Fires, Active Shootings & Natural Disasters: Looking at In-Building Systems Through a Public Safety Lens

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Agenda

1. Public Safety Issues & Opportunity
2. Market Impacts / Trends
3. NFPA/IFC Codes & UL2524 Standard
4. Public Safety Frequency Bands
5. Public Safety Architecture
6. Public Safety Systems & Best Practice

Public Safety Opportunity

- The FCC estimates that an improvement of one minute for 9-1-1 response time would save 10,000 lives in the US each year
  - 80% of 911 calls are generated from a cell phone → 60% from cell in-building!
- Evolution of NFPA & IFC fire codes will continue to drive demand
  - New codes will also create confusion & opportunities
- There are more than 5.6 million commercial buildings in the US today!
  - Growth of 6% to 8% per year
- In-building public safety DAS will double by 2021 and revenue will increase to $1.7 billion with largest spend in North America
- Public Safety will help drive new commercial cellular sales opportunities
- Public Safety is a 'MUST HAVE & REQUIRED' by many AHJ's

NFPA & IFC CODES

Glossary

- ERRCS/ERRS/ESCS: Emergency Responder Radio Communications System / Emergency Services Communications System
- DAS: Distributed Antenna System
- PS-DAS: Public Safety DAS
- PS LTE: Public Safety LTE
- Indoor Repeater / BDA: Bi-Directional Amplifier
- AHJ: Authority Having Jurisdiction
- FirstNet: First Responder Network Authority is an independent government authority with a mandate to provide specialized communication services for public safety
- NFPA: National Fire Protection Association
- IFC: International Fire Code

ERRCS (Public Safety DAS)

What is it?

- An In-Building Public Safety Communication System ensures that radio signals are able to penetrate into all areas of buildings, including areas that are especially difficult for RF to penetrate such as stairwells, elevators, basements, and thick-walled or shielded

Why is need?

- Radio signals have limited propagation through various materials. Factors include how deep inside a building the receiver may be, wall composition, whether a building has energy saving “low-e glass” or other energy saving cladding, the specific frequencies in use (low frequencies penetrate better).
- In order to meet local codes enforced by local AHJ/FM (Authority Having Jurisdiction) buildings needs to comply with comply with either IFC, NFPA codes or codes enforced by local AHJ
- IFC 510 , NFPA 72 & 1221 Main codes being enforced by AHJ

NFPA 72 & 1221 – Section 9.6

Emergency Services Communications Systems

NFPA 72 CODES	NFPA 72 - 2013	NFPA 1221 - 2016	NFPA 1221 - 2019
In-Building Solution Required	**NFPA 1** Section 11.10	**NFPA 1** Section 11.10	**NFPA 1** Section 11.10
Pathway Survivability for Coaxial Cable Required	2 Hour for Riser Coaxial Cable – Sec. 24.3.6.8	2-Hour for Riser Coaxial Cable - Sec. 9.6.2.1.3	Backbone Cable Routed Through Enclosure Matching Bldgs. Fire Rating Sec. 9.6.2.3
Plenum Rated Coaxial Cable Required	Yes, Riser & Feeder Coaxial Cable Sec. 24.3.6.8	Yes, Riser & Feeder Coaxial Cable – Sec. 9.6.2.1.1.1	Yes, Backbone & Antenna Distribution Cables Sec. 9.6.2.1
Lightning Protection Required	Not addressed in Section 24.5.2	Yes, In accordance with NFPA 780 – Sec. 9.6.3	Yes, Section 9.6.3 Installed per NFPA 780
Isolation of Donor Antenna Required	Yes, 15 db – Sec. 24.5.2.3.3	Yes, 20 db – Sec. 9.6.9	Yes, 20 dB Above System Gain Sec. 9.6.9
Battery Backup Required	12 Hours – Sec. 24.5.2.5.5.2	12 Hours – Sec. 9.6.12.2	12 Hours Battery or Generator Section 9.6.12.2
Signal Strength & Area Coverage Required	-95 dBm – Sec. 24.5.2.3 90% General – Sec. 24.5.2.2.2 99% Critical – Sec. 24.5.2.2.1	DAQ 3.0 - Sec. 9.6.8 90% General - Sec. 9.6.7.5 99% Critical - Sec. 9.6.7.4	DAQ 3.0 - Sec. 9.6.8 90% General - Sec. 9.6.7.4 99% Critical - Sec. 9.6.7.3
Monitoring By Fire Alarm Required	Yes – Sec. 24.5.2.6	Yes – Sec. 9.6.13	Yes – Sec. 9.6.13 & Chapter 10 of NFPA 72
Cabinets for Equipment & Battery Backup Required	Yes, NEMA 4/NEMA 4X – Sec. 24.5.2.5.2	Yes, NEMA 4/NEMA 4X – Sec. 9.6.11.2	Yes, NEMA 4/4X & NEMA 3R for Batteries Sec. 9.6.11.2
Monitor Antenna Malfunction Required	Yes, Donor Antenna – Sec. 24.5.2.6(2)(a)	Yes, Donor Antenna – Sec. 9.6.13.1(2)(a)	Yes, Donor Antenna – Sec. 9.6.13.2.1(5)
System Acceptance/Testing	Section 24.5.2.1.2 &14.4.10	Section 9.6.4, 11.3.9 & 11.3.9.1	Section 9.6.4, 11.3.9 & 11.3.9.1
Listing of Equipment	Not Specifically Addressed	Not Specifically Addressed	Specific Listing Requirement TBD by the AHJ

IFC – Section 5.10-ERRCS

Emergency Responder Radio Coverage Systems

IFC CODES	IFC - 2015	IFC - 2018	IFC - 2021
In-Building Solution Required	Sec. 510.1	Sec. 510.1	Sec. 510.1
Pathway Survivability for Coaxial Cable Required	Not Specifically Addressed in Section 510. Referenced in 2013 NFPA 72 Sec. 24.3.6.8	Yes, Section 510.4.2. Reference to NFPA 1221. ** Also See NFPA 1221 TIA 16-2	Yes, Section 510.4.2. Reference to NFPA 1221.
Plenum Rated Coaxial Cable Required	Not Specifically Addressed in Section 510. Referenced in 2013 NFPA 72 Sec. 24.3.6.8	Yes, Sec. 510.4.2. Reference to NFPA 1221	Yes, Section 510.4.2 Reference to NFPA 1221
Lightning Protection Required	Not Specifically Addressed in Section 510	Yes, Sec. 510.4.2 Per NFPA 780 as Referenced in NFPA 1221	Yes, Sec. 510.4.2 Per NFPA 1221 Sec. 9.6.3 Installed per NFPA 780
Isolation of Donor Antenna Required	Not Specifically Addressed in Section 510	Yes, 20 db – Sec. 510.4.2.4 (4)	Yes, 20 db – Sec. 510.4.2.4 (4)
Battery Backup Required	24 Hours – Sec. 510.4.2.3	12 Hours – Sec. 510.4.2.3 or 2- Hours Battery w/ Emergency Generator	12 Hours – Sec. 510.4.2.3 or 2- Hours Battery w/ Emergency Generator
Signal Strength & Area Coverage Required	-95 dBm – Sec. 510.4.1 95% General – Sec. 510.4.1 99% Critical – Not Specifically Addressed in Sec. 510	DAQ 3.0 - Sec. 510.4.1.1 95% General - Sec. 510.4.1 99% Critical - Sec. 510.4.2 Reference to NFPA 1221	DAQ 3.0 - Sec. 510.4.1.1 95% General - Sec. 510.4.1 99% Critical - Sec. 510.4.1
Monitoring By Fire Alarm Required	Not Specifically Addressed in Sec. 510 – See 2013 NFPA 72	Yes – Sec. 510.4.2.5	Yes – Sec. 510.4.2.5
Cabinets for Equipment & Battery Backup Required	Yes, NEMA 4 – Sec. 510.4.2.4 (1) & (2)	Yes, NEMA 4/NEMA 3R – Sec. 510.4.2.4 (1) & (2)	Yes, NEMA 4/NEMA 3R – Sec. 510.4.2.4 (1) & (2)
Monitor Antenna Malfunction Required	Not Specifically Addressed in Section 510	Yes, Donor Antenna – Sec. 510.4.2.4(4)	Yes, Donor Antenna – Sec. 510.4.2.4(4)
System Acceptance/Testing	Section 510.5.3	Section 510.5.3	New – Section 510.5.4 Annual – Section 510.6.1
Listing of Equipment	Not Required by Section 510	Not Required by Section 510	Yes, Section 510.4
Mounting of Donor Antenna	Not Specifically Addressed	Not Specifically Addressed	Section 510.5.1

UL 2524

What is it?

New Standard that covers products used for in-building 2-way emergency radio communication enhancement systems (e.g. repeater, transmitter, receiver, signal booster components, power supply, and battery charging system components) installed in a location to improve wireless communication at that location. These requirements do not include determination of compliance with regulations of the Federal Communications Commission (FCC). OEM's will need to secure UL2524 certification through an NRTL Nationally Recognized Testing Laboratory where required by AHJ

- **Approved by the Standards Technical Panel(STP) in October 2018**
  - **Revision to the UL 2524 Standard approved in January 2019**
- **Certified as a system which includes the Repeater, Annunciator, and Battery Back-up unit**
- **AHJ's are already asking for UL2524 approved systems and list is growing….**
- For more information on State, Local, and National codes please check:
  https://www.saferbuildings.org/useful-links

Code Changes currently in the works

- NFPA 1225 – New consolidation plan of 1221 & 1061 – Plan is for 2022 revision
- New oscillation alarm
- Hardening of PS LTE
- Potential code change from -95 requirement to reduce cost of systems for building owners
- Alignment between NFPA & IFC regarding battery back up
  - NFPA is currently 12 hours or generator in section 9.6.12.2
  - IFC is 12 hours OR 2 hours w/generator in section 510.4.2.3
- Monitoring of passive devices including splitters, antenna, etc.
- UL 2524 as a required standard in next version of code
- New proposal from Chief Perdue to tie Building Pathway Survivability Code to ERRCS In-Building Fire Code

Market Trends & Impacts in 2020 and beyond….

- Many AHJ's now require UL2524 solutions today & list is growing
- Compatibility of BDA/DAS systems with other equipment within the building
  - Alarm systems, BMS/BACnet Building Automation & Control
- CBRS in public safety space
- Impacts of noise within system
- Monitoring of passive system
- Fiber to the antenna solutions in Public Safety

Public Safety Frequency Bands

Public Safety Frequencies

- Similar to commercial spectrum ownership and operation, the frequencies used by public safety groups and first responders will vary depending on the state, market, and/or county. Each system will be operating one or more of the following frequencies:

Freq.	Downlink	Uplink
VHF	136-174 MHz	
UHF	380-512 MHz	
700 MHz PS	758-775 MHz	788-805 MHz
800 MHz PS	851-861 MHz	806-816 MHz

Public Safety Frequencies

- VHF/UHF
  - Set up for many narrowband channels as small as 6.25KHz
  - Unlike 700MHz and 800MHz, the Tx (Downlink) and Rx (Uplink) channels don't have a designated frequency range. They can be spread out and interleaved across the frequency band
- 700 MHz(SMR)/PS LTE & FirstNet
  - 20 MHz (10 DL/10 UL) of 700 PS Band has been allocated for FirstNet, providing uniform LTE coverage for many critical organizations. The roll out of this service has been gradual.
- 800 MHz
  - Currently the most commonly used Public Safety frequency band

Public Safety
Repeater Classes

Repeater Classes

- Public Safety repeaters are classified in two categories based primarily on the filtering bandwidth for the supported channels.
- The AHJ may specifically require the use of a Class A or Class B repeater.

Class A	Class B
Capable of finer filtering to select channels as narrow as **6.25KHz**	Allows for the selection of channels as narrow as **250KHz**
Typically, capable of supporting **8 or more narrowband channels**	Typically supports **one or two wideband filters** (up to 20MHz) to support multiple channels
Ideal for system that has channels **dispersed** throughout the band or interleaved with channels that need to be excluded from the system	Ideal for system where all the supported channels are **contiguous**
Recommended for applications that are **sensitive to noise**	Can introduce **more noise** to the system if the supported traffic channels are non-contiguous

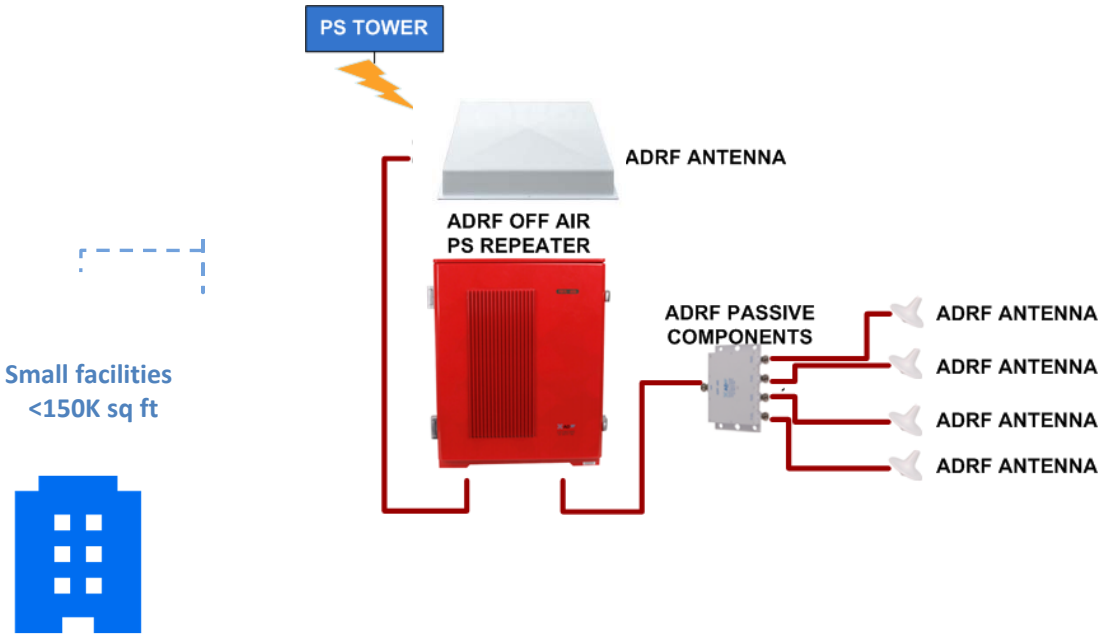
Public Safety
System Architecture

Types of Inbuilding DAS

Passive DAS:

- A passive public safety DAS is comprised of signal source, typically a repeater (BDA), that feeds a network of passive components to feed server antennas and provide coverage throughout a building.
- Typically used in small to medium sized buildings
- More common solution for Public Safety than Commercial due to the use of lower frequency bands. This allows for better propagation and ability to cover larger areas with the same RF output power

Small Deployment: Public Safety Passive Repeater System



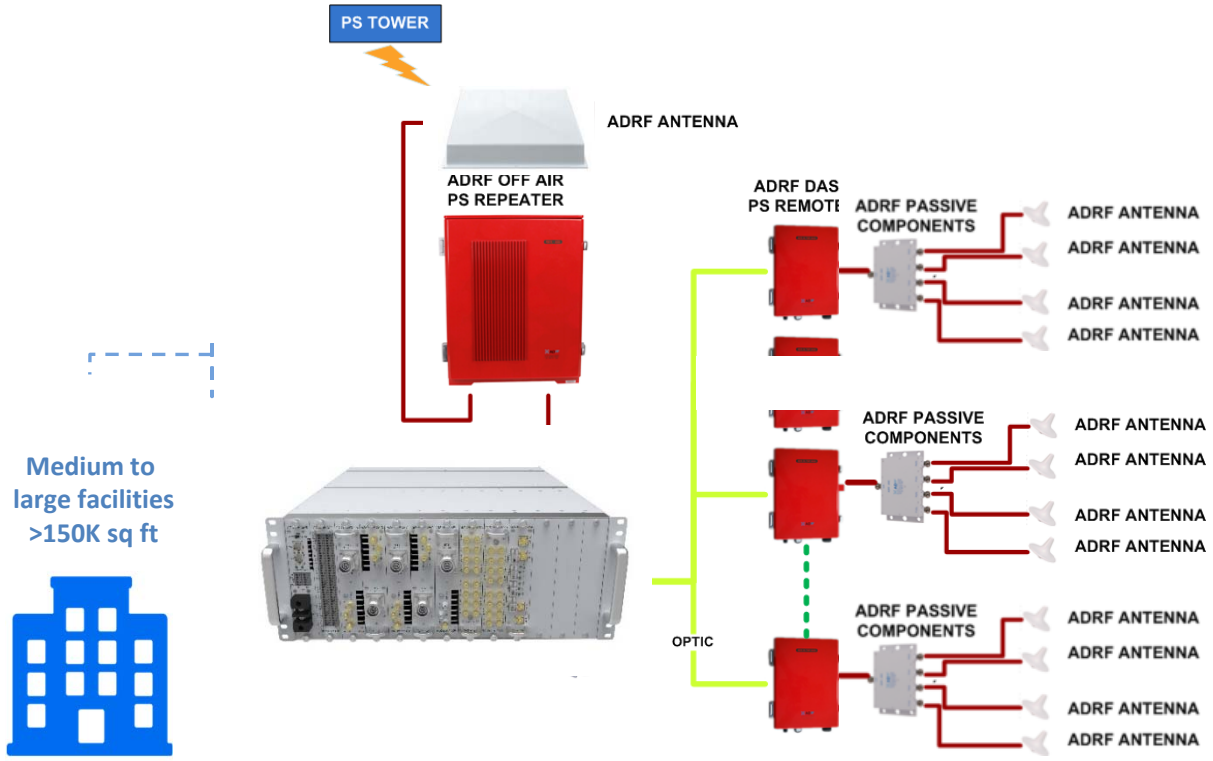
Types of Inbuilding DAS

Active DAS:

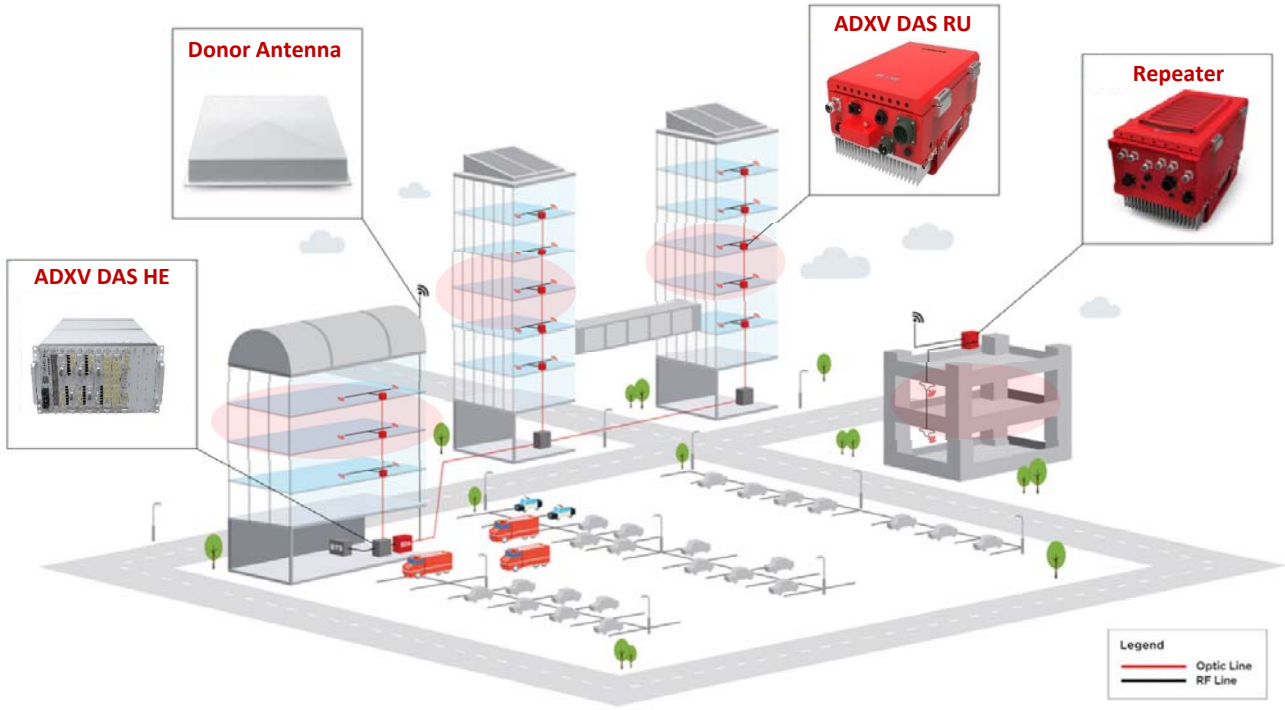
- An active public safety DAS (also known as fiber DAS) is comprised of a signal source, typically a repeater that feeds into a fiber DAS headend. The signal is converted from RF to optical and distributed over fiber to multiple remote amplifier locations where it's converted back to RF and distributed to passive networks of components and antennas
- These systems are typically used in medium to large sized venues

Medium/Large Deployment: Public Safety

Active Fiber DAS



Public Safety Solutions in a Business Campus



Public Safety System
Identify to Implementation….

Steps for In-building PS System Deployment

1. Identify AHJ / Frequency License Holder / Local Requirements
2. Site Survey/Baseline testing
3. Preliminary Design
4. Statement of Work (SOW)
5. RF Survey/CW testing
6. Update design
7. Pre-construction survey
8. Final design
9. Order equipment
10. Installation
11. Commissioning
12. System acceptance & sign-off
13. Annual Maintenance & Health Check

Stakeholders

- First Responders / Public Safety Agencies
- FCC frequency license holder(s)
- OEMs: repeaters, active fiber DAS, passives, antennas, & coaxial cable
- System Integrators: RF testing, design & installation
- Material Distributors: Logistics, coordination, supply
- Building owners (REITs)
- Local AHJ (Authority Having Jurisdiction)
- Specifiers (Architects, etc.)
- FCC
- Wireless Carriers

Public Safety System Design

- Equipment: It is important to keep in mind the frequency bands used in the system and to design using components that can support these frequencies
- Coverage: Due to the propagation characteristics of the low frequencies used for public safety (compared to commercial frequencies), larger areas can be covered with lower power amplifiers. This will also dictate the use of an active or passive DAS
- Capacity: Public safety communication is rarely restricted by capacity when compared to data-heavy communication of commercial systems (for now). This means that the only capacity consideration would be at the donor signal source, which is typically a macro cell site.

Public Safety System Design

- VHF/UHF: a choice has to be made on whether to maintain separate Tx and Rx coax paths or to multiplex them. This needs to be considered on the donor and server side. The deciding factors include:
  - The spectral separation of the Tx and Rx channels
  - The spatial layout requirements of the donor and server antennas
  - The size of the system and the number of remotes if it is a fiber DAS
  - The VHF/UHF multiplexers can be very expensive and large since they will be custom made for every different set of frequencies

Step for success when deploying a public safety system

- Engage the AHJ early to understand their set of requirements for in-building public safety system & this will help prevent delays during the system approval process
  - Each local Authority Having Jurisdiction (AHJ) interprets the NFPA code differently
  - DAS must meet their specific interpretation in order to get approved
- Engage a System Integrator that understands the local codes and understands Rf. The right SI will make your project go smoothly from start to finish.
  - Rf study, design, system selection based on needs/requirements, installation, turn-up, commissioning, testing, approval, C of O
  - LEED certification is great for energy conservation, but impacts coverage within a building
- Delays are most commonly a result of:
  - ERRCS does not meet local code requirements
  - DAS Alarming
  - Battery Backup Alarming
  - Insufficient RF Coverage at critical areas such as elevators and stairwells
- Proper planning upfront & engaging the right partners will save time and money

Thank you

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