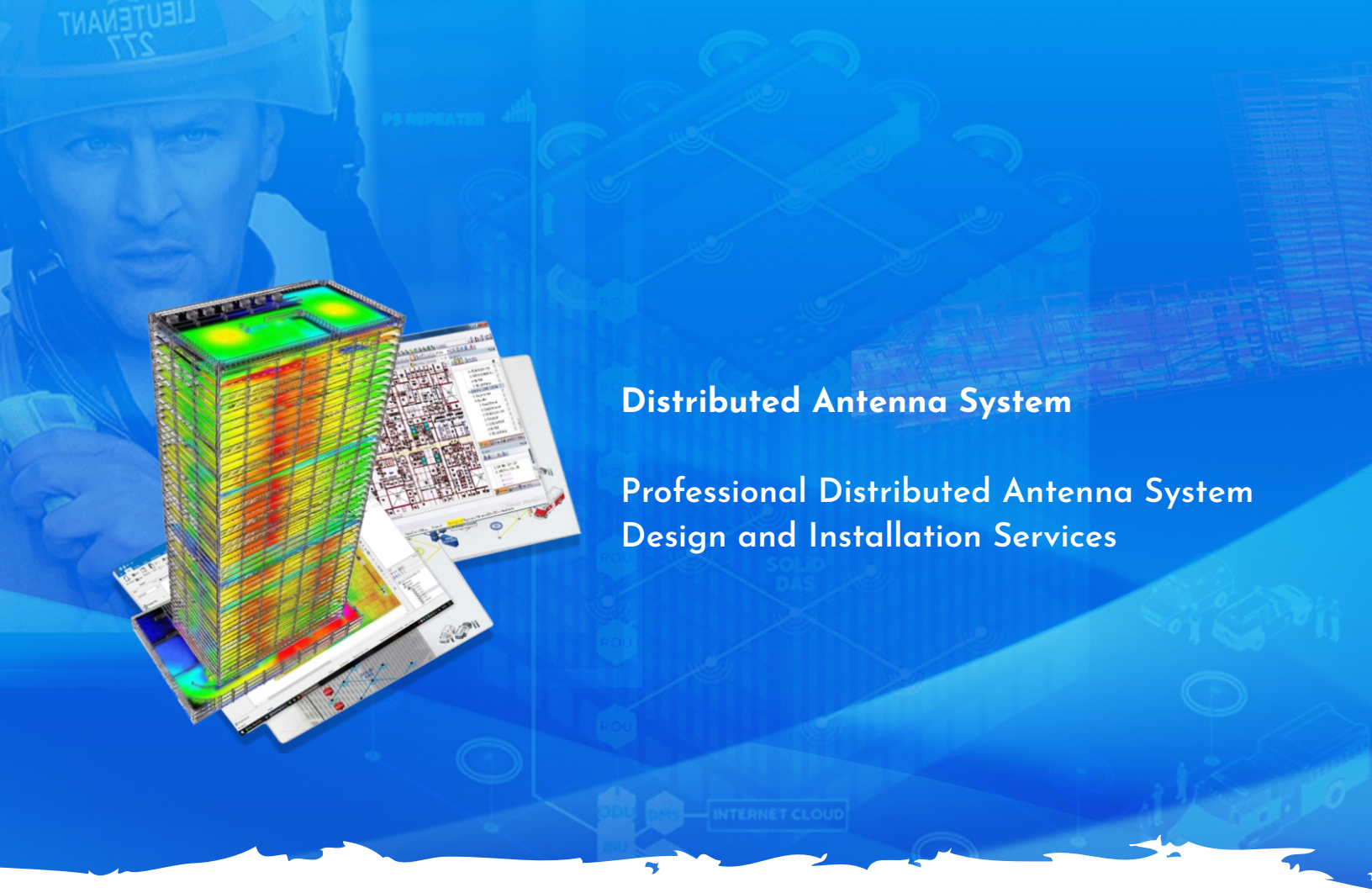


PUBLIC SAFETY

Distributed Antenna Systems

(ERRCS)

DASWave

daswave.com

PUBLIC SAFETY DAS (ERRCS)

Have you ever hired a General Contractor to design, install and commission your Public Safety DAS system to only have the contractor at the end not be able to deliver a working system that passes strict fire code compliance?

DAS systems specifically Emergency Responder Radio Communications System" or ERRCS are required in most counties, in fact in most commercial buildings DAS is part of the fire code. So, it is not surprising that many General Contractors who are tasked with DAS installations are unfamiliar with how to meet compliance as it pertains to correct installations. In the construction industry, many General Contractors habitually choose the "low bid" contractor and expect that they will deliver the same high quality, well planned DAS system that is required to meet compliance.

It wouldn't be the first time DasWave has received called at the end of a job to fix a DAS project where the contractor didn't deliver as expected. The real challenge is that the fire inspector will not sign off on the compliance and this will delay the occupancy permit required for tenants to move in. This now becomes an escalated issue where budgets get thrown out the window. This type of miss management and scope slip can be easily avoided by getting the right information up front.

One of the first mistakes that we see contractors make is getting their iBwave design done by firms who do not know the local codes. This may seem like a smart way to save some money; however, this shortcut typically leads to a risk element to the job when the system doesn't work and that is where the finger pointing starts. A lot of times freelance designers are not familiar with recent compliance changes to fire code or innovations in the industry. The customer is the one who ultimately suffers as they cannot legally have tenants move in until the fire marshal has signed off on these last items.

Our intention in putting together this short eBook is to educate individuals about the complexities of this critical part of commercial construction compliance. If you are in populated areas you know that it can be difficult to stay ahead of all the laws and regulation pertaining to compliance, for this reason alone you might consider partnering with DasWave. DasWave is based in California with a Boston office as well and we do all aspects of DAS in house without the use of subcontractors. We have iBwave trained designers, trained commissioning technicians and software required to do a RF design.

WHAT IS DAS?

DAS goes by a lot of different acronyms Distributed Antenna Systems also known as DAS systems sometimes known as bidirectional amplifier systems or BDA systems and many others. Depending who you are having a discussion with you might hear the term ERRCS or Emergency Responder Radio Communications System. The purpose of most DAS systems is to extend the range of radio signals into areas which would otherwise be considered a "dead zone". Most commercial buildings are notorious for having areas in which radio signals are difficult to receive reliable radio signals because they are behind a mountain, in a Valley on lower floors of a building like a basement or elevators etc. If there are any inhibitions to the radio signal being received there, then exists a need for that radio signal to be somehow enhanced or modified so that that radio signal can be reliably transmitted for emergency purposes.

There are seemingly endless technologies that assist with creating a reliable radio signal, they include passive repeater, satellite transmitters, satellite receivers, translators, transponder's, simulcast sites, additional repeaters etc. We will go into some of the advantages and disadvantages including operation and cost. You need to remember that every building environment is different, so most situations are not the same. Setting aside the legal requirements if the system is in properly installed it may cause significant radio Interference the penalties for causing this type of interference can be severe so you want to make sure the job is done correctly.

COMPLIANCE FOR SIGNAL COVERAGE

State and local governments have enacted some rules and regulations to ensure the maintenance of critical coverage. Under the 2016 and 2019 California Fire Code, all new buildings (or major remodels) that block the radio signal from the fire department radio system are required to "fix" the issue. By installing some signal enhancement systems, signals can be picked up from outside the buildings and piped into the building interiors. The installations have two basic types of systems:

1. Passive Repeater System

Passive repeater systems will work in most circumstances where the dead zone is limited to roughly 250,000 square feet and there is an adequate donor signal from the fire department on the roof of the building. The system consists of a donor antenna on the roof of the building, coax cable, signal splitters, and the appropriate number of service antennas inside the building. In most circumstances passive systems can be the more expensive option of the two DAS systems. The advantages of a Passive DAS system is Passive DAS systems don't need fiber optic cables in general and consist of simple BDAs (Bi-Directional Amplifier). A simple example of a passive component used in a DAS system would be a diplexer. It doesn't require power. The signal just runs through it, much like water runs through a pipe. DAS installations consisting of only passive components are rare. This is because as DAS installations get bigger and more sophisticated, they need to be controlled and monitored remotely.

2. Active DAS System

This system uses an active amplifier system to pick up, amplify and rebroadcast the radio signal from the fire department, police department, cellular, PCS, or whatever signal you are trying to bring into the building. They only boost the signal to be stronger so that it can be distributed throughout the building. If the system is for the fire department, there are many requirements that vary by jurisdiction which typically include 24-hour battery backup, the need for the equipment to be located in a 2-hour fire-rated room and having the vertical riser cables located in a 2-hour fire-rated riser which is not always available in the building design.

Passive system: Signal is captured via donor antenna travels through lightning arrestor BDA; supported by UPS amplified and pushed out to a serving antenna line balanced with couplers. Utilized by 95% of job sites typically maxes out at 45 antennas.

Active DAS system: Signal is captured via donor antenna travels through lightning arrestor > BDA BDA feeds into active DAS the RF is modulated in to light and travels via fiber feeds remote amplifiers signal is amplified and pushed out to a serving antenna line balanced with couplers. Remote amplifiers depending on frequencies and coverage needs can handle 20-35 antennas each. Depending on frequencies and solution there can be 4-60 remotes on a system. Only utilized by 5% of the customers; customers that include mega hospitals, large college campuses, theme parks, large Boeing campuses, Microsoft campuses, larger sporting venues.

MORE **ABOUT DAS**

DAS, or distributed Antenna Systems, BDA Systems, Signal Boosters, and Bi-Directional Amplified Systems are used for many radio applications. Some of the most common examples include Police Department, Fire Department, Two-Way Radio applications, and Cellular telephone technology.

Building Interference

EERCS or Emergency Responder Radio System is basically a tool that extends the range of radio signals into areas that are otherwise considered as the 'dead zone'. These areas include lower floors of a building, elevator, lobbies, basements, stairwells, and vestibules.

Geographical Interference

Other forms of interference can include hills/mountains, valleys or areas blocked by other natural terrains. Now how can we solve the dead zone challenge in these areas? Well, there are different methods that can be used, such as passive repeater, and additional repeaters. Each of these methods has its pros and cons.

Class A Signal Boosters

These signal boosters are known as channelized units. This class of signal boosters has the advantage of being able to single out individual signals within the public safety bands to rebroadcast while not rebroadcasting the entire band. This is especially important whenever there are radio signals from entities that do not want their signal to be rebroadcast.

The working of these boosters is fairly simple; at the very starting point, the amplifier breaks down the radio signals into individual radio channels and amplifies the individual signals. Afterwards, these individual signals are recombined to a single antenna, and broadcasted back into the building or dead zone. Since you are only rebroadcasting the desired signals, all the energy will be invested in the rebroadcast is for desired signals and none of it will be used for undesired signals. There is only so much power available in these systems, so conserving the energy for the needed signals is sometimes required to make the system work.

The disadvantage in Class A is that you need to add additional hardware any time the entity. These systems are commonly required by AHJs being installed.

Note:

According to the FCC rules, you must have permission to rebroadcast radio signals. So when using the Class A amplifier, the system will eliminate any need to determine if any foreign signals need permission.

Class B Signal Boosters

These signal boosters are known as broadband units. This type of signal boosters are great for users who decide to add another radio channel. Since, you do not have to add any hardware to rebroadcast that channel provided, it is within the existing frequency range of the signal booster.

Their working process is simple too; firstly, the filters in the unit pass a certain range of frequencies while eliminating frequencies outside of the filter range. Next, the system filters pass a range of frequencies to the amplifier, boost the signal, and rebroadcast the signals into the building or dead zone.

The only problem with Class B boosters is that any radio signal within the passband of the filters will be rebroadcast, regardless of whether you have received permission to rebroadcast their signals.

So 7/800 Mhz is the newest most common technology for the majority of all AHJs. Older, more rural or smaller AHJs will often have VHF (150MHz) or UHF 450MHz systems. VHF and UHF DAS systems are more costly to deploy as they require custom filters that need to be replaced whenever the AHJ makes changes. When an AHJ upgrades from VHF or UHF to a new system needs to be deployed.

Note:

For ERRCS; if installing a BDA in Orange County the only public safety frequencies available would be from OC Sherriff department. In other words, there are no other foreign frequencies. This differs from cellular. In Cellular if you rebroadcast cellular 800 you are rebroadcasting all 4 carriers. In ERRCS if you are rebroadcasting 800PS you are only rebroadcasting the local AHJ. Furthermore 7/800PS should not require any additional hardware to upgrade. Majority of DAS systems can handle 24 channels or more and AHJs rarely require more than 16 channels. Also because of the potential issues with Class B all Class B BDAs must be registered with the FCC either by the owner, integrator or licensee of the frequencies.

Riser Diagram

A typical Riser Diagram shown here depicts a typical installation of a 7-story building with 2 underground levels. The underground parking levels utilize 3 antennas on each level due to the parking areas having an open type of construction thus allowing the radio signal to propagate easily throughout the parking levels. The tenant floors of the building have many more walls which is why it requires 4 antennas per floor to reliably propagate the signal throughout the floors.

It is important to note that the number of antennas on each floor may vary from building to building. This is because many buildings vary in layout and construction type. So it is not uncommon to have different numbers of antennas on different floors.

As you can see, signal couplers are available in multiple values. These values are typically chosen to evenly distribute the radio signal throughout the floors, considering the signal loss of the cable, connector loss, and signal splitter loss. The value of the couplers comes in dB. A 3dB is 50% power most commonly a job has more 6dB couplers and at the head end 10dB and 15dB are common. We look to balance the output of the antennas utilizing different coupler values.

However, there are many instances where one may want an uneven distribution. This mainly occurs when certain areas of the building have acceptable coverage without any assistance or save more of the signal to provide coverage in areas of the building that do not have sufficient signal. There are hundreds of considerations made to properly design a DAS system for any given dead zone where the signal falls below -95dBm the requirements of the local AHJ (Authority Having Jurisdiction).

RF Distribution

Passive–DAS systems utilize coaxial cables for all cabling throughout the building. Usually there is a limit on the sq. ft. that can be covered by a Passive DAS system utilizing exclusively RF coaxial distribution - which is about 250,000 square feet. Systems larger than that typically utilize fiber distribution or Active DAS. The cable has a signal loss in every foot of cable, so the more cable that is run, the more signal that is lost (this is more notable for the passive das and this should be moved up).

The amplifiers being used here usually have a limit of 5-watt output (more than 5 watt require the same FCC license as a radio tower. This power is divided amongst all of the radio signals that pass through the amplifier system in the ratio of their relative input levels. Therefore, you can easily run out of signal for the building when you take into account the limits of the amplifier and the signal loss in the cables and the signal splitters that feed the various antennas.

Fiber Distribution

Fiber Distribution Systems are mainly used on larger Campus style projects. The main reason is the lack of signal loss in fiber cable, along with lesser cost of installation. It's all RF distribution. Both passive coaxial and active fiber systems are RF distribution systems both have sq ft limitations.
Fiber systems use fiber from the head end (main unit) to all the remote units. Each remote unit will amplify the fiber signal and turn it back into RF at typically a one-watt level. This output is used to distribute signals on a single large floor or multiple smaller floors to cover up to 100,000 square feet via coaxial RF cable distribution. Each floor (or group of floors) will have a separate remote unit with the two watt output and typically as many remote units as needed can be added to the system.

For instance, you have 50 floors in the building, you can have one remote unit per floor for a total of 50 remote units with one watt each or effectively 50 watts of power for the entire building - which cannot be done with RF distribution systems. Also, a campus that has multiple buildings can be fed with a single head end with a fiber feed to each building, thus making the system far more economical for such situations. Many of my jobs in DT LA or Seattle are 50+ floors and are completed using a single 5w BDA. It's more about sq. ft. than the number of floors. If a single 800Mhz BDA and UPS cost is 17k and a BDA UPS and Fiber headend cost 26k and each remote cost is about 8 k. each remote adds approx. 100,000 sqft up to about 50 remotes. A single BDA headend covers about 250,000 sqft again this seems redundant.

Fiber Cable Types

There are two types of fiber cables; multimode and single mode.

The multimode cables can carry more information on them because they have several modes of operation which can be used simultaneously. The only problem with multimode cables is that it works to a distance of only 1500 feet. This problem arises mainly due to high signal loss through the cable.

Single mode cables, on the other hand, can carry very less information but they also have very little signal loss. Therefore, single mode cables can run up to 10 miles without having to install a fiber repeater system. A fiber repeater system is usually used to boost the distance that the signal can travel.

At DasWave, signal boosters have single mode cables utilized in them. 99% of Active DAS utilize single mode fiber, lets not explain the difference between SM and MM fiber as most of our customers are aware of the difference lets just state we utilize SM fiber with Sam Charlie Angle Polished Connectors (or APC-SC.

RF Cable Types

There are many different types of RF cables available but only a few are appropriate for installing signal boosters. The majority of the jurisdictions either require CMP or CMR cable and of course outdoor rated for the donor.

At times, a combination of these cables is used. For instance, a buildings rating can require fire retardant cable and then pass to an area requiring plenum rated cables. This process is also known as transitioning. The problem in transitioning is not just the cost factor but also the reliability factor. When two types of cables are combined it is feasible to transition the cable and access the junction so it is normal to run all plenum rated cables. Transitioning from OSP to CMP to CMR is not an issue, all of our cables are of similar signal velocity and rated for 50ohm. We often intentionally use larger diameter cables for reduced signal loss. Typically we only run two types of cable CMP inside and OSP for the donor.

In a standard installation process, the cable is run from the rooftop donor antenna to the BDA amplifier system. This way the signals are picked from the donor site.

Code requires OSP or outdoor rated cables for outdoor, by code these cables are limited how far they can enter into a building because of the burn rate and toxins produced. Therefore we transition from OSP to Plenum either in a service can on the roof or within the top floor of the building.

All DAS RF cables are 50-ohm coaxial cables. In the TV industry, however, all coaxial cables are cables 75-ohm. In case a 75-ohm cable is installed instead of the 50-ohm cable, the system will exhibit problems that can be difficult to trace and expensive to repair. Therefore, when working with RF cables, you have to be absolutely certain that you are using the correct cable for the job.

Flexible Braided Cables

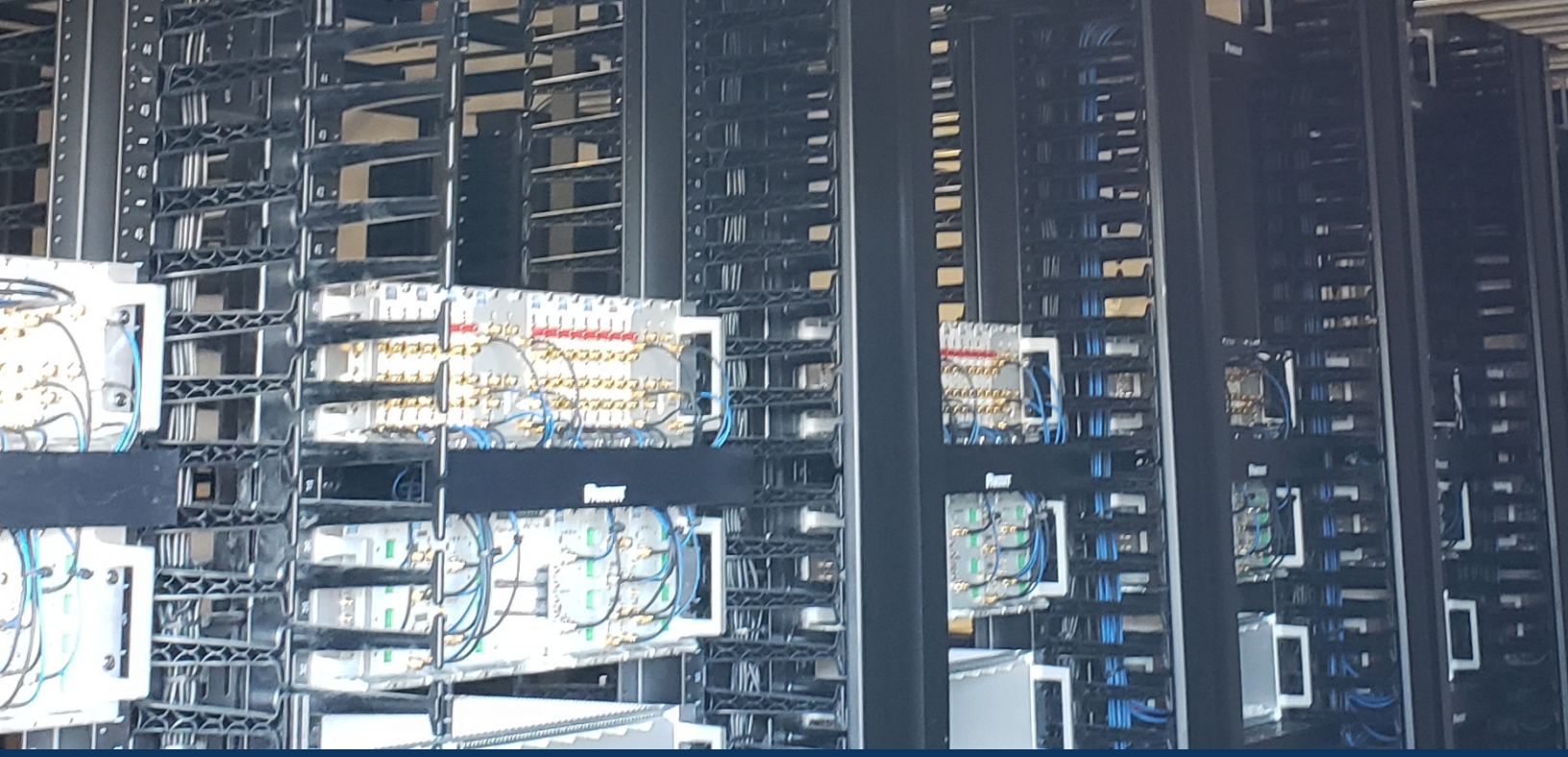
Flexible braided cables are sometimes used at coupler and antenna locations to relieve tension and provide the ability to utilize smaller pull boxes. Also are utilized at the Head end to maintain bend radius and allow for more compact headend installs.

Semi-Rigid Hardline Cables

Mostly the RF distribution is done with hardline cables. This is mainly because hardline cables offer lower signal loss per foot of the cable and the shielding in the cable is also protected.

The most common cable is the ½" diameter hardline cable which is used for 98% of all of our cable runs. Our designs will not utilize 7/8" cable. In 19 years of DAS I've only gone larger than ½" twice. Under very special circumstances will we use larger than ½". We will utilize a 3/8" cable for the smallest systems.

We are the designers we make the proper choice for the customer. For the most part all three of the major manufactures of ½" cable are interchangeable for well designed systems. Things that determine our cable choice are certifications, cost, durability, termination tool cost, and availability. Again these are behind the scenes process not selling points.



THE DELICATE BALANCE **OF DAS SYSTEMS**

All the DAS systems operate in a mode where the transmit frequency is the same as the received frequency. This is referred to as simplex frequencies, rarely is this ever the case.This scenario places a stringent requirement on the system designer as well as installer to be absolutely shown that the system does not feedback into itself (which can cause radio interference). When the RF feedback occurs, a small portion of the output of the amplifier gets back into the input of the amplifier, thus causing the feedback loop. At this point, you will not hear anything because the feedback radio signal is inaudible. However, this signal will cause severe radio interference to anyone on a nearby frequency and it can destroy the amplifier unit in your system.

Oscillations or "feedback loop" occur when serving antennas are too close to the donor antenna or when a system is improperly commissioned. Again both of these items are on us as the designer and integrator. Explaining the science behind this issue and how to avoid it sounds pretty easy and actually is for a qualified RF tech.

In order to prevent the feedback loop, In order to prevent an oscillation a generated signal of a known value is injected into the serving line at the BDA while a spectrum analyzer is used to measure the power level of the generated signal received by the donor antenna. Per CFC 510 the max allowable gain of the BDA is 15dB less than the difference between the generated signal and received signal. So if we inject 0dB and we see -100 from the donor the max allowed BDA gain is 85dB. Until this was written into the most recent code industry standard was 20db, however our standard is and always has been 25db. Therefore if a +20db signal is injected into the serving line and -100 is received by the donor we have 120dB of isolation. We can then run the max of 95db gain. Not that we would ever run max gain on any BDA.

This situation is very similar to that of a singer on stage standing in front of the PA speakers and getting a feedback screed when they get too close to the speakers. The noise hair is caused because the microphone is amplified and sent out on the speaker which then picks up the microphone again. This process continues on and on until you break the cycle by moving the speakers away or covering the mouth in order to prevent the speaker sound from getting into the microphone.

As you can see in the adjacent drawing, feedback path shows in between the antenna on rooftop and one of the antennas inside the building are causing the signal on the roof to reach the fourth floor. In an ideal situation, the signal is shown at the roof of the building, bending around the outside of the building and re-entering the building on the 4th floor which is now picked up by the 4th-floor antenna. In reality, however, the signal will penetrate the roof of the building and the floors until it reaches the 4th-floor antenna most of the time.

Please note that there are times when the signal will follow the path shown by the arrows by reflecting off the side of an adjacent building or other nearby objects.

However with the most recent trend in SoCal DAS codes change requiring a 17 microsecond uplink delay antennas are being required every 100ft including on upper floors so isolation testing to prevent oscillation is more important than ever.

THE DAS PROJECT PROCESS

The main idea of the DAS project is to deliver a world class DAS solution at an affordable price. Owing to our extensive field experience, we can install the most reliable and efficient solutions with superior performance in an economical manner. DasWave uses innovative solutions to get the lowest cost of providing you with the required radio coverage. This also saves you from the surprise costs of installing a DAS system.

At DasWave, we believe that any project is easier to do when there is sufficient time to plan and implement the solution. Therefore, we routinely follow up with building owners, developers, subcontractors, General Contractors, architects, managers, engineers, and other interested parties when the building is right for issuance of the Certificate of Occupancy.(This is determined by the original construction schedule and by the issued revised construction schedules usually controlled by the General Contractor for new construction.) Usually the stakeholders get last minute corrections on surprise notice from the inspector that they have not completed the DAS requirements. on such equations we get emergency calls to install a system on short notice. Now since we keep all the materials in stock for the common DAS systems, we are actually able to move quickly to take the heat out of your problem. When discussing the detail to solve your building problem, we usually require the following information from you: (Sometimes the General Contractor or owner does not know or does not believe a DAS is required until the end of the job when the inspector asks about the DAS or tests the frequencies. These types of scenarios result in needing an emergency DAS install in the shortest amount of time possible).

1. Price Quote

As shared earlier, every building has different requirements so every project requires a different plan. Therefore, in order to provide you a custom price, we quote jobs every week we don't design every week. We do not take responsibility for performance of systems we do not design.

This design requires architectural floor plans of each floor including the roof of your building so that we can determine its size, shape, dimensions, and construction materials. This also enables us to estimate the dead zones and determine what it will take to bring the signal into the building. Every quote requires a review of the architectural distance to the donor site, surrounding buildings, frequencies, Federal, state, and local AHJ codes.

2. Jurisdiction

Since each Authority Having Jurisdiction, or AHJ, has different requirements, we need to know which jurisdiction has control over the development of your particular project. Once the architectural plans of your building have been obtained, we work on designing the project so that it complies with the regulation of the local AHJ. Only then can we provide an accurate price quote for the work.

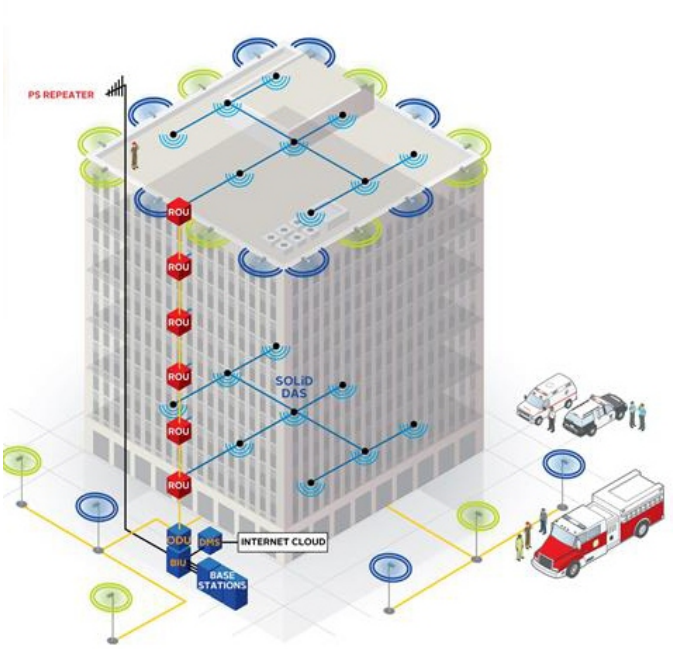
3. Job Walks

In many cases, a site walk is very helpful in determining the issues that may not be apparent from first look at the plans of building. For example, if the building is under construction, we can get a better idea of the details by walking around and checking how the surrounding of the building affects the radio signal inside the building. In many cases we can determine that some of the floors may not even require the DAS antennas. We may also end up finding an easier way to perform the same installation for you.

FIRE DEPARTMENT **PLAN CHECK**

In order to get your project plan approved by AHJ, we must first submit the plans for approval. The plans are drawn using CAD files so we require access to the CAD files compiled by your architect. We can use PDF files for the initial evaluation. However, we cannot use the PDF files to get plan approval if we are awarded the project.

Typically it takes 1-2 weeks to draw out the plans and input them into existing CAD files. Some jurisdictions also offer plan checks that are over the counter, while others require 6 weeks for a routine check. Majority of the construction projects are in the City of Los Angeles which requires 6 weeks for plan check. Prior to submitting an AHJ Plan check the design has to be approved by the customer. If the design is approved by AHJ and then the customer changes the locations the design will have to go back through plan check. The building owner, GENERAL CONTRACTOR and electrical team installing the pathway will need to sign off before submitting to the AHJ for plan check.



THE OPTIMAL TIME FOR **CABLE INSTALLATION**

If you ask us, the best time to install antenna cables is right when the framing is finished. At this point, the skin of the building is complete with windows. Since some of the cables are put through conduits, it is essential to get the conduit installation done before the cables are pulled through the conduit. Let's talk further about how conduit and DAS installation is done: Conduit comes in 10' sticks. It's a metal tube. It is impossible to install cable prior to all the conduit being installed Best time to install conduit is during the concrete pour so it is essential to complete the design early. And just because the framing is complete does not mean the windows are installed or the drywall is completed it means the drywall can start and windows can start. Honestly the best time to pull cable is three months prior to date of completion by then all the pathway should be complete and power should be available for the HE also the all the interior doors should be installed prior to grid testing.

1. Conduit Installation

Your electrical or low voltage contractor can run the conduit for the DAS system. Therefore the contractor needs to pull the electrical permit for the DAS system. It is important to ensure that the conduits are installed according to our design instructions to meet the code requirements for conduit locations and size. Please note that the electrical permit needs to be signed off prior to the inspection with the fire inspector. It is important that any deviation from the initial design that lengthens the cable runs needs to be communicated so the system can be rebalanced before the passives are shipped so if alterations to the design that change values of the couplers can be made.

2. DAS Installation

Every project is unique but all of them require conduit work. California code requires a 2" riser conduit from the DAS equipment (which is typically located in a 2 hour rated IT room or the MPOE located in the lower levels of the building) to the donor antenna on the roof of the building. Some jurisdictions also require a 2-hour rating for the conduit; others require a 2-hour rating for all vertical rises on the distribution inside the building. This should all be in conduit installation Our field engineers install all cables, make all connections, mount all antennas, and commission systems with our industry standard Anritsu Spectrum Analyzer and signal generators in order to ensure the system meets and exceeds the stringent AHJ requirements.

EXTENDED **CONSTRUCTION SCHEDULES**

In cases when a large span of time comes between power cable installation and the completion of a system, there is tendency of damage and other problems because many people are unfamiliar with the delicate RF cables; and they end up causing damage. In order to prevent such a situation from occurring, we make every reasonable effort but it is not always possible to prevent all the damage.

Our cables are typically installed in conduit protected from other trades. Our cable is delicate during install but is actually pretty robust once installed. We normally install late on a jobsite because we are the very last to be inspected by the AHJ.

EQUIPMENT INSTALLATION

The main equipment for the DAS system can be installed at any time the equipment room is ready. It is also easier to paint in the room if it is completed before our equipment is installed. If the room is supposed to be painted it is not ready until the room is painted.

Two of the most expensive components of our system 24 hour UPS and BDA. Both of them can be easily removed by an unauthorized personnel so we do not like to install the equipment until there is a locked room for the equipment. All systems require a dedicated 20A circuit to power our equipment. We are also required to ground the equipment, so the electrical contractor needs to provide an electrical ground. No we do not prefer a lockable room as the GENERAL CONTRACTOR or electrical contractor do not typically hand these keys out, means that hours are wasted waiting for access, also in 19 years I've never had a BDA or UPS stolen off the wall. There is almost no street value to our equipment. Also once it's mounted on the wall and part of the building; if it did go missing it's on the GENERAL CONTRACTOR.

The 5 alarms, that are required by code, must be wired to the DAS annunciator by using two CAT5 cables. The annunciator provides the alarm signals to the fire alarm company via dry contacts who monitors the alarms per the fire code.

TURN UP AND TESTING

The BDA is pre-programmed and bench tested at our pre-fab facility prior to being shipped to site to ensure DASWave delivers the best quality product on every install. Each antenna system is thoroughly tested in order to determine the circuit integrity and performance. Part of this process is the 20 grid signal strength test to ensure -95dB has been achieved in 90% of every floor including all critical areas such as stairwells, elevator lobbies, and vestibules. Please note that some AHJs require this testing to be submitted for review prior to scheduling a site inspection.

Note that if an internet connection is provided, we can also remotely program, , and monitor the system.

Once we determine that the system is fully functional; and is providing the proper coverage, we test the alarms, and schedule for final inspection. After everything has been fully tested, DasWave will check the performance of the RF coverage for the fire department. The DAS system is not that of the fire department but of the customers. As required by many AHJs DASWave will be present during the AHJ walk with a Spectrum Analyzer to monitor the testing process If any issue surfaces during the inspection, DasWave team will attempt to rectify the problem while the inspector completes their inspection so that the inspector does not have to return for another inspection.

ANNUAL **MAINTENANCE REQUIREMENTS**

According to the California Fire Code, DAS systems are required to be tested and certified annually like many other systems within the building. This particular requirement varies with different AHJs.

DasWave can perform the annual testing of your system to verify the operational parameters of your system. We also offer an annual maintenance program which includes the cost of the annual verification required by the fire code. Under your annual maintenance program, we will perform the following:

1. Verify that you are still getting the proper coverage from your DAS system – By performing the same standard 20 grid testing that was completed during commissioning.
2. Verify the alarms required that are handed off to the alarm company by ensuring that alarm monitoring is fully functional.
3. Verify the battery system is functional. For this, we test the battery system while we are on site and extrapolate its capacity. Please note that the batteries must be periodically replaced.
4. Measure the system gain and amplifier performance by comparing the system performance to the recorded measurements so as to determine if there have been changes in system performance.
5. Test the cable and antenna performance by inspecting your cables and antennas to verify the integrity of the connections. Sweep the antenna system to verify return losses.
6. Check the donor antenna for wear & tear, physical damage and verify that it is mounted and aimed correctly.

From time to time, many jurisdictions reconfigure their systems and then, the building owner is required by law to make necessary changes in order to accommodate the changes by the AHJ. Construction or remodeling of nearby buildings can also block the radio signal into certain portions of your building. If that portion of your building relies on the natural signal and not the DAS system, you will have to extend your DAS system. New buildings erected between yours and the donor site that cause a deficiency are liable for costs, it's best though if your annual recertification is performed by a reputable company such as DASWave to prove you had coverage before the new building. The cause may not be your fault, but it is still your responsibility to resolve according to the fore code.

daswave.com