



The Hazard Zone, Firefighter Safety, Trunking, & Portable Radios

APCO International
75th Annual Conference & Expo 2009
August 16-20, 2009
Las Vegas, Nevada

*This presentation is dedicated to the health and safety
of public safety employees.*

The first tool used to enhance fireground communications was a speaking trumpet. The first record of its use was in 1752, when the City of New York purchased six speaking trumpets “for the use of the Corporation.” The trumpet is still in use today, not on the fireground, but as the insignia of fire department rank.

Facilitators / Presenters

*The Hazard Zone,
Firefighter Safety, Trunking, &
Portable Radios*

Facilitators / Presenters

- **Leif Anderson**
 - Deputy Chief, Technical Services
 - Phoenix Fire Department
- **Doug Mummert**
 - Division Chief, Technical Services
 - Phoenix Fire Department
- **Mark Schroeder**
 - IT Project Manager, Technical Services
 - Phoenix Fire Department

Session Agenda

*The Hazard Zone,
Firefighter Safety, Trunking, &
Portable Radios*

Session Agenda

The agenda for this professional development track includes:

- Review the vocabulary specific to the story
 1. Fireground 101
 2. Radio 101

Session Agenda

- Review the beginning of the story
 - Overview of the Phoenix Fire Department (PFD)
 - PFD radio communications (1970s – 2000s)
 - Winds of radio change
- Review the middle of the story
 - Problem identified
 - Requirements developed
 - Solutions identified
 - Solutions evaluated
- Review the end of the story
 - PFD radio communications (2010s – forward)
 - Lessons learned

Disclaimer

*The Hazard Zone,
Firefighter Safety, Trunking, &
Portable Radios*

Disclaimer

- We're going to tell you a story about our experience...
 - It's our story...
 - We hope you enjoy it & find similarity, but it's ours
 - i.e., we're not trying to tell anyone how to do anything and we're certainly not trying to sell anything
- We're experts in firefighting, we do not profess to knowledgeable or proficient in much else...
 - But still, we have this experience to share
- In general, firefighters are typically extremely action oriented people and very committed problem solvers!
 - We don't get to go home unless we mitigate the problem

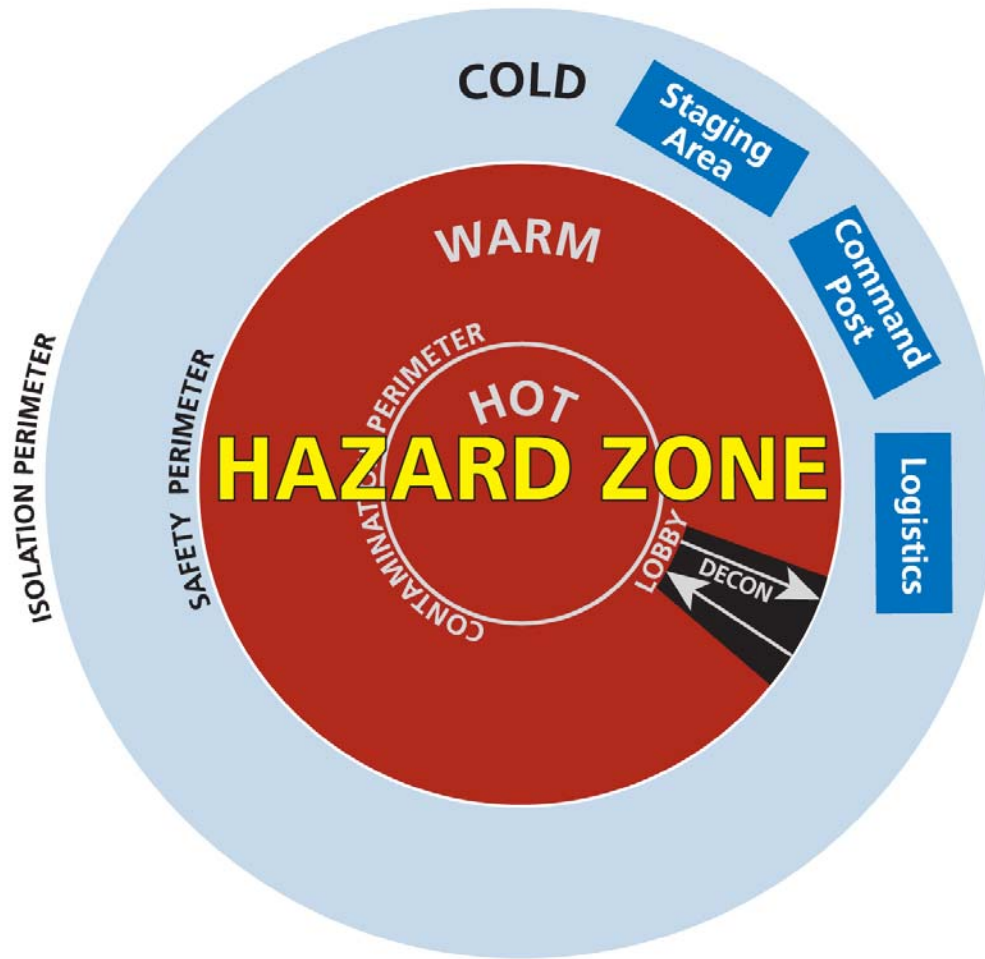
Vocabulary

*The Hazard Zone,
Firefighter Safety, Trunking, &
Portable Radios*

Fireground 101 – The Fireground

- The “fireground” is defined as the area where the fire situation creates potential hazard to fire personnel.
 - “Fireground” is synonymous with “hazard zone”
 - It’s a geographically definable area
 - It’s normally a relatively small area
 - Variable - a residential house vs. a high rise

Fireground 101 – Control Zones



Fireground 101 – Fireground Safety

The Fireground – The Hazard Zone

- The fireground is a dangerous, hostile, and inhospitable place...
 - Firefighting is a complex process with complex tasks that occur in:
 - Non-discretionary situations (must act immediately)
 - Confined spaces
 - With high heat and diminished visibility
 - Significant background noise
 - Wearing 60 lbs of clothing, in awkward body positions

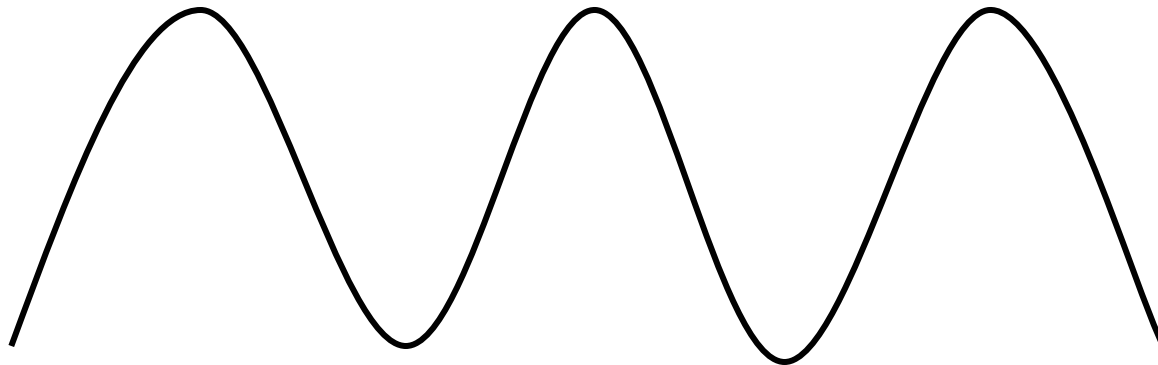
Fireground 101 – Fireground Ticket

Before entering the Hazard Zone, each person **must have** (PFD Standard Operating Procedures, Volume 2) :

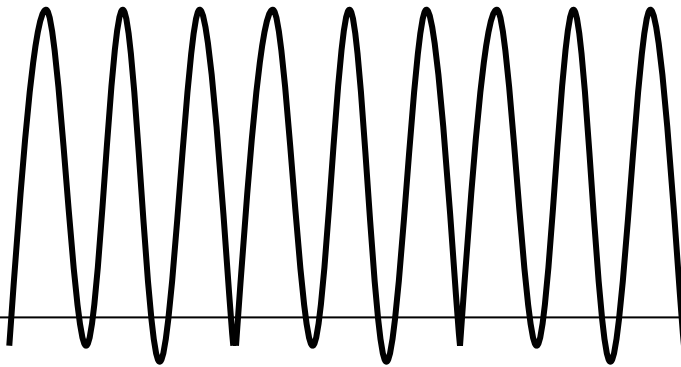
- The appropriate personal protective equipment (PPE), including respiratory protection (SCBA)
- A partner
- An assignment from Command
- A portable radio

Radio 101 – Frequencies

- “Frequency” refers to how fast a radio wave alternates...



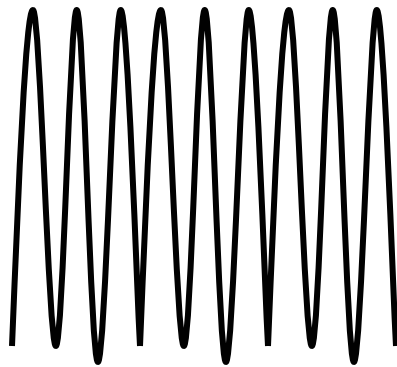
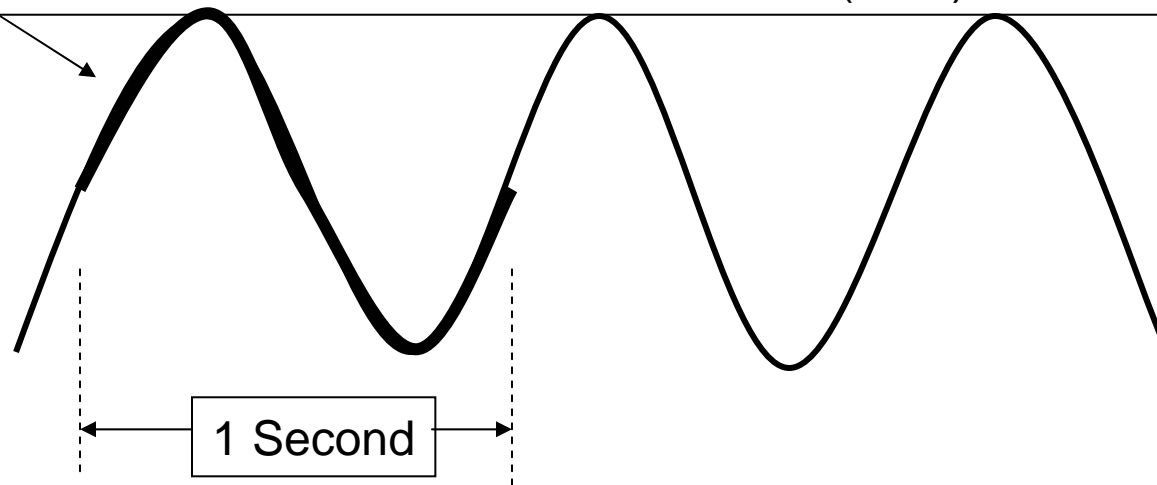
Low Frequency



High Frequency

Radio 101 – Frequencies

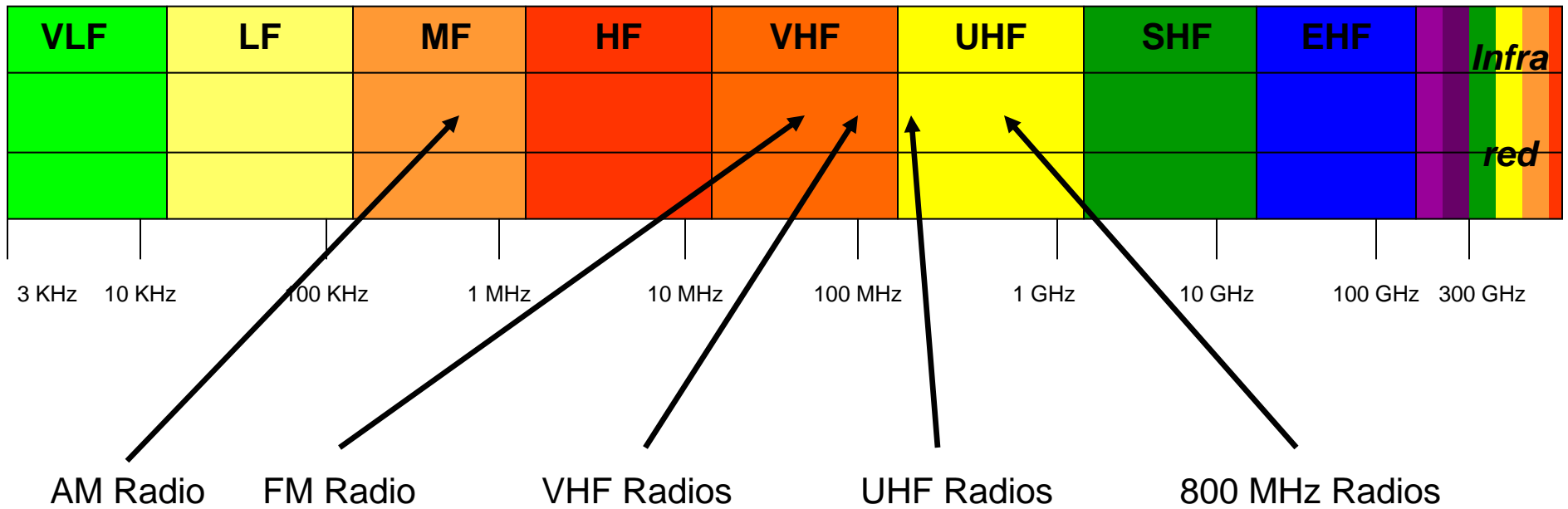
One cycle of a wave in one second's time = one Hertz (1 Hz)



One million cycles per second = one MegaHertz (1 MHz)

Radio 101 - Spectrum

- Spectrum refers to the entire range of radio frequencies...

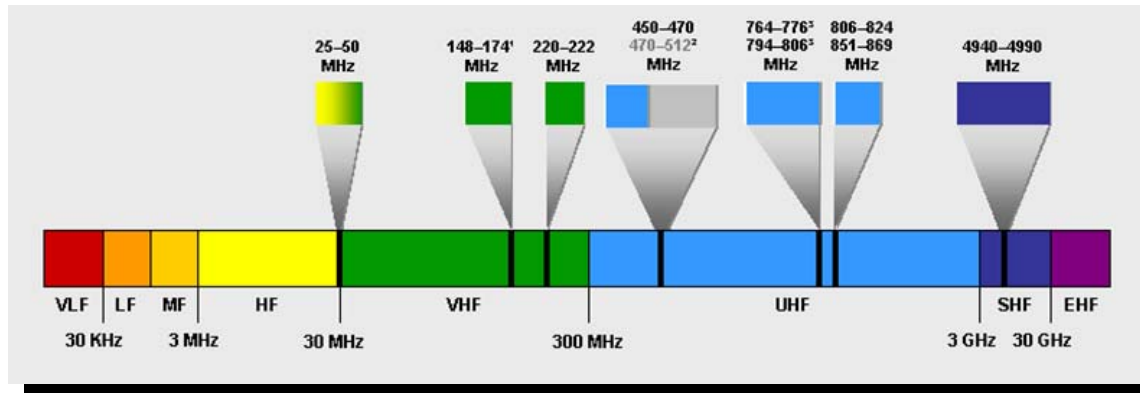


Radio 101 - Spectrum

- The need/desire for additional spectrum has proliferated since the late 1980s
 - Everybody uses spectrum everyday
 - Cell phones, BlackBerries, pagers, bluetooth, cordless telephones, wi-fi, garage doors, RC toys, GPS, radar, microwave ovens, etc.
- But, spectrum is a limited resource
 - You can't mine for it, you can't drill for it... simply, it is what it is and there isn't any more
 - Improved technology provides the potential to utilize it more effectively

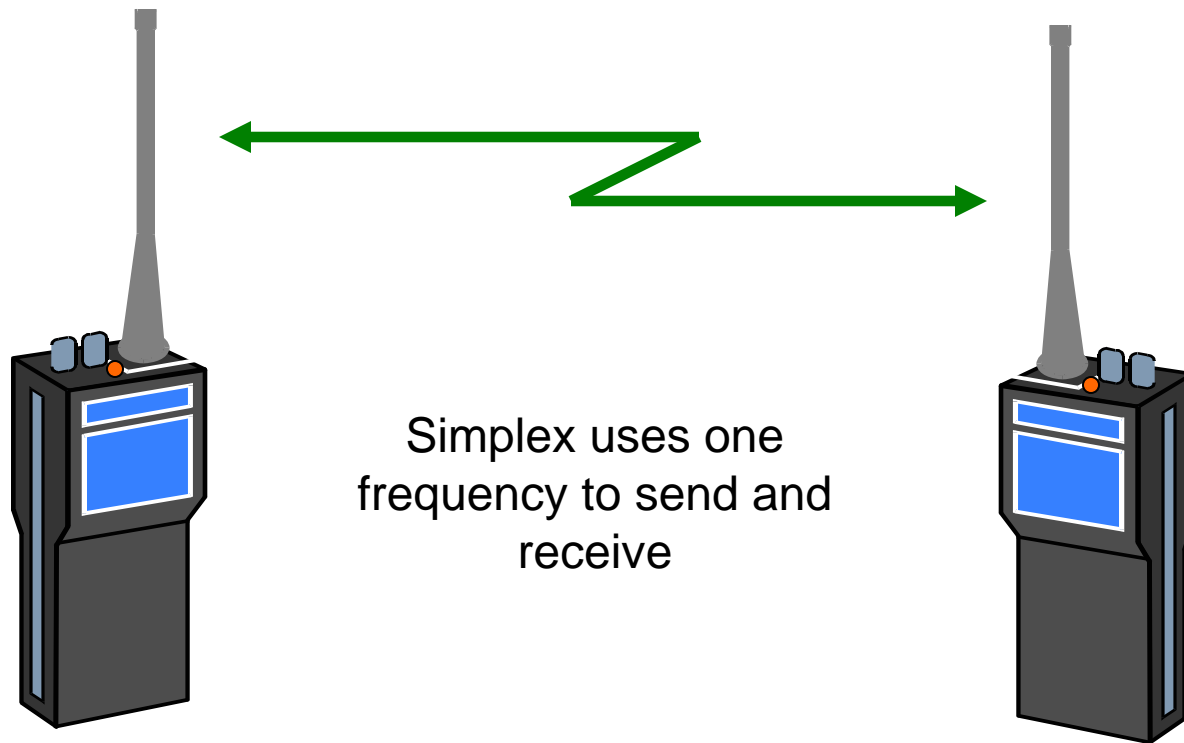
Radio 101 - Spectrum

- Public safety operates in certain frequencies ranges called “bands”
 - Low band (25-50 MHz)
 - VHF (150-174 MHz)
 - UHF (450-512 MHz)
 - 700 MHz
 - 800 MHz
 - 4.9 GHz (broadband data)



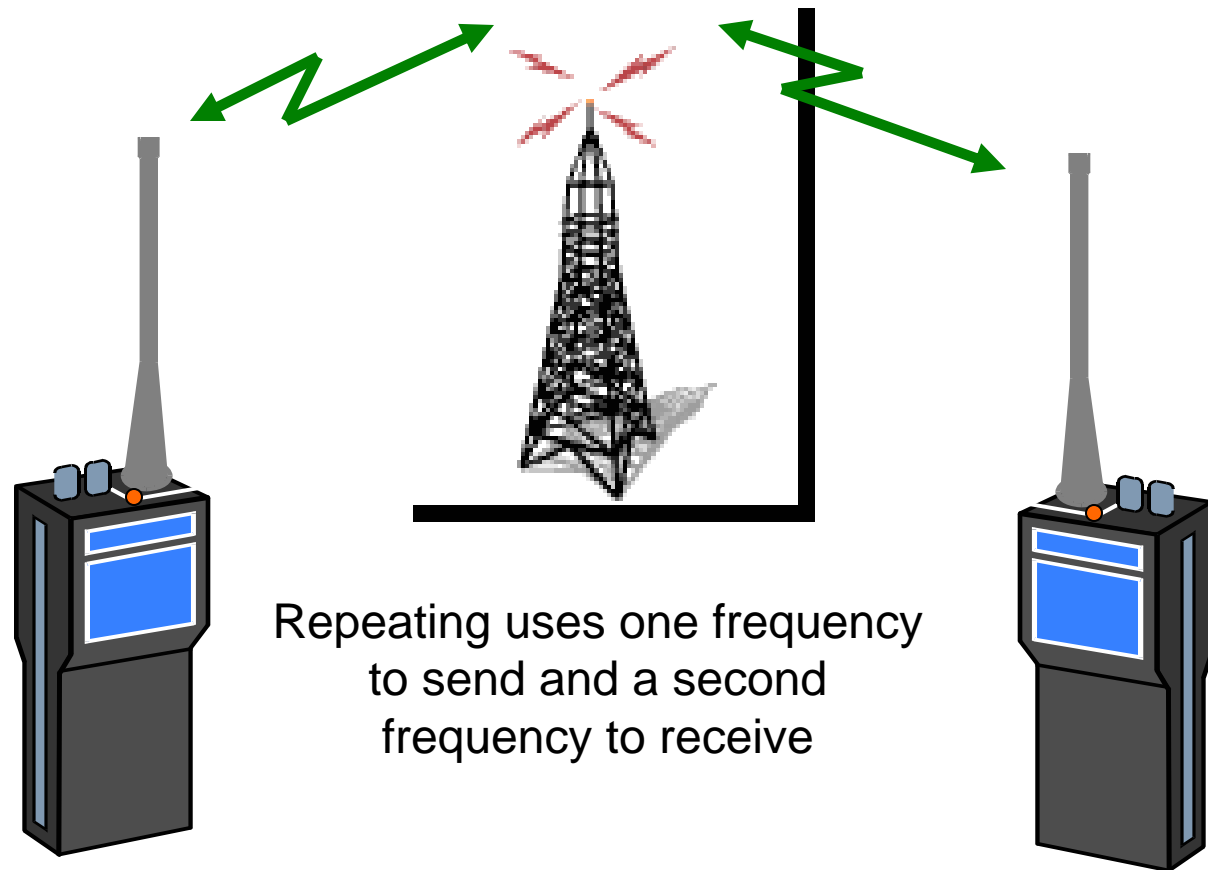
Radio 101 - Simplex

- **Simplex** (aka direct, radio-to-radio, & talk-around)



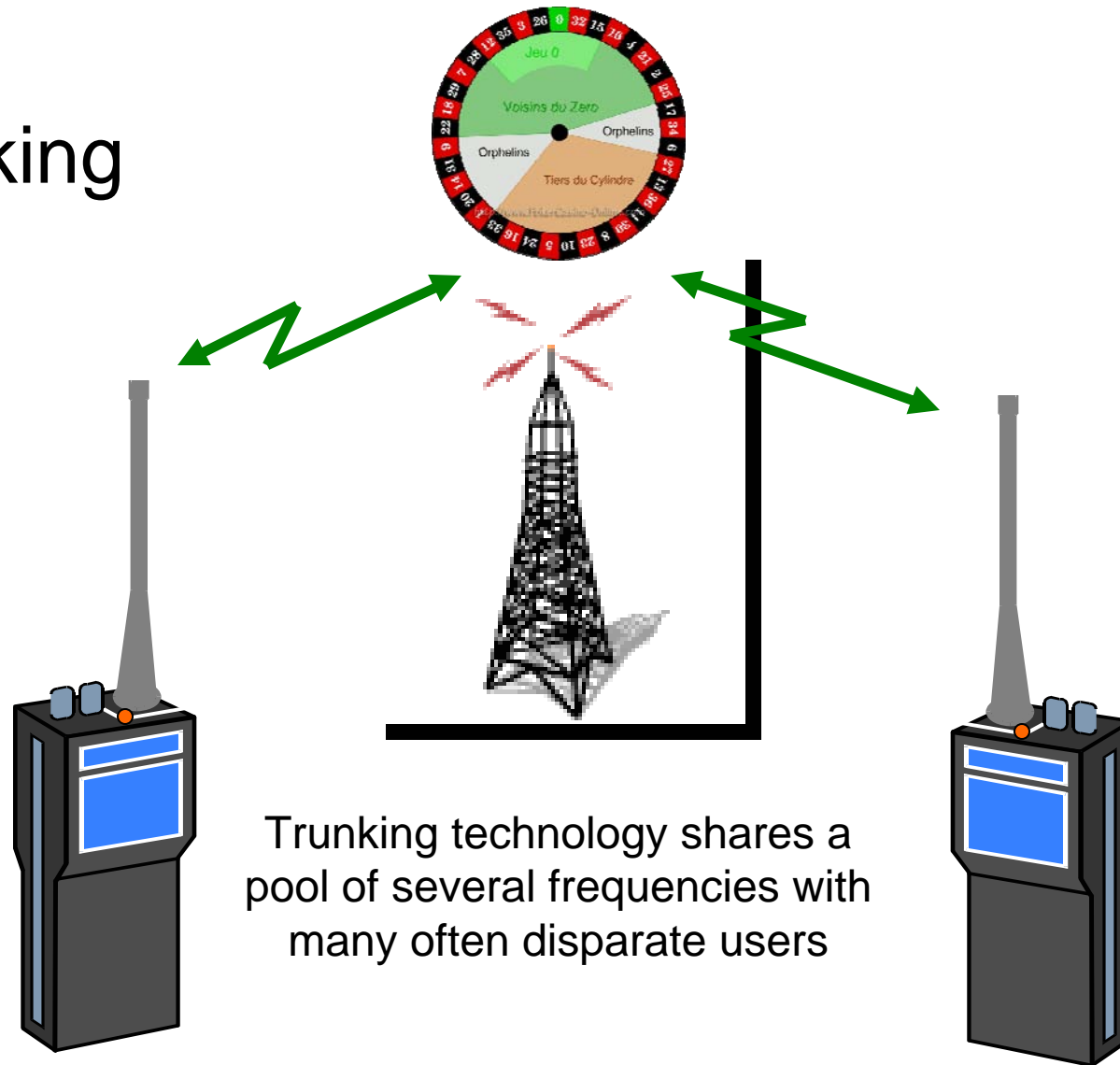
Radio 101 - Repeated

- Repeated



Radio 101 - Trunked

- Trunking



Radio 101 - Comparisons

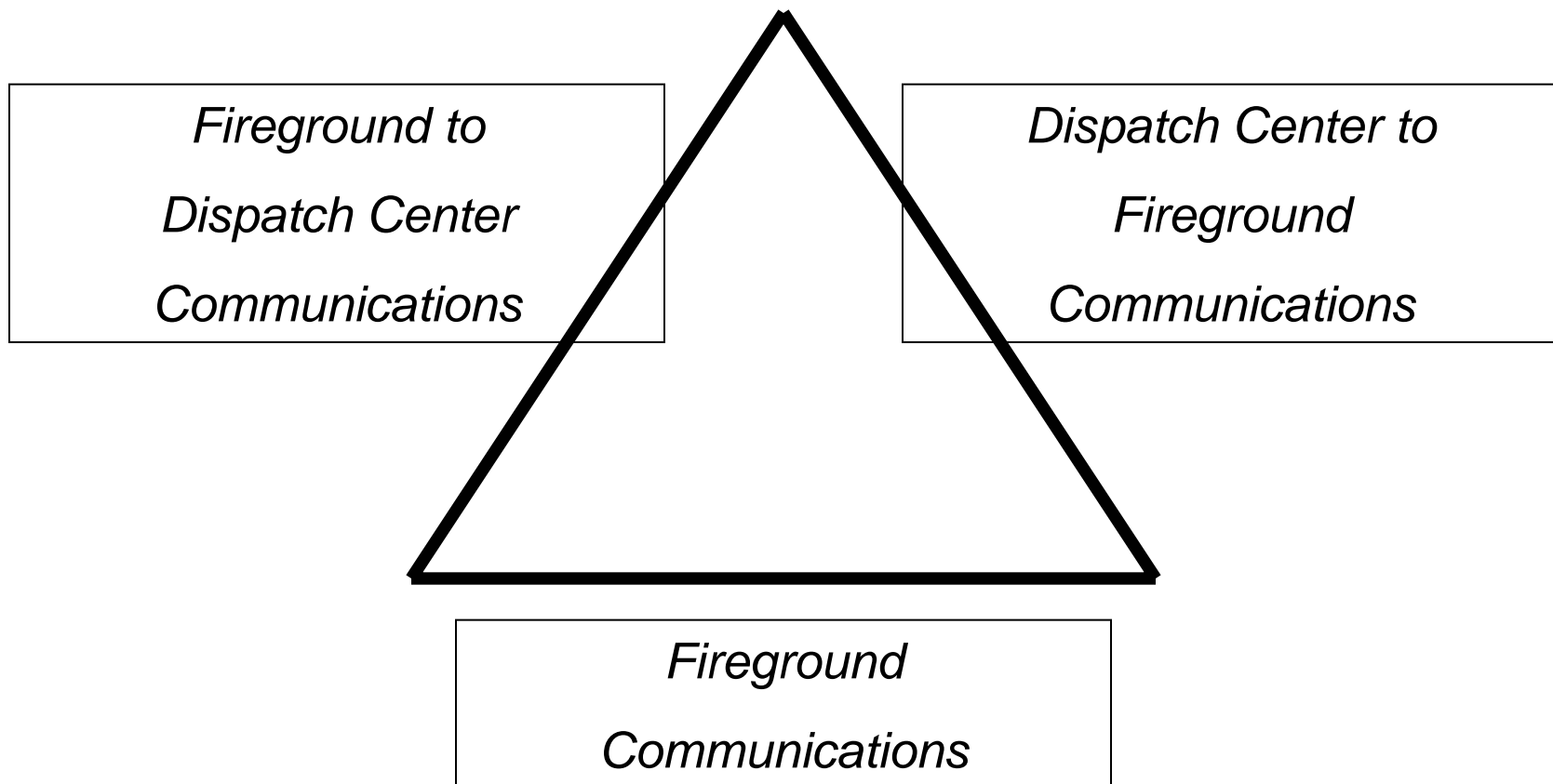
- No two radio systems are identical!
- Variables include:
 - Coverage, capacity, topography, buildings, vegetation, weather, maintenance schedules, equipment age, software version, etc.

Radio 101 - Comparisons

- **Simplex System** - users working in close proximity
 - Local area (approximately 2 miles), dedicated capacity, immediate, uninterrupted, extremely reliable, functionally simple, operationally predictable.
- **Repeated System** - users working over a large area
 - Wide area, dedicated capacity, moderately reliable (coverage and capacity), functionally moderate, operational moderately predictable.
- **Trunked System** - great numbers of possibly disparate users, over great areas, for the purpose of sharing frequencies
 - Wide area, capacity efficient, moderately reliable (coverage, capacity, computers), functionally complicated, operational moderately predictable.

Radio & Hazard Zone Communications

A hazard zone 'radio system' is the combination of all three sides of the triangle!



Overview of the Phoenix Fire Department

*The Hazard Zone,
Firefighter Safety, Trunking, &
Portable Radios*

Phoenix Fire Department - Overview

- 5th most populous city
 - 1,567,924 residents
 - 517 square miles
 - 60 fire stations
 - 155,257 calls (FY08/09)
- 12th largest metro area
 - 4,300,000 residents
 - Maricopa County leads nation in population growth since 2000
 - Population gained 696,000 since 2000
 - That increase surpasses all but the 15 most populous US cities

Phoenix Fire Department - Overview

- Automatic aid consortium
 - The Phoenix Fire Department dispatches a total of 20 cities/jurisdictions
 - 160 fire stations
 - 302,881 calls (FY08/09)
 - 2,000+ square miles
 - The closest most appropriate fire service resource is dispatched regardless of jurisdictional boundaries

Phoenix Fire Department - Overview

- We're technologically advanced...
 - Documented command procedures
 - Radio order model
 - Computer aided dispatch (CAD)
 - Station alerting
 - Automatic vehicle locating (AVL)
 - Mobile computers
 - GIS
 - GPS
 - Tactical premise

Current PFD Radio Communications (1970s – 2000s)

*The Hazard Zone,
Firefighter Safety, Trunking, &
Portable Radios*

Phoenix Fire Department - 70's-00's

Analog, Simplex, VHF Radio System

*Fireground to
Dispatch Center
Communications*

*Diversity
Receivers*

*Dispatch Center to
Fireground
Communications*

*Mountain-top
Transmitters*

Fireground Communications

*Simplex, Analog,
VHF (150s), 16 Frequencies*

Winds of Radio Change

*The Hazard Zone,
Firefighter Safety, Trunking, &
Portable Radios*

Winds of Radio Change

- National conversation: WHY CHANGE?
 - 1950's based technology (outdated)
 - Unable to support all operational needs
 - Current frequencies overloaded
 - No additional channels available
 - Inadequate support for secure operations
 - FCC changes
 - 700 MHz
 - Narrow banding
 - Increase risk of interference

Winds of Radio Change

- 1980 - Hired consultant: 800 MHz
- 1988 - Hired consultant: 800 MHz
- 1993 - Hired consultant: 800 MHz / P25
- 1995 - Hired consultant/Integrator: 800 MHz / P25, developed system requirements & specifications
- 1995/1998 - Surveyed other cities, met with manufacturers, Police and Fire conducted independent reviews, vendor forum held (presented cases for and against P25)
- March 1998 - Council authorized RFP
- July 1998 - RFP Issued
- January 1999 - Proposal received

Winds of Radio Change

- We purchased a new radio system!
 - A “trunked” (shared) radio system was purchased to provide efficient, wide-area, public safety communications throughout Fire’s automatic aid coverage area
 - The system is a Motorola, digital, trunked, 700-800 MHz, simulcast, Astro 25 (P25), Smartzone
 - Seven zones
 - IR sites
 - Covers 17 cities/jurisdictions and approximately 2,000+ square miles
 - 117 frequencies
 - 98/95 (2% GOS)
 - 12, 17, & 23 dB (portable radio, on hip, swivel clip)

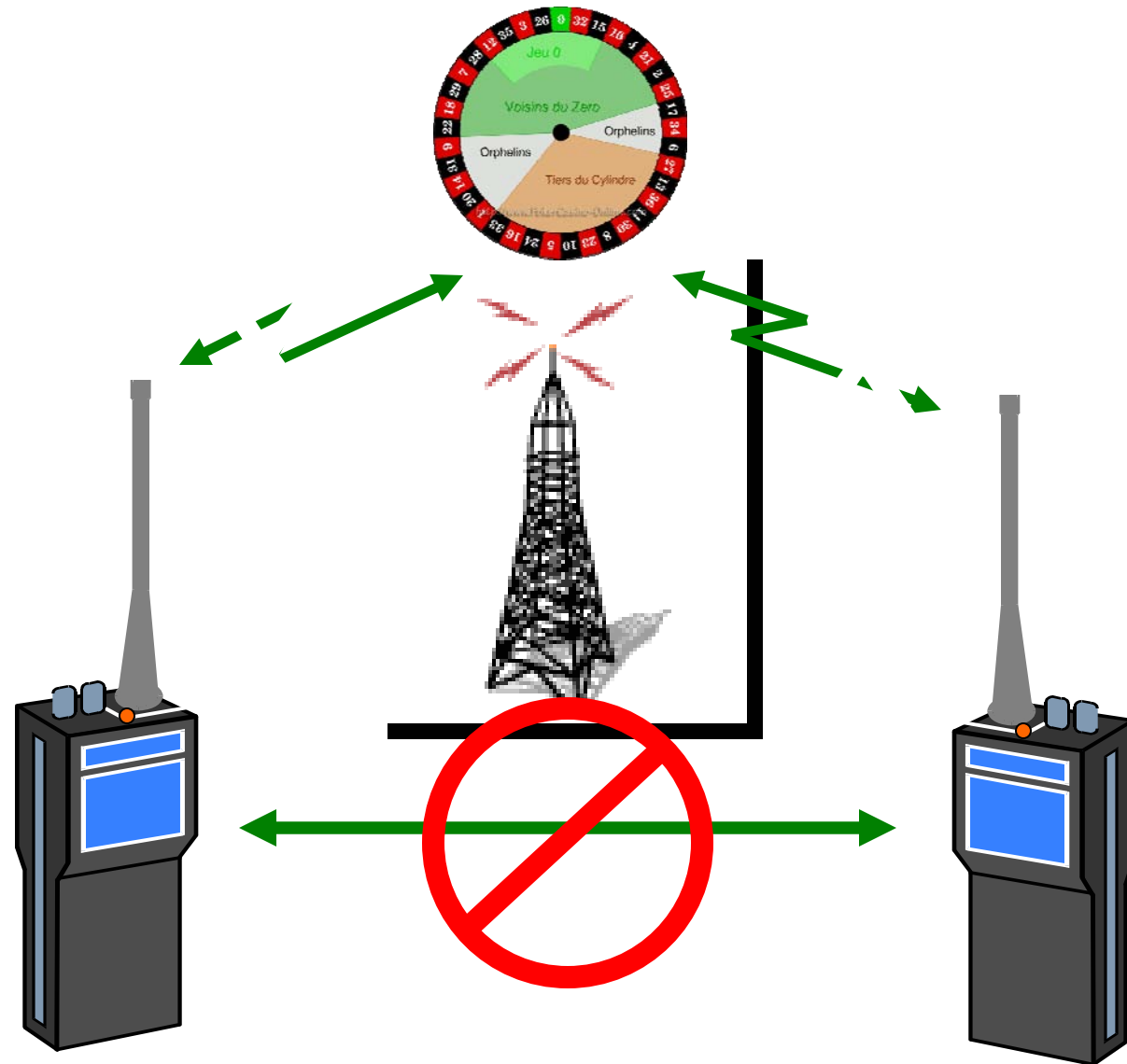
Problem Identified

*The Hazard Zone,
Firefighter Safety, Trunking, &
Portable Radios*

Problem Identified

- Trunked radio systems use a complex network of computer controllers & fixed location radio infrastructure that relays (repeats) messages
 - Provides nearly instantaneous radio communications to large groups of users simultaneously, regardless of location in the coverage area
- While designed as a robust architecture, the sophistication of a trunked radio control structure that provides the trunked wide area operation complicates communications for local area, onscene, emergency response

Problem Identified



Problem Identified

- *Fluor Daniel Telecom Company: requirements analysis report Nov. 10, 1995:*
 - “A radio system with a high degree of building penetration and coverage is required.”
 - “For buildings with difficult propagation, a transportable repeater is recommended.”
 - “Where adequate coverage and/or a transportable repeater are not available to support tactical operations, the system should support simplex.”

Problem Identified

- There is no need for wide area radio operations during typical hazard zone situations
 - These are local area operations that need a functionally simple, reliable, and operationally predictable communications system
- Simple, reliable, & predictable is critical to the safety of firefighters working in the hazard zone

Problem Identified

- Further investigation...
 - NFPA 1221 Fireground Communications
 - Simplex channels
 - Monitored by Tactical Radio Operator
 - NFPA 1981 SCBA
 - Intelligibility score for speaking thru a mask
 - Pass equals 80% or higher
 - Digital runs at 55% or less
 - Enhanced vocoder equals 65%

Requirements Identified

*The Hazard Zone,
Firefighter Safety, Trunking, &
Portable Radios*

Requirements Definition 27

- Consultant hired to investigate/research the Fire Department's needs:
 - Unique functional requirements vs. technical solution options

Requirements Definition 27

- Hazard zone
 - Analog, simplex
 - Vehicle repeaters or remote base stations
- Initial dispatch and non-hazard zone
 - Trunked radio system (RWC)
- Intra-discipline and interoperability
 - Trunked radio system (RWC)
 - Radio patching using console
 - Expand RWC (encourage participation)
- Communications continuity (redundancy)

Solutions Identified

*The Hazard Zone,
Firefighter Safety, Trunking, &
Portable Radios*

Transition Solutions

- In Phoenix, a simplex fireground is a given...
- The real question at that point was:
 - “How will you transmit simplex fireground messages to and from the Incident Commander and the Dispatch Center?”

Transition Solutions

- Transition options included:
 - Build a 700 MHz simplex infrastructure parallel to the RWC
 - Transition to the RWC using Digital Vehicular Repeaters
 - Use existing analog, simplex, VHF infrastructure
 - Use the trunked radio system “as is”

Solutions Evaluated

*The Hazard Zone,
Firefighter Safety, Trunking, &
Portable Radios*

Solutions Evaluated - DVRS

- Digital Vehicular Repeater System (DVRS)
 - DVRS appeared the most viable cost effective solution
 - Other technologies not ready or too expensive
 - DVRS field testing proved concept would work
 - Concern was activation/deactivation of device

Solutions Evaluated - DVRS

Scripted In-Building Testing

- Testing was conducted at a total of eleven buildings in various locations
- There were a total of 1382 individual simplex radio transmissions between individuals deployed throughout the buildings in a simulated fire department response

Solutions Evaluated - DVRS

At the Incident Command location:

- 1350 of the transmissions were successfully received at the Incident Command location
 - Either directly on the simplex channel or relayed by another DVR through the PRWN system
- A total of 32 failures were recorded out of 1382 transmissions.
 - 24 out of the 32 failures were associated with simplex traffic from the elevator position deployment
 - These are not DVR failures, but a failure of the incident fire ground simplex traffic to directly reach the Incident Command location
 - Other portable units on scene received the simplex transmissions!

Solutions Evaluated - DVRS

At the Incident Command location:

- Of the 32 failures, only 4 transmissions of simplex traffic were not received by at least one of the secondary DVR locations
 - DVR locations simulated standard Sector Officer positions
- When the Dispatch Center transmitted to units on the fire ground, 100 % were received by the Incident Command location

Solutions Evaluated - DVRS

Scripted In-Building Testing

At the Dispatch Center:

- Of the 1350 successful transmissions received at the Incident Command location, only 2 transmissions were scored as failures (99.85%)
- A review of the audio recorded at the Alarm Room indicated useable audio for both of the transmissions

Solutions Evaluated - DVRS

Integration into Fire Operations

- Labor and management did not want to over task any field personnel
- Any new technology would have to be integrated into an existing action during response
- The use of the Mobile Computer terminal (MCT) was proposed as the activation device
 - Pressing any status button indicating the unit arrived onscene also activated the DVRS

The End of the Story: Current Status of Radio System

*The Hazard Zone,
Firefighter Safety, Trunking, &
Portable Radios*

Current Status

- Regional governance
 - Regional Wireless Cooperative (April 2009)
- Divided our transition into two phases:
 - Non-hazard zone (scheduled completion Dec. 2009)
 - Hazard zone (in progress)
- Continuing to learn, research, and develop new communications processes

Lessons Learned

*The Hazard Zone,
Firefighter Safety, Trunking, &
Portable Radios*

Lessons Learned

- <http://www.phoenix.gov/fire/800.html>
 - Requirements Definition 27, et al.
- US Fire Administration's Voice Communications Guide for the Fire Service (Oct. '08)
- NTIA Technical Report TR-08-453 (Jun. '08)
- Other general stuff
 - Get involved and develop your requirements
 - There isn't an out-of-the box solution for everybody
 - Regional governance is a must for any and all systems that are shared
 - Don't confuse a requirement for local hazard zone communications with 'interoperability'
 - Marketing and training are critical

Session Questions

True / False Questions:

- There are four (4) mandatory things a Phoenix firefighter must have before they can enter a hazard zone: proper personal protective equipment, a partner, an assignment from command, and a portable radio. *(True)*
- The Phoenix Fire Department requires the use of simplex in the hazard zone. *(True)*
- Trunked radio communications are 100% reliable within all NFPA building types. *(False)*

Audience Questions?

The Hazard Zone, Firefighter Safety, Trunking, & Portable Radios
Session Code 2017