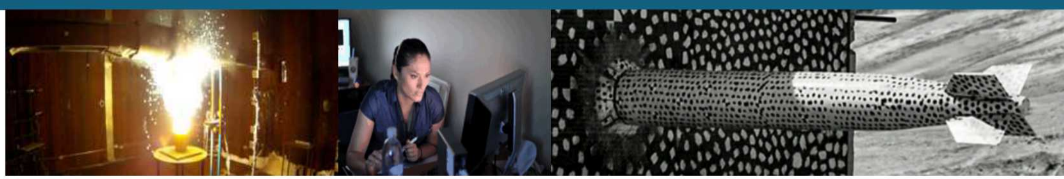
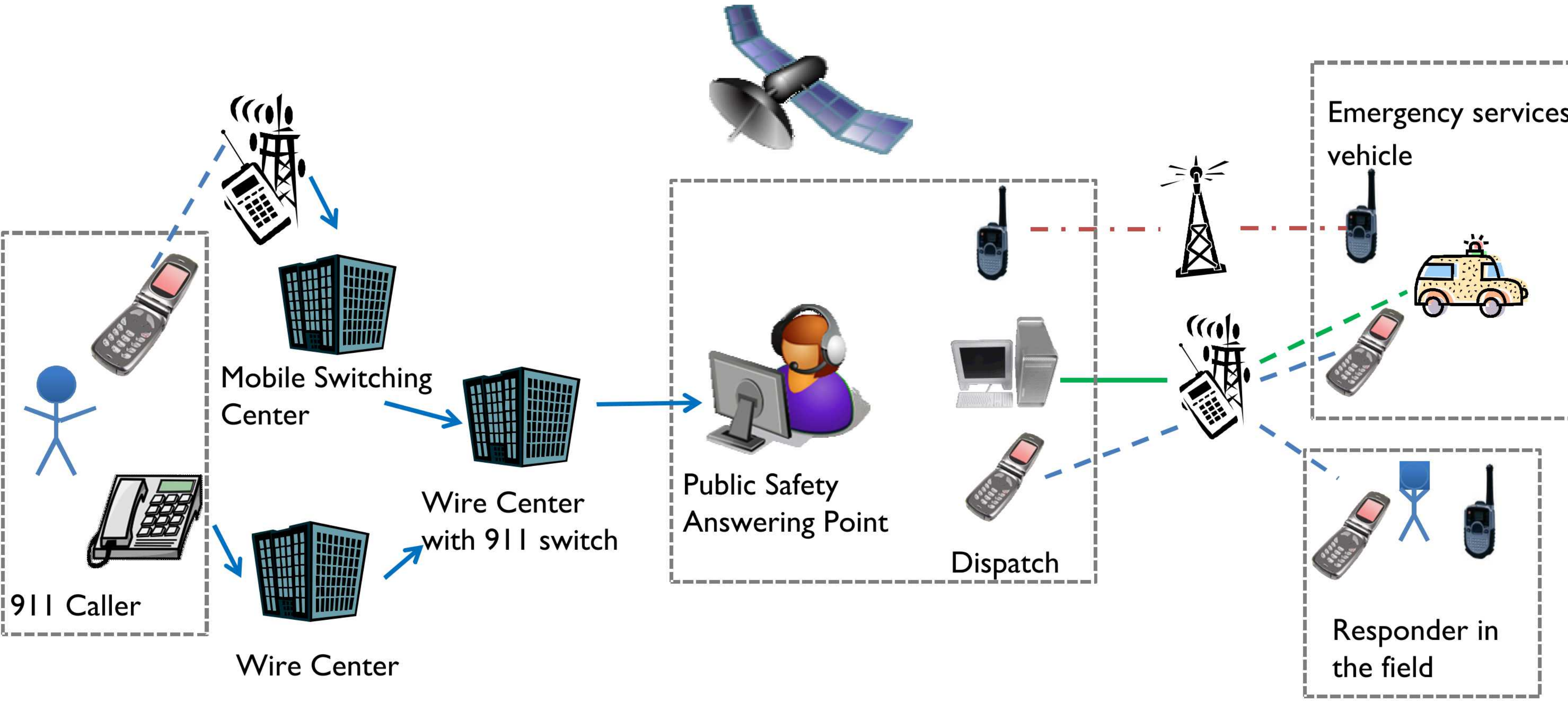
SAND2019-14806PE

P25 System Summary



Andjelka Kelic

The 9-1-1 System (high level)

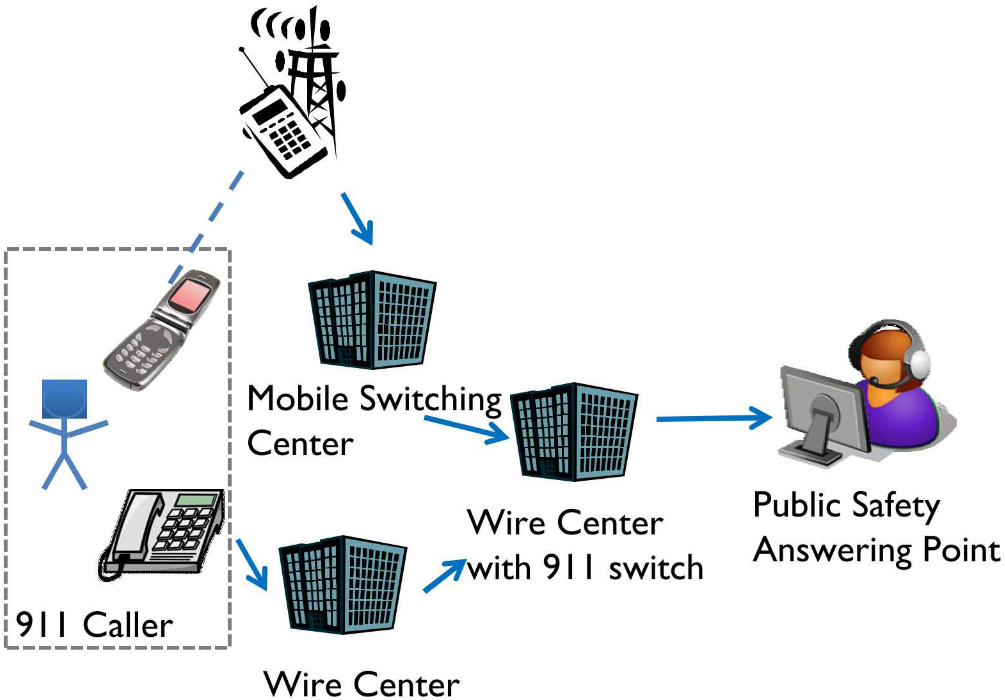


The system is complex and requires a wide variety of assets to allow it to provide service. Those assets include cellular/landline, satellite systems, and handheld radios.

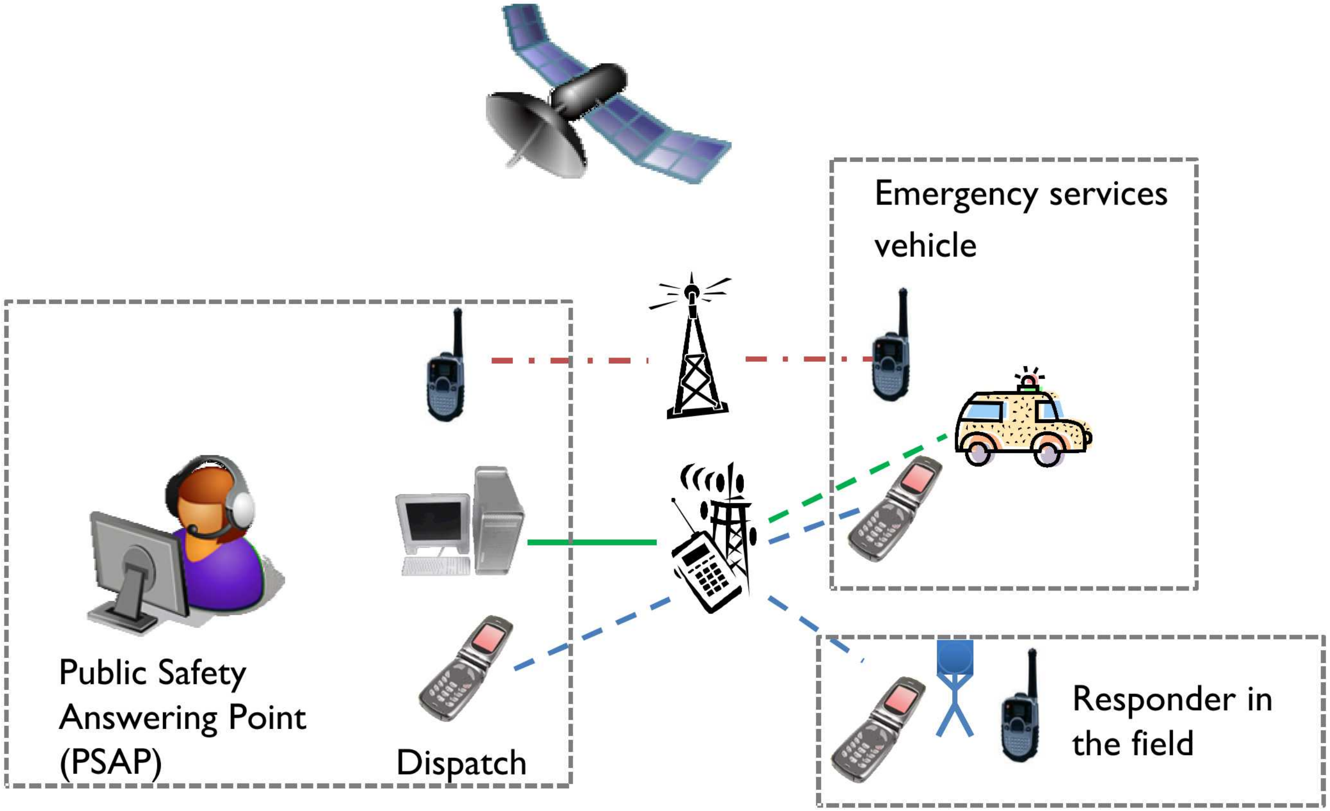
The Call Routing Portion

The telecommunications carriers own the facilities that route the calls for both cellular and landline

- Highly redundant system
- Power conditioning equipment and generators at wire centers and mobile switching centers (days)
- Generators or battery backup at cell towers (hours to days)



The core of the 9-1-1 system (dispatch)



- Satellite assets provide GPS for automated vehicle location and dispatch and satellite phones for responders
- Cellular network and/or P25 (or conventional) radio system are used to provide dispatch services
- PSAP facilities have generators for electrical power backup

The Dispatch P25 Radio System

Resembles somewhat of a hub and spoke system with servers at its core

- These servers will have some sort of backup power, typically generator for the facility and server grade UPSes for the cutover

Connections are via a redundant IP-based network either owned by the locality or potentially leased from the local telecommunications provider

- Class of switches and routers and their level of protection in terms of power conditioning and backup will vary

Remote sites can either be simple radio towers or be host sites that control additional simple radio sites, together known as cells

There appears to be little to no redundancy for the master site (analysis assumes there is no redundancy and will be caveated appropriately)

Telecommunications Equipment Testing

Tests of the 5ESS and DMS100 switches and associated equipment in the 1980s* found the following:

- No permanent damage to the equipment, some of the in-process calls were dropped
- The ability of the equipment to process calls for a short time afterward was degraded but recovered on its own (about 20 minutes)
- Equipment that used fiber cabling in place of copper saw no impact from the cabling itself

Changes to hardware and software were made after the tests to allow for recovery without operator intervention

Newer versions of 5ESS and DMS-100 switches are still manufactured today by Alcatel-Lucent and Nortel Networks respectively, and are prevalent in the public switched telephone network

*Beauchamp, N. A. et al. "Nuclear Weapons Effects Studies for the 5ESS Switch. Volume 3. EMP (Electromagnetic Pulse) Studies. Part 1. Testing and Analysis." (1986).

*Booz-Allen and Hamilton, Inc. "Electromagnetic Pulse (HEMP) on the Northern Telecom Inc. DMS-100 (Trademark) Switch. Volume 1. Executive Summary." (1988).

P25 System Mitigations

Based on testing data and analysis of the systems, the following mitigation activities are recommended

- Maintain a backup master site, or connectivity to another local/regional entity that could serve as a backup master site
- Use of optical fiber instead of copper where possible
- Use of shielded copper and Ethernet surge protectors
- Filter power to devices using power conditioning equipment such as a UPS
- Grounding of equipment wherever possible
- Lightning protection systems for radio towers and associated equipment

Additionally equipment could be enclosed in hardened racks which could provide limited mitigation for SREMP and potential mitigation for HEMP