Optical Zonu Public Safety White Paper April 2022

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Executive Summary

Public Safety Distributed Antenna System (DAS) are designed to ensure fully functional RF communication for first responders. Traditionally the system employs external Antenna (Donor Antenna) or dedicated Base Station (with wired backhaul), to connect to existing wireless network and through a system of coax cables, amplifiers, and in-building antenna, ensures coverage within the structure. Each system addresses the topological requirements of the specific building/complex/structure. There are many cases where the distance to the Donor Antenna, OR the dedicated Base Station, from the headend location of the in-building distribution hardware is too long for coax cable to transport the RF signals without suffering significant loss.

To solve the issue of transporting the RF signals over longer distances (where coax cable can't be effectively utilized) – RF over Fiber transports are the main technology that are both useful and cost effective.

Currently there are no existing guidelines, set forth by the NFPA or the IFC, for public safety deployments that speak specifically to RF over Fiber Transport systems. Therefore, we infer that the NFPA and IFC certifications may not be required to deploy and utilize RF over Fiber transport, as long as the signal link integrity (RF levels, noise floor etc.) is not impacted. Your own due diligence on this matter is advised. The following links will allow you to do your own review and make an educated decision.

Optical Zonu Corporation (OZC) offers a true neutral fiber optic transport for Public Safety. Our products do not add or modify data, nor do they amplify the signals passed through. Rather the OZC solution does an analog conversion from RF to light and passes the light through the "lossless" environment of fiber optics, allowing the signal to pass cleanly and without degradation.

Internationally recognized bodies of Codes and Standards for "Public Safety"

The National Fire Protection (NFPA) is an international nonprofit organization devoted to eliminating death, injury, property, and economic loss due to fire, electrical and related hazards and sets the Codes and Standards for the Life & Safety fields which encompass the "Public Safety" Radio and Communication Networks. Similarly, the International Fire Code (IFC) is another industry recognized Code and Regulation body that has been adopted in 42 states, the District of Columbia, New York City, Guam, and Puerto Rico. As a model code, the IFC is intended to be adopted in accordance with the laws and procedures of a governmental jurisdiction. The following links are reference points for you to make your own educated decision on the classifications related to an Optical Zonu RF over Fiber Transport solution.

List of NFPA – National Fire Protection Association - Codes and Standards
IFC – International Fire Code - ICC (iccsafe.org)

What is a “Public Safety” Wireless Network?

Public safety Distributed Antenna Systems (DAS), often referred to as an Emergency Responder Radio Coverage System (ERRCS), is a life safety system that gives first responders access to seamless, uninterrupted wireless communication for their handheld radios. In the US Public safety channels allocated by the FCC are available in the *VHF band, 220 MHz band, UHF, T-Band, 700 MHz narrowband, 700 MHz broadband, 800 MHz band, 4.9 GHz, and 5.9 GHz bands*.

Basic requirements of a “Public Safety” Wireless Network

Hardware and Coverage

Unlike traditional Cellular DAS designs, public safety networks require access in parts of buildings that are infrequently used. Elevators, fire escapes, fire pump rooms, and emergency exits, all require public safety network access, as these are the areas that first responders communicate from in the event of a crisis.

Public safety networks also require specialized equipment such as heat resistant cables and backup generators, that aren’t as readily available as traditional cellular DAS infrastructure. This means longer lead times and potential delays in network planning and deployment.

Security: Public safety networks must meet the trust requirements and security mandates of organizations exchanging data through it.

Sustainability: Public safety networks must meet the needs of first-generation stakeholders without compromising its ability to meet the demands of future collaborators.

Affordability: Public safety network design and deployment should be affordable to the entire community of users expecting to use this service.

Use of Spectrum: Public safety networks should be efficiently designed so as to effectively use the entire available spectrum.

As mentioned above, “inbuilding” public safety networks typically adhere to guidelines outlined by the NFPA and IFC. Here are some of the most important protocols as defined by the two organizations:

Equipment Enclosures: The NFPA and IFC specify that all equipment supporting the public safety network must be housed in NEMA-4 compliant enclosures.

Signal Strength: The NFPA and IFC stipulate a minimum signal strength of -95 dBm to meet acceptable signal strength standards.

Battery Backup: Equipment that supports the public safety system must be able to function for 24 hours on a backup battery.

Fire Ratings: Cables connecting public safety electronic equipment must meet a two-hour fire rating.

Distance Limitations

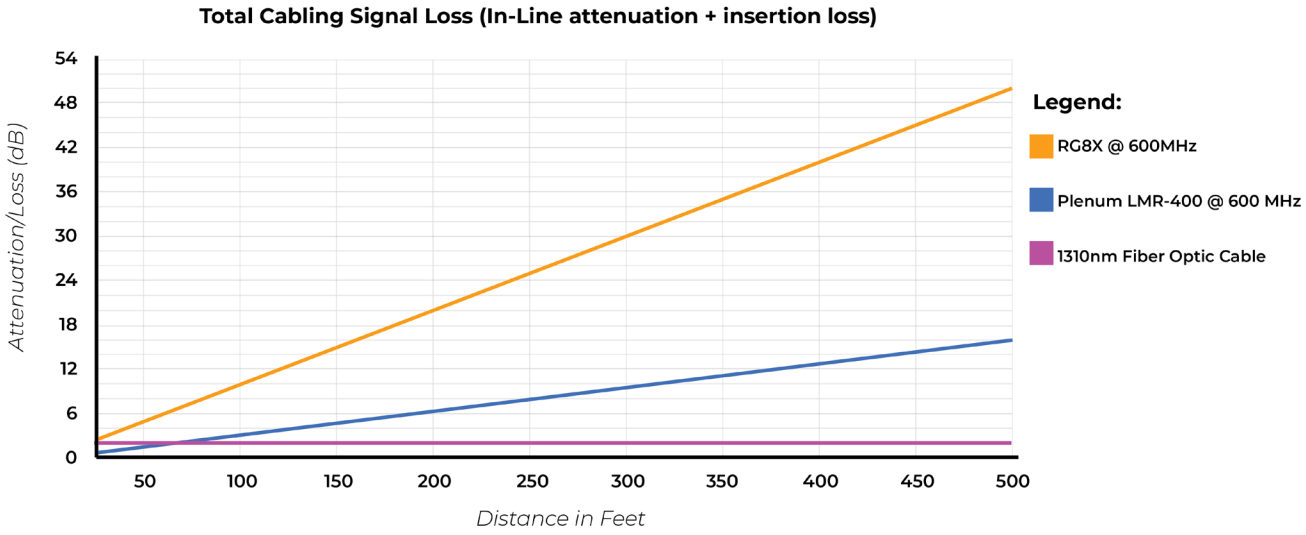
Attenuation of Radio Frequency signal travelling through coax cable is a well know issue in signal propagation and directly impact architecture layout of Public Safety architecture. The table below reflects examples of RF Signal Loss in dB per 100ft.

Attenuation (dB per 100 feet)

Coax Cable Signal Loss (Attenuation) in dB per 100ft*								
Loss*	RG-174	RG-58	RG-8X	RG-213	RG-6	RG-11	RF-9914	RF-9913
1MHz	1.9dB	0.4dB	0.5dB	0.2dB	0.2dB	0.2dB	0.3dB	0.2dB
10MHz	3.3dB	1.4dB	1.0dB	0.6dB	0.6dB	0.4dB	0.5dB	0.4dB
50MHz	6.6dB	3.3dB	2.5dB	1.6dB	1.4dB	1.0dB	1.1dB	0.9dB
100MHz	8.9dB	4.9dB	3.6dB	2.2dB	2.0dB	1.6dB	1.5dB	1.4dB
200MHz	11.9dB	7.3dB	5.4dB	3.3dB	2.8dB	2.3dB	2.0dB	1.8dB
400MHz	17.3 B	11.2dB	7.9dB	4.8dB	4.3dB	3.5dB	2.9dB	2.6dB
700MHz	26.0dB	16.9dB	11.0dB	6.6dB	5.6dB	4.7dB	3.8dB	3.6dB
900MHz	27.9 B	20.1dB	12.6dB	7.7dB	6.0dB	5.4dB	4.9dB	4.2dB
1GHz	32.0dB	21.5dB	13.5dB	8.3dB	6.1dB	5.6dB	5.3dB	4.5dB
Imped	50ohm	50ohm	50ohm	50ohm	75ohm	75ohm	50ohm	50ohm

* **Note:** Coax losses shown above are for 100 feet lengths. Loss is a length multiplier, so a 200 ft length would have twice the loss shown above and a 50 ft length would have half the loss. This multiplier factor is why you should keep cable installation lengths between radios and antennas as short as practical!

A solution for RF signal transport, used for at least 30 years, is a transport over single mode optical fiber. The signal is converted to optical signal that propagate with very low attenuation, and then reconverted to electrical signals. As the graph below shows, it is easy to discern the benefits of a single-mode RF over fiber transport as compared to traditional Coaxial transports and the "loss to distance" ratio. At distances exceeding +75 feet we see noticeable attenuation in Coaxial deployments.



Radio Frequency over Fiberoptic (RFoF) is a straightforward proven solution for the propagation attenuation through coax cables.

The Benefits of RF over Fiber Transports

- Very low signal loss (less than 0.5 dB/km) allowing for connections of several kilometers without the need for amplification.
- Flat frequency response across the entire frequency band, meaning there is no need for slope compensation
- Immunity to EMI and RFI due to fiber being a non-conductive medium
- Security against signal interception
- Flexible and lightweight for ease of deployment
- Low maintenance – install and forget technology
- Simple installation
- Cost effective compared to high end, low loss coax cable and slope compensation amplifiers.
- OZC's RF over Fiber Transport Solutions do not amplify signal but simply ensure a quality signal reaches from the signal "Source" to the "Remote" and vice versa. Since our products do not amplify signal, but rather pass signal in a "lossless" fiber environment.

How does a "Public Safety" Fiber Transport Operate?

A wide range of Public Safety Fiber Transport Solutions, utilized for ONLY transporting RF signals through Fiber Optics network. Hardware performs an analog conversion from RF to light. The specialized fiber optic transport equipment application is specifically for instances where Coaxial cable is not feasible to transport RF signal, because of distance; or to avoid complex high-priced solutions.

Optical Zonu provides a "lossless"[1], cost effective means of RF transport a direct alternative to a coaxial transport. The OZC RF over Fiber Transport solutions offerings is an effective means to maintain a quality RF signal from the point of signal insertion through the point of transmission. Our products do not modify data content, nor does it amplify the signals passed through the system. Rather the Optical Zonu solution does a simple analog conversion from RF to light and passes that signal over the "lossless" environment of fiber optics, where the inserted signal can cleanly pass without degradation. This point remains consistent whether it is used in a Simplex/Duplex, Directional/Bi-Directional fashion, our products are solely a means of "RF TRANSPORT", the benefit being the "lossless" nature of Fiber optics.

Since our products are only a means of RF Transport from dedicated sources (Base stations, BDAs etc.) to Remote sites (DAS, Passive Antenna points etc.) for a distance, there is currently no classification established by the IFC, and NFPA.

Optical Zonu's RF over Fiber Transport Solutions do not amplify signal but simply ensure a quality signal reaches from the signal "Source" to the "Remote" and vice versa. Since our products do not amplify signal, but rather pass signal in a "lossless" fiber environment there are no existing guidelines set forth for public safety deployments that speak specifically to RF over Fiber Transport systems by either the IFC, or the NFPA.

All current standards are based upon the "Source", and "Remote" hardware, for this reason Optical Zonu has no classification and in our opinion should be considered for part of your public safety design.

[1] "Lossless" fiber environment is based upon the assumption that the "Signal Source" is a 5W unit with a signal insertion into the Optical Zonu RF over Fiber Transport that does not exceed +17dBm.

Optical Zonu helps design “public safety” networks

As a leader in RF over Fiber transport solutions for in-building DAS system design, we’ve had a lot of experience finding the best ways to help plan and deploy public safety RF over Fiber transport solutions. As previously stated OZC currently remains unclassified in global standards. We’re in regular communication with the Safer Buildings Coalition and system integrators to ensure network designs meet the requirements of these organizations.

Identify Critical Areas and transport Critical Communications

Optical Zonu allows RF over Fiber transports to carry critical signals without causing significant loss along the transport path. This makes it easier for stakeholders to have key communications where they have identified critical areas (i.e., emergency exit, control room, equipment room, etc.) of the network that will require special attention.

RFoF as a transport Media-Unaltered RF to RF

RF over fiber (RFoF) is a method of converting a radio wave (RF) into light by modulating the intensity of the light source (typically a laser) with RF signal. This is an analog process, and no digitization is used. The light signal is then transmitted over a fiber optic cable, which replaces and exceeds the capabilities of traditional copper coax cable. RFoF is not distance-limited like coax, which only goes to 300 ft (approx.). The signal is unamplified, or “boosted” in any manner.

OZC Offerings “Public Safety” Fiber Transport

Optical Zonu offers a wide range of Public Safety Fiber Transport Solutions, utilized for transporting RF signals through a Fiber Optic network. Our hardware performs a patented analog conversion from RF to light. Our application is designed for instances where Coaxial cable is not feasible to transport RF signal, because of distance, security or to avoid more complex solutions.

Optical Zonu provides a “lossless”, cost effective means of RF transport for Public Safety as a direct alternative to a coaxial transport. The Optical Zonu RF over Fiber Transport solution is an effective means to maintain a quality RF signal from the point of signal insertion through the point of transmission. Our products do not add or modify data content, nor do they amplify the signals passed through the system. Rather the Optical Zonu solution performs an analog conversion from RF to light and passes that signal through the “lossless” environment of fiber optics, where the inserted signal can cleanly pass without degradation. This point remains consistent whether it is used in a Simplex/Duplex, Directional/Bi-Directional fashion, our products are solely a means of “RF TRANSPORT.”

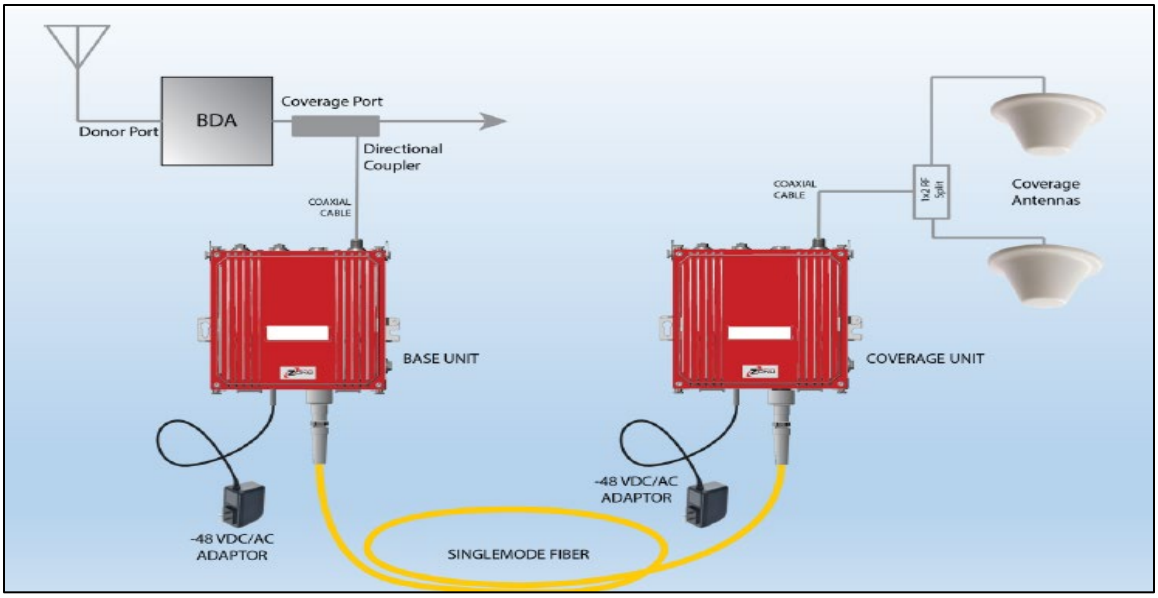
Our products only transport RF signal from dedicated sources (Base stations, BDAs etc.) to Remote sites (DAS, Passive Antenna points etc.) and do not amplify signal but simply transmits a secure and quality signal from dedicated “Source” to the “Remote” and vice versa. There are no existing classifications or guidelines set forth for public safety deployments that speak specifically to RF over Fiber Transport systems by either the IFC or the NFPA.

All current certification standards are based upon the “Source”, and “Remote” hardware, for this reason Optical Zonu has no classification and in our opinion can and should be considered as a part of your public safety design.

Implementation Examples

The Optical Zonu Public Safety Antenna Extender product supports Point to Point or Point to Multi-Point distributions of Public Safety bands (and Cellular). A Multi-point system can be distributed to up to eight locations serving RF coverages at a low cost.

Point to Point Example



US Public Safety

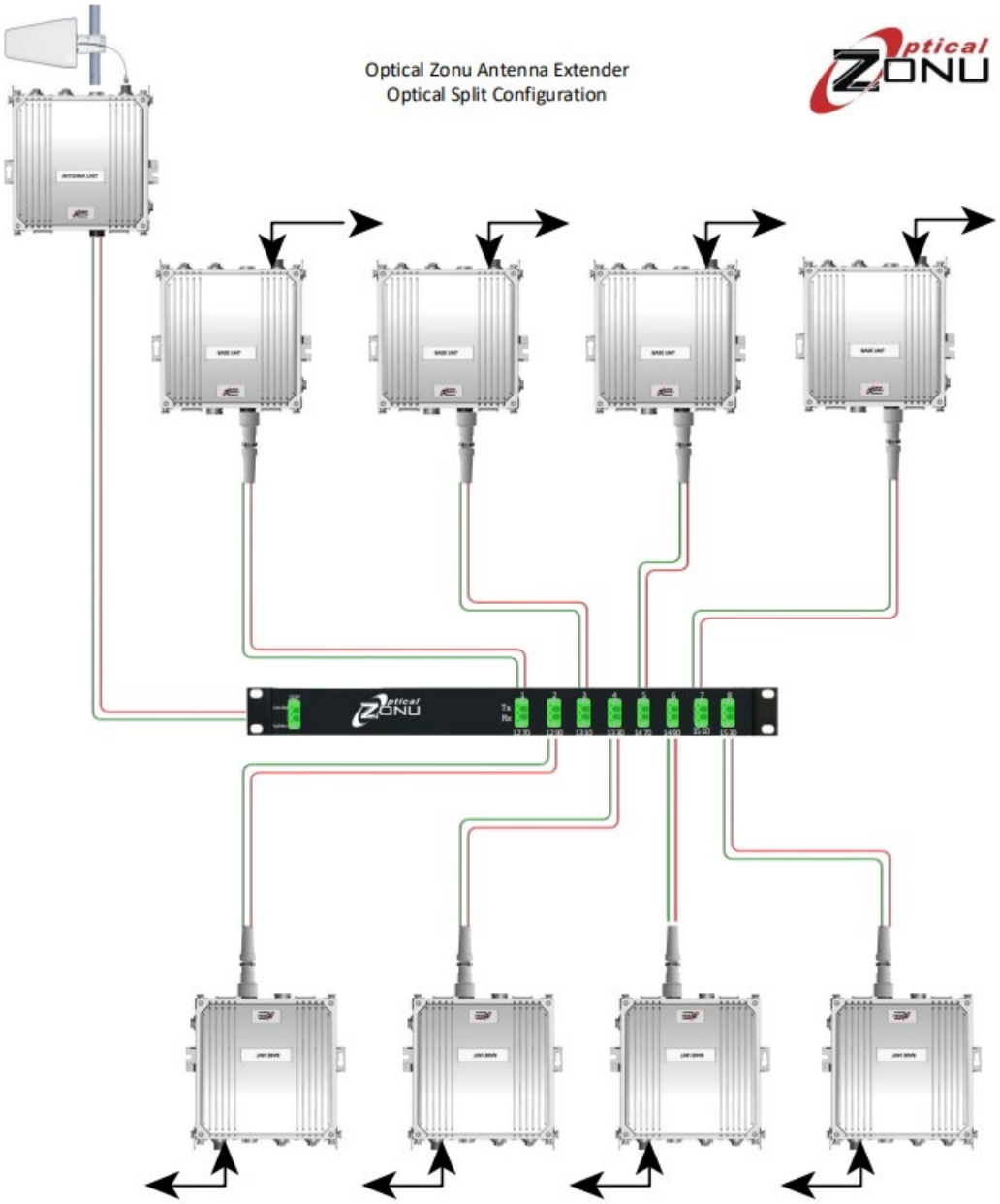
	Band	Base to Mobile	Mobile to Base
Frequency Range	Narrowband	768 – 775 MHz	798 – 805 MHz
	NPSPAC/800	851 – 860 MHz	806 – 815 MHz

FirstNet

	Band	Base to Mobile (Downlink)	Mobile to Base (Uplink)
Frequency Range	14	758 – 768 MHz	788 – 798 MHz

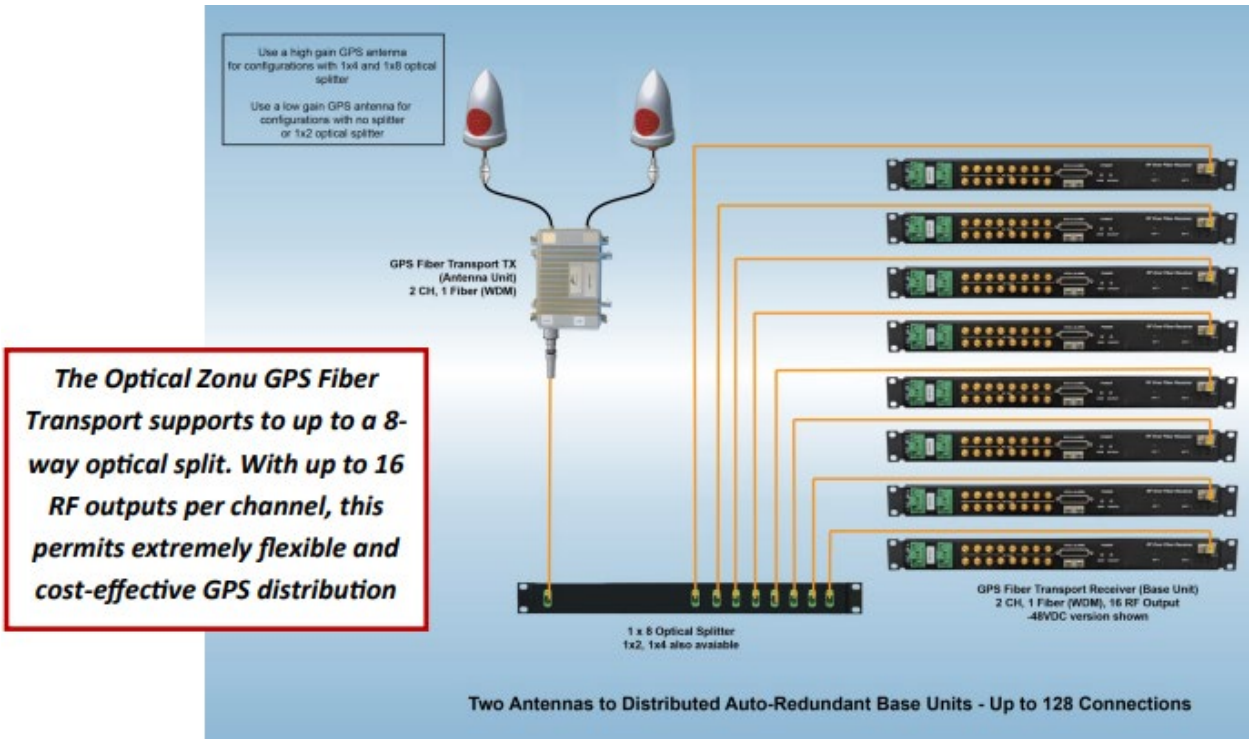
Point to Multi-Point Deployment - Eight Point Example

The below image shows a typical deployment of the OZC PS Antenna Extender product line. Currently deployed at the US Bank Arena Minneapolis, MN. Distributed Antenna Extender Simulcast coverage to as many as 8 DAS locations from a single off-air donor antenna. The Antenna Unit connects to up to 8 Equipment Units through the Optical Distribution Tray.



GPS RF over Fiber Transport

The GPS Fiber Transport Link by Optical Zonu provides a simple, cost-effective, and reliable RF connection between the GPS antenna and receivers in those instances where coaxial cable is impractical. Currently deployed with the NY/NJ Port Authority for use providing timing for Cellular/ Public Safety base stations throughout interstate transit tunnels.



We are ROHs compliant and all Optical Zonu products are manufactured and shipped from southern California facility.

OZC RFoF Products Significant Advantages:

- "Lossless" Fiber Transport Solutions
- Simplified Installation – Plug and Play.
- Real time, No latency
- Cost Effective
- Patent and Legacy approval by US Government

Fire Resistant

- 24x7 support
- Made in the United States

About Optical Zonu

Optical Zonu Corporation (OZC) is a leading OEM of RF Over Fiber Solutions. Based in the United States since 2003 all manufacturing and assembly is done in our southern California facility. Optical Zonu has developed a variety of patented RF over Fiber Transport, and Fiber based solutions, offering the "lossless" environment of Fiber as a replacement for long coax runs. OZC has a history for delivering reliable, dependable products to a broad range of customers.

Offering a simpler and more cost-effective means for solving complicated Coaxial transport problems. Optical Zonu RF over Fiber Transport and GPS products are being deployed by all the major US Cellular Carriers as well as Aerospace, Defense and Local, State and Federal Municipalities for Public Safety sites.

Conclusion

Given that a classification does not currently exist specific to Public Safety for RF over Fiber Transport systems by either the IFC or the NFPA and given that our products do not radiate or amplify RF signals, but rather ensure they are carried in a near "lossless" state, our products should be given due consideration when designing or bidding your next Public Safety project.

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