	n/a
Washington DC 1	1	3111	BM	n/a	n/a
West Central Florida 1	1	2	WCF	n/a	n/a
Mid Atlantic Region 1	1	3173	MARC	Regional	n/a
Mountain Region 1	1	3177	MARC	Regional	n/a
Northeast Region 1	1	3172	MARC	Regional	n/a
Southern Region 1	1	3175	MARC	Regional	n/a
Southeast Region 1	1	3174	MARC	Regional	n/a
Southwest Region 1	1	3176	MARC	Regional	n/a
1776 2	2	1776	MIT	n/a	n/a

Chicagoland Control Center Repeaters

#	C-Bridge Name	ID	City	Tx Freq	Color	Offset	Timeslot	Trustee	Notes
1	Schaumburg IL (VHF)	311745	Schaumburg	146.70000	1	-.6	TS1 TS2	WB9PHK	On air
2a	Schaumburg IL	311712	Schaumburg	443.06875	0	+5	TS1 TS2	WB9PHK	On air
2b	Dundee IL	2	East Dundee	443.06875	0	+5	TS1 TS2	WB9PHK	On air
2c	Barrington IL	3	Barrington	443.06875	0	+5	TS1 TS2	WB9PHK	On air
2d	West Chicago IL	4	West Chicago	443.06875	0	+5	TS1 TS2	WB9PHK	On air
2e	LaGrange IL	5	LaGrange	443.06875	0	+5	TS1 TS2	WB9PHK	On air
3	Schaumburg IL (900)	311764	Schaumburg	927.66250	0	-25	TS1 TS2	WB9PHK	On air
4	Batavia IL	311713	Batavia	443.08125	1	+5	TS1 TS2	WB9PHK	On air
5	Mundelein IL	311714	Mundelein	423.29375	2	-3	TS1 TS2	WB9PHK	On air
6	Aurora IL	311719	Aurora	443.42500	1	+5	TS1 TS2	W9LSL	On air
7	Belvidere IL	311735	Belvidere	442.75000	10	+5	TS1 TS2	K9VO	On air
8	Winnebago IL	311739	Winnebago	440.05625	3	+5	TS1 TS2	W9TMW	On air
9	Homer Glen IL	311715	Homer Glen	442.83125	3	+5	TS1 TS2	WB9PHK	On air
10	Algonquin IL	311723	Algonquin	443.95625	15	+5	TS1 TS2	WD9BBE	On air
11	Chicago IL (Loop)	311731	Chicago	442.97500	4	+5	TS1 TS2	WD9BBE	On air
12	Wauconda IL	311762	Wauconda	442.12500	1	+5	TS1 TS2	N9CWM	On air
13	Plato Center IL	311728	Plato Center	444.97500	1	+5	TS1 TS2	WR9ABQ	On air
14	Lockport IL	311737	Lockport	443.22500	2	+5	TS1 TS2	N2BJ	On air
15	New Lenox IL	311738	New Lenox	444.40000	2	+5	TS1 TS2	N2BJ	On air
16	McCook IL	311746	McCook	440.75625	1	+5	TS1 TS2	N9CWM	On air
17	Rockford IL	311766	Rockford	443.45000	1	+5	TS1 TS2	N9MCS	On air
18	River Grove IL	311767	River Grove	443.35000	1	+5	TS1 TS2	K9SA	On air
19	Danville IL	311749	Danville	443.82500	10	+5	TS1 TS2	KC9DTN	On air
20	Morton IL	311752	Morton	442.20000	12	+5	TS1 TS2	KB9YVN	On air
21	Elburn IL	311759	Elburn	443.64375	6	+5	TS1 TS2	W9XA	On air
22	Plano IL	311760	Plano	443.65625	6	+5	TS1 TS2	W9XA	Off air
23	Chicago IL (BMK) *	311720	Chicago	440.30000	1	+5	TS1 TS2	W9BMK	Chi-DMR
24	Chicago IL (VO) *	311722	Chicago	443.92500	1	+5	TS1 TS2	K9VO	Chi-DMR
25	Danville IL *	311749	Danville	443.82500	10	+5	TS1 TS2	KC9DTN	Chi-DMR

* Note: The Danville IL, Chicago (BMK) & Chicago (VO) sites are on the **CHI-DMR** c-bridge (KC9MNL) which is attached to the **ChicagoLand** c-bridge

Chicagoland Control Center Repeaters

#	C-Bridge Name	ID	City	State/Prov	Tx Freq	Color	Offset	Timeslot	Trustee	Notes
26a	**Walworth WI**	315504	Walworth	Wisconsin	441.94375	9	+5	TS1 TS2	N9OIG	On air
27	**Rock Lake WI**	315505	Rock Lake	Wisconsin	442.19375	9	+5	TS1 TS2	N9OIG	On air
28	**Lake Geneva WI**	315508	Lake Geneva	Wisconsin	442.12500	9	+5	TS1 TS2	KB9LTE	On air
29	**Milwaukee WI**	315511	Milwaukee	Wisconsin	442.20625	9	+5	TS1 TS2	N9OIG	On air
30	**Waterford WI**	315516	Waterford	Wisconsin	440.76875	4	+5	TS1 TS2	N9OIG	On air
31	**Racine WI (900)**	315523	Racine	Wisconsin	927.98750	-25	+5	TS1 TS2	N9OEZ	On air
32a	**Racine WI**	315520	Racine	Wisconsin	440.00625	9	+5	TS1 TS2	KR9RK	On air
32b	**Kenosha WI**	2	Kenosha	Wisconsin	440.00625	9	+5	TS1 TS2	KR9RK	On air
32c	**Downtown Racine WI**	3	Downtown Racine	Wisconsin	440.00625	9	+5	TS1 TS2	KR9RK	On air
32d	**Sturtevant WI**	4	Sturtevant	Wisconsin	440.00625	9	+5	TS1 TS2	KR9RK	On air
32e	**Union Grove WI**	5	Union Grove	Wisconsin	440.00625	9	+5	TS1 TS2	KR9RK	On air
33	**Franklin WI**	315522	Franklin	Wisconsin	443.43125	9	+5	TS1 TS2	N9OIG	On air
34	**Punta Gorda FL**	111217	Punta Gorda	Florida	442.92500	1	+5	TS1 TS2	KA1DJ	On air
35	**Englewood FL**	311258	Englewood	Florida	444.10000	1	+5	TS1 TS2	W4MO	On air
36	**Palm Harbor FL**	313738	Palm Harbor	Florida	443.95625	15	+5	TS1 TS2	WD9BBE	On air
37	**Humboldt IA (VHF)**	311923	Humboldt	Iowa	147.39000	4	-.6	TS1 TS2	K0HU	On air
38	**Gary IN (VHF)**	311849	Gary	Indiana	146.91000	1	-.6	TS1 TS2	W9CTO	On air
39	**Raleigh NC**	313738	Raleigh	North Carolina	442.51250	1	+5	TS1 TS2	K4HA	On air
40	**Nashville (NW) TN**	314708	Nashville	Tennessee	444.58750	1	+5	TS1 TS2	WA4BGK	On air
41	**Nashville (E) TN**	314721	Nashville	Tennessee	440.52500	1	+5	TS1 TS2	W4DER	On air
42	**Colleyville TX**	314830	Colleyville	Texas	443.26250	1	+5	TS1 TS2	W5HK	On air
43	**Mobile Repeater**	311717	Schaumburg	Illinois	443.08125	1	+5	TS1 TS2	WB9PHK	On/Off air

Chicagoland Control Center Coverage Map
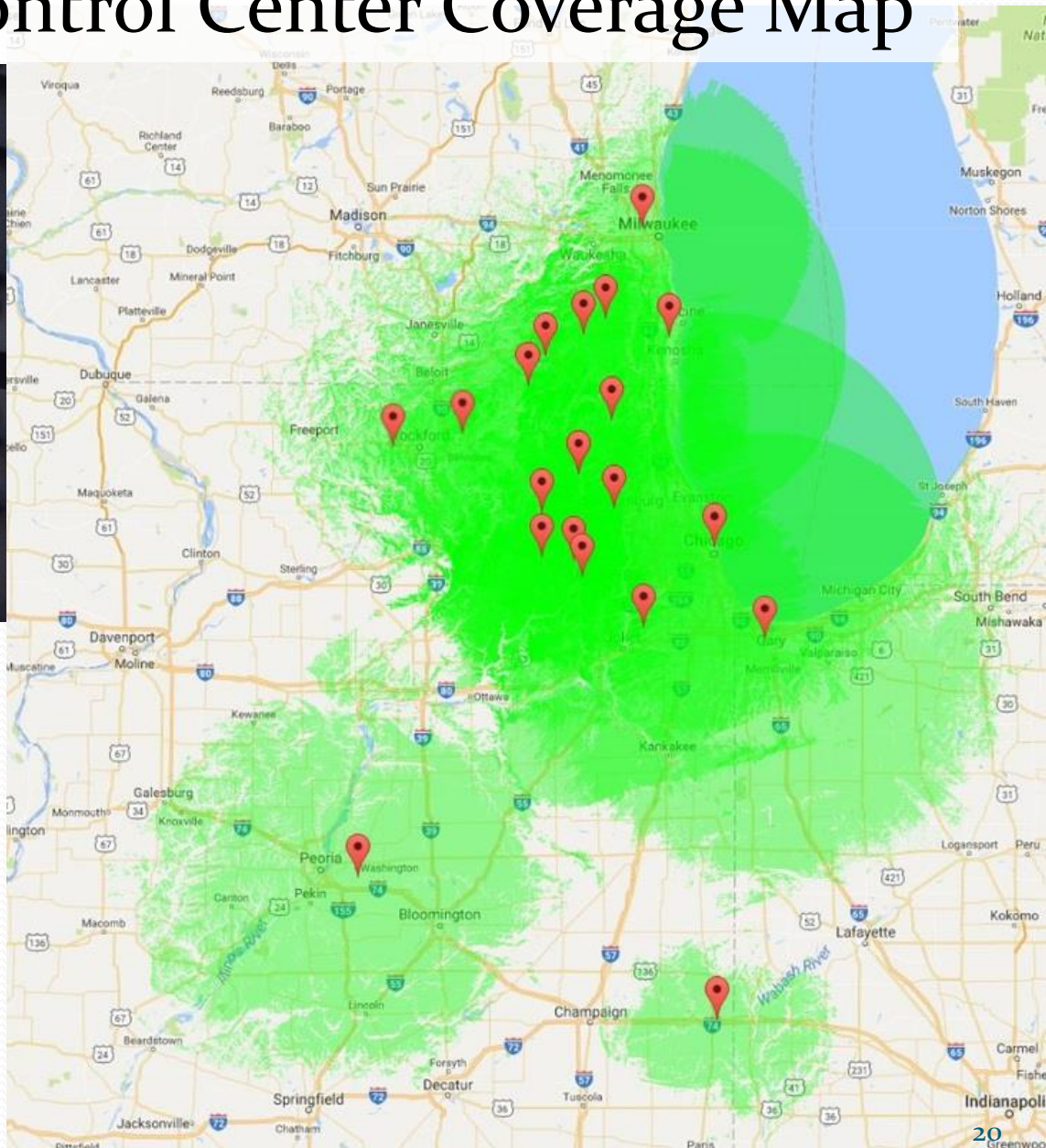
Chicagoland Web Site
chicagoland-cc.org

- Please use the minimum number of resources (repeaters) for your QSO.

- Site Local-9 (**Talk Group=9 on Time Slot =1**) is available on any repeater. Only that repeater is keyed up and active for the QSO, similar to a stand alone system.

- Check website for latest site information and other general news.

Some Common Radios Used

The End… Thanks All

From Chicago Land Control Center
WB9PHK & FishFar Radio Group

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