

# Vehicular Repeater Systems

Institution of Fire Engineers  
Command & Control Symposium

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## AGENDA

- ❑ What are Vehicular Repeaters?
- ❑ How do they work?
- ❑ Vehicular Repeaters in the Incident Command System

# What are Vehicular Repeaters?

- A repeater is a base station radio that automatically and simultaneously retransmits signals received on one frequency onto a second frequency at a higher power
- A Vehicular Repeater (VR) is a low power repeater located in a vehicle and connected through a mobile radio

## How do they Work ?

- Located with the mobile radio
- Interconnects with control head cable
- Requires a second antenna in vehicle
- Can be switched in or out as needed
- Works with conventional or trunked systems
- Requires a conventional frequency pair for portable radios
- Capable of processing emergency signals

# Why Use a VR?

- Heavy building losses
- Portables out of system range
- Frees up trunk system talkgroups
- Local incidents not requiring wide coverage
- Lower cost analog portables
- Take advantage of conventional channels
- Minimal training required

# Components

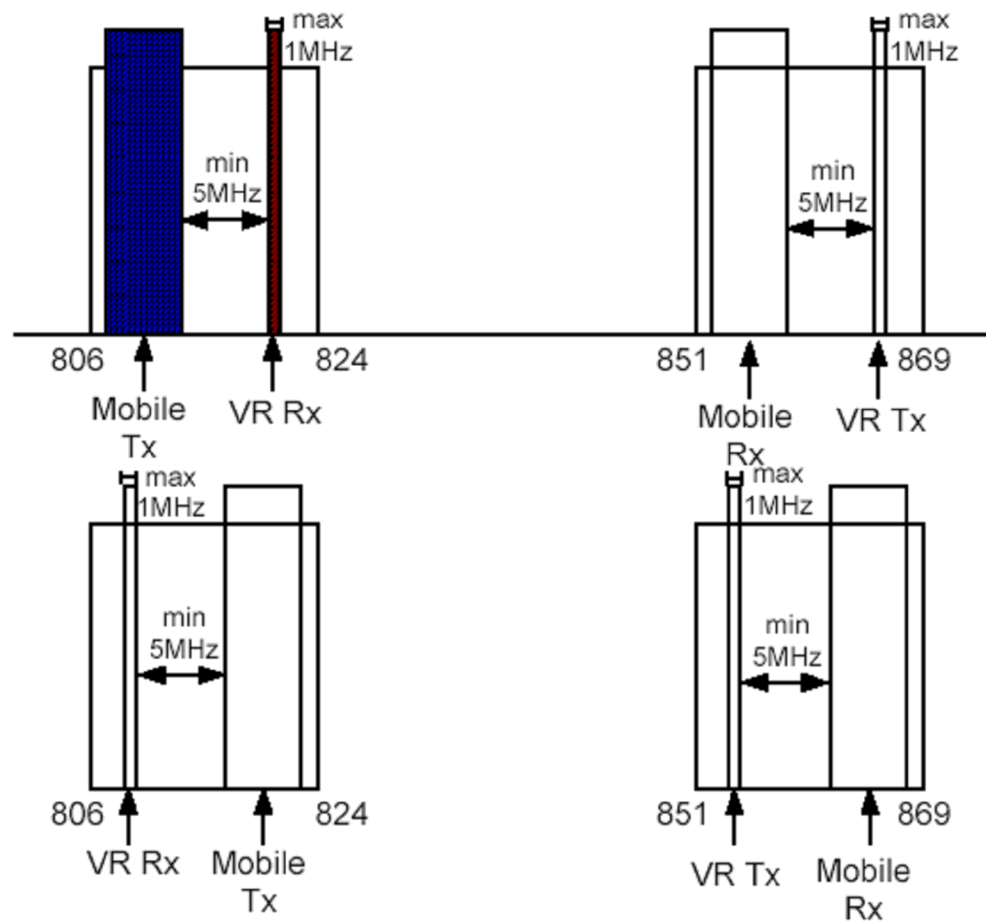


# Control Head

New VRS Button

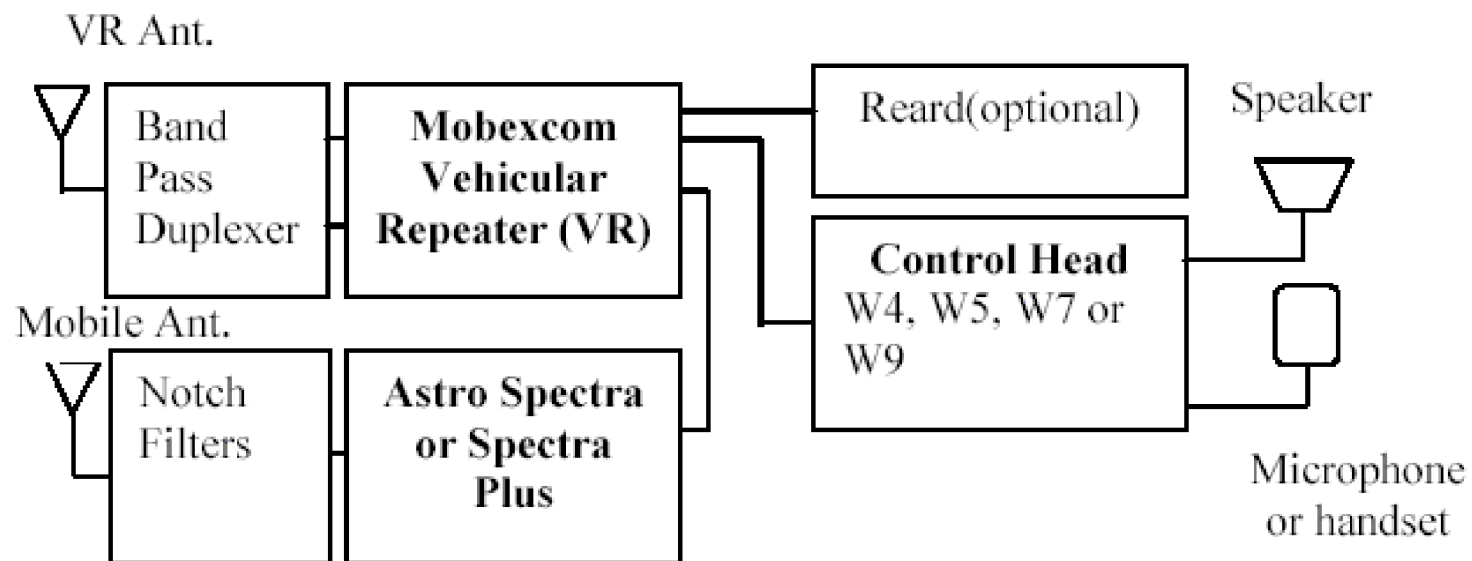


# Channel Spacing





# Block Diagram



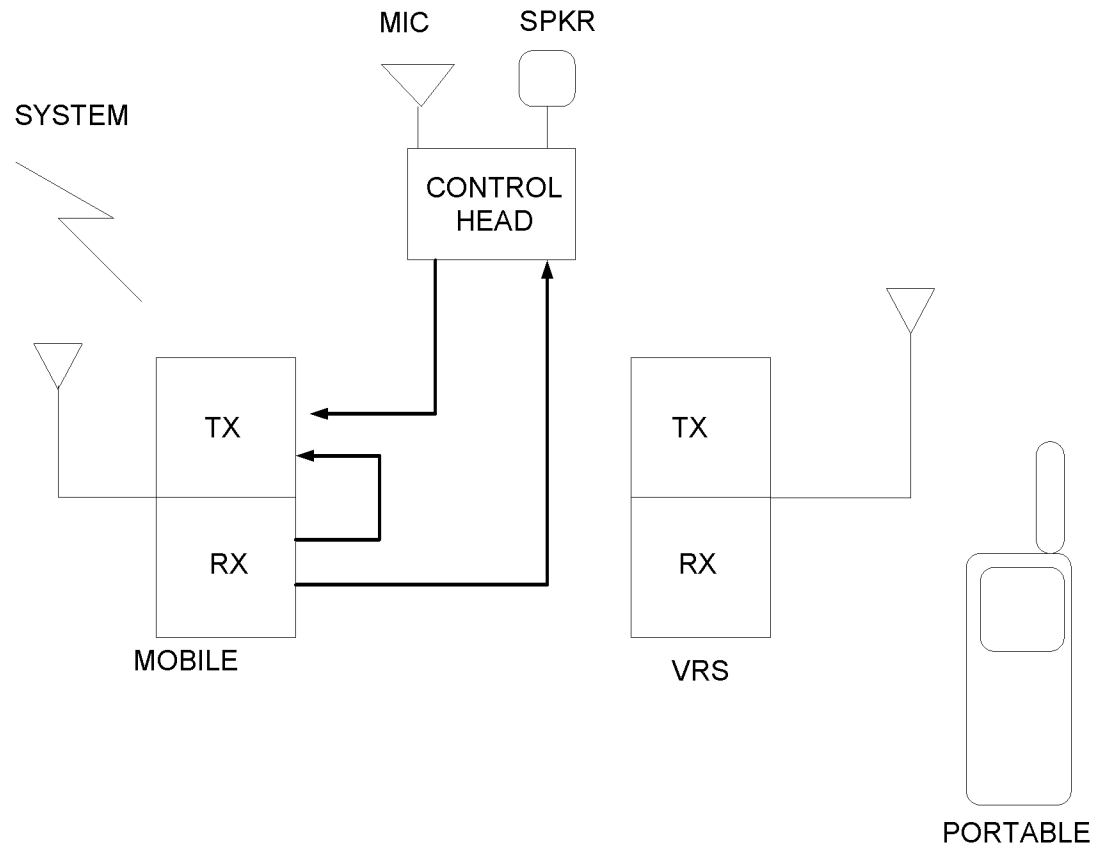
# Installation Considerations

- Two antennas are required
- Antenna isolation required
- Use Maximum horizontal separation
- Programmed with user software
- In-band 800 uses a duplexer

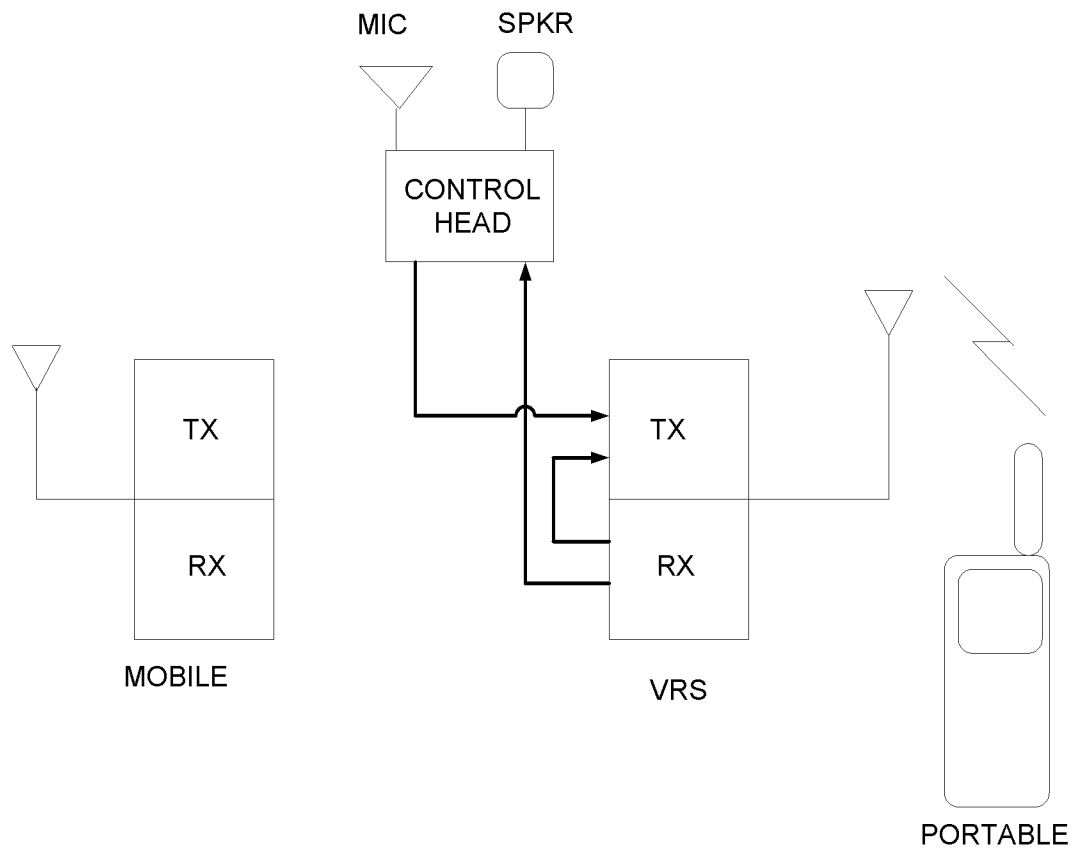
# Operating Modes

- **Mobile Mode**- VR off, normal mobile radio operation
- **Local Mode**- VR on, repeater operation with portable radios
- **System Mode**- VR on, both local repeat and (trunk) system operation enabled

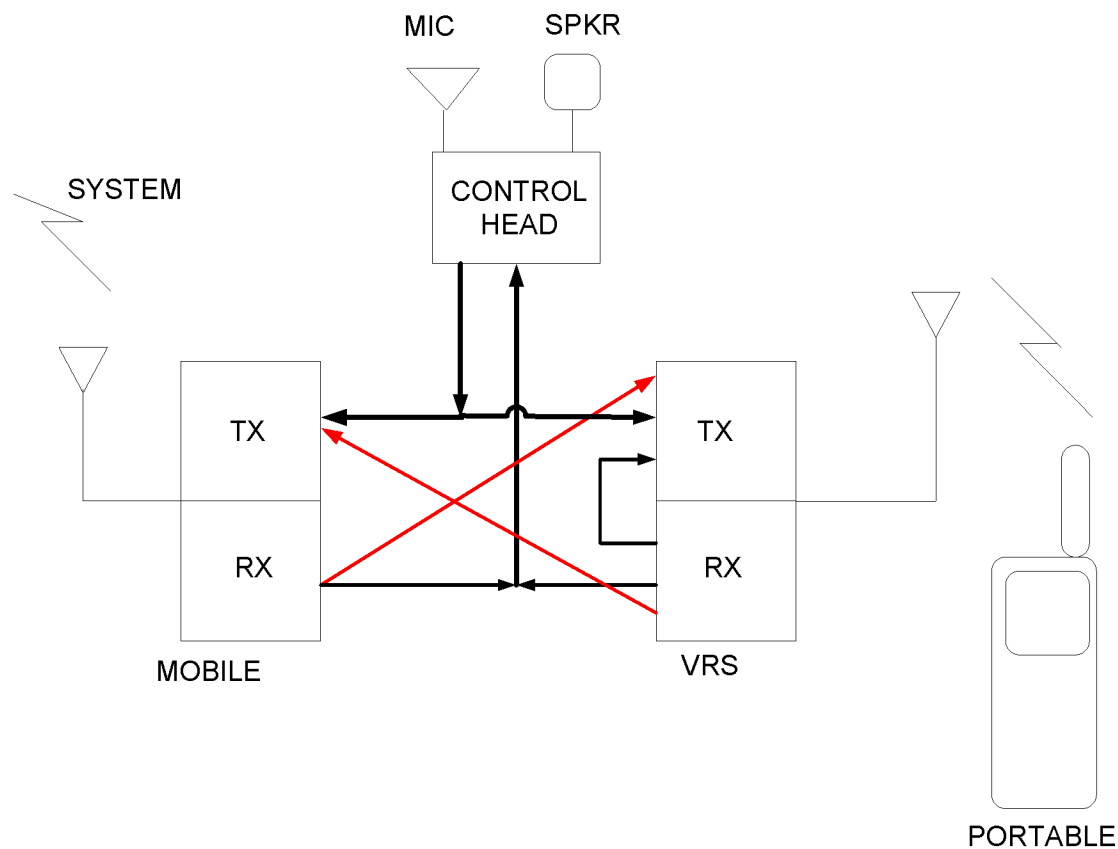
# MOBILE MODE



# LOCAL MODE



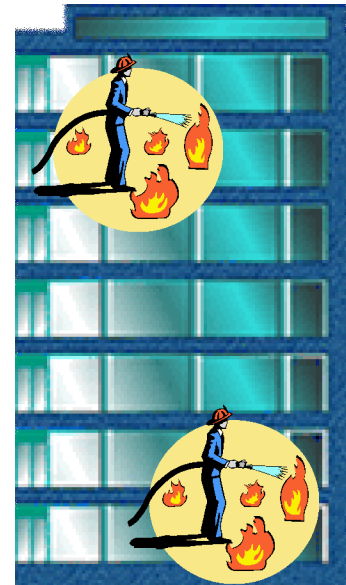
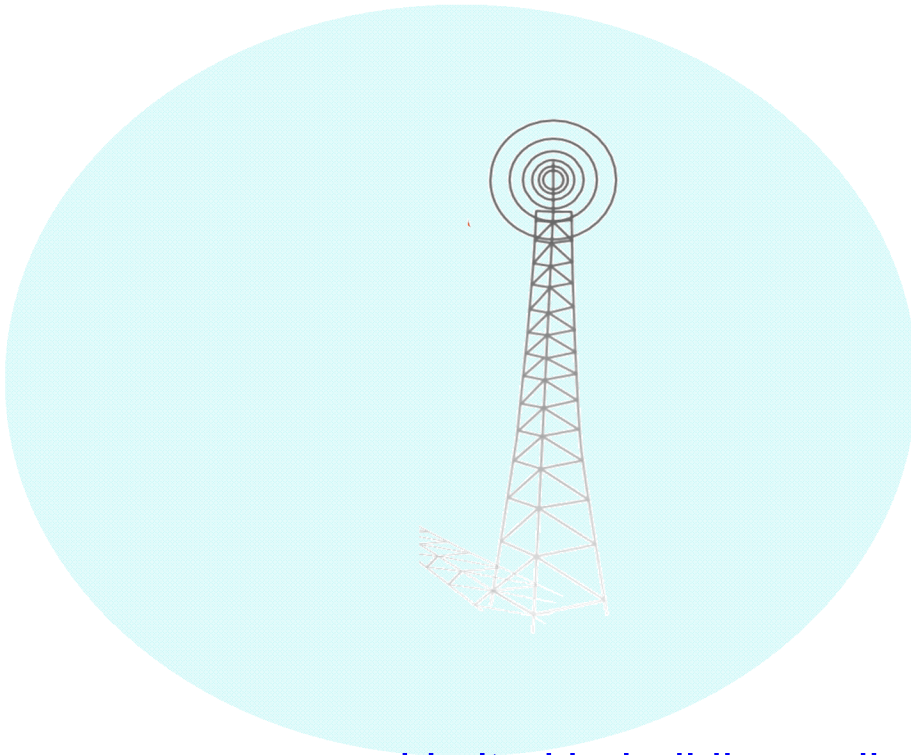
# SYSTEM MODE



# Incident Command Operations



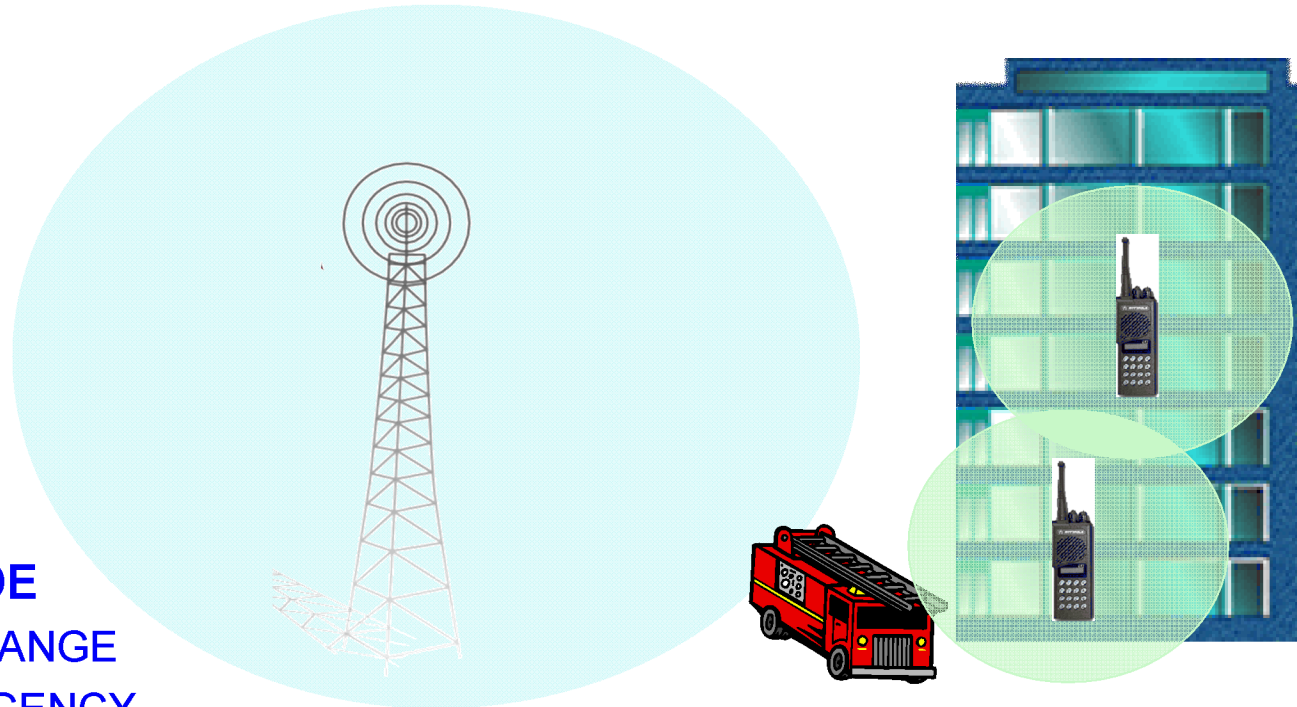
## IN-BUILDING TACTICAL COMMUNICATIONS WITHOUT VEHICULAR REPEATER



- Limited in-building radio communications on tactical channels in most large buildings



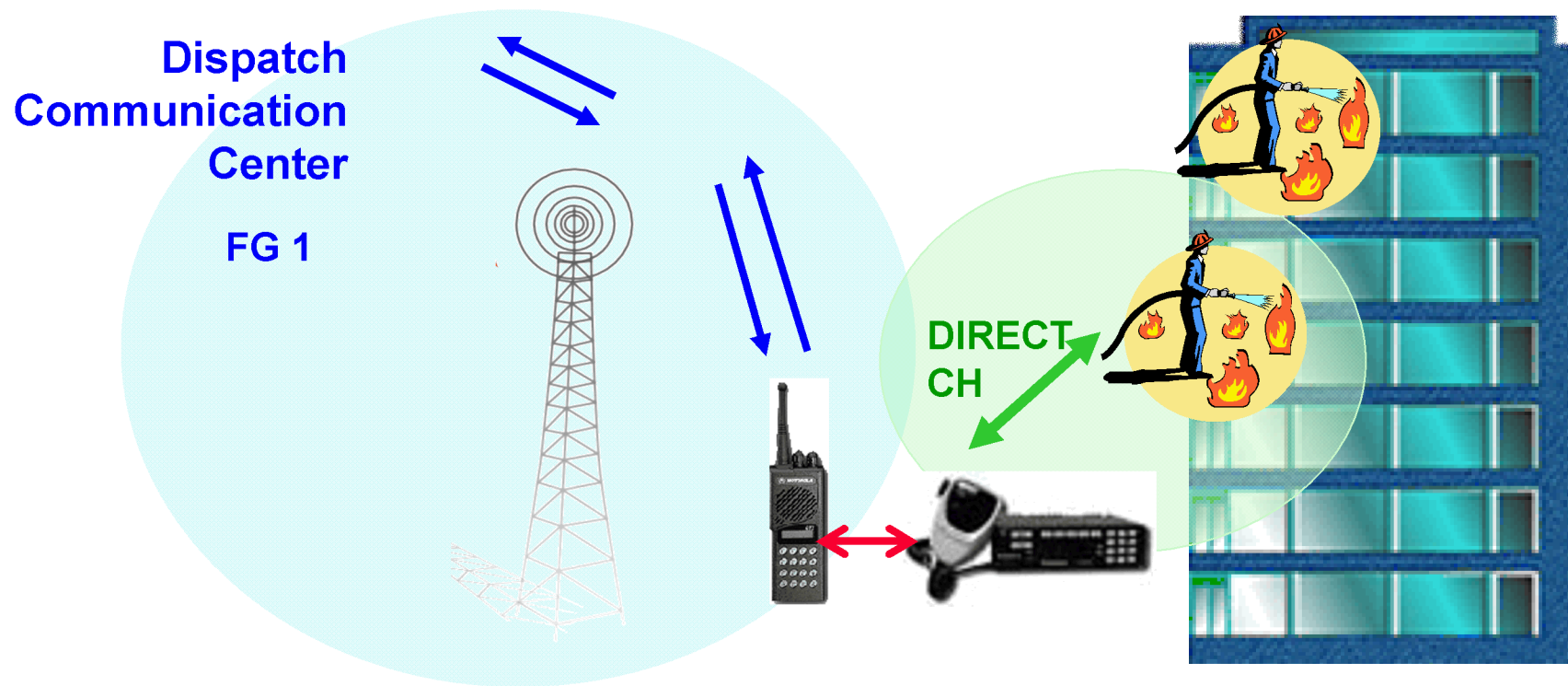
# IN-BUILDING TACTICAL COMMUNICATIONS WITHOUT VR – DIRECT MODE



## DIRECT MODE

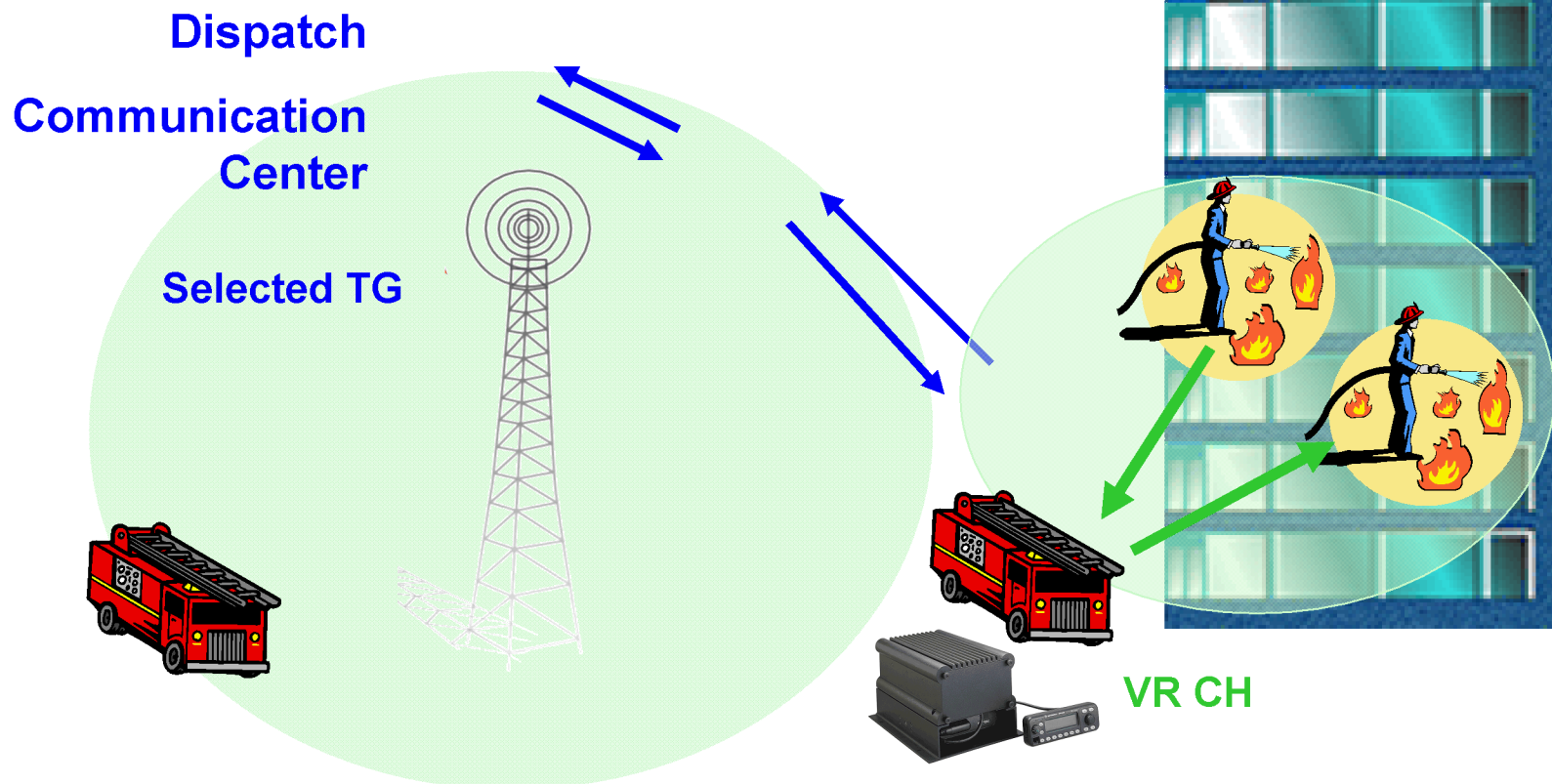
- LIMITED RANGE
- NO EMERGENCY
- NO DISPATCH
- NO LOGGING

# IN-BUILDING TACTICAL COMMUNICATIONS WITHOUT VR – DIRECT MODE



Incident Commander - Using the Mobile radio  
in Direct mode and the portable on tactical  
channel.

# IN-BUILDING TACTICAL COMMUNICATIONS USING VR in System Mode



VR = Communications 'Bridge' between the network (on the selected tactical channel) and the local users on the VR Channel

# IN-BUILDING TACTICAL COMMUNICATIONS USING VR

VR increases the radio communications range by:

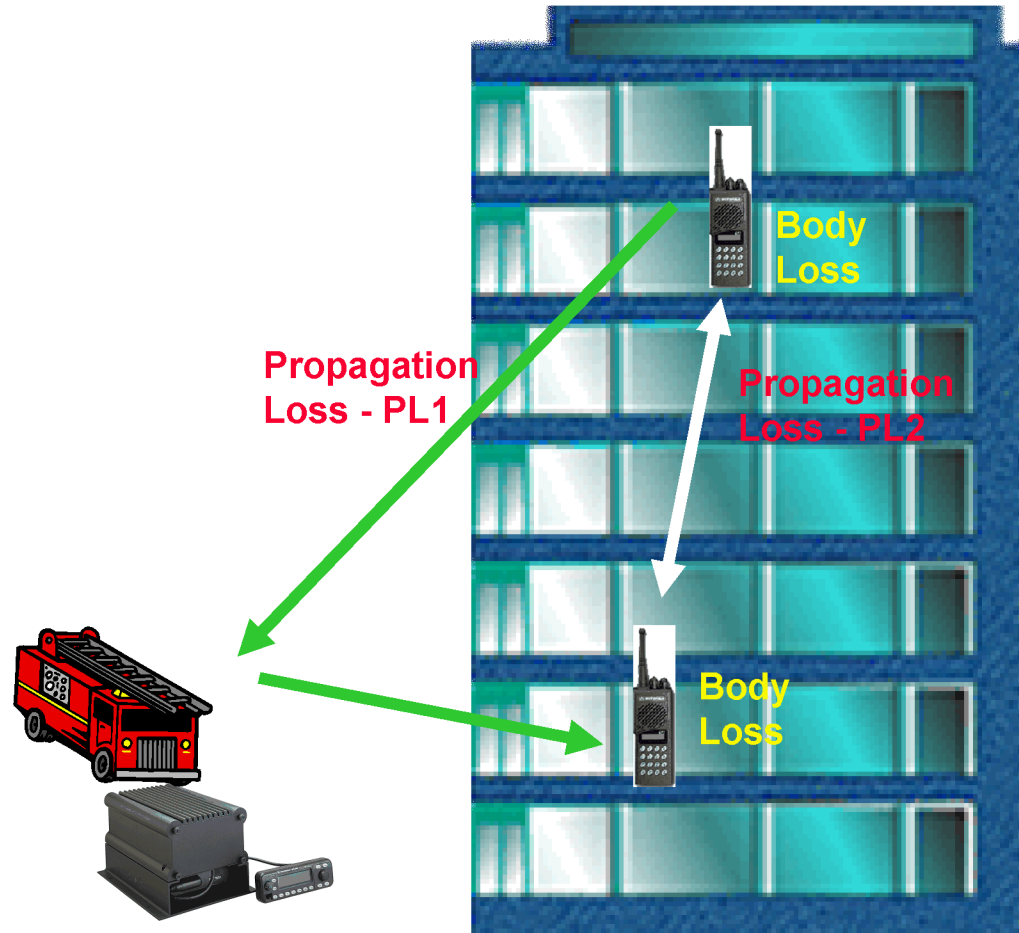
Eliminating half of the Body Loss

Body Loss = Antenna Inefficiency

*Typically body loss reduces the radio signal 10-20 times.*

Regenerating the signal

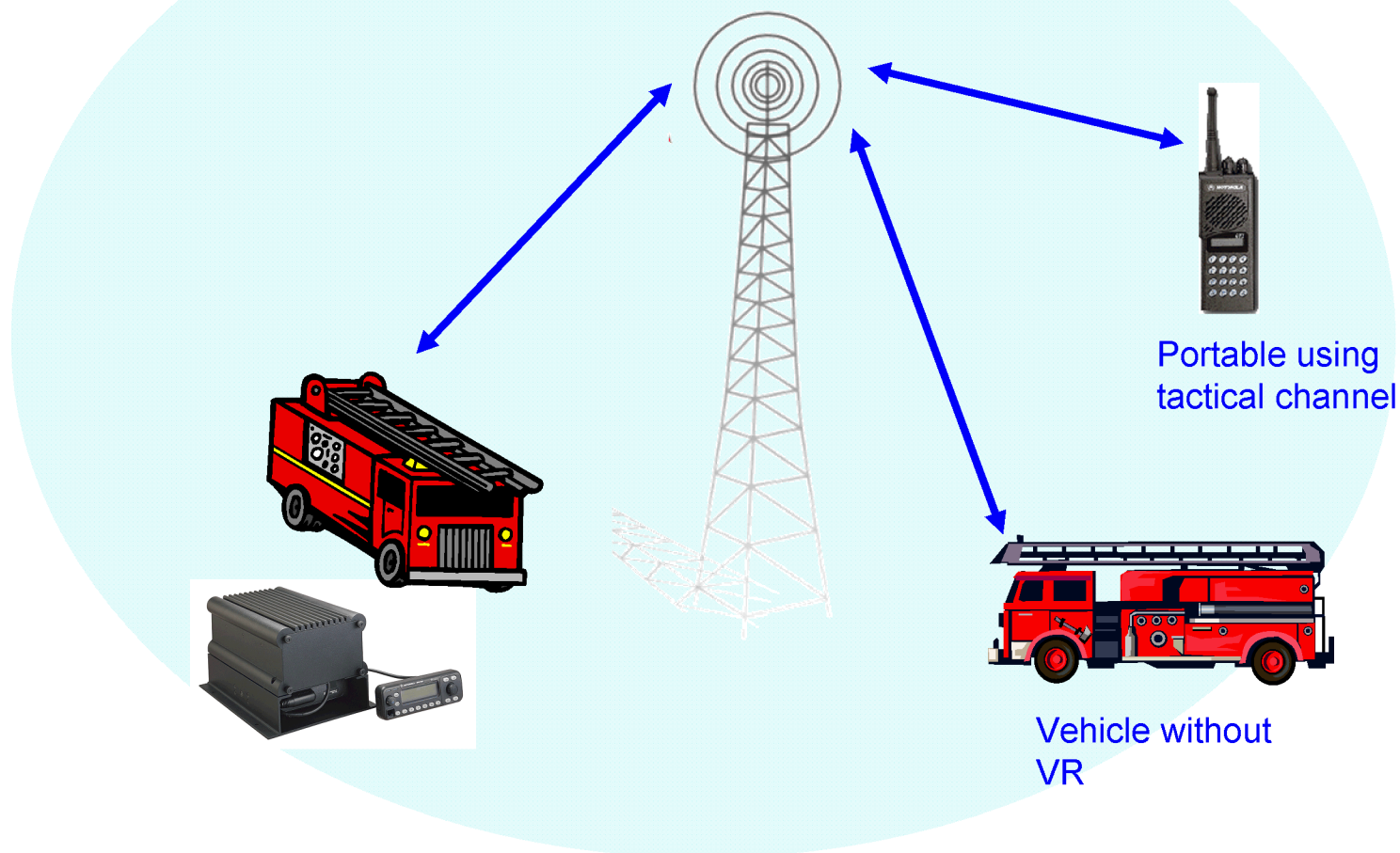
Typically Path Loss 1 < Path Loss 2



## OPERATING THE VR

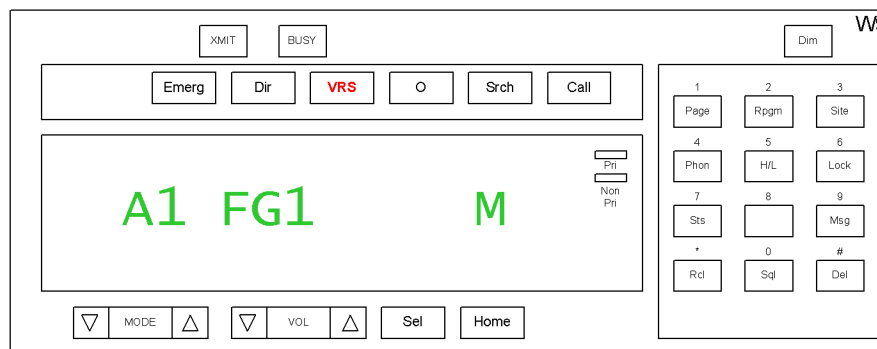
### MOBILE MODE = VR OFF

- Select Mobile mode on VR equipped fire trucks when no in-building communications are required

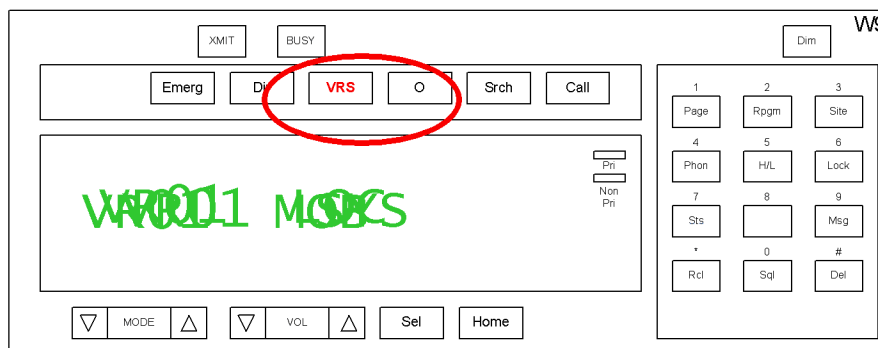


# OPERATING THE VR MOBILE MODE = VR OFF

- After Power Up the VR is OFF by default.



- Selecting the VR Mode



# Sample Portable Programming

- Zone A-Trunked System
- Zone B- Conventional VR
- Zone C- Talkaround (direct)

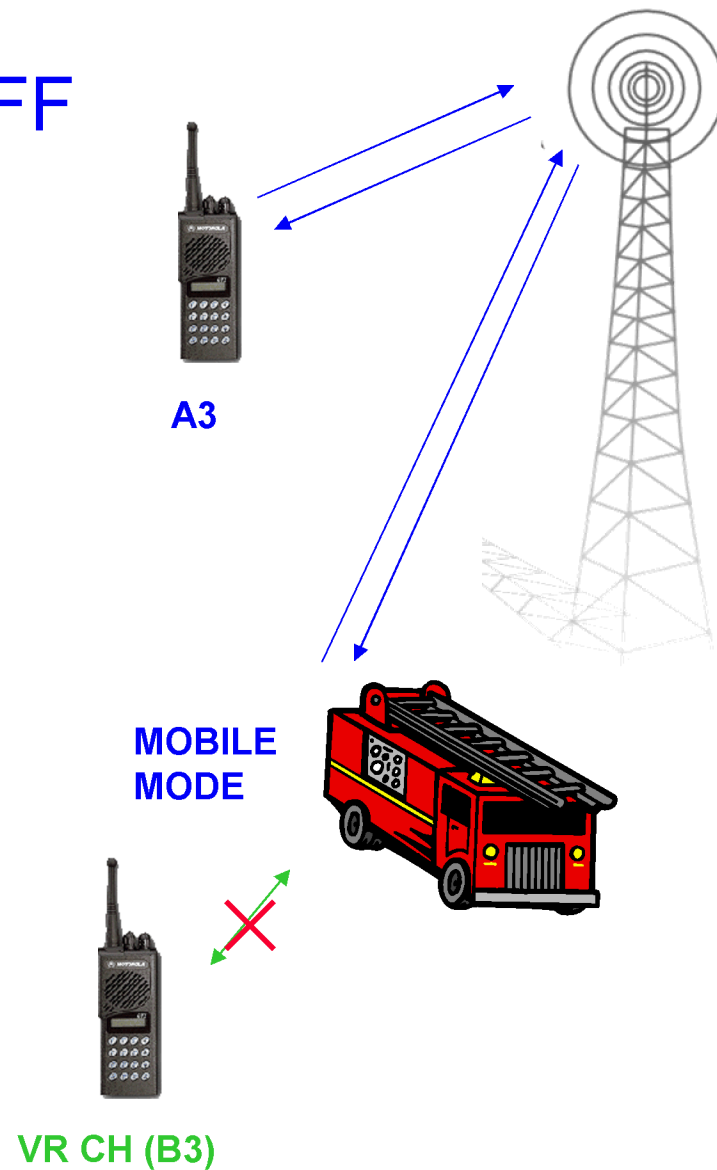
Or use repeat/direct switch

A, B, C Zone Switch



## OPERATING THE VR MOBILE MODE – VR OFF

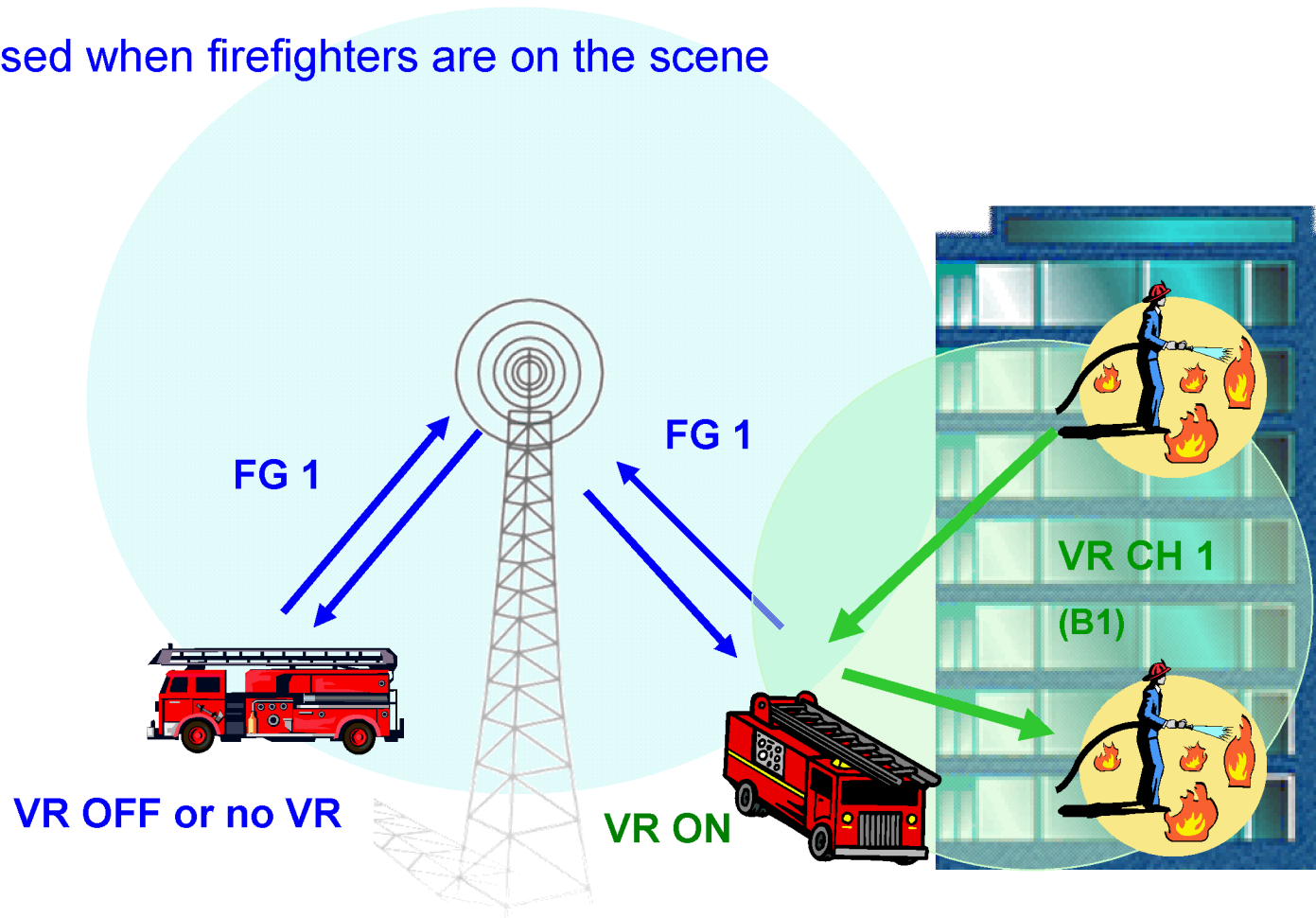
- Portables switched to a tactical CH – no changes to present operation.
- Portables switched to a VR CH – no communication when VR is OFF
- No emergency processing by VR while VR is OFF





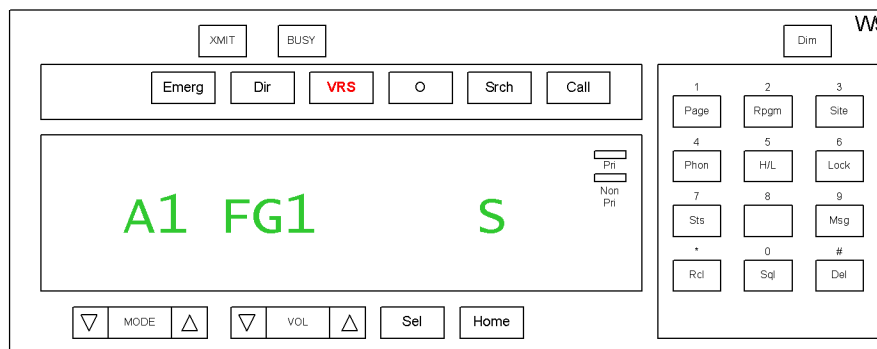
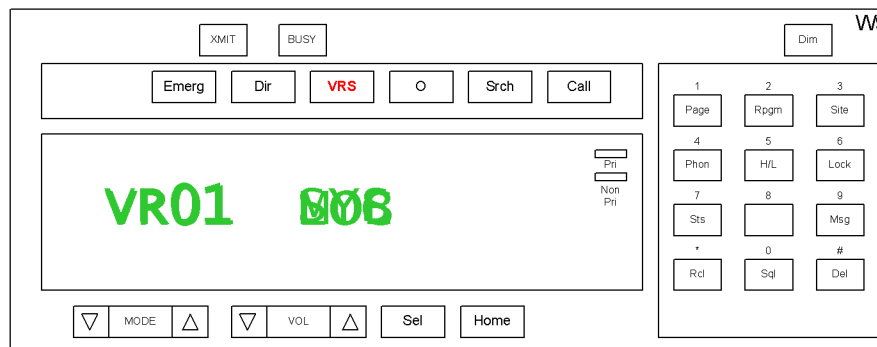
# OPERATING THE VR SYSTEM MODE = VR ON

- Used when firefighters are on the scene



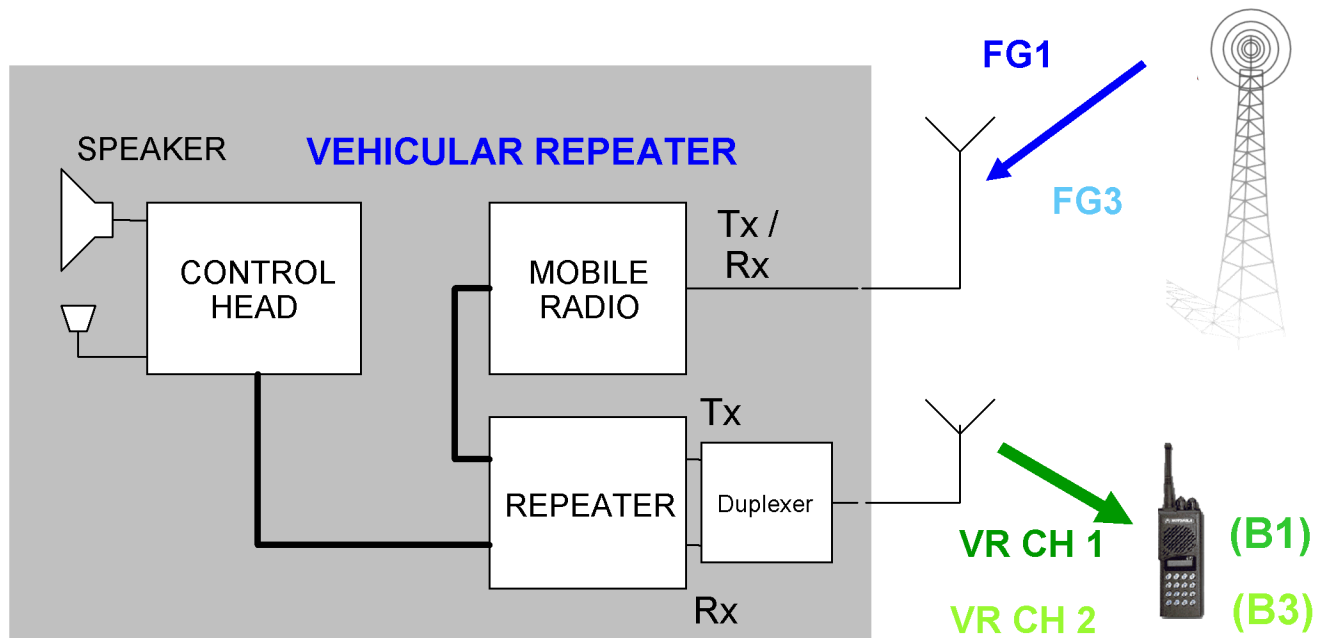
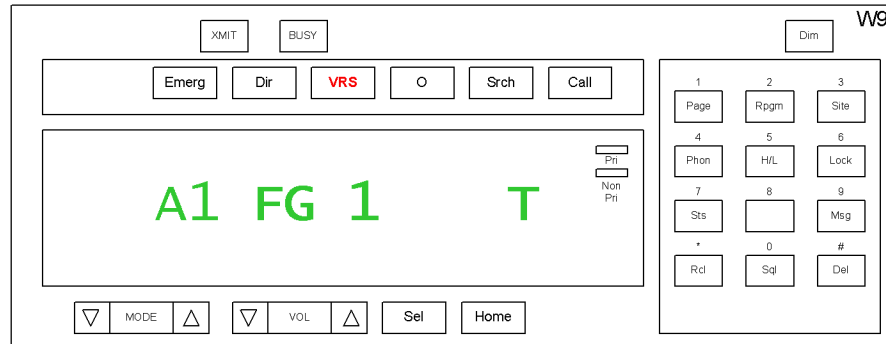
# OPERATING THE VR SYSTEM MODE = VR ON

- Selecting System Mode



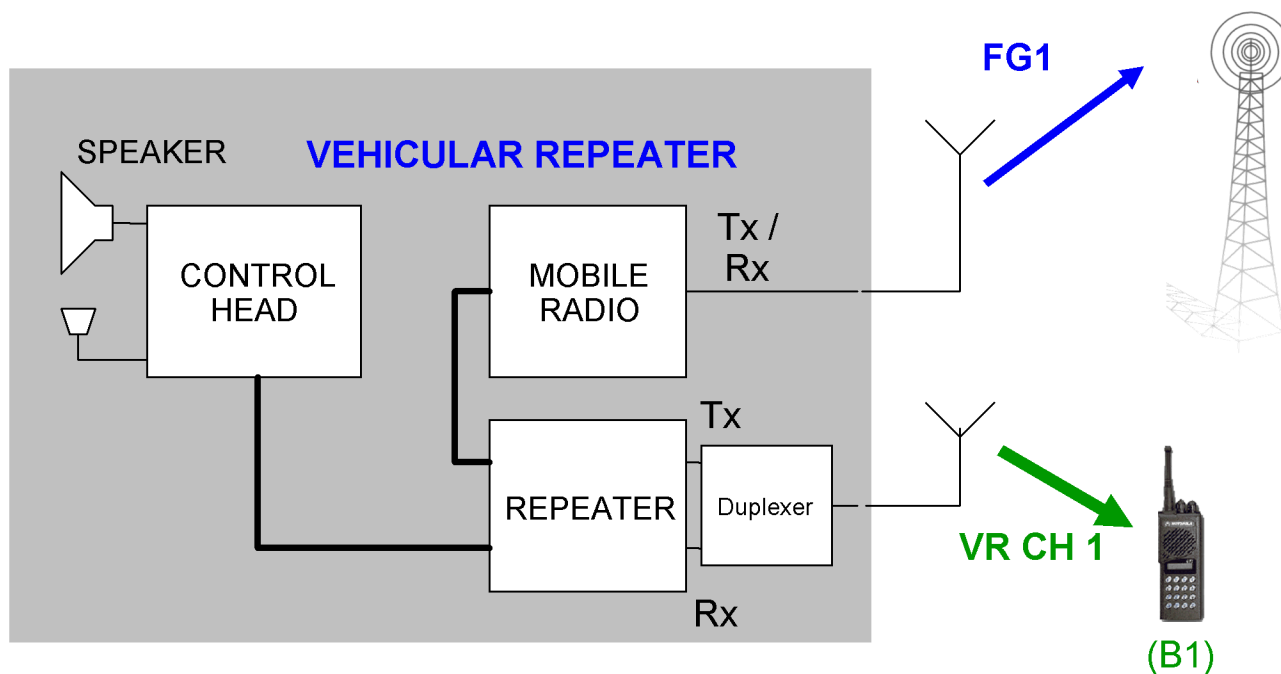
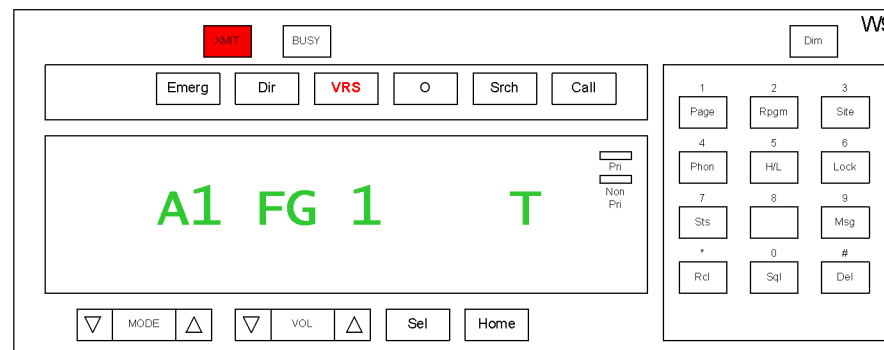
# OPERATING THE VR SYSTEM MODE = VR ON

- Mobile Receiving



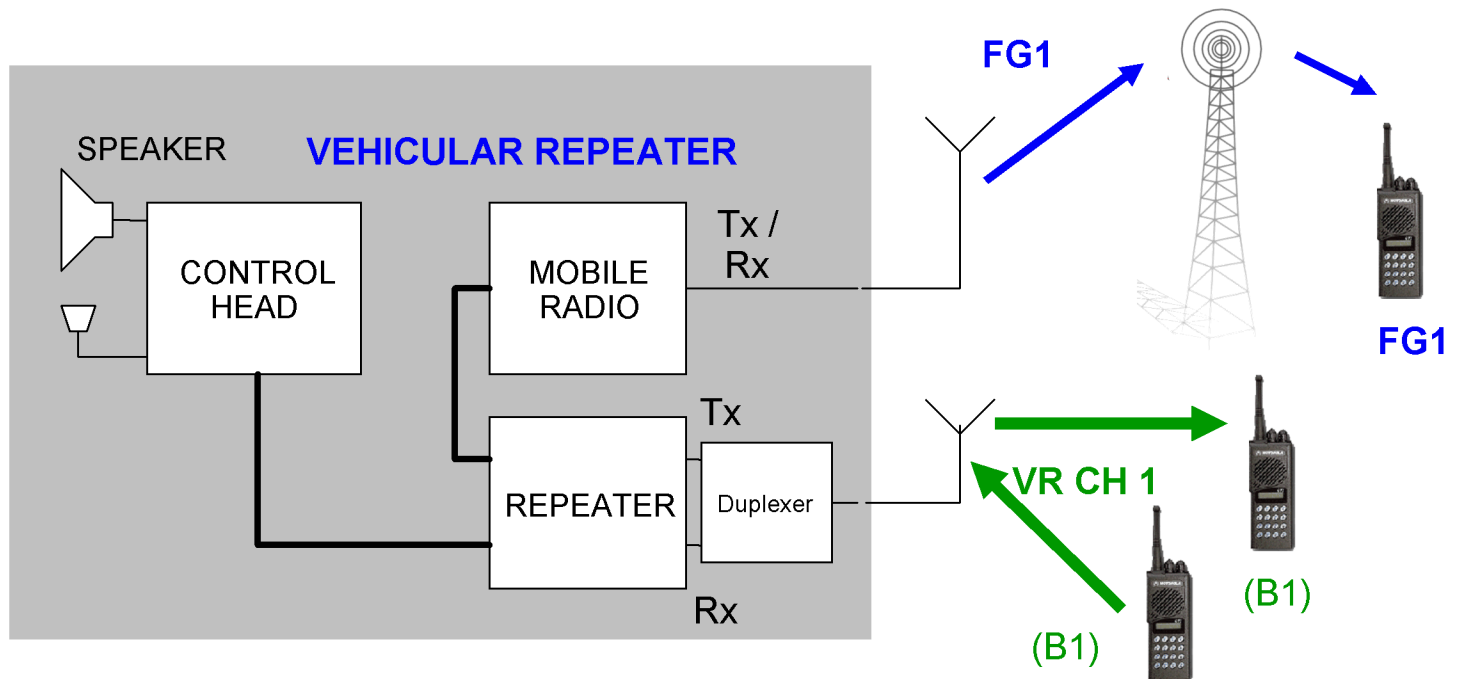
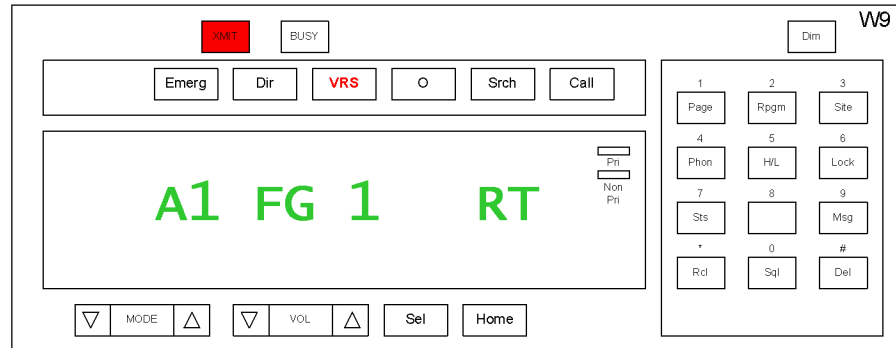
# OPERATING THE VR SYSTEM MODE = VR ON

- Mobile Microphone PTT



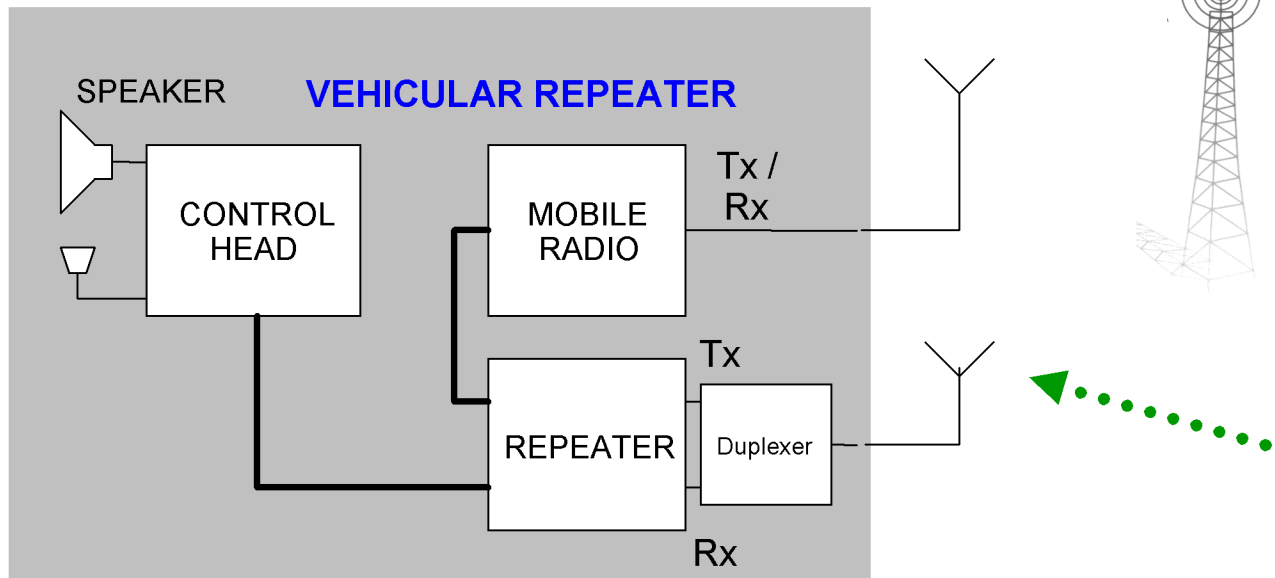
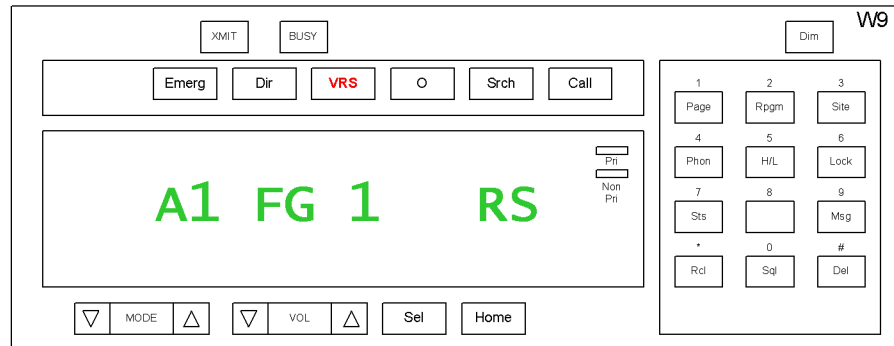
# OPERATING THE VR SYSTEM MODE = VR ON

- VR Receiving



# OPERATING THE VR SYSTEM MODE = VR ON

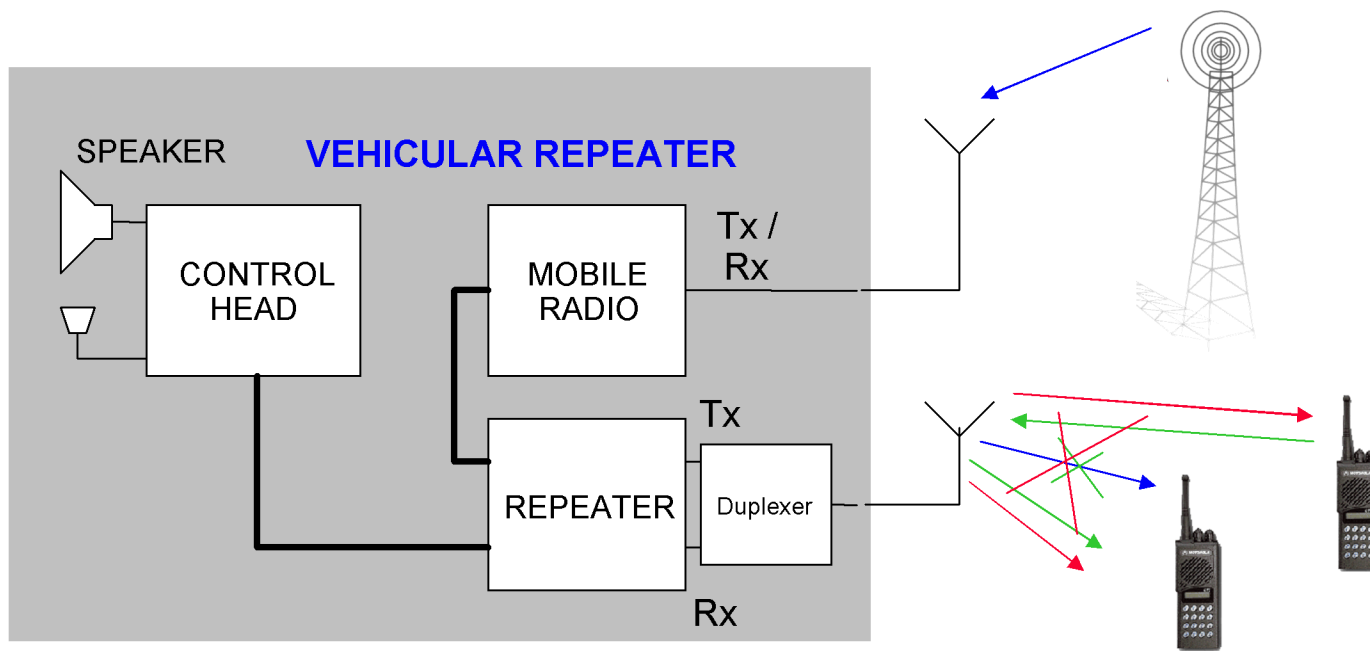
- VR Receiving without or with wrong PL



# OPERATING THE VR SYSTEM MODE – PRIORITIES

Speaker Audio  
Speaker Audio

- Microphone
- Portable
- System



## OPERATING THE VR SYSTEM MODE

- FIRE CALL – DISPATCHER ASSIGNS FIRE GROUND CHANNEL AND VR CH

**FG1 → A1 → B1 (VR1)**

**FG2 → A2 → B2 (VR2)**

- VR EQUIPPED ENGINES HAVE THE VR OFF UNTIL ARRIVAL AT THE FIRE SCENE
- FIRE FIGHTERS ENTER THE BUILDING AND STAY ON THE ASSIGNED FG CHANNEL (A1, A2, or A3) UNTIL THEY ARE OUT OF NETWORK COVERAGE
- FIRE FIGHTERS SELECT B1 OR B2 AND COMMUNICATE THROUGH THE VR
- IN THE UNLIKELY SITUATION OF OUT OF VR COVERAGE, THE FIREFIGHTERS SWITCH TO DIRECT CHANNELS AS FOLLOWS:

**B1 → C1**

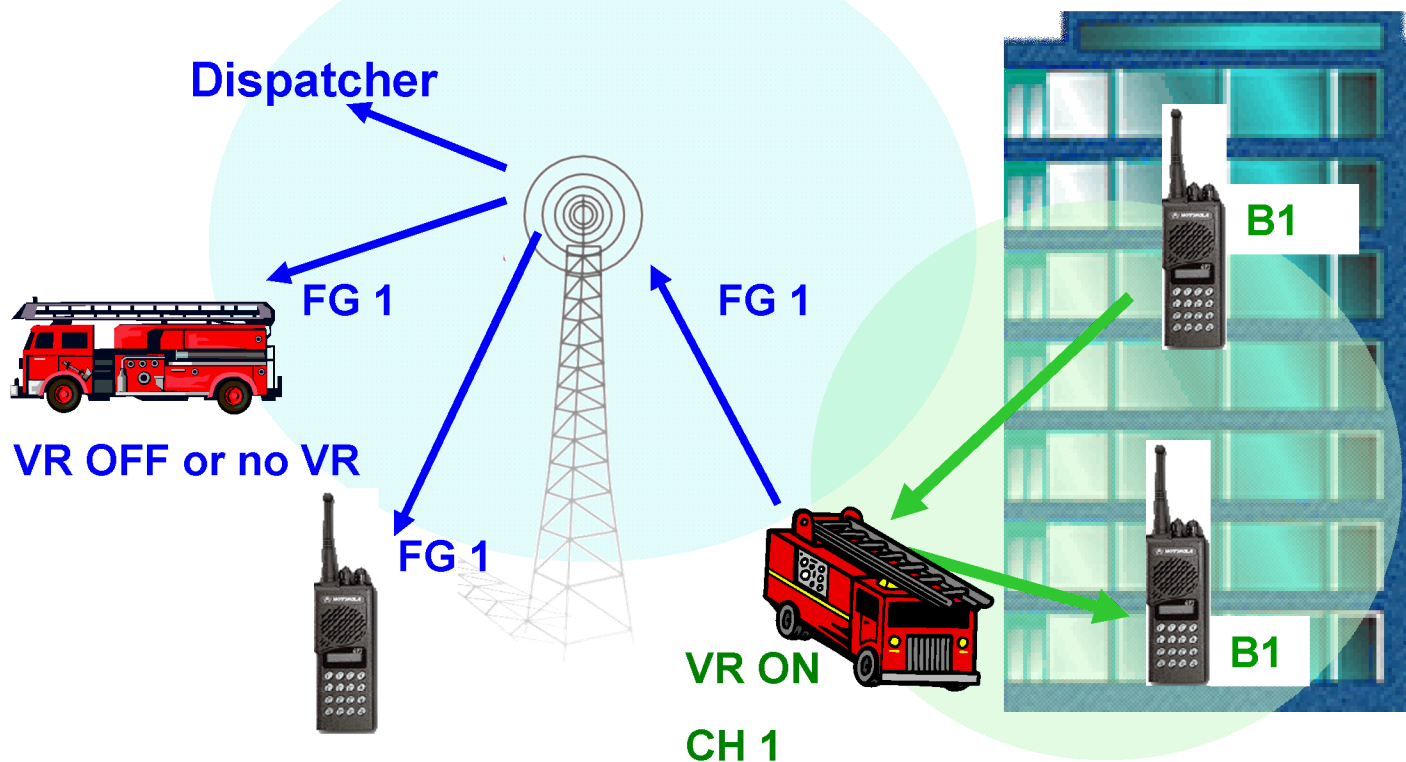
**B2 → C2**



## OPERATING THE VR SYSTEM MODE

- Portables set to the assigned tactical channel are used until radios are out-of coverage (A1, A2 etc).
- Portables are switched to the corresponding VR channel - for example A1 → B1
- Trailing tones – heard at the end of transmission when PTT is released
- VR out-of-range – switch to Direct channel (TALKAROUND)
  - B1 → C1
  - B2 → C2

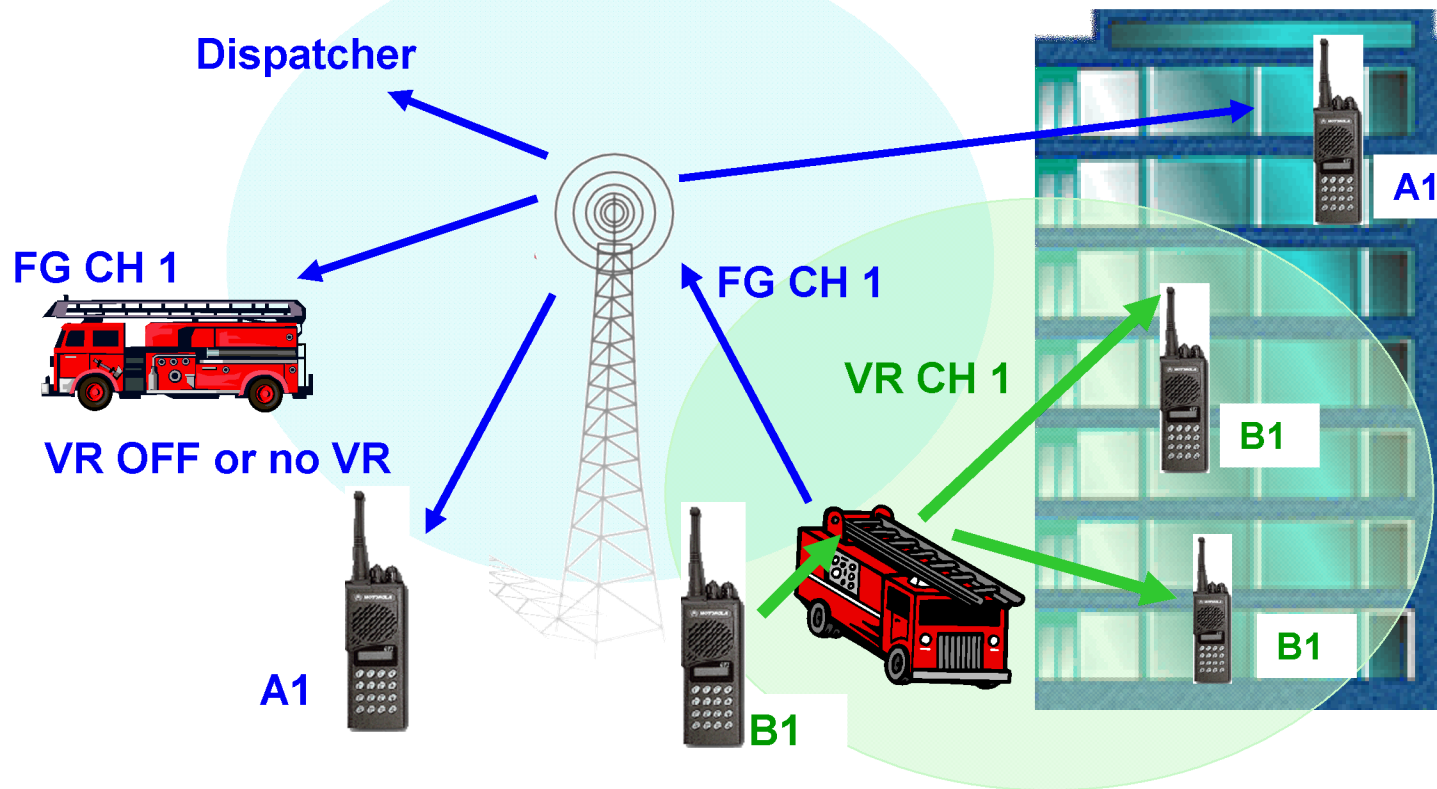
## OPERATING THE VR SYSTEM MODE = VR ON



Portable set on the assigned VR channel presses PTT and talks simultaneously to:

- Other portable users on VR CH1 within the VR coverage area
- Incident Commander – inside chief car
- Dispatcher / Operations Center
- Other Network users on the same FG Ch

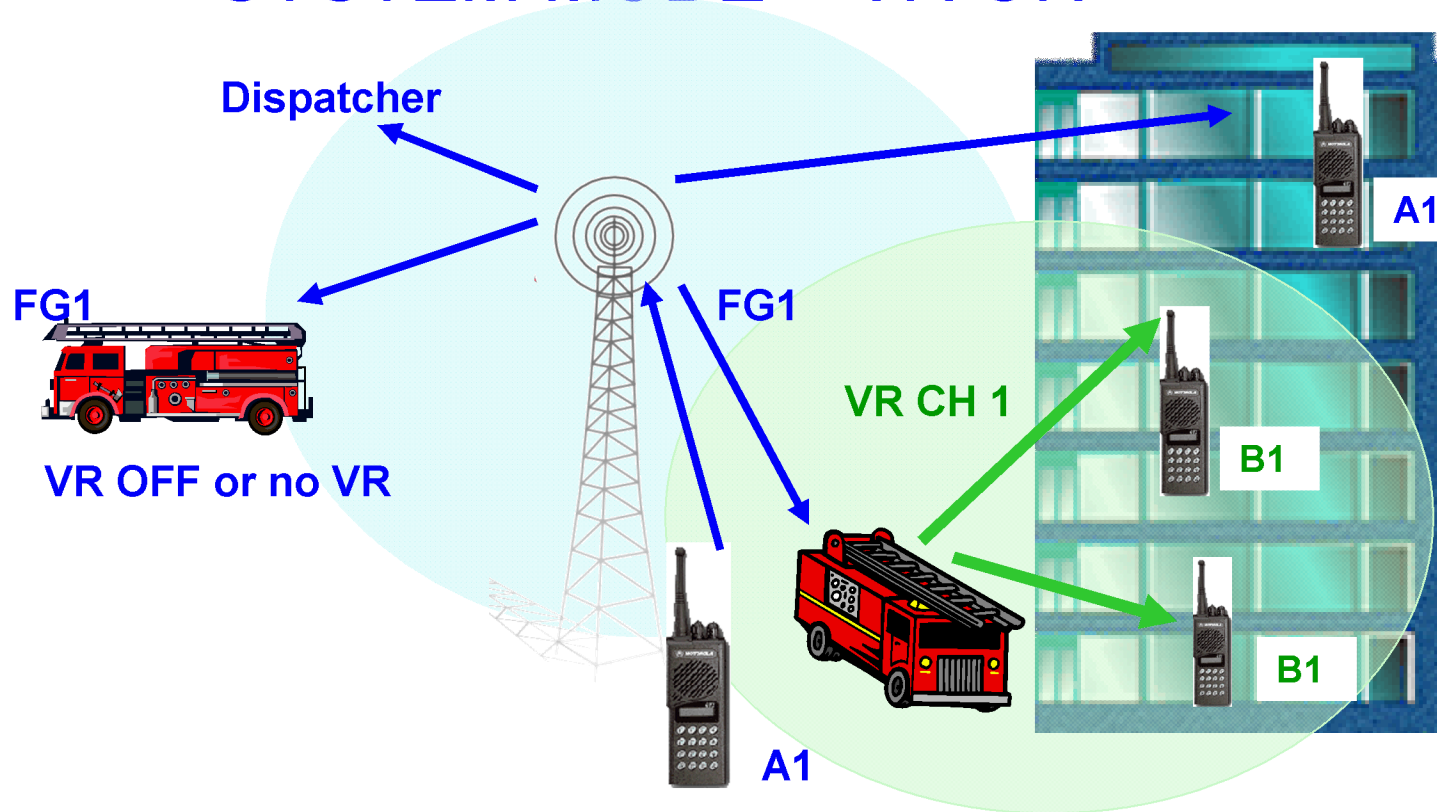
## OPERATING THE VR SYSTEM MODE = VR ON



Incident Commander with portable set to the assigned VR channel presses PTT and talks simultaneously to:

- Portable users on B1 within the VR radio coverage area
- Dispatcher
- Other users on B1 & A1

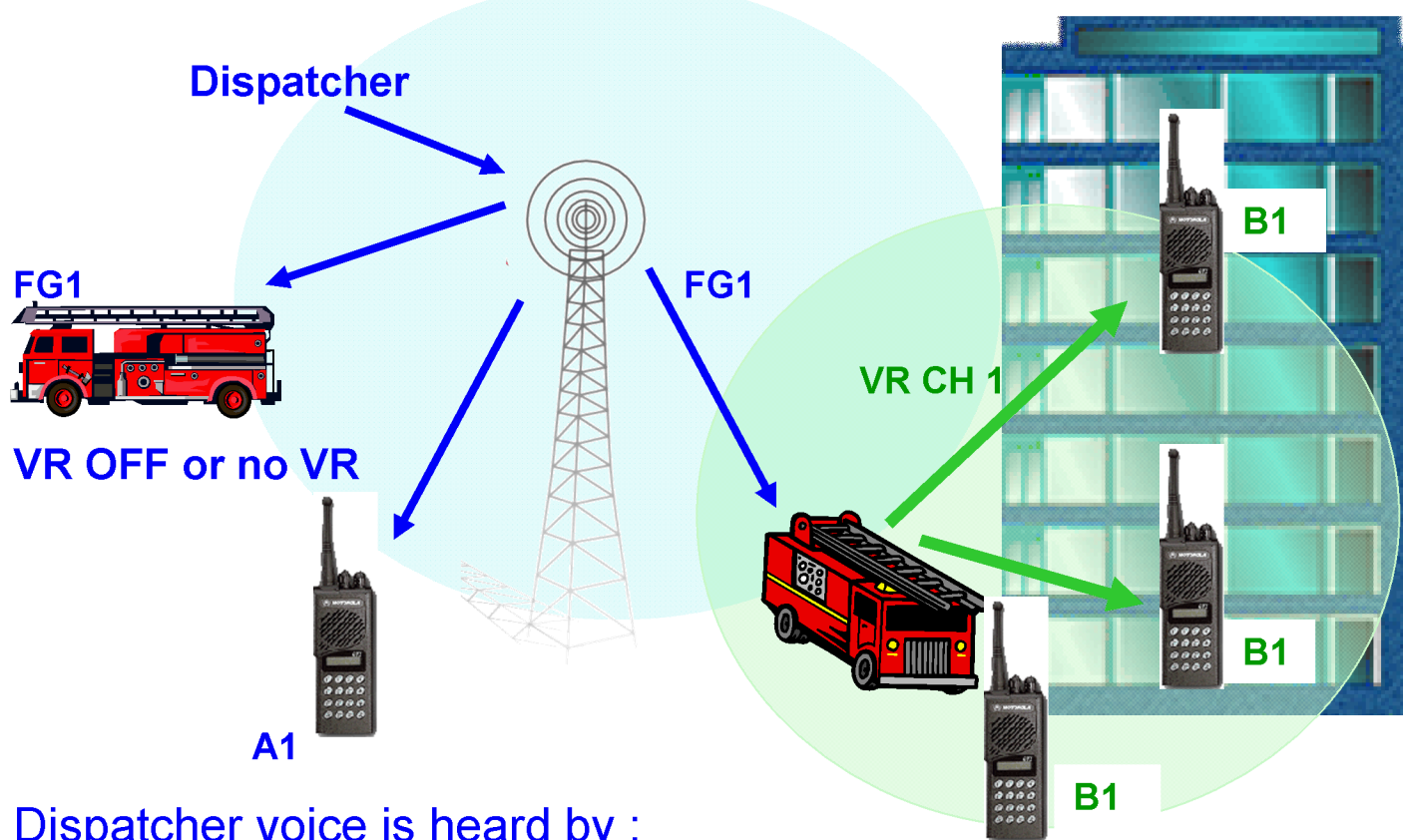
## OPERATING THE VR SYSTEM MODE = VR ON



Incident Commander with portable set to the assigned tactical channel presses PTT and talks simultaneously to:

- Portable users on B1 within the VR radio coverage area
- Dispatcher
- Other users on A1

## OPERATING THE VR SYSTEM MODE = VR ON

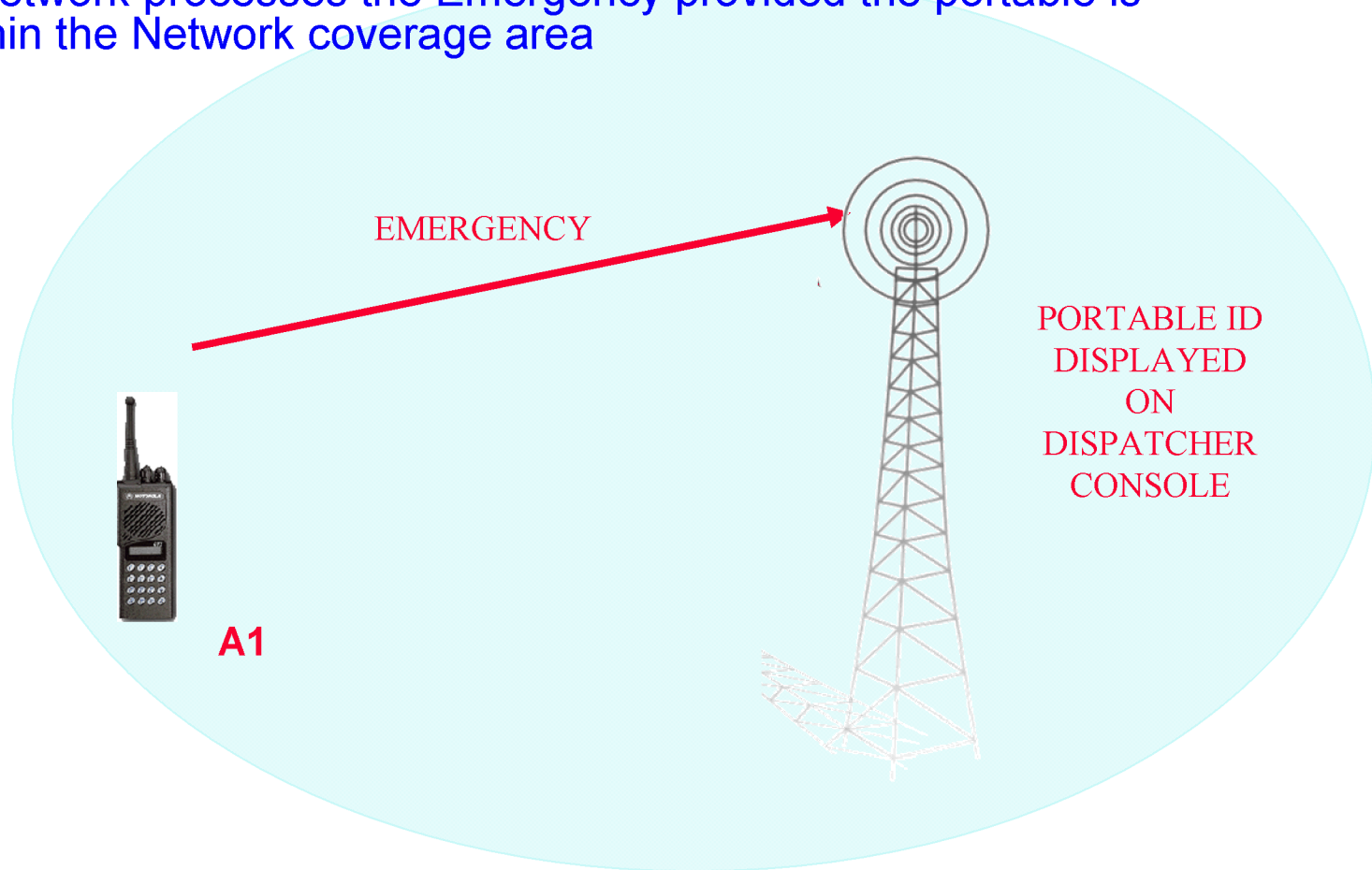


Dispatcher voice is heard by :

- Portable users on VR CH1 within the VR coverage area
- Incident Commander (A1 / B1 / Inside command vehicle)
- Other FG1 users

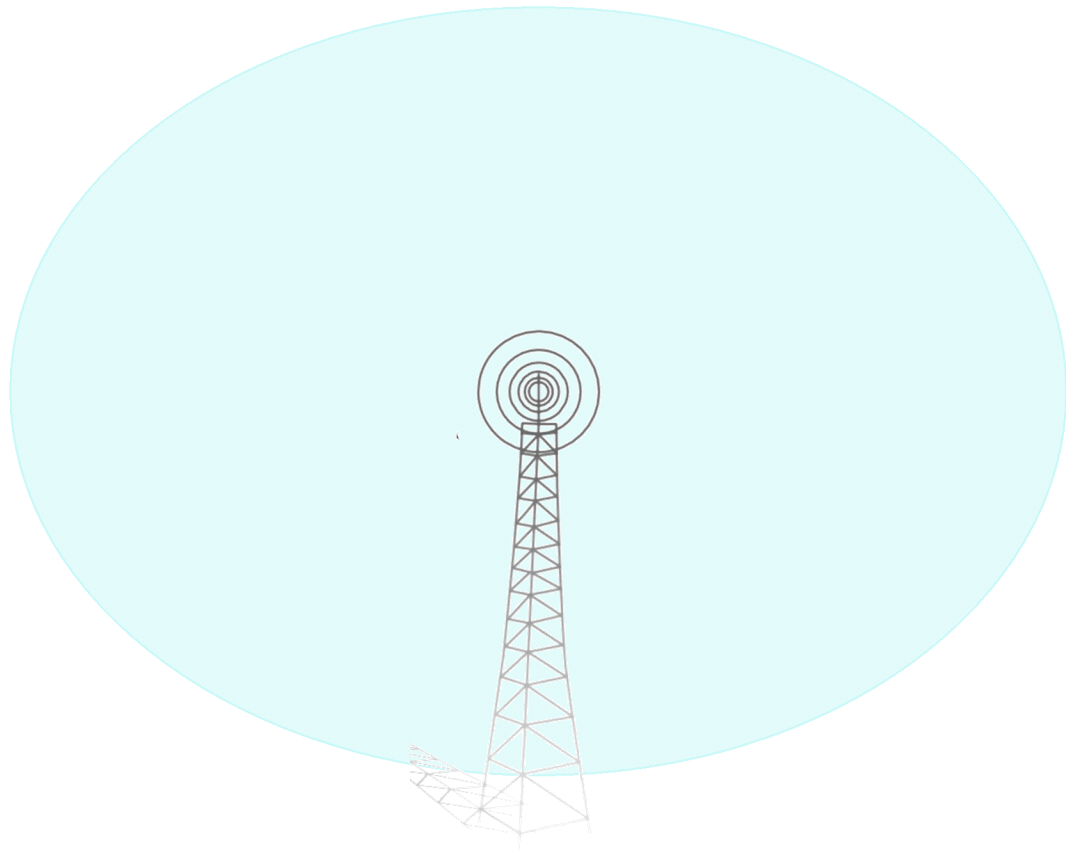
# PORTABLE EMERGENCY PROCESSING WITHOUT VR

- Portable set on a tactical channel activates the Emergency button
  - Network processes the Emergency provided the portable is within the Network coverage area



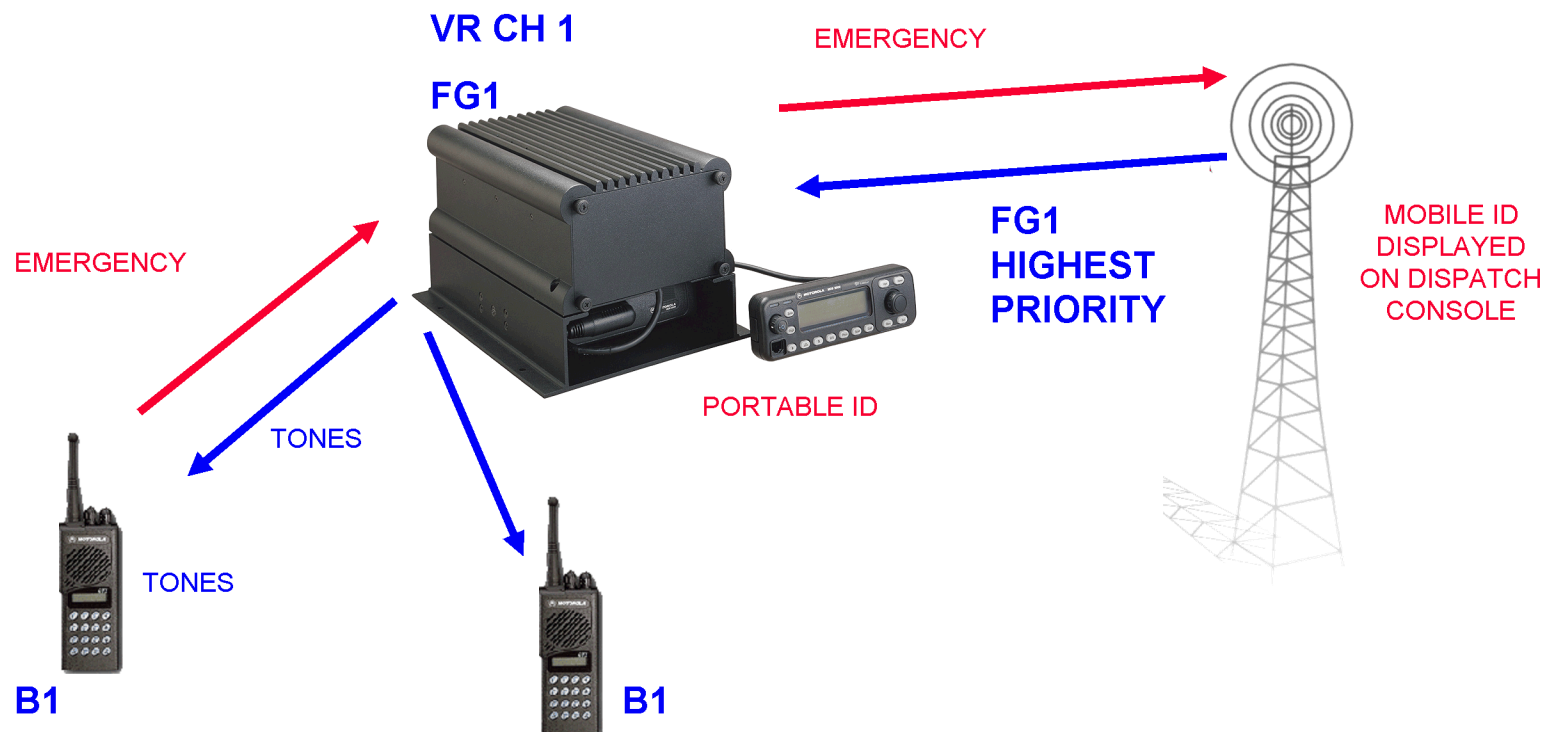
## PORTABLE EMERGENCY PROCESSING WITHOUT VR

- Portable set on a tactical channel activates the Emergency button – if out of network range, the Emergency is not processed at all.
- Portable set on Direct channel inside building – pressing the Emergency button does not activate emergency processing.



# PORTABLE EMERGENCY PROCESSING BY VR

- Portable on VR channel (B1) activates the Emergency button.
- If VR is ON and set to VR CH1 the Emergency is sent to the network
- If VR is OFF (with VR CH1 being the last channel in use), the Emergency causes the VR to automatically switch ON and process the Emergency to the Dispatch.





# PORTABLE EMERGENCY PROCESSING BY VR

VR CH 1  
FG1

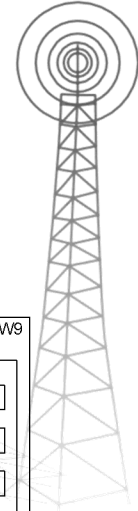
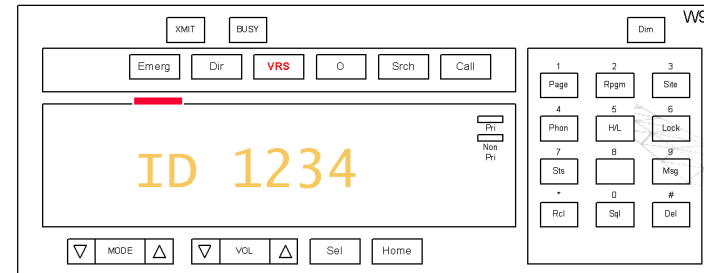


PORTABLE ID  
EMERGENCY  
MDC 1200

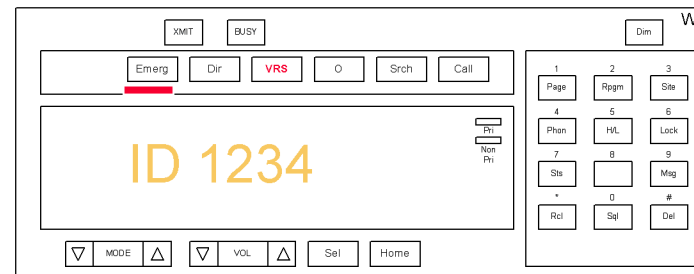
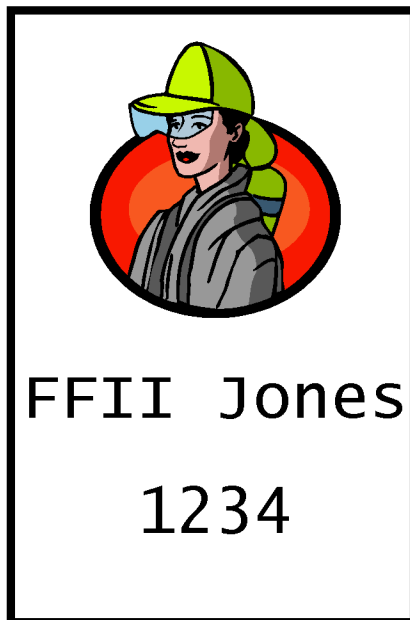


B13

MOBILE TRUNKED ID



# MAYDAY EMERGENCY RESPONSE BY INCIDENT COMMANDER



Incident Commander

Knows where FF Jones is assigned

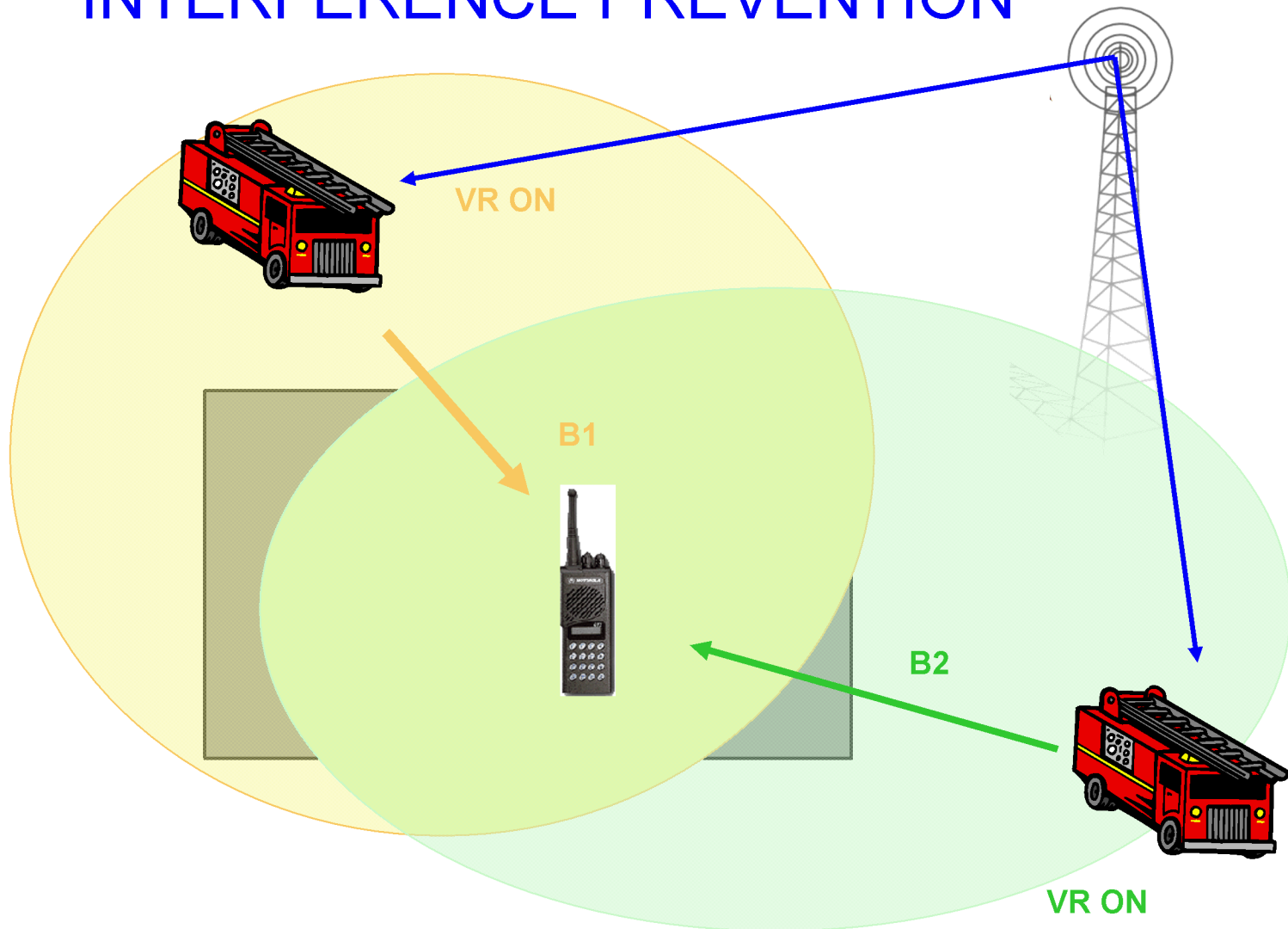
And can send the RIT Team to help her

Personnel Accountability Tag (PAT) or other  
accountability system

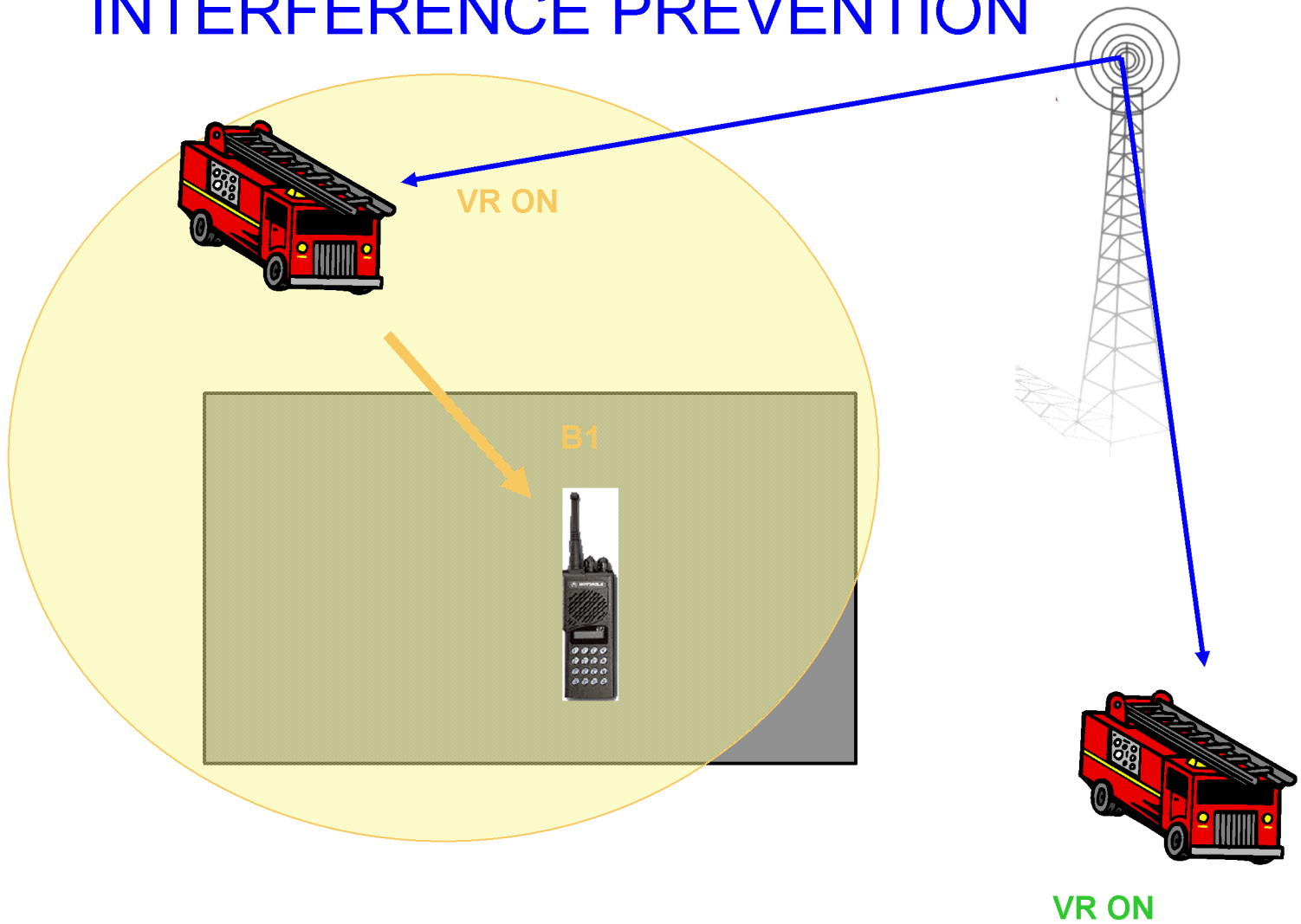
## PORTABLE EMERGENCY PROCESSING BY VR

- Portable on B1 declares MAYDAY
- If any other VRs on B1 are in the area, they all display the *ID number of the portable*
- One VR sends the Mayday message to the network / dispatcher AND emergency tones to the portable radios (B1)
- *Mobile radio ID* displayed on Dispatcher console
- Incident Commander may verify the portable ID on the mobile radio control unit display and the Mobile ID from the Dispatch
- Incident Commander may redirect other portable users to another tactical channel / VR channel AFTER setting up another VR accordingly. (emergency tactical or revert)

# INTERFERENCE PREVENTION

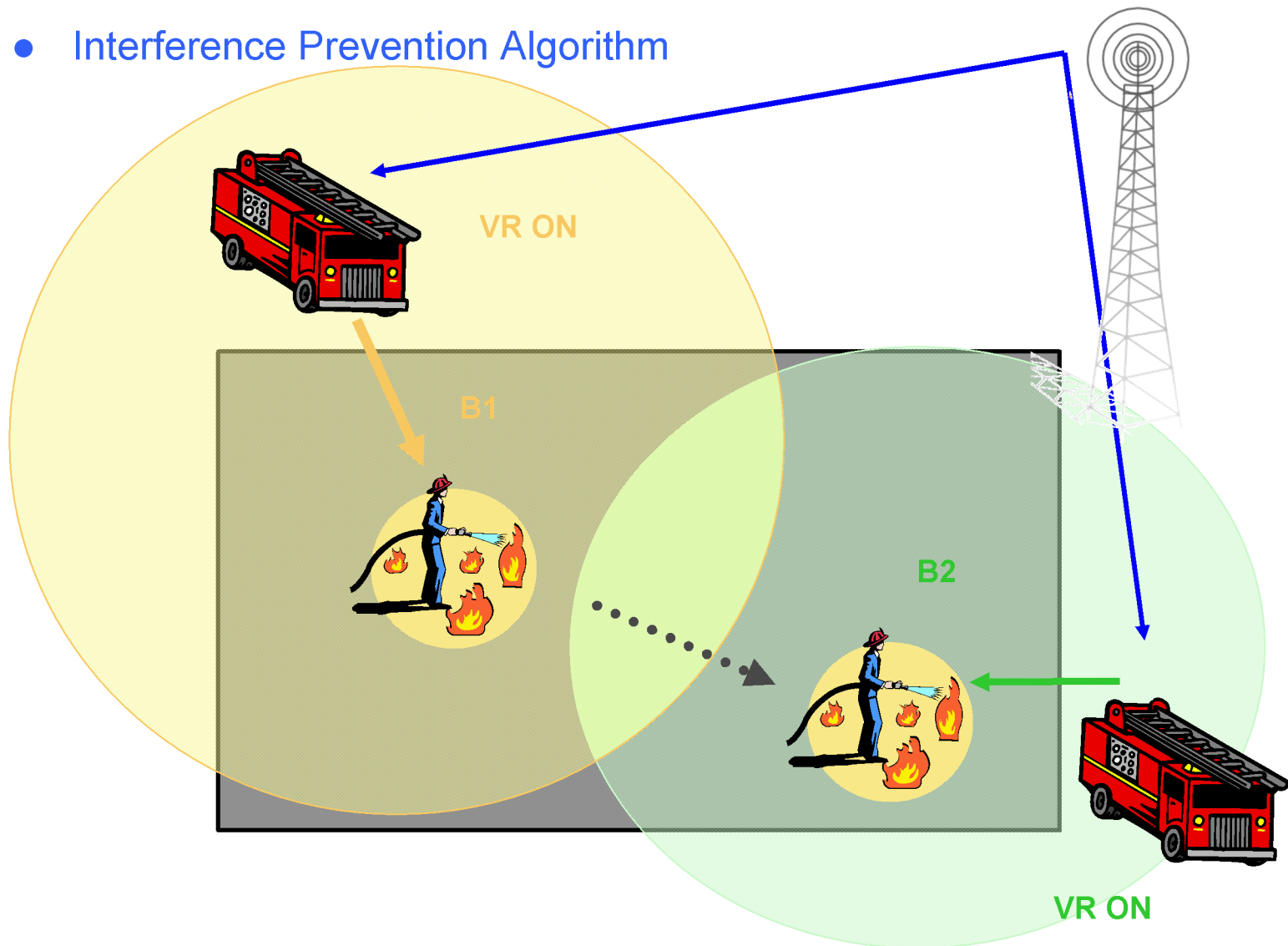


# INTERFERENCE PREVENTION



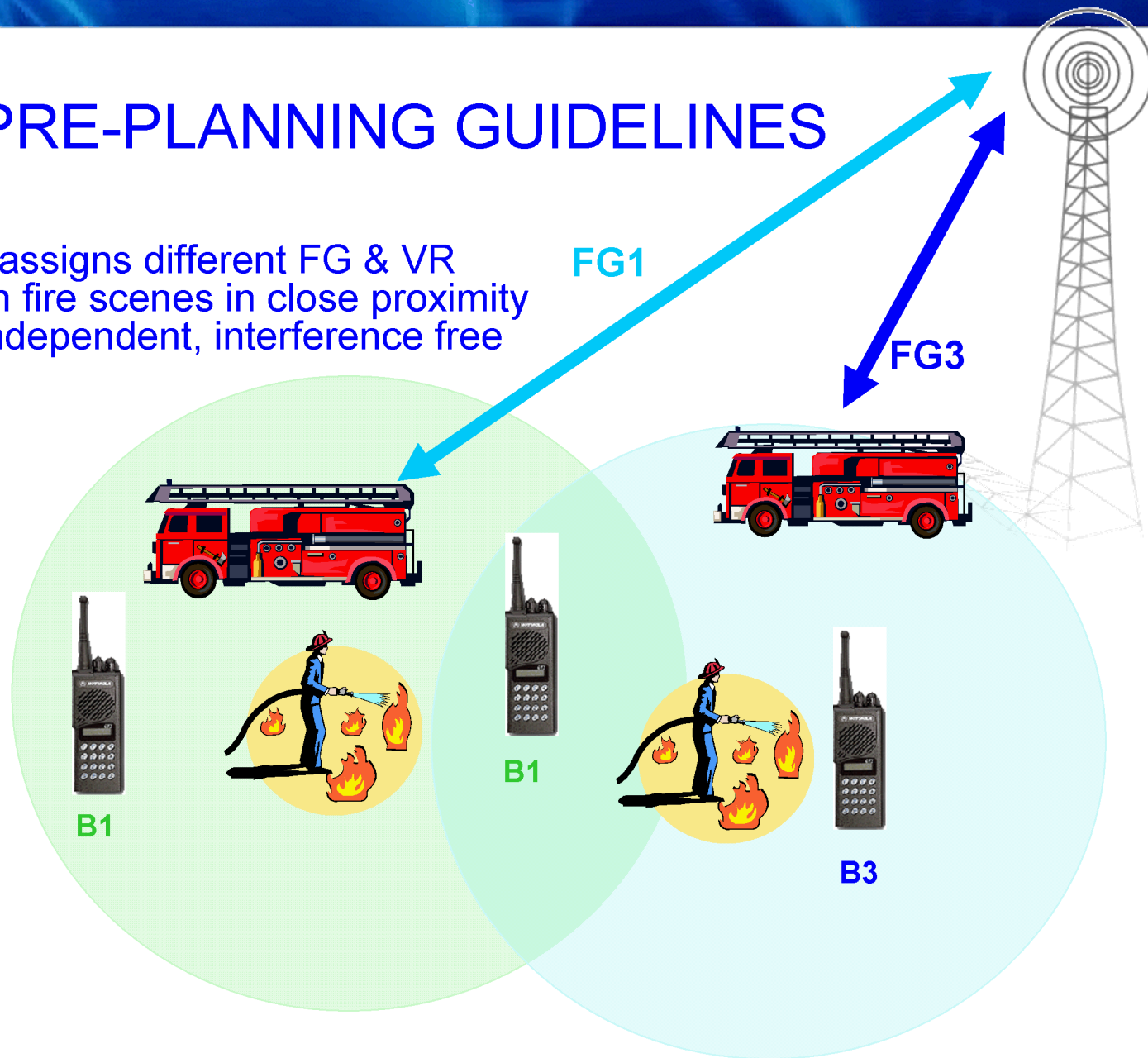
# PRE-PLANNING GUIDELINES

- Interference Prevention Algorithm



## PRE-PLANNING GUIDELINES

- Dispatcher assigns different FG & VR channels on fire scenes in close proximity to ensure independent, interference free operation.



## PRE-PLANNING GUIDELINES

- Identify possible conventional channels for portable use.in-band or cross-band
- Establish channel & zone protocols. Make sure they are easy to understand
- Identify buildings and areas with Network radio coverage problems
- Find optimum location for VR equipped command vehicles to ensure best radio coverage of the building and the fire hazardous areas
- Establish MAYDAY/PAR protocols. Setup a backup VR for handling of Mayday channel steering / rerouting
- Establish multiple VR channels for large incident command structure



QUESTIONS ??

