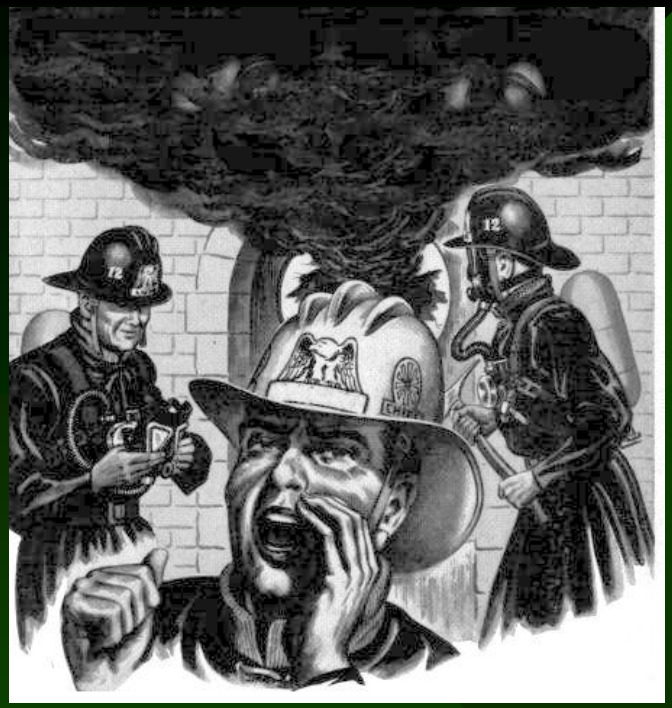
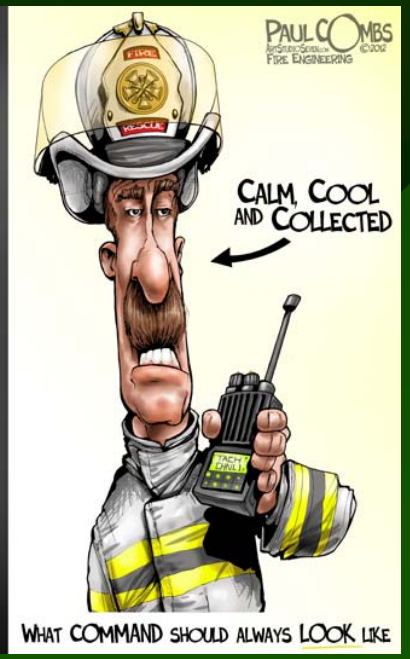


Can you Hear Me Now ???

Radio Communications 101



Communications and Radios

- The bread and butter of how we communicate.
  - Radio Frequencies
  - Wide Band vs. Narrow Band
  - Base Stations / Repeaters
  - Simplex Operations
  - Trunking vs Conventional
  - Cross Band Repeaters
  - MABAS IFERN Interoperability
  - MARC Interdisciplinary Frequencies
  - xCALL/xTAC State and Federal Interoperability
  - WISCOM

So, what does it boil down to?

•Fire departments rely heavily on two-way radios to communicate between companies, departments, and other disciplines at emergency and disaster scenes. Fire Departments utilize radio frequencies in the VHF-Low, VHF-High, UHF and 800 MHz frequency bands for day-to-day operations. Newer technologies include the use of analog and digital transmissions and trunking technologies using incompatible protocols.

•While these systems may meet the routine needs of individual departments, experience has shown that lack of interoperability between companies operating at an emergency scene can lead to serious and potentially life threatening consequences.

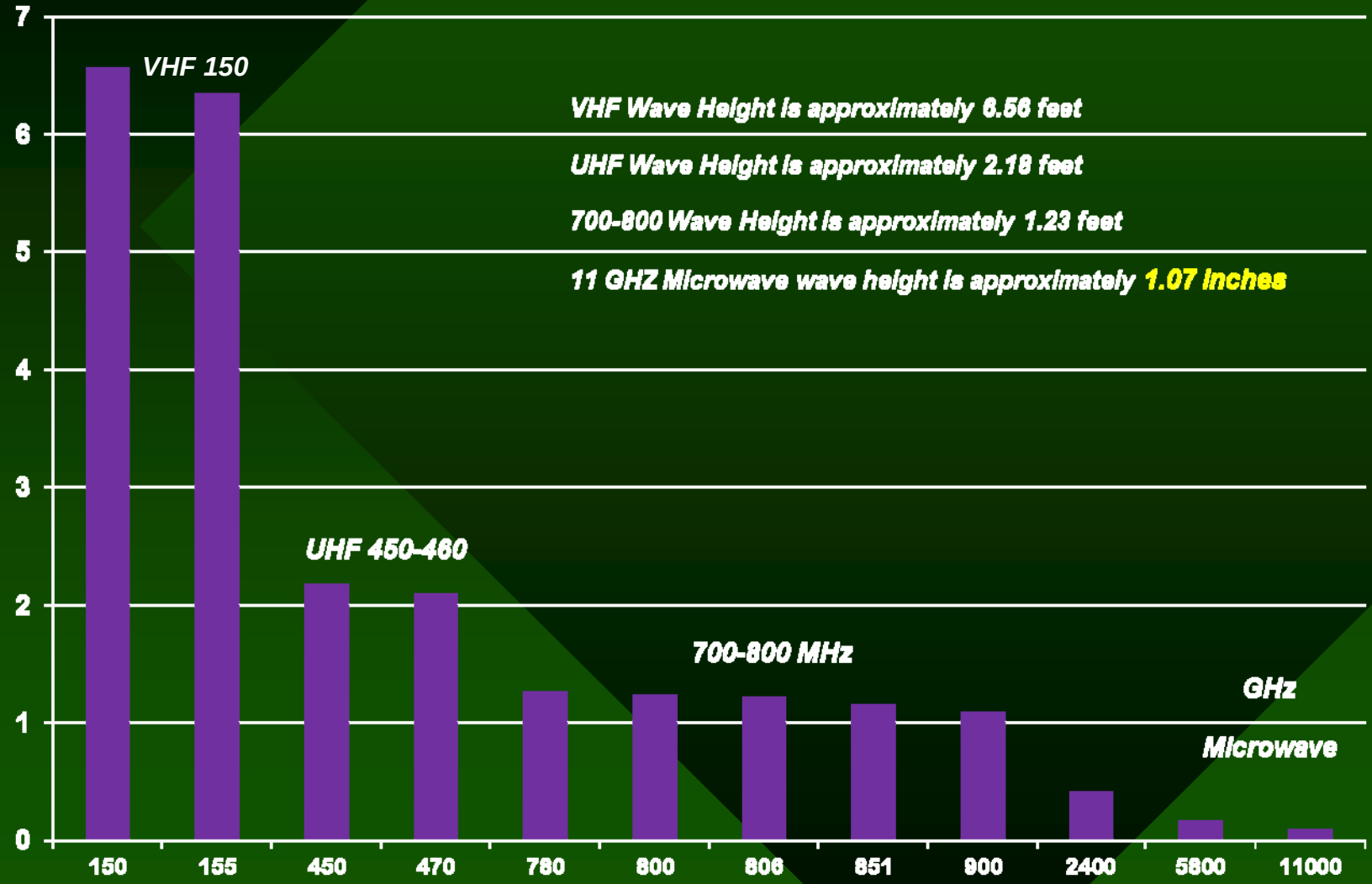
•The FCC's national radio frequency band plan specifies four VHF-High Band radio frequencies for fire service interoperability and fireground operations. There are also five analog public safety mutual aid frequencies in the 800 MHZ band plan. The state of Wisconsin has identified the frequencies of Mutual Aid Radio Channels (MARC) as a statewide, interdisciplinary, coordination channels for use by police, fire, EMS, and other governmental agencies.

•Departments that utilize frequencies other than VHF-High Band for primary operations have developed various systems to communicate with MABAS departments at mutual aid calls. These systems include cross-band mobile repeaters and console patches to VHF base stations. These systems have many limitations, have tendencies to cause harmful interference, limit operating areas, may violate FCC rules, and could jeopardize the safety of personnel at emergency scenes.

•NFPA standard 1221, Standard for the Installation, Maintenance, and Use of Emergency Communications Systems, Section 6-3.1.3 and 6-3.1.4 recommend that, "A simplex radio channel shall be provided for on-scene tactical communications" and "Communications system design shall be such that a portable radio is capable of operating properly within the dispatch area without the use of mobile radio frequency (RF) amplifiers".

•MABAS and the Wisconsin Emergency Management (WEM) have entered into an agreement to provide disaster response statewide. The potential exists for fire and EMS units to be operating for extended periods of time several hundred miles from their local jurisdiction or other distant jurisdictions may be operating in a stricken community during a disaster. Common mutual aid operations and fireground frequencies that will function statewide are essential.

Understanding Radio Frequencies



150	155	450	470	780	800	806	851	900	2400	5800	11000
6.56	6.34	2.18	2.09	1.26	1.23	1.22	1.15	1.09	0.41	0.169	0.089

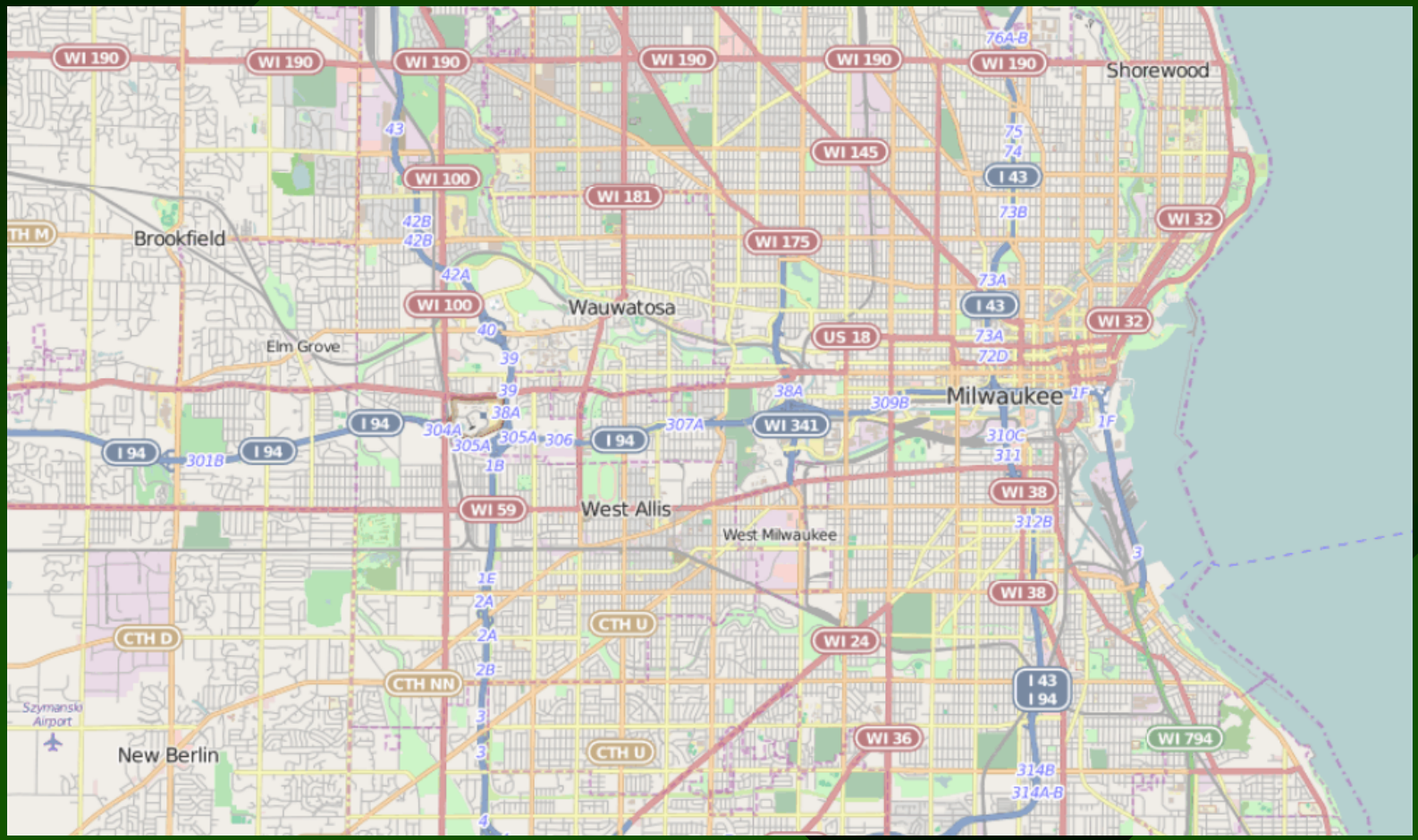
Wide Band vs Narrow Band

- FCC directive issued 12 years ago to narrow band radios.
- All radios had to be narrow banded by January 1, 2012
- Go from 25 hz spacing to 12.5 hz spacing between frequencies. In the future will see 6.25 hz spacing.
- Half the volume (think water), same amount of power (think pressure)
- About a 21% loss in coverage. If you had marginal coverage before narrow banding it was abundantly clear after narrow banding where your coverage gaps were.
- Increased the availability of frequencies
- Issues with wide band pagers
- Possible Solutions – Simulcasting, Text Messaging

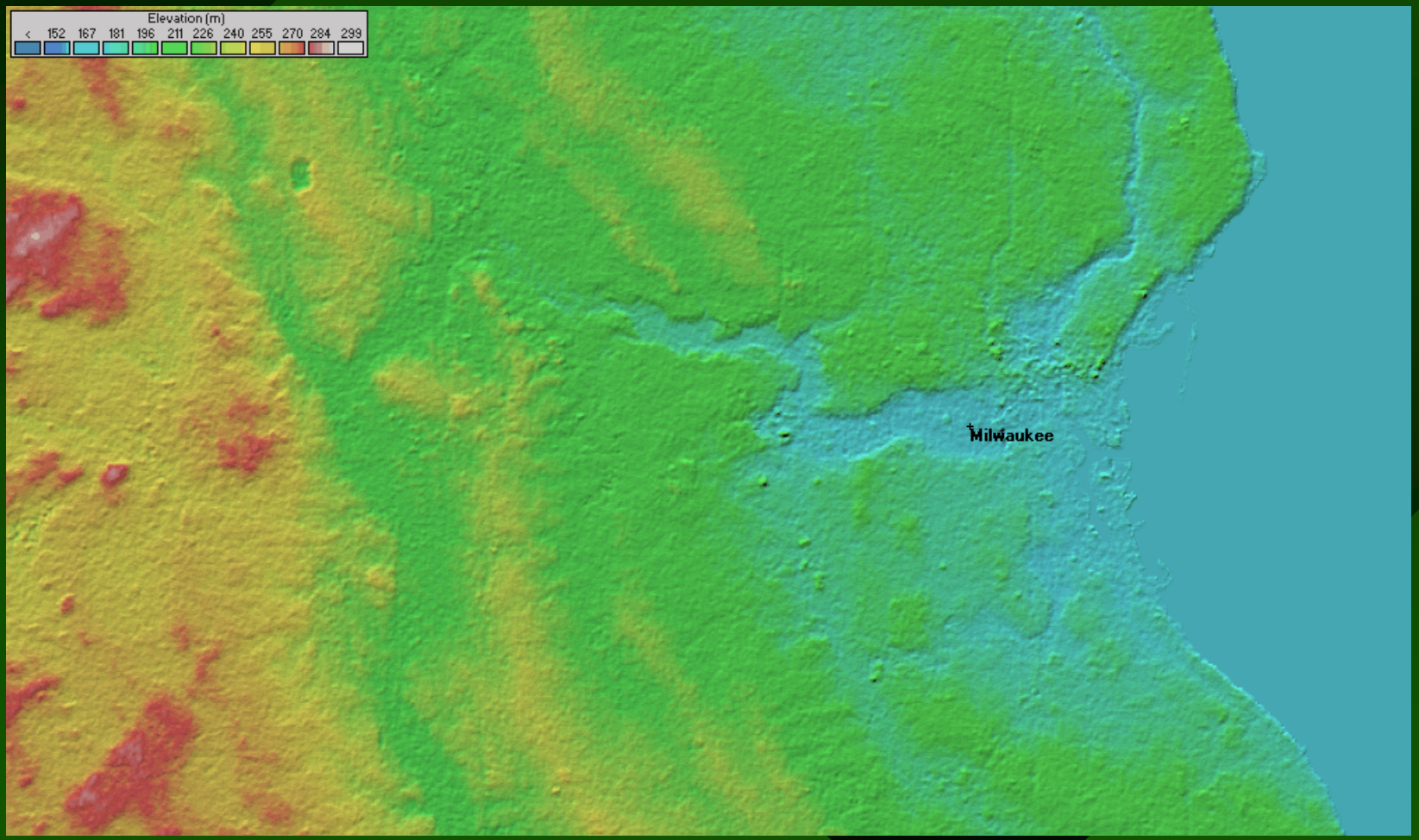
Radio Coverage Issues

- Terrain in your area greatly affects radio transmissions
- Floor Noise / Background noise. Anything that generates RF.
- Antennas – stubby vs conventional length
- Solar flares
- Ducting
- Poorly tuned radios
- Poor or corroded mobile antenna connections

Terrain Coverage Issues



Terrain Coverage Issues



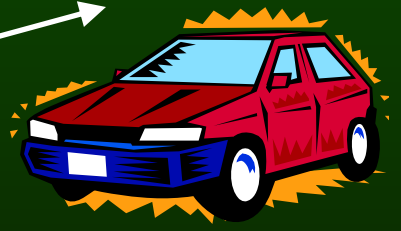
Base Station / Repeater Operation

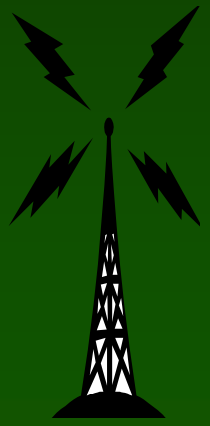
- Base Stations & Repeaters are designed to be located at high sites – *Antenna masts, water towers, or other very high locations. (125 to 200 ft above ground)*
  - Repeaters uses two frequencies – one in and one out
  - Ability to hear weak signals
  - Ability to rebroadcast signals over a broader area
  - Use of voting receivers to enhance coverage (signal to noise ratio)
  - Spin-up time for the Repeater (100 to 400 ms)
  - Input audio can or should go direct to the console after voted
  - Base Stations use same frequency to transmit & receive.

Repeater Operation *(Conventional System)*

BASE TRANSMIT FREQUENCY

(Mobile Receive) = 460.0125 MHz





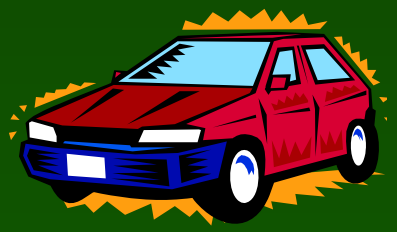
MOBILE TRANSMIT FREQUENCY

(Mobile Transmit) = 465.0125 MHz

Repeater System *(Conventional System)*

BASE TRANSMIT

460.0125



MOBILE

RECEIVE

460.0125

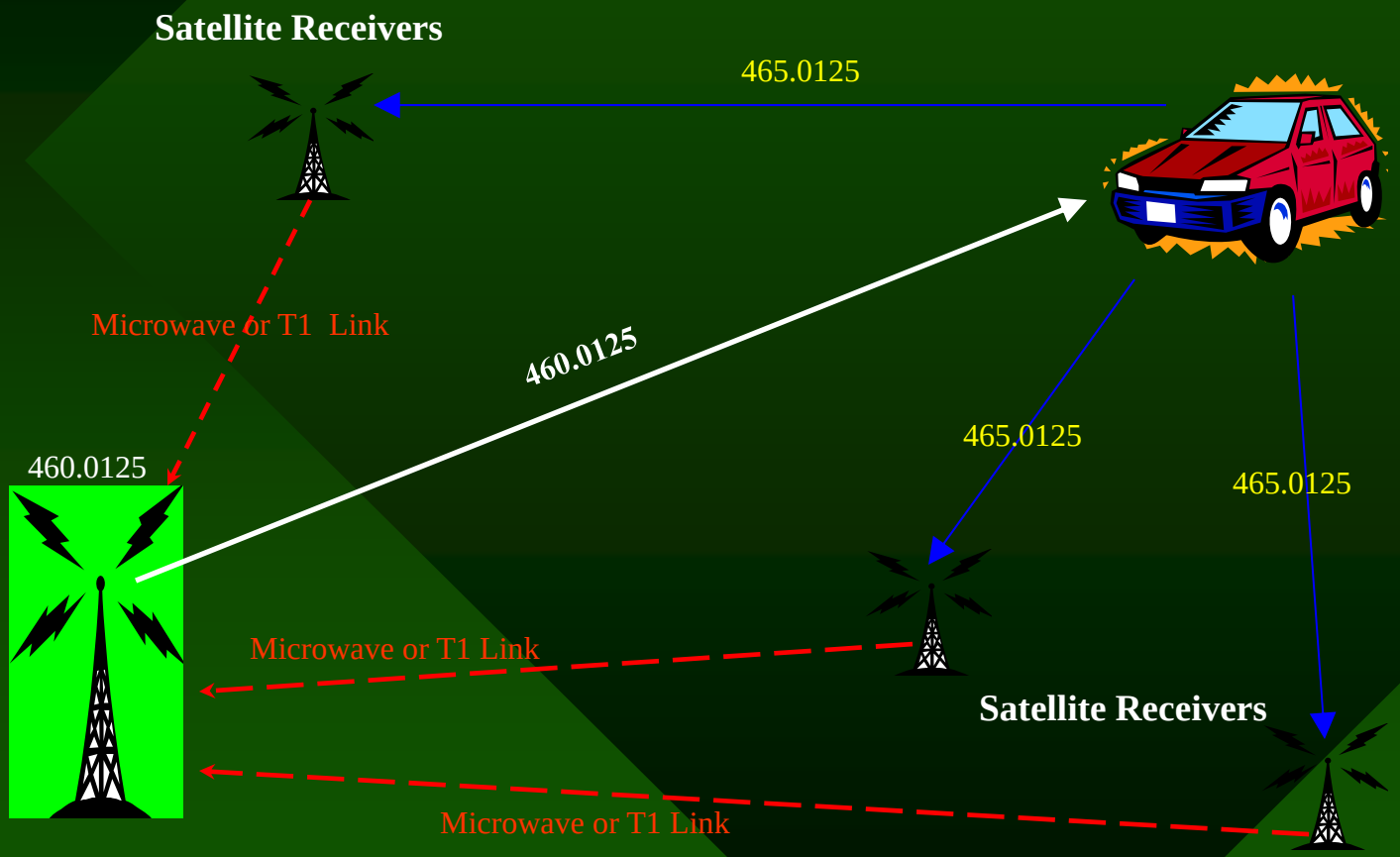
- **REPEATER SYSTEMS UTILIZE ONE FREQUENCY TO TRANSMIT AND ANOTHER FREQUENCY TO RECEIVE.**

MOBILE

TRANSMIT

465.0125

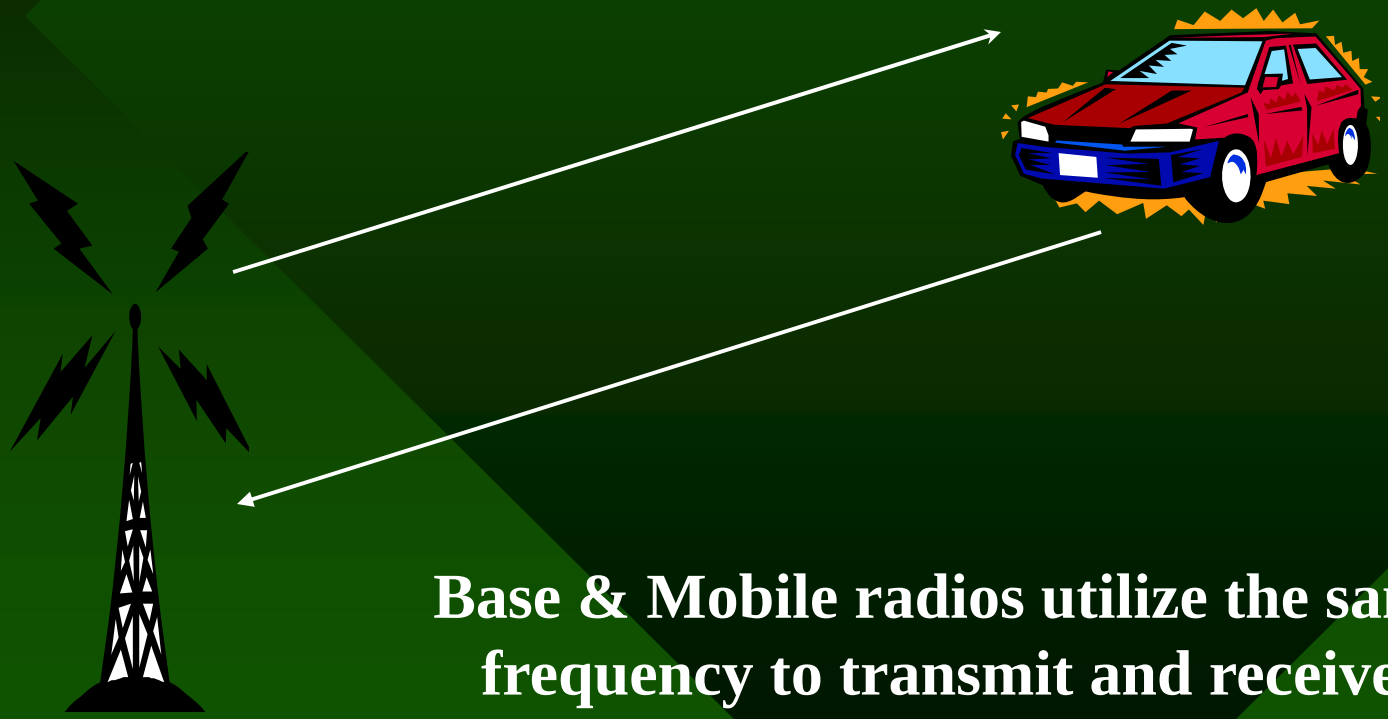
Repeater System *(Conventional Satellite Receiver System)*



Simplex Operation

- Radio to Radio communications without any other assistance
  - Also called Talk Around
  - Transmit and Receive on a single frequency
  - Handhelds have a limited range (3 to 5 watts)
  - Mobiles have a greater range (10 to 50 watts)
  - No delay in key ups
  - Many operational and interoperability channels available.
  - Simplest of all fire ground channels with the least amount of technology between the fire fighters and Command
  - Problematic when attempting to use portable radios when talking to Dispatch especially on IFERN

Simplex Operation



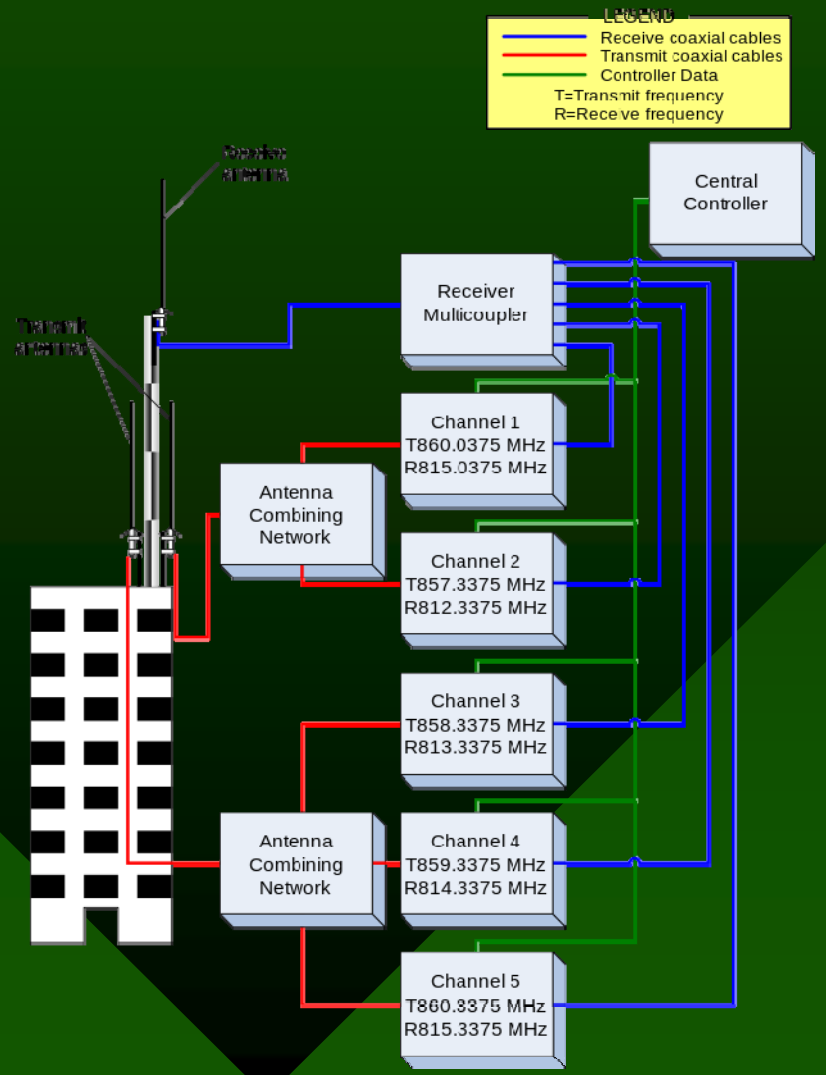
Base & Mobile radios utilize the same frequency to transmit and receive.

TX = RX = 453.4000 for all radios.

Trunking vs Conventional Systems

A trunked radio system is a complex type of computer-controlled two way radio system that allows sharing of relatively few radio frequency channels among a large group of users. Instead of assigning, for example, a radio channel to one particular organization at a time, users are instead assigned to a logical grouping, a "talkgroup". When any user in that group wishes to converse with another user in the talkgroup, a vacant radio channel is found automatically by the system and the conversation takes place on that channel. Many unrelated conversations can occur on a channel, making use of the otherwise idle time between conversations. Each radio transceiver contains a microcomputer to control it. A control channel coordinates all the activity of the radios in the system. The control channel computer sends packets of data to enable one talkgroup to talk together, regardless of frequency.

From Wikipedia, the free encyclopedia



Trunking Systems (Basic Operation)

http://en.wikipedia.org/wiki/Trunked_radio_system

- Control Channel for each site. Data packets from field units are sent to the trunking system over a dedicated channel. Based on the radio ID that will determine the capabilities of the mobile/portable radio user (subscriber) on the system.
- Talk Groups – Analogous to radio channels within a trunking system.
- Operation – Push-to-talk. Mobile/portable requests a talk grant on a trunking system. Data sent over the control channel. If the mobile/portable radio is authorized on the system, and authorized on the talkgroup the radio receives a talk grant. Then all radios on the trunking system with the same talk group are notified about the impending transmission, and a frequency pair are assigned. Every time you initiate a PTT transmission there is a high probability your radio traffic will go out over a different frequency pair.

Trunking Systems (Basic Operation)

http://en.wikipedia.org/wiki/Trunked_radio_system

Trunked radio takes advantage of the probability that with any given number of user units, not everyone will need channel access at the same time, therefore fewer discrete radio channels are required. From another perspective, with a given number of radio channels, a much greater number of user groups can be accommodated. In the example of the police department, this additional capacity could then be used to assign individual talk groups to specialized investigative, traffic control, or special-events groups which might otherwise not have the benefit of individual private communications.

To the user, a trunking radio looks just like an "ordinary" radio: there is a "channel switch" for the user to select the "channel" that they want to use. In reality though, the "Channel switch" is NOT switching frequencies as in a conventional radio but when changed, it refers to an internal software program which causes a talkgroup affiliation to be transmitted on the control channel. This identifies the specific radio to the system controller as a member of a specific talkgroup, and that radio will then be included in any conversations involving that talkgroup.

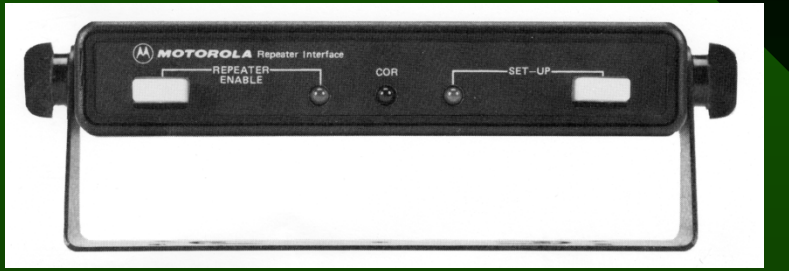
Technology…. Be careful and always test your coverage for interior ops!

Trunking Systems (Basic Operation)

http://en.wikipedia.org/wiki/Trunked_radio_system

- Types of Trunking Systems
  - Open Sky – City of Milwaukee
  - Motorola Type 2 Analog – Milwaukee County (Updating to APCO P25)
  - Motorola APCO P25 Digital – Waukesha County
  - EDACS – Ozaukee County
  - LTR – Logic Trunked Radios (Generally business systems)
  - EF Johnson APCO P25 Digital – State of Wisconsin (WISCOM)
  - TETRA (Terrestrial Trunked Radio) – TDMA primarily in Europe
  - iDEN (Integrated Digital Enhanced Network) - Nextel

Cross Band Repeater
(Motorola RICK HLN-3333)



- Designed to be mounted in a vehicle to connect separate radio bands together
  - Connect any VHF/UHF/800 fire ground frequency to any other VHF/UHF/800 fire ground frequency.
  - MUST MAKE SURE radio is not in scan
  - Select the two channels to be connected
  - Push the button – green light on RICK comes on
  - MUST MAKE SURE THE RICK IS OFF when done
  - Somebody MUST ALWAYS monitor the crossband patch.

Cross Band Repeater *(JPS Raytheon ACU-M)*

- Interconnects 4 audio ports, 2 VoIP channels and a local operator
- Can interconnect radios in any band including HF, VHF, UHF, P25, 800Mhz and Nextel iDEN phones
- Simple, intuitive interface used for diagnostics, programming and feature control
- Optional network connectivity that can be controlled via WAIS Controller Software
- Compatible with existing ACU radio interface cables
- Internal pre-configured radio template library for all supported devices
- Can be installed in a vehicle, in a rack, or in a Pelican case
- Powered by battery, vehicle +12 outlet, 120 VAC

IFERN MABAS Frequencies

- *Simplex frequencies for Mutual Aid*
  - IFERN – Primary Mutual Aid Dispatch Channel
  - IFERN 2 – Secondary Base Channel
  - FG RED - is a primary operational channel
  - FG WHITE – secondary operational channel
  - FG BLUE – Water Supply or EMS
  - FG GOLD – tertiary operational channel
  - FG BLACK – tertiary operational channel
  - FG GRAY – tertiary operational channel
  - FG GREEN – NOT AUTHORIZED in Wisconsin
  - Strongly urge all counties especially near the Illinois Border to start planning for the implementation of IFERN 2

MARC Channels

- MARC 1 is the Statewide mutual aid repeater. Each county has one MARC 1 repeater which must be turned on when requested.
- Used for large scale incidents requiring county wide interoperability communications
  - MARC 2 is the simplex version of this channel and is also to be used when contacting Flight for Life.
  - Marc 3 & 4 are simplex operational channels
  - Fire and Police agencies have these frequencies programmed in their radios.
  - Is used as part of an interagency response to water emergencies in Racine County.

xCALL / xTAC Nationwide Interops

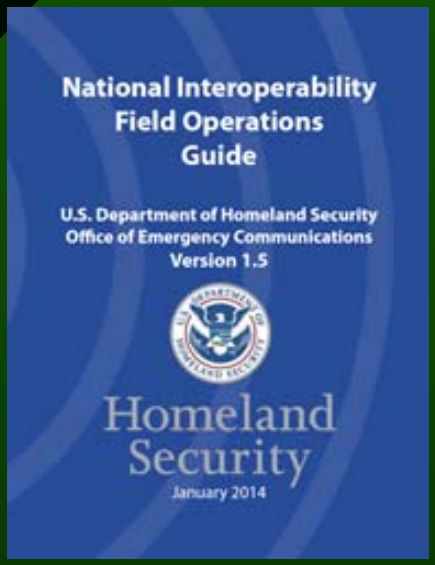
- xCALL and xTAC are nationwide interoperability frequencies to be used when an incident requires interfacing with units from the State of Wisconsin or the Federal Government. Also can be used for local emergencies that potentially could escalate.
  - VCALL10 is the VHF (150 MHz) calling channel to establish contact. VTAC 11 through 14 are simplex channels for on scene communications with various assets.
  - UTAC 40 is the UHF (460 MHz) calling channel with UTAC 41 through 43 can be used in repeated or simplex mode.
  - 8CALL90 is the 800 MHZ calling channel with 8TAC91 through 94 can be used in repeated or simplex mode
  - 8TAC RED, 8TAC WHITE, and 8TAC BLUE are statewide simplex interoperable channels.

Radio Programming Example

	Bank A		Bank B		Bank C	
1	FIRE DISPATCH	Racine Fire Dispatch	IFERN	Primary MABAS Base	FIRE DISPATCH	Racine Fire Dispatch
2	RA FG 1 RPTR	Repeated FG 1	FG RED	Operations	RA FG 1 RPTR	Repeated FG 1
3	RA FG 2 RPTR	Repeated FG 2	FG WHITE	IC / Liasion	RA FG 2 RPTR	Repeated FG 2
4	RA FG 3	Simplex FG 3	FG BLUE	EMS / Water Supply	RA FG 3	Simplex FG 3
5	VCALL 10	Haz Mat/Interop Calling	FG GOLD	Alternate Fire Ground	MARC 1 RPTR	Interdisiciplinary
6	VTAC 11	Haz Mat/Interop Tactical	FG BLACK	Alternate Fire Ground	MARC 2 / FFL	Interdisiciplinary
7	VTAC 12	Haz Mat/Interop Tactical	FG GRAY	Alternate Fire Ground	MARC 3 / DV	Interdisiciplinary
8	VTAC 13	Haz Mat/Interop Tactical	IFERN 2	Secondary MABAS Base	MARC 4 / DV	Interdisiciplinary
9	VTAC 14	Haz Mat/Interops Tactical	NAT SAR	Search & Rescue	USCG 16	USCG Calling
10	VTAC 36 Repeated	Tactical CMD Repeater	WEM Car-Car	WEM Car to Car	USCG 22	USCG Ops
11	Open	Open	WEM SE Repeated	WEM SE WI Repeated	USCG 23	USCG Ops
12	ALL SAINTS EMS	EMS	VLAW 31	Old WISPERN	ALL SAINTS EMS	EMS
13	RA FG 3	Tertiary FG Simplex	VLAW 32	Alternate WISPERN	RA FG 3	Tertiary FG Simplex
14	RA FG 2	Secondary FG Simplex	STATE EMS A	State EMS Hospitals	RA FG 2	Secondary FG Simplex
15	RA FG 1	Primary FG Simplex	STATE EMS B	State EMS ALS	RA FG 1	Primary FG Simplex
16	FIRE DISPATCH	Racine Fire Dispatch	STATE EMS C	State EMS BLS	FIRE DISPATCH	Racine Fire Dispatch

NIFOG

WIFOG



National Interoperability Field Operations Guide

The Office of Emergency Communications (OEC) publishes the National Interoperability Field Operations Guide (NIFOG) as a reference guide for public safety radio technicians and communications planners. The waterproof, pocket-sized guide (also available in PDF format) contains radio regulations, tables of radio channels, and technical reference information. This guide is ideal for those establishing or repairing emergency communications in a disaster area.

http://www.dhs.gov/national-interoperability-field-operations-guide

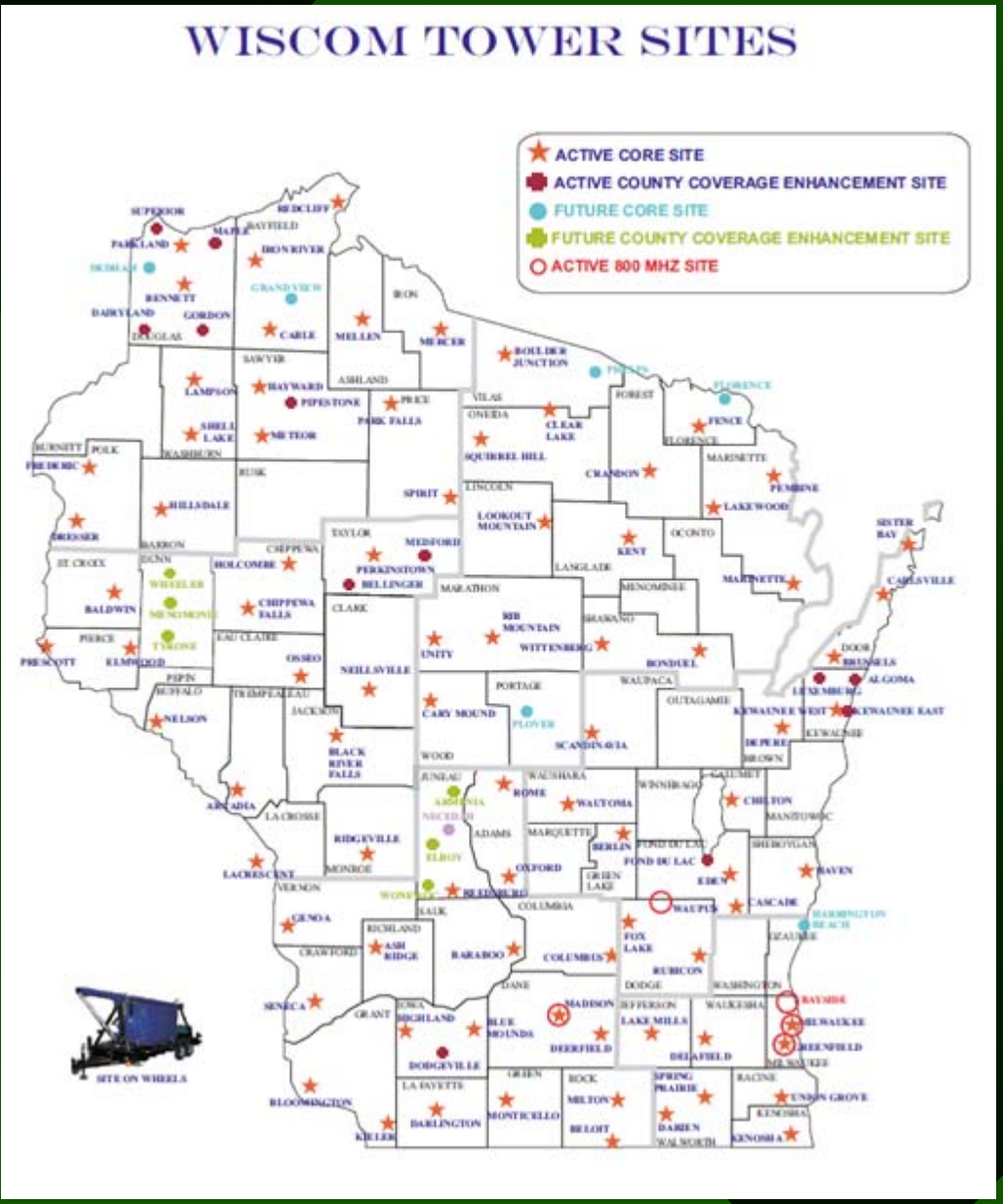
WISCOM Statewide Interoperability

The Wisconsin Interoperable System for Communications (WISCOM) is a shared system that first responders in communities across the state will use to communicate during a major disaster or large-scale incident. WISCOM will support up to four simultaneous conversation paths during an incident, dramatically increasing the current capacity available with statewide mutual aid channels and allowing responders from any area of the state to assist another community without losing communication capabilities.

Currently there are 90 sites across the State of Wisconsin.

Available talkgroups include eight statewide SCALL/STAC channels, four RCALL/RTAC channels in each WEM region, MABAS 1, MABAS 2, Haz Mat, Collapse, and EPS.

WISCOM TOWER SITES



WISCOM Statewide Interoperability

Common Talk Groups

- SCALL1 / STAC2-8 (Statewide Keyup)
- RCALLx1 / RTACxx (Regional Keyup)
- xxTRVL, xxCOM, xxSCAN (County TG)
- MABAS 1 (Statewide Keyup / Admin)
- MABAS 2 (Statewide Keyup / Logistics)
- Collapse (Statewide Keyup)
- Haz Mat (Statewide Keyup)
- EPS 1 (LE Statewide Keyup)
- Hospitals (Local & Regional Keyup)
- Daily Users (Greenfield FD/PD)

Things to think about…

- Console Patches to IFERN from 800 Systems – Avoid if at all possible. Consider implementing IFERN 2 in your dispatch centers.
- Intra-Divisional or Intra-radio system responses
- Consider ordering new mobile radios with VHF APCO P25 trunking capabilities for operation on WISCOM
- Consider adding WISCOM mobile radios to your Mutual Aid Apparatus
- Consider adding WISCOM mobile radios to your ambulances for patient reports. Most Wisconsin hospitals now have WISCOM capabilities.
- Create and Implement the ICS 205 radio communications plan and practice regularly with the plan (Natural Disasters, ASI, Major Incidents)

INCIDENT RADIO COMMUNICATIONS PLAN (ICS 205)

1. Incident Name:	2. Date/Time Prepared:	3. Operational Period:
RC Active Shooter Incident (CFS – ASI)	Date: Date Time: HHMM	Date From: Date Date To: Date Time From: HHMM Time To: HHMM

4. Basic Radio Channel Use:

Zone Grp.	Ch #	Function	Channel Name/Trunked Radio System Talkgroup	Assignment	RX Freq N or W	RX Tone/NAC	TX Freq N or W	TX Tone/NAC	Mode (A, D, or M)	Remarks
		Primary Dispatch	RASO F1 or RAPD F5	Command	N	186.2	N	186.2	Analog	IC to Dispatch
		Incident Command	VCALL 10	Command	N	156.7	N	156.7	Analog	On Scene Incident Command
		Operations LE	VTAC 11	Tactical	N	156.7	N	156.7	Analog	Outer Perimeter/Evacuation
		Operations LE	VTAC 12	Tactical	N	156.7	N	156.7	Analog	Interior Tactical 1
		Operations LE	VTAC 13	Tactical	N	186.2	N	156.7	Analog	Interior Tactical 2
		Operations LE	VTAC 14	Tactical	N	186.2	N	186.2	Analog	Investigations / Intelligence
		Operations EMS	FG Blue	Tactical	N		N		Analog	EMS Triage / Transport
		Operations Fire	FG Gray	Tactical	N		N		Analog	Fire Tactical Operations

5. Special Instructions:

8CALL 90 Repeater & 8TAC93 Repeaters to be enabled and Dispatch MUST transmit once over the enabled channel.
MARC 1 Repeater to be enabled for Alternate Communications
Notify Hospitals for possible mass casuality
Notify surrounding FIRE/EMS and LE Agencies via WISCOM RCALL21 or teletype about possible mutual aid – place on stand-by
Utilize RCALL21 for communications between Dispatch Centers in the region

6. Prepared by (Communications Unit Leader)**:** Name: Signature:

ICS 205	IAP Page	Date/Time: Date

INCIDENT RADIO COMMUNICATIONS PLAN (ICS 205)

1. Incident Name:	2. Date/Time Prepared:	3. Operational Period:
RC Active Shooter Incident (CFS – ASI)	Date: Date Time: HHMM	Date From: Date Date To: Date Time From: HHMM Time To: HHMM

4. Basic Radio Channel Use:

Zone Grp.	Ch #	Function	Channel Name/Trunked Radio System Talkgroup	Assignment	RX Freq N or W	RX Tone/NAC	TX Freq N or W	TX Tone/NAC	Mode (A, D, or M)	Remarks
		Operations FIRE	IFERN 2	Tactical	N	67.0	N	67.0	Analog	Fire / EMS Staging
		Incident Command	VCALL 10 8TACRED	Command Cross Band	N	156.7	N	156.7	Analog	On Scene Incident Command
		Operations LE	VTAC 11 8TACGOLD	Tactical Cross Band	N	156.7	N	156.7	Analog	Outer Perimeter / Evacuation
		Operations LE	VTAC 12 8TACBLACK	Tactical Cross Band	N	156.7	N	156.7	Analog	Interior Tactical 1
		Operations LE	VTAC 13 8TACGRAY	Tactical Cross Band	N	186.2	N	156.7	Analog	Interior Tactical 2
		Operations LE	VTAC 14	Tactical	N	186.2	N	186.2	Analog	Investigations / Intelligence

5. Special Instructions:

Cross Band Tactical Operational channels for incoming units.

Racine Fire TC1 – ACU-M can link up to 4 channels, Milwaukee PD – ACU1000 can link more than 10 channels, Kenosha Sheriff – ACU1000 can link more than 10 channels, Walworth County Sheriff – ACU1000, Rock County Beloit PD – ACU-m can link up to 4 channels.

6. Prepared by (Communications Unit Leader)**:** Name: Signature:

ICS 205	IAP Page	Date/Time: Date

Things to think about…TICP

- Developing and Implementing a Tactical Interoperable Communications Plan (TICP)
- TICP is intended to document the interoperable communications resources available within your County
- TICP documents who controls each resource, and what rules of use or operational procedures exist for the activation and deactivation of each resource.
- A tool used for incidents and planned events

Things to think about…TICP

- Expand participation into a decision-making group.
- Execute formal agreements among participating agencies to include Federal, State, and tribal agencies.
- Expand multi-disciplinary participation to develop standard operating procedures (SOPs).
- Ensure that all participating first responder agencies attain and maintain National Incident Management System (NIMS) / Incident Command System (ICS) compliance.
- Identifies weaknesses with the communication system

First Responder Network Authority (FirstNet)
12201 Sunrise Valley Dr
Reston, VA 20192

- FirstNet will be a public safety-grade network built to meet the needs of our nation's first responders
- FirstNet will provide public safety users with priority access to the network
- FirstNet will harden the network to assist with resiliency during natural disasters, incidents and man-made threats
- FirstNet will enhance public safety communications by delivering mission-critical data and applications that augment the voice capabilities of today's land mobile radio (LMR) networks
- FirstNet will enable local communications management and keep incident commanders in control
- FirstNet will be judicious with taxpayer dollars while remaining focused on offering its services to public safety at a compelling cost
- Wisconsin's Consultation with FirstNet on June 18th, 2015

In Closing

- Interoperability Council is looking for a few Fire Service Representatives for the following Sub-Committees
  - **NPSBN Sub-Committee** – One Career and one Volunteer fire service representative, and 2 EMS representatives (Bringing FirstNet to Wisconsin).
  - **911 Sub Committee** – State Fire Chiefs Association representative
  - **LMR Sub-Committee** – NE Representative, SE Representative, WC Representative (Working on issues related to Land Mobile Radio Systems).

Don’t get frozen out – Keep abreast of new technologies