Federal Building and Fire Safety Investigation of the World Trade Center Disaster

Project #8,
Emergency Response

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J. R. Lawson, Project Leader
Building and Fire Research Laboratory
National Institute of Standards and Technology
U.S. Department of Commerce
james.lawson@nist.gov

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Contributing Personnel

- J. Randall Lawson
- Robert L. Vettori
- Schuyler Ruitberg
- Lisa Petersen
- Steve Cauffman

NIST Experts:

- Vincent Dunn, FDNY (retired)
- John J. Hodgens, FDNY (retired)
- Kevin S. Malley, FDNY (retired)

- Nustats, Inc.

Purpose of Project #8

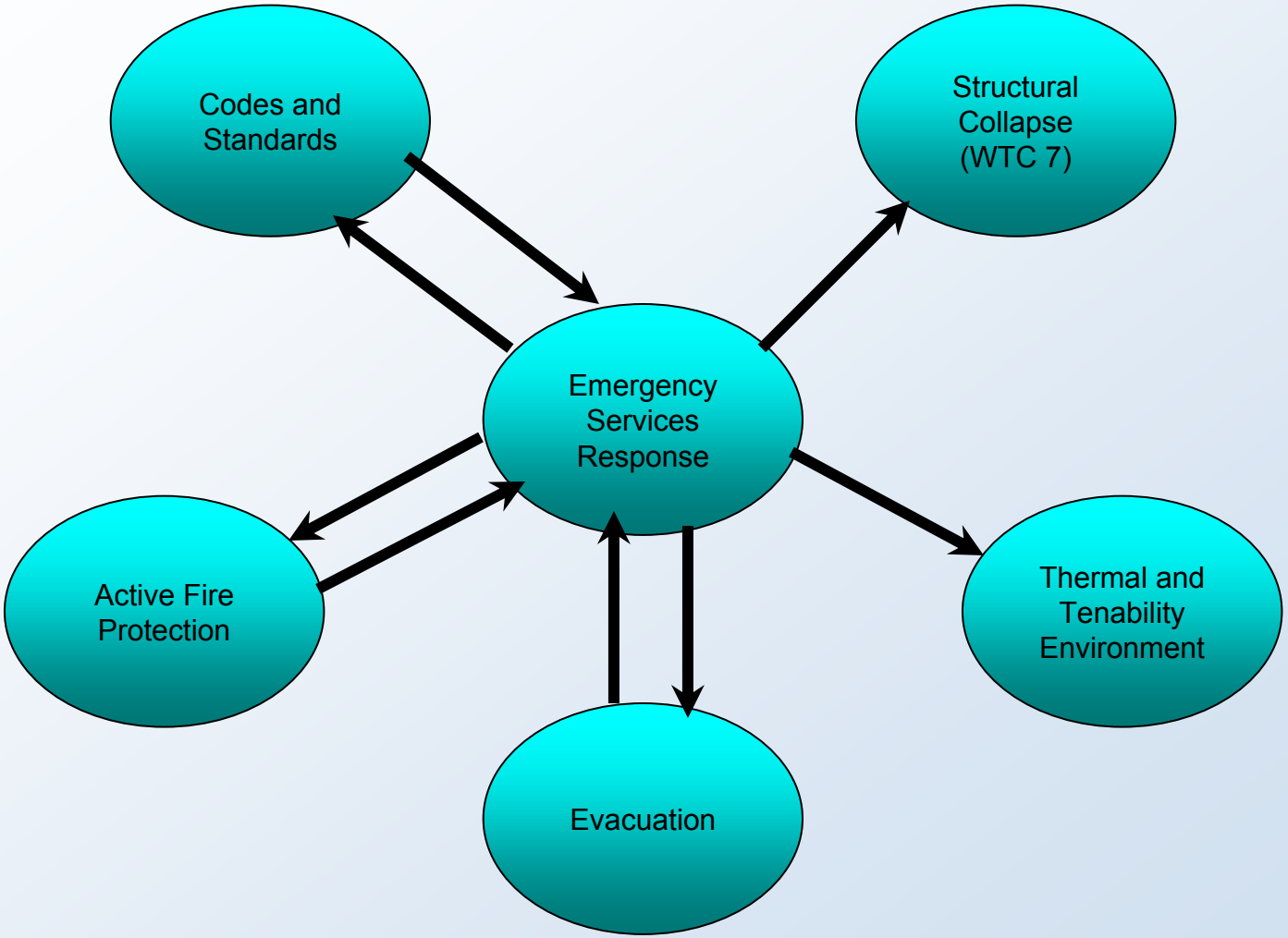
1. Fully documenting what happened during the response by the fire services to the attacks on the World Trade Center, up to the time of collapse of WTC 7;

2. Identify issues that need to be addressed in changes to practices, standards and codes;

3. Identify alternative practices and/or technologies that may address these issues; and

4. Identify R&D needs that advance the safety of the fire service in responding to massive fires in tall buildings.

Interactions With Other WTC Projects



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Changes After the 1993 Bombing

- Office of Emergency Management (OEM) was established to assist with inter-agency operations
- FDNY Incident Command System was upgraded:
  - Addressed the delegation of functions; Command, Planning, Operations, Logistics, & Finance
  - Added Command Staff: Safety, Information, & Liaison
  - Interagency representation at command posts
  - Established a Communications Coordinator
  - Expanded Field Communications Unit operations
  - Added an officer to Field Comm operations
- 800 MHz radios were purchased for FDNY management.

Changes After the 1993 Bombing

- PANYNJ adopted a policy for implementation of fire safety recommendations made by local government fire departments after a fire safety inspection of PANYNJ facilities.

- PANYNJ adopted a policy for prior review by local fire safety agencies of fire safety systems to be introduced to or modified in a facility.

- PANYNJ entered into an agreement with FDNY which reiterated the above policies and recognized the right of FDNY to conduct fire safety inspections of PANYNJ properties in NYC, provided guidelines for FDNY to communicate needed corrective actions to the PANYNJ, assured that new or modified fire safety systems were in compliance with local codes and regulations, and required third-party review of such systems by a NY State licensed architect or engineer.

Changes After the 1993 Bombing

- FDNY worked with the PA to upgrade WTC fire protection
  - FDNY high-rise radio repeater was installed
  - Fire Command Desks installed in WTC 1 and 2
  - Elevator intercom system was upgraded
  - New Operations Control Center was added to the complex on the B1 level of WTC 2
  - Multiple power sources installed for emergency lighting
  - New decentralized fire alarm system was installed at the WTC
  - Various fire drills were conducted at the WTC and some included FDNY participation

First Person [face-to-face] Interviews Conducted

- New York City

  FDNY Interviews - 68

  Command Officers, Company Officers, Firefighters, Rescue Squads, EMS, Communications, Fire Marshals, etc.

  NYPD Interviews - 25

  Command Officers, Special Operations Division Officers, Communications Personnel, and Aviation Unit Officers

- Port Authority of New York and New Jersey

  PANYNJ Interviews - 15

  PAPD Command Officers, Police Officers, Building Safety Staff, Communications & Vertical Transportation Personnel

- Other

  Security, Fire Safety, and Communications - 3

Role of Each Responding Department on September 11, 2001

FDNY - Established operational control and the Incident Command Post for the WTC operations, conducted evacuation and rescue operations, and fought fires at the disaster.

PAPD - Established security at the WTC and conducted evacuation and rescue operations.

NYPD - Established traffic control, perimeter security at the site, security for command posts, and conducted evacuation and rescue operations inside the WTC. The aviation units supplied observation capabilities and assessed the potential for roof rescue.

OEM - Functioned as a multi-agency command resource center and provided support for all agencies and departments working at the disaster.

Emergency Responder Operations

FDNY's Initial Size-up of WTC Conditions:

- A large aircraft had hit the WTC 1 building.
- Large fires were burning on multiple floors at and above the impact zone.
- The elevators were not working and people were trapped inside many of the elevators.
- The sprinkler system and standpipe systems were likely compromised.
- It was likely that no water supply was available to fight the fires at and above the impact zone.
- It was likely that many of the occupants trapped at and above the impact zone were already dead or would die before help could get to them.

FDNY Operations at the WTC

No one interviewed by NIST thought that the WTC towers would totally collapse.

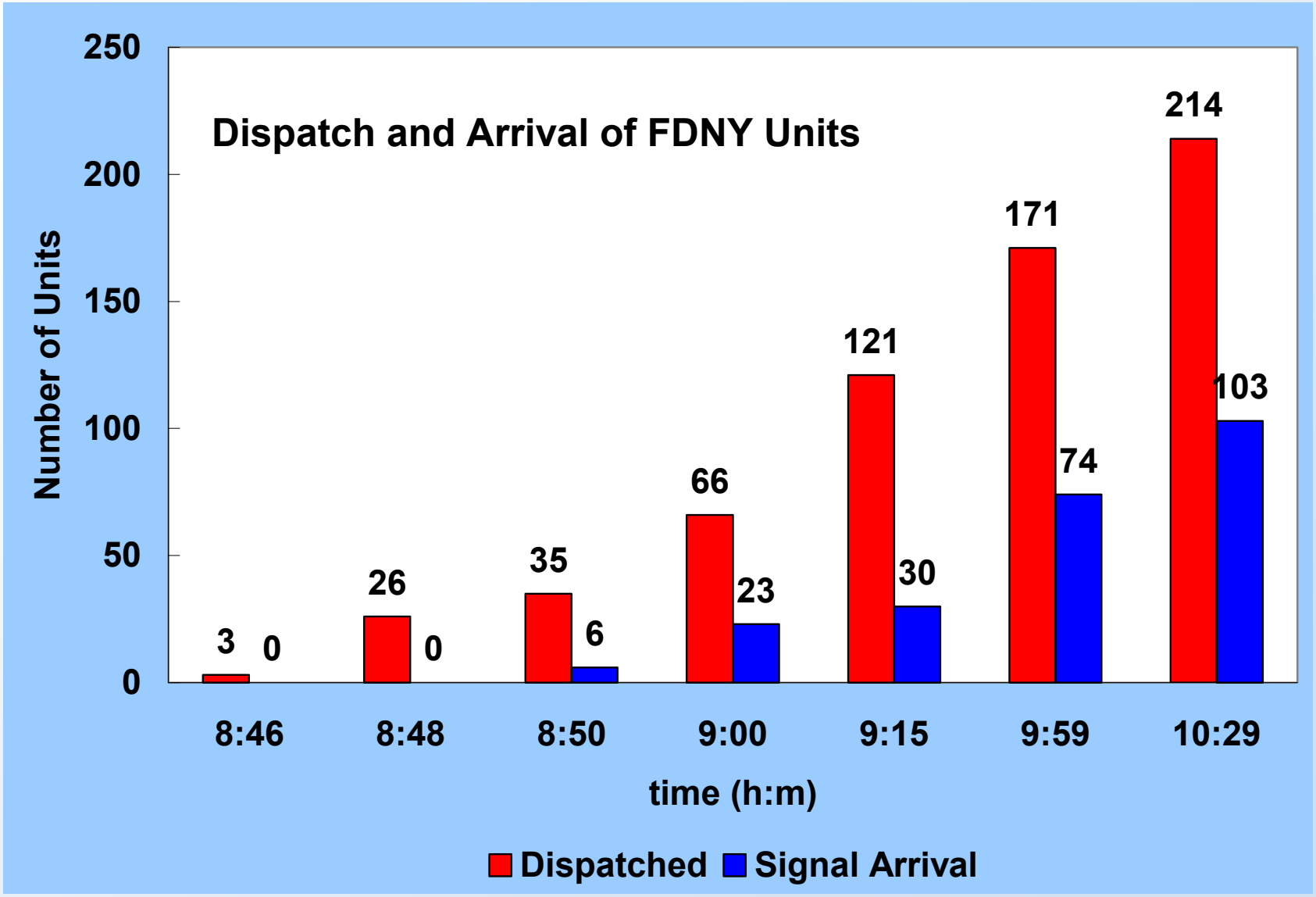
Three operational strategies:

Outside Command Posts & Inside Command Communicating with the Outside Command Post - Fires in the buildings were too large and were located too high in the buildings to accomplish fire fighting activities that could save the lives of occupants above the fires. The objective was to evacuate and rescue all below the fires.

Command Officers for Inside Operations - The fires were too large to extinguish. The objective was to get enough personnel and equipment upstairs to cut a path through the fire to rescue occupants above the fires, and also evacuate and rescue all below the fires.

Company Level Command - Saw this as a conventional but large high-rise fire. The objective was to get up to the fire floors and extinguish the fires. In some cases firefighters were persuaded by higher ranking officers to switch from the idea of fire fighting to evacuation and rescue operations.

FDNY Units Dispatch to the WTC



Emergency Responder Command Posts

FDNY established one Incident Command Post and four Operations Command Posts at the scene.

- Incident Command Post at West and Vesey Streets
- Lobby Command Post inside of WTC 1
- Lobby Command Post inside of WTC 2
- Lobby Command Post inside the Marriott Hotel
- Command Post at West and Liberty Streets

NYPD established two Mobilizations Points and an aviation ground level landing zone at one location.

- Mobilization point at Church and Vesey Streets
- Mobilization point at West and Vesey Streets
- Landing zone at the ball field on West Street

PAPD had a Command Post located inside WTC 5

Staging, Assignments, & Personnel Accountability

- Emergency responders generally followed their department protocol related to staging, assignment, and accountability.
- Some freelancing (not officially assigned or directed) was experienced during the emergency response at the WTC complex.
- An Operations Post and staging area was ordered for operations inside of WTC 1. It was to be established by the first arriving FDNY units on the 70th floor of the building.
- FDNY established off site staging areas at different locations in the city for assembling personnel and equipment and for managing units and assignments at the WTC site.
- Many FDNY units assigned to the WTC site did not know which building was WTC 1 and which was WTC 2. The buildings were not well marked.
- FDNY personnel had great difficulty trying to safely get into the WTC towers as a result of falling debris and human jumpers.

Staging, Assignments, & Personnel Accountability

- FDNY maintained personnel accountability on Command Boards located at the lobbies of WTC 1 and 2 and at the Incident Command Post at West & Vesey Streets in front of WFC 2.
- EMS maintained personnel accountability and patient tracking information on paper tablets.
- NYPD maintained a personnel accountability list at each Mobilization Point. This list was typically kept on a clipboard.
- PAPD maintained personnel accountability from the PAPD Police Desk located inside of WTC 5.
- With the collapse of WTC 2, all accountability lists for each department were lost, and no records were maintained beyond the WTC site.
- 91 FDNY fire apparatus and vehicles parked at the WTC complex were destroyed when the WTC towers collapsed. Unit assignment lists (Riding lists) for many of these units were lost.

FDNY Operations at the WTC

Access to the buildings:

1. After aircraft impact only two elevators out of 198 were operating inside the two WTC towers. WTC 1, from the lobby to the 16th floor. WTC 2, from the lobby to the 40th floor.

2. The stairways were filled with occupants evacuating the buildings. FDNY personnel and other emergency responders reported difficulty attempting to climb the stairs in the counter flow environment.

3. Counter flow in the staircases made it difficult for emergency responders to carry equipment up the stairways.

4. Counter flow in the staircases caused teams of emergency responders to become separated, causing delays and disrupting team operations.

FDNY Operations at the WTC

Human Physiological Challenge:

1. Firefighters' personal protective equipment weighs approximately 23 kg (50 lb).

2. Firefighters carry an additional 23 kg (50 lb) of gear with them for high-rise fire fighting, i.e., hose packs, tools, and extra air-tanks.

3. Many of the firefighters were only able climb the first 10 to 12 stories on the stairways before they had to rest. Subsequent climbing would often require additional rest periods and hydration after ascending an additional 3 to 5 floors. Some firefighters and other emergency responders with light loads were able to climb a second unit of 10 floors before resting.

4. Climbing many floors of stairs and carrying heavy loads up the stairs seriously degrades the physical capabilities of firefighters during high-rise rescue and fire fighting operations.

Emergency Responders & High-Rise Buildings

- First responding FDNY units took from 4 to 10 minutes to get to the WTC complex. They then got their equipment and received assignments, another 3 to 5 minutes. Time to begin operations 7 to 15 minutes.

- Of the 27 emergency responders interviewed that were inside WTC 1, maximum floor height achieved before WTC 2 collapsed, a time period of 1 hour 13 minutes:

  1 – A police officer carrying no extra equipment and in a patrolman's uniform climbed to the 44th floor.

  8 – Emergency responders (FDNY, PAPD, NYPD) climbed to the 30's. Two FDNY took an elevator to the 16th floor.

  16 – Emergency responders (mostly FDNY) climbed to the 20's.

  2 – Emergency responders (NYPD) climbed to the teens.

- **Estimated climbing rate based on a 60 minute climbing period to their maximum height: 1.4 to 2 minutes / floor**

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Emergency Responder Operations

Situational Awareness:

Definition: The degree of accuracy by which one's perception of the current environment mirrors reality.

Perception vs. Reality

- View of the situation
- Incoming information
- Expectations & biases
- Incoming information vs. expectations

Factors that Reduce Situational Awareness

- Insufficient communications
- Fatigue / stress
- Task overload & Task underload
- Group mindset
- "Press on regardless" philosophy
- Degraded operating conditions

Emergency Responder Operations

Situational Awareness:

- Emergency responders working outside of the WTC buildings that could view building conditions and communicate over radios had adequate situational awareness.

- Situational awareness for personnel that observed the building damage and fires from outside the buildings before entering experienced difficulty maintaining their awareness after entering the buildings.

- Emergency responders working inside of the WTC buildings, who could not see what was happening outside and had poor radio communications, had poor situational awareness.

- Emergency responders working inside of the WTC buildings who could not see what was happening outside and had good radio communications had better situational awareness over those with poor radio communications.

Fire Fighting Operations at the WTC

Three cases were identified where fire fighting occurred before WTC 2 collapsed.

1. Fireball victims were extinguished with the use of hand extinguishers at the lobby of WTC 1 upon FDNY arrival at the scene.

2. A Port Authority employee was reported as using a hose line to extinguish flames entering a staircase in one of the towers, allowing occupants to evacuate down the staircase.

3. At 9:55 a.m. firefighters on the 78th floor inside WTC 2 reported that they were going to extinguish two fires in the B staircase so that they could get to the A staircase.

Evacuation and Rescue Operations

- PAPD began assisting with the evacuation of WTC 1 immediately after the building was hit by the aircraft.
- FDNY & EMS began assisting injured building occupants upon arrival at the WTC complex.
- NYPD personnel climbed the stairs in WTC 1 and provided oxygen for FDNY personnel exhibiting heart or respiratory difficulties.
- **FDNY & EMS personnel assisted the evacuation of occupants and injured from each of the two towers and other areas around the complex.**
- FDNY personnel chopped a hole through the wall of a shop in the concourse level to provide an evacuation route out of the complex.
- **PAPD and FDNY personnel assisted with the rescue of occupants from elevators in the WTC complex.**
- **FDNY, PAPD, & NYPD personnel assisted the evacuation of mobility challenged building occupants from the WTC complex.**
- FDNY, PAPD, & NYPD personnel using their flashlights assisted the evacuation of building occupants after the collapse of WTC 2.

Roof Evacuation

- Standard evacuation protocol for the WTC towers as recommended by The Port Authority of NY & NJ stated that building occupants only evacuated down the stairs.
- The Port Authority had no procedures for roof evacuation.
- NYPD had a roof rescue protocol that had been prepared with the cooperation of FDNY. NYPD helicopters evacuated a number of people from the WTC roof during the 1993 bombing.
- FDNY had the same basic roof rescue protocol as NYPD but only planned to use it as a last resort to save the lives of building occupants that may have gotten on to the roof.

Roof Evacuation

Air Support Plan, High-Rise Fires Objectives:

- Provide FDNY with the capability to place fire personnel on the roof of high-rise buildings, otherwise inaccessible due to fire conditions for the purpose of ventilating and search.
- Control, comfort and direct people who view themselves as trapped and remote from help.
- Provide the lobby command post with intelligence on roof conditions.
- Evacuate persons in need of immediate medical attention.
- Provide a capability to evacuate the roof as a last resort.

NYPD Aviation Units Roof Operations

- NYPD aviation units arrived at the WTC by 8:52 a.m. They checked to see if roof rescue was possible and reported back that they were unable to land as a result of heavy smoke conditions.

  First person interviews with aviation unit personnel also indicated that heat from the building's fires was causing the helicopter engine temperature to increase.

  An aviation unit called again at 9:38 a.m. for permission to land on the roof of WTC 1. First person interviews indicated that the aviation units were desperate to assist the people trapped and jumping from the upper floors. There was no indication that landing conditions had improved.

  Five minutes after the request to land, a senior NYPD officer ordered that no one was to rappel onto the buildings.
  Definition: rappel – to descend by means of a rope.

First Person Accounts of Telephone Communications

- Before the attack at the World Trade Center both landline and cellular telephone systems were working.
- Moments after the first aircraft impacted WTC 1 the telephone systems were stressed by increased caller volume.
- Although there was impact damage and fires were burning in the two World Trade Center towers, some landline telephones were working in the buildings.
- After the collapse of WTC 2, a number of cellular phone systems were not functioning in lower Manhattan.
- After the collapse of WTC 2, there were still some landline telephones working within the city block areas adjacent to the World Trade Center.

Emergency Responder Radio Systems

Simplex Communications - direct point-to-point, HT-to-HT, or HT-to-Base Station (HT = Handie-talkie)

Duplex Communications - transmissions are channeled through a radio repeater.

PAPD Operations - Duplex through their dedicated WTC police department repeater.

FDNY Operations - Simplex for command channel and tactical operations

- Duplex through their dedicated WTC FDNY high-rise repeater.
- Cross-band through the Battalion Car repeater.

NYPD Operations - Simplex between ESU teams members and the ESU Mobilization Point.

- Duplex through the NYPD SOD and Div 1 repeaters.

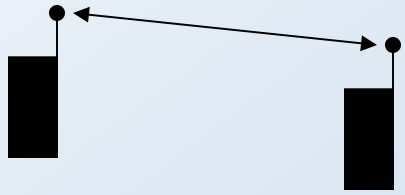
FDNY Radio Communications Systems

Radio systems available to FDNY during operations at the WTC

- Firefighter Handie-talkie (HT) radios - 154 MHz, VHF

  Seven Channels:

  1 - Universal HT frequency (tactical channel on 9/11)
  2 - City Wide base (command channel on 9/11)
  3 - Queens mobile
  4 - Manhattan mobile
  5 - Brooklyn mobile
  6 - Staten Island Mobile
  7 - High-rise repeater: RX, 154 MHz / TX, 153 MHz



Simplex
Point-to-point

Duplex
Through a repeater

- Command & Management HT radios - 800 MHz, UHF

- Battalion Car Cross-band repeater, - 154 / 460 MHz, VHF/UHF

  [RX, 154 MHz & TX, 460 MHz]
  [RX, 460 MHz & TX, 154 MHz]

  Cross-band dual repeater

- WTC FDNY high-rise building repeater, 50 W - 153 / 154 MHz, VHF

  [RX, 153 MHz & TX, 154 MHz]

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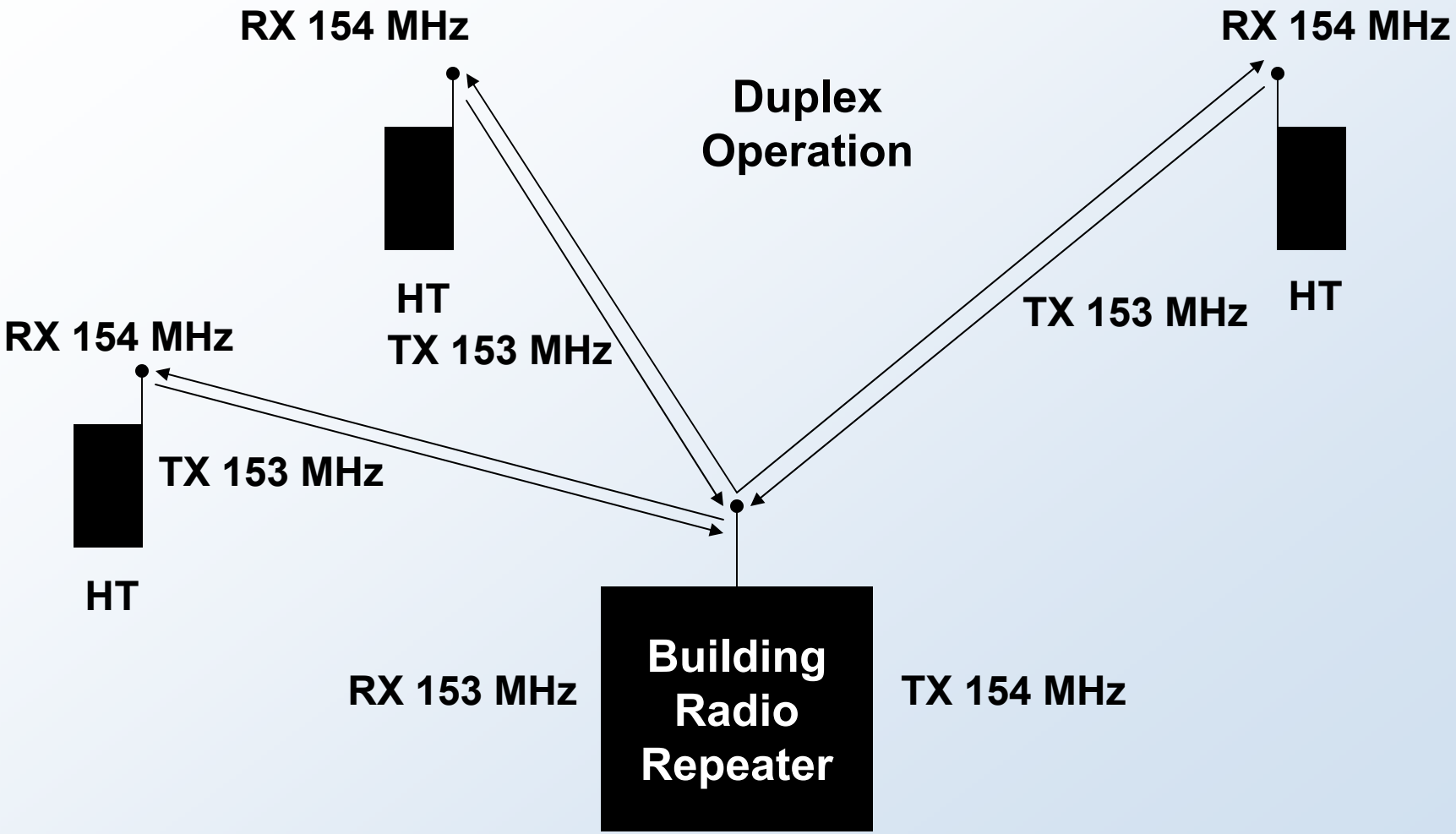
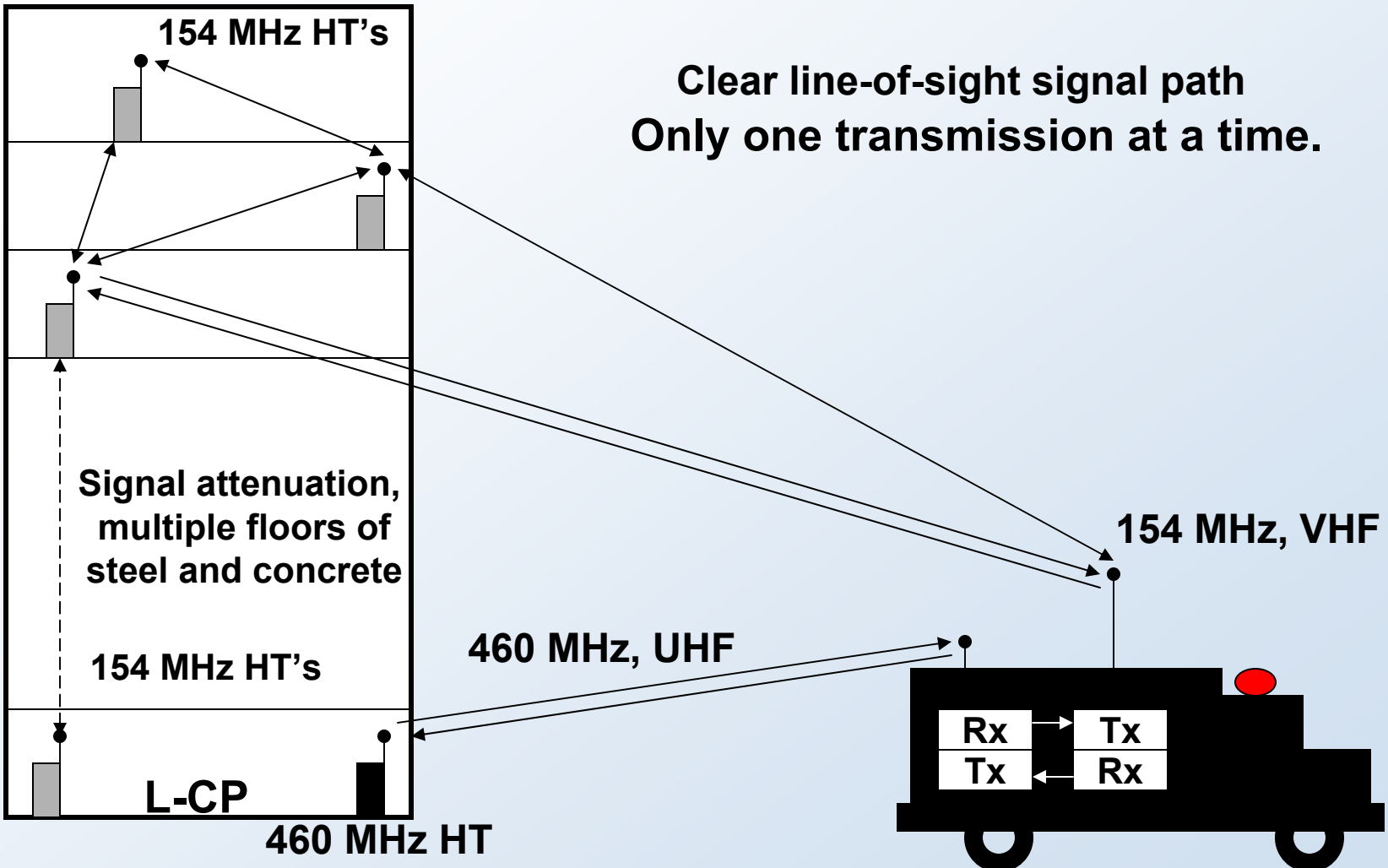
Example: Radio Repeater System



Only one radio transmission at a time.

Example: Battalion Car Cross-band Repeater



Drawing by NIST base on document by Battalion Chief Orio J. Palmer and original drawing by FF Bill Kristoff, FDNY, WNYF, Repeater Systems, 3rd 1998.

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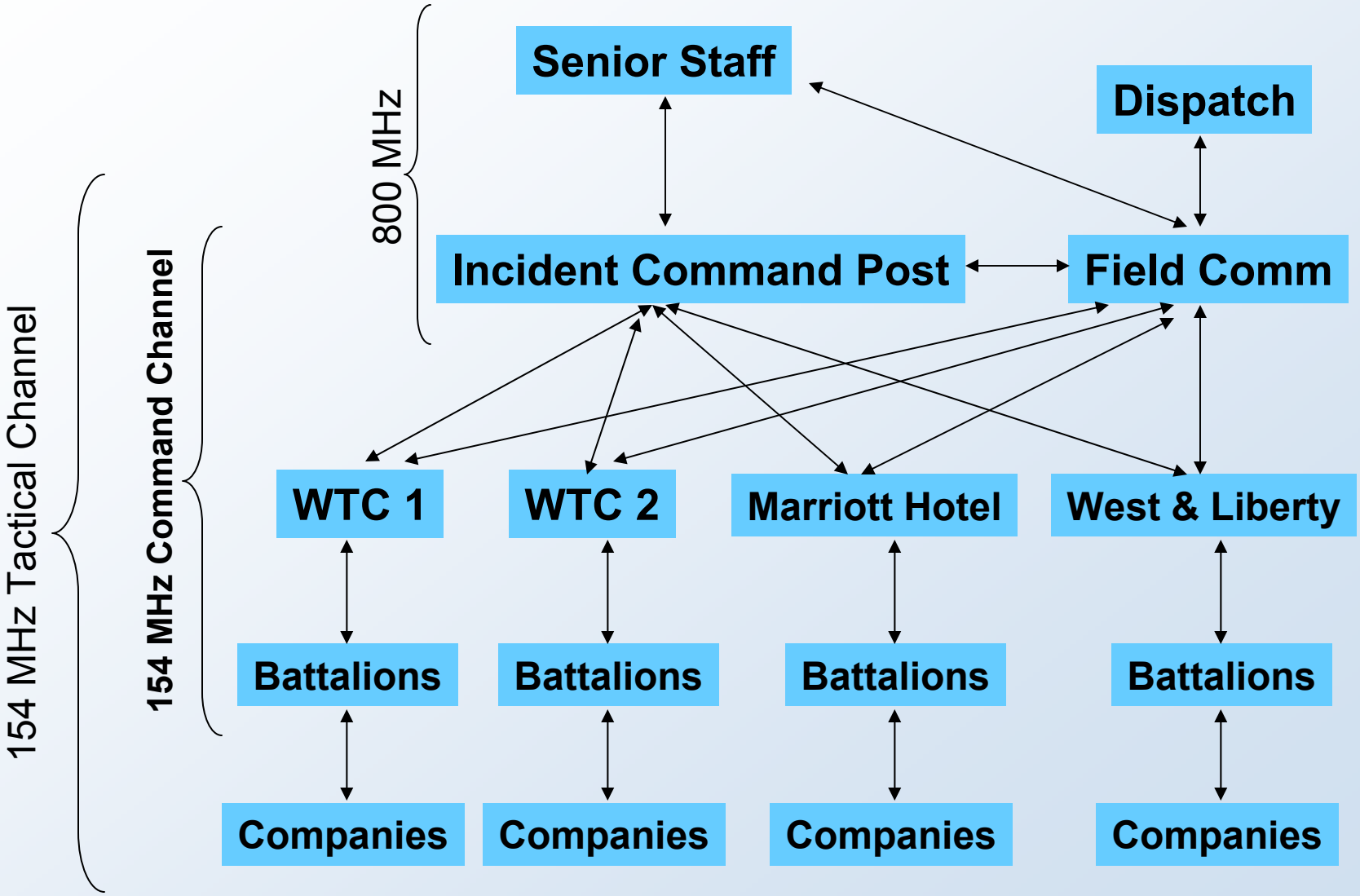
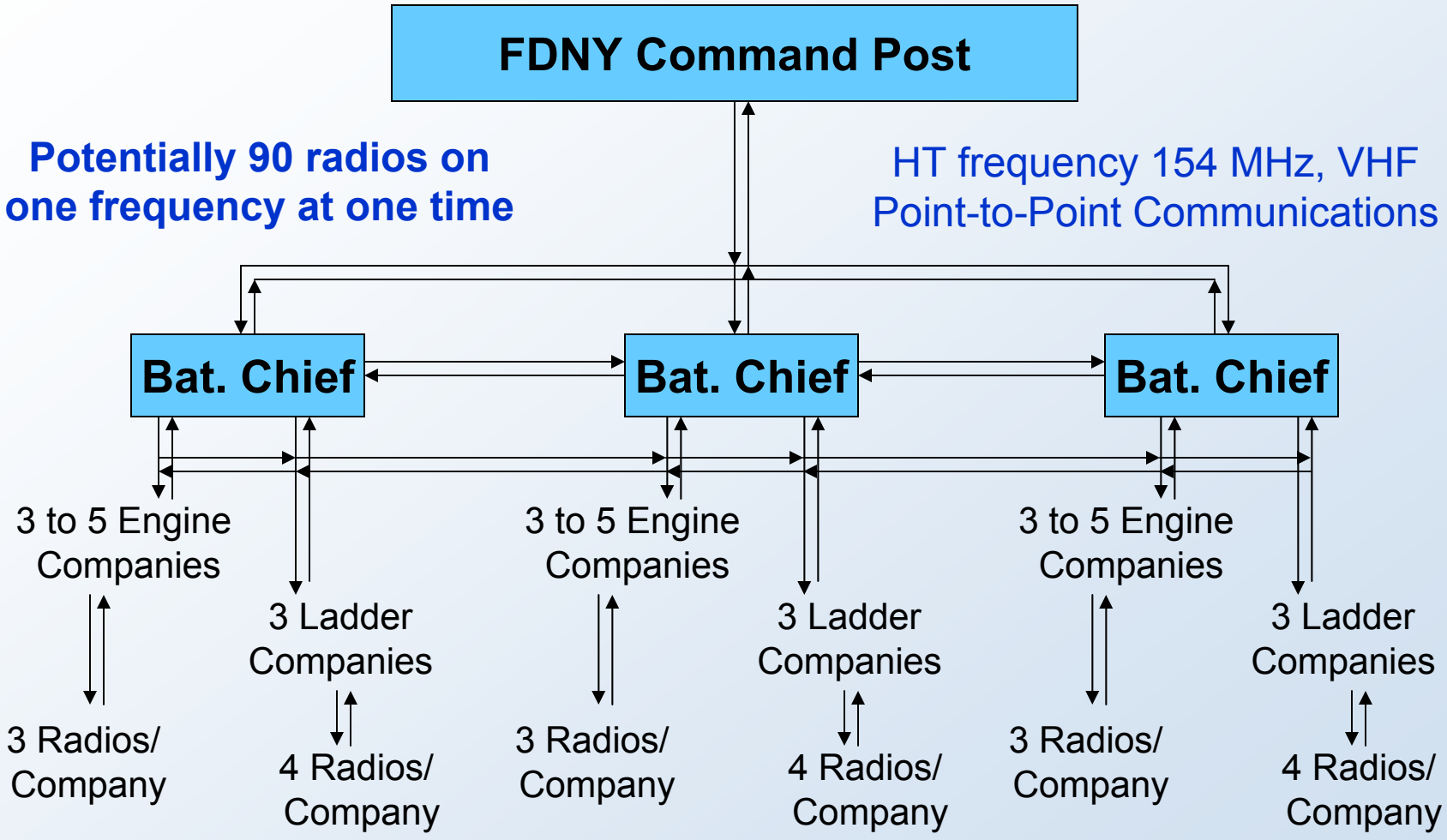
FDNY Radio Communications System



Example: Handie-Talkie Radio System Structure



Only one radio transmission at a time

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FDNY Handie-Talkie (HT) Radios

- FDNY HT radios used until March 14, 2001 - Motorola Saber 1 and Saber 1E, analog, 150 MHz VHF, output power 1 Watt, with 6 simplex channels and 1 duplex repeater channel
- FDNY deployed new radios - Motorola XTS 3500 R, digital, 800 MHz UHF, output power 2 Watts and 5 Watts, 16 channels plus additional channels for Battalion Chiefs and higher ranks.

  Why were they deployed?
  - provide error correction
  - reduce interference
  - provide interoperability with other city agencies
  - increase the number of frequencies
  - provide higher output power levels
- Motorola XTS 3500 R radios were recalled by FDNY on March 21, 2001.

  Why were they recalled?
  - On March 19th a firefighter in trouble calling Mayday and was not heard.
  - NYC document states the Mayday was not heard because of simultaneous radio transmissions.
- The Saber HT's were placed back into service as a result of the recall . FDNY used them at the WTC complex on September 11, 2001.

Radio Communications

- All three of the responding departments, FDNY, NYPD & PAPD experienced difficulties with radio communications.

- Each of the departments was aware of the shortfalls associated with their radio communications systems as it related to operations in high-rise buildings.

- Two basic issues with radio communications:

1. Normal function of the radio equipment in high-rise environments. (Radio signal attenuation in steel and concrete buildings)

2. The volume of radio traffic.

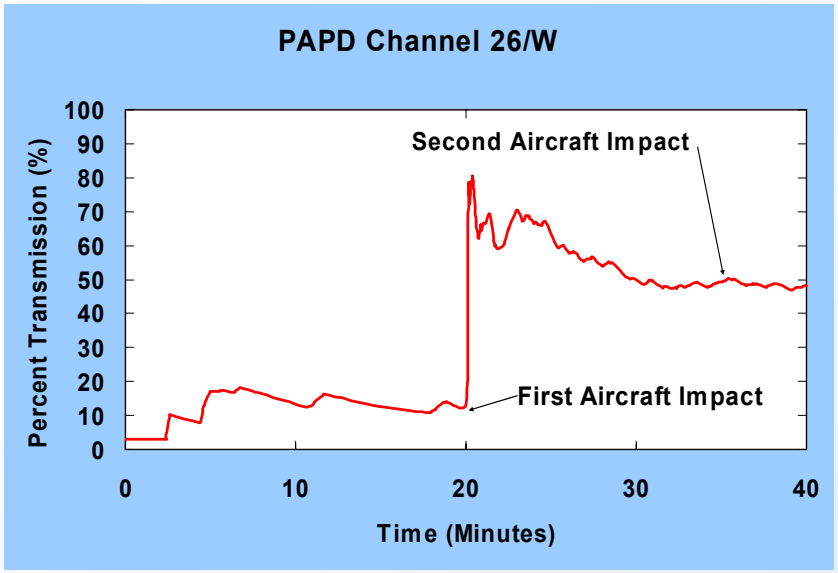
Radio Communications, continued

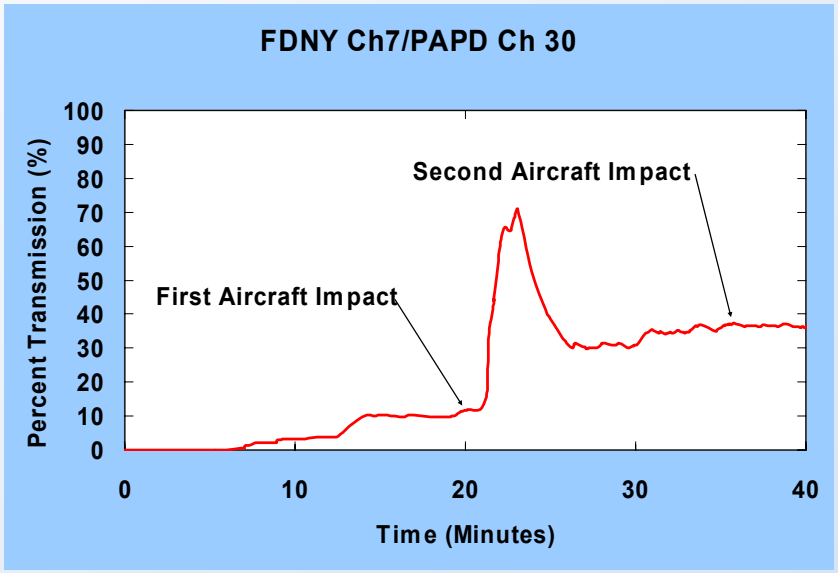
1. After the first aircraft struck WTC 1, there was an approximate factor of 5 peak increase in traffic level over the normal level of emergency responder radio communications, followed by an approximate factor of 3 steady increase in level of subsequent traffic.

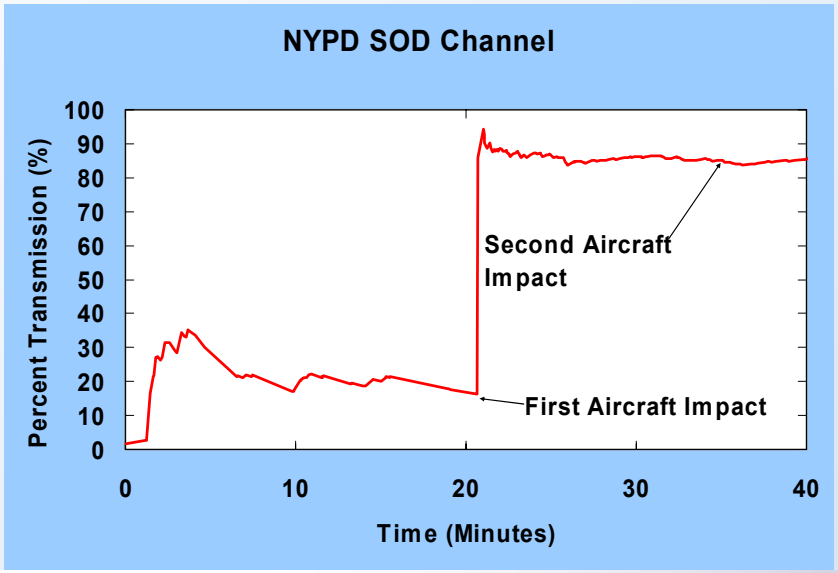
2. A surge in communications traffic volume made it more difficult to handle the flow of communications and delivery of information.

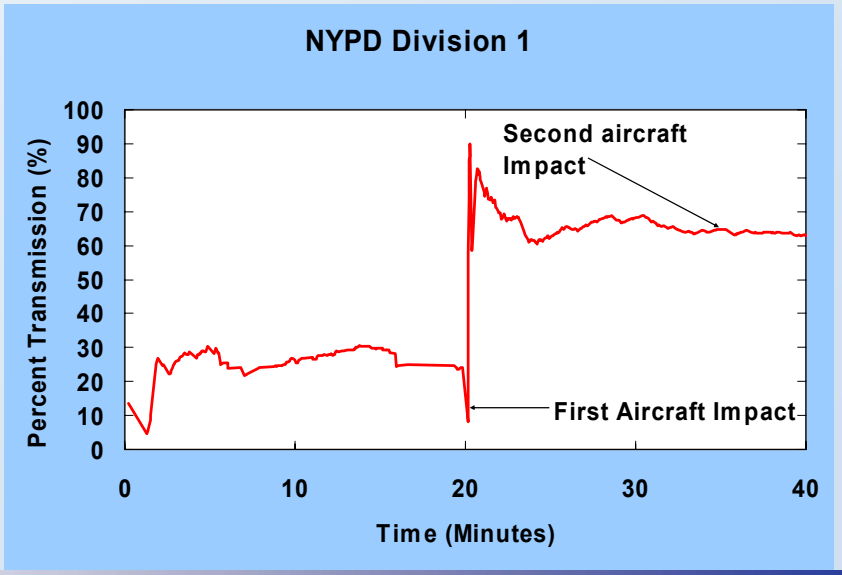
3. Analysis of radio communications records indicates that roughly 1/3 to 1/2 of the radio messages during surge conditions were not complete nor understandable.

Radio Traffic Volume – T% = 100(Transmission Time/Total Time)









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Readability of Radio Communications

Factors affecting communications:

- background noise either at the transmission point or receiving point or both;
- operating health of transmitting and receiving radios and antenna systems;
- doubling or crossing of radio signals caused by multiple transmissions at the same time on the same radio frequency; and
- radio transmissions may be affected by attenuating materials or electromagnetic interference and reflected signals.

Radio Communications, continued

- Both PAPD and NYPD had handie-talkies with open or stuck microphones that produced radio interference. In addition, reports came in from the field indicating that radios were not working well.

- There were many cases where FDNY, PAPD, and NYPD personnel made radio calls, and they never received an answer. This may be attributed to the failure of the radio system or the inability of the person called to answer. There were cases where the person called would answer and would not be heard by the party that originated the call.

Radio Communications, continued

The following examples of radio communications relate to:

1) the surge in radio traffic
2) the inability of the radio systems to handle more than one message at a time, and
3) undesirable radio operations practices

Between when the first aircraft hit and approximately 10:00 AM, emergency responder communications included the following types of messages:

- asking officers to stay off the air
- comments that messages were being cut-off, there was crossing or doubling, and messages were unreadable
- comments that multiple units were talking at the same time and requests that units talk one-by-one

Radio Communications Readability Analysis

Readability, is a communications term used to define the ability of a person to hear and understand a radio transmission.

Readability Scale:

1 – Unreadable
2 – Barely readable, occasional words distinguishable
3 – Readable with considerable difficulty
4 – Readable with practically no difficulty
5 – Perfectly readable

Note: This is a subjective scale related to a trained human's ability to hear and understand communications transmissions.

Ref: The ARRL Handbook for Radio Communications

Analysis Method for Readability

- Most readability analysis work was conducted by NIST personnel with extensive radio communications experience.

- Experienced personnel trained less experienced staff personnel on readability analysis techniques.

- To reduce the subjective nature of the ratings system, where radio communications analysis was difficult, more than one experienced person would listen to the communications and provide an analysis.

Readability Summary Before Attack

	Readability Scale				
Dept.	1	2	3	4	5
PAPD Ch 26/W Police Desk	8%	17%	19%	56%	0%
FDNY H-R Ch 7 (PAPD Ch 30) Repeater	n/a	-	-	-	-
NYPD Div. 1	2%	9%	8%	21%	60%
NYPD SOD	0%	0%	14%	23%	63%

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Readability Summary During Operations

	Readability Scale				
Dept.	1	2	3	4	5
PAPD Ch 26/W Police Desk	9%	24%	43%	24%	0%
FDNY H-R Ch 7 (PAPD Ch 30) Repeater	10%	26%	42%	18%	4%
NYPD Div. 1	11%	26%	32%	23%	8%
NYPD SOD	10%	35%	32%	19%	4%

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Radio Communications, continued

- NYPD had relatively good radio communications on their point-to-point communications in the WTC towers because there were only six ESU teams working on the frequency, and

- NYPD's mobilization point that was communicating with ESU personnel inside the towers was set up more than a city block away from the towers allowing for more direct or line-of-sight communications with the towers.

- FDNY was attempting to operate communications systems from inside the WTC towers where building components attenuated radio communications signals.

Radio Communications, continued

- Even though the Battalion Car Cross-band Repeater was turned on at approximately 9:07 a.m. and was to be delivered to the WTC 2 lobby command post, there is no record that FDNY used the cross-band repeater at the WTC site. All known personnel that may have used the repeater died with the collapse of WTC 2.

- FDNY radio protocol specified that only one Battalion Car cross-band repeater was to be used at any incident. This was to prevent multiple repeaters at one site from interfering with each other.

- There is no evidence that the WTC 1 lobby Command Post used either the FDNY/ WTC high-rise channel 7 repeater or the cross-band repeater to communicate with other personnel up inside the tower.

Radio Communications, continued

- Analysis of the FDNY City-wide, high-rise, channel 7 (PAPD channel 30) repeater recording indicates that the World Trade Center high-rise repeater was operating.

- At approximately 9:05 a.m. the repeater's recording system recorded the WTC 1 Lobby Command Post attempts to check repeater operations. Handset and handie-talkie radio communications were recorded.

- It is possible that one or both of the following conditions complicated the radio check that took place at the WTC 1 Lobby Command Post:
    1. The radio repeater handset earpiece was broken.
    2. The radio repeater handset volume was not turned up.

- It is unlikely that the repeater's antenna was broken or misdirected by debris since radio signals were received during the radio check from inside WTC 1 and the communications that followed from inside WTC 2.

- The repeater system recorded radio communications that took place between several different firefighters and several different FDNY officers as they worked inside of WTC 2.

Equipment Contributing to Operations

Equipment that influenced emergency responder operations:

- Handie-talkie radios, for transmitting and receiving evacuation and rescue information (for surviving responders).
- Flashlights, for providing needed light while evacuating from the WTC complex after WTC buildings collapsed.
- Self-Contained Breathing Apparatus (SCBA), for providing safe air to breathe after WTC 2 and WTC 1 collapsed.

Inter-Agency Cooperation

- A significant amount of evidence (first person interviews, reports, and photographic data) shows that the different agencies were working together during the WTC disaster.

- Data also indicates that inter-agency operations were hampered by the loss of the OEM command center that was located inside WTC 7.

    - OEM functions became dispersed
    - The OEM communications center was lost
    - The computer systems and other equipment used to provide support for emergency response operations was lost
    - Unified operations structure for the emergency response was diminished

- First person interview data and photographic data shows OEM personnel working with different emergency responder departments and located at the various department command posts.

- First responder interviews suggest that inter-department competition had minimal affect on operations at the WTC complex on the morning of September 11th. First person interview data also suggests that some of the problems experienced were due to personnel not understanding operating practices of the other agencies.

Command and Control

- Difficulties with command and control began with the dispatch of large numbers of fire fighters to the WTC before adequate command posts and staff could be assembled to manage them.

- Self-dispatch further complicated command and control at the incident.

- FDNY & EMS command and control was affected by many private and volunteer ambulance units self-dispatching that contributed to clogging the streets so that other responders assigned to the WTC had difficulty getting through.

Command and Control, continued

- FDNY apparatus had to be moved to allow some ambulances to get through and exit the site with victims.

- FDNY command and control was seriously affected by the lack of good communications.

- FDNY's system for maintaining records of unit assignments at each command post was not capable of managing the numbers of units and personnel being assigned to the incident.

- FDNY, NYPD, and PAPD: there was no means to back-up the unit assignment records generated at the command posts.

National Practices, Standards, and Codes

Occupant and Emergency Responder Safety

- NFPA 101, Life Safety Code

Emergency Responder Operations and Safety

- Department of Homeland Security, National Incident Management System
  Department of Homeland Security, National Response Plan
- NFPA 1500, Standard on Fire Department Occupational Safety and Health
- NFPA 1521, Standard for Fire Department Safety Officers
- NFPA 1561, Standard on Emergency Services Incident Management System
- NFPA 1620, Recommended Practice for Pre-Incident Planning
- NFPA 1710, Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments

Emergency Responder Equipment

- NFPA 1221, Standard for the Installation, Maintenance, and Use of Emergency Services Communications Systems
- NFPA Technical Committee Standard on Electronic Safety Equipment
- NFPA 1851, Standard on Selection, Care, and Maintenance of Structural Fire Fighting Protective Ensembles
- NFPA 1971, Standard on Protective Ensemble for Structural Fire Fighting
- NFPA, 1981, Standard on Open-Circuit Self-Contained Breathing Apparatus for the Fire Service
- NFPA 1982, Personal Alert Safety Systems (PASS) for Fire Fighters
- NFPA 1999, Standard on Protective Clothing for Emergency Medical Operations

Mobility Impaired Occupants

- As the emergency responders started evacuating WTC 1 after the collapse of WTC 2, they found mobility impaired occupants still in the staircases going down.

- Several ambulatory mobility impaired occupants were reported to be walking down the stairs with one hand on each hand rail as they took one step at a time going down. In addition, they were often accompanied by one person, another occupant or an emergency responder. This blocked others behind them from moving more rapidly down the stairs.

- FDNY and PAPD personnel found 40 to 60 mobility impaired occupants on the 12th floor of WTC 1 as they went down and attempted to clear each floor on their way out. These impaired individuals had been placed on this floor in an attempt to clear the stairways.

- Emergency responders were assisting approximately 20 of these mobility impaired people down the staircase just prior to the collapse of WTC 1. It is unknown how many fatalities occurred with this group.

High-Rise Buildings & Emergency Response

Example: Fire department response to a 60 story high-rise building, occupants trapped above fires on the 58th floor and no operating elevators.

Firefighters carrying equipment and wearing PPE ~ 125 minutes
Firefighters carrying no equipment and not wearing PPE ~ 90 minutes

Firefighters carrying equipment and wearing PPE ~ 70 minutes
Firefighters carrying no equipment and not wearing PPE ~ 50 minutes

Firefighters begin to climb 10 minutes
Fire department arrival 4 minutes

NIST

Issues

Evacuation - Comments

- Missed opportunities to better communicate information among the occupants, 911 operator dispatch, fire department dispatch, police department dispatch, emergency management service dispatch, and site security.

  - Inadequate situational awareness

  - Convergence confusion among first responders

Issues

Emergency Response - Access and Firefighting

- Physiological impact on firefighters with equipment climbing more than 10 to 12 floors during an emergency.

- Adequacy of capacity for egress and firefighter access during full evacuation of fully occupied tall buildings.
  - Access to high-rise buildings by first responders is hindered by counter flow, egress capacity, and lack of available elevators.

- Distance between stairwells where standpipes are located. (Standpipes supply water for fire suppression.)

Emergency Response - Communications

- Lack of rigorous pre-emergency inspection and testing of radio communications systems within high-rise buildings to identify performance gaps and inadequacies.

Issues

Emergency Response - Communications, continued

- Performance requirements for emergency communication systems in buildings.
  - Design, testing, certification standards
  - Maintenance and inspection requirements
- Lack of communications network architecture (interoperability) and operational protocols for intra- and inter-agency communication at all levels of organizational hierarchy. This includes:
  - Overall network architecture that covers local networking at incident sites, dispatching, and wide-area urban and rural networks
  - Scalability in terms of the number of first responders using the system and in providing radio coverage in large buildings with challenging radio frequency propagation environments
  - Interoperability with existing legacy emergency communications systems
  - Localization techniques to identify first responders within indoor building environments
  - Conventional two-way systems versus wireless network systems

Issues

Emergency Response - Command and Control

- Availability of detailed procedures and methods for gathering, processing, and delivering situational information to all first responders, including 911 operators, wardens, incident commanders, etc.; this covers voice, video and data integration.

- Availability of effective codes and protocols for establishment and uninterrupted operation of the incident command and control system and for preservation and dissemination of information managed by command posts.
    - Command posts establishment within the collapse zone of buildings that received serious impact damage and contained large multi-floor fires.
    - Establishing the command post prior to dispatch of needed units
    - Impact of self-dispatch and free-lancing on command & control first responders and ambulances
    - Assignment and tracking (accountability) system for large scale emergencies
    - EMS and private ambulance personnel did not have protective clothing

- Secure location of state and local emergency operations centers (EOC).

Issues

Emergency Response - Command and Control

- Rapid adoption and execution of a unified emergency response mission by all first responder ranks.

- The dispatch of large numbers of personnel and apparatus and the ability of management to maintain accountability in a timely manner associated with arrival and deployment of personnel and the ability of the incident site to effectively accommodate large numbers of personnel and apparatus.

Questions?