



**SOLUTION WHITE PAPER**  
**VOTING & SIMULCAST**

## SUMMARY

When dealing with coverage issues with a radio system, voting and simulcast are two elegant solutions to maximize and improve talk-in and talk-out coverage. You can use voting and simulcast separately or together to eliminate gaps in poor or non-existent coverage zones. Voting provides roaming-style infill talk-in coverage, while simulcasting uses multiple transmitters to transmit over the same frequency to provide overlapping talk-out coverage areas.

## PROBLEM OF COVERAGE

One of the fundamental challenges faced in implementing and operating any radio system is having enough coverage, particularly in areas that have difficult terrain where obstructions can cause blank spots in an otherwise complete coverage plan.

This problem has been made worse with narrowbanding and digital upgrade path mandates. Many radio system users who had sufficient coverage for years with wideband and/or analog systems have suddenly found that outlying areas are no longer accessible via their handheld or mobile radios.

The resulting a loss of coverage in certain areas can be at best a nuisance, at worse a critical liability.

The obvious solutions would appear to be to do one of the following:

- add more repeaters into the network or
- to increase the transmit power at existing sites

The answer, however, is often not that simple:

Adding more repeaters requires additional frequency pairs, which are often difficult to obtain, and burdens users with a more complicated channel plan.

Increasing transmitter power does not guarantee a substantial increase in coverage, while the cost is and impact on equipment footprint at existing sites often high.

Increasing transmitter power at the infrastructure level does not solve the problem of talk-in coverage from mobiles and handhelds, since these are generally at a fixed output power.

Fortunately there are elegant solutions available to address the problem of talk-in and talk-out coverage, while maintaining spectrum efficiency, a seamless user experience and lower power transmission.

“Loss of coverage in certain areas can be at best a nuisance, at worse a critical liability...”



# SOLUTION

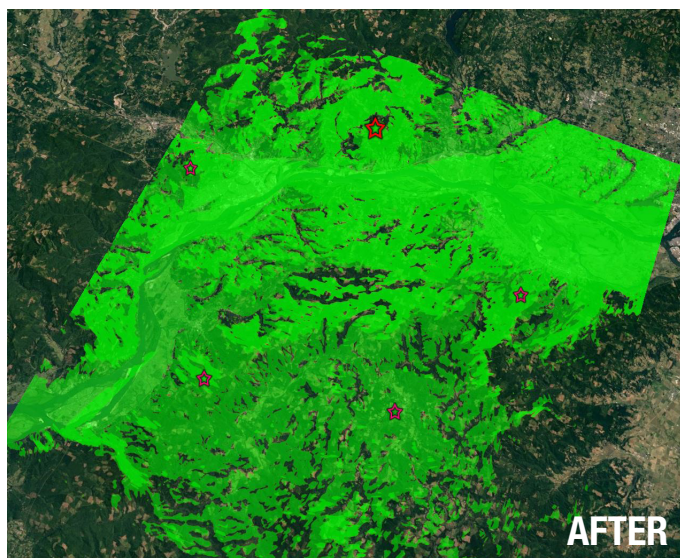
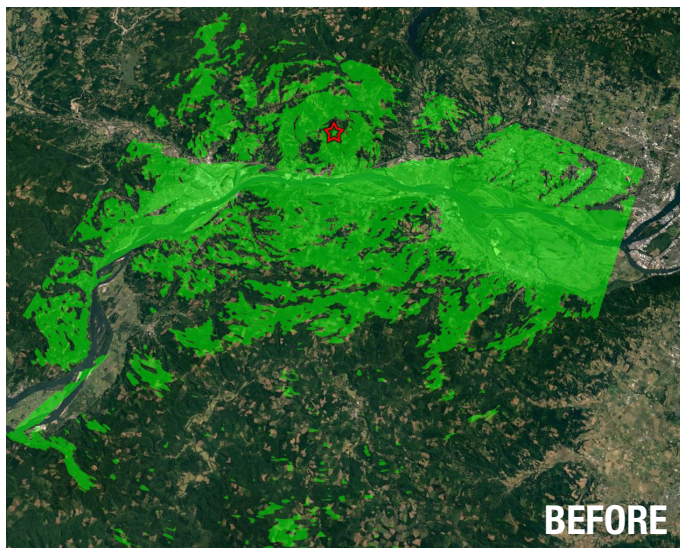
## STRATEGIES FOR MAXIMIZING COVERAGE

The solution to poor coverage in areas of limited frequency availability involves a two-part strategy:

1. Add voted receiver infrastructure to improve talk-in coverage.
2. Add simulcast transmitter infrastructure to improve talk-out coverage.

Depending on whether there are problems with talk-in, talk-out or both, any combination of voting and/or simulcast can be used.

Adding extra sites in strategic areas that provide coverage where there are currently gaps eliminate areas of poor or non-existent coverage. With the voting and/or Simulcast infrastructure in place, users can roam throughout the areas of extended coverage without changing channels or modifying their radio use behavior in any way.



## WHAT IS VOTING

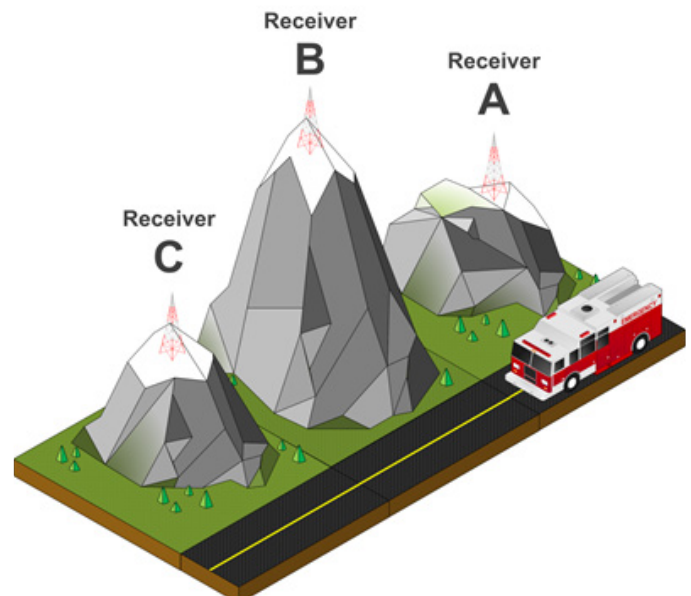
A voting configuration solves the problem of talk-in coverage by having multiple receiver stations all operating on the same frequency deployed at various locations over the area, providing reception coverage everywhere that it may be needed. These receivers all have a backhaul (i.e. microwave, wire or radio) connection to a central device known as a voting controller.

When a transmission from the user occurs, the voting controller 'listens' to the demodulated audio from each of receivers in the system and determines which one has the strongest signal. It does this by measuring the amount of noise in the audio using statistical methods to calculate a signal's Received Signal Strength Index (RSSI) or Signal-to-Noise Ratio (SNR) for analog communications, or Bit Error Rate (BER) for digital communications.

Once the voting controller picks (i.e. votes for) the strongest received signal, it passes this signal onto the intended location via a backhaul connection or radio re-transmission.

To better understand the concept of voting, imagine the following scenario involving a vehicle equipped with a mobile radio traveling down a highway surrounded by mountains.

**“Address the problem of talk-in and talk-out coverage, while maintaining spectrum efficiency, a seamless user experience and lower power transmission.”**

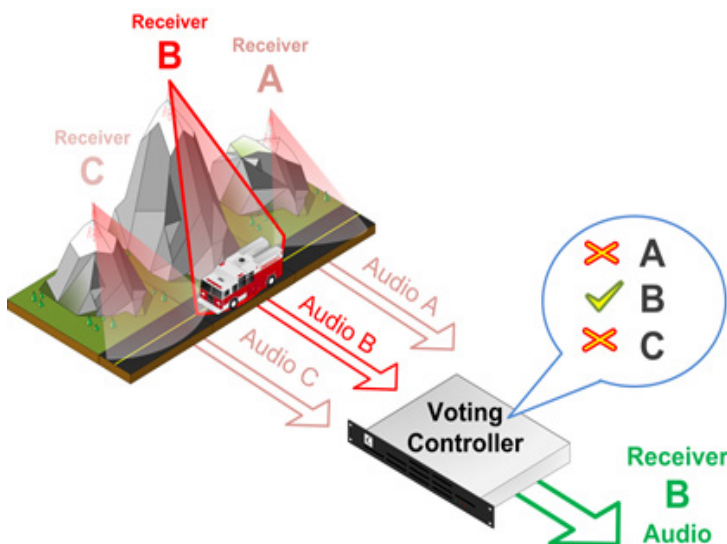
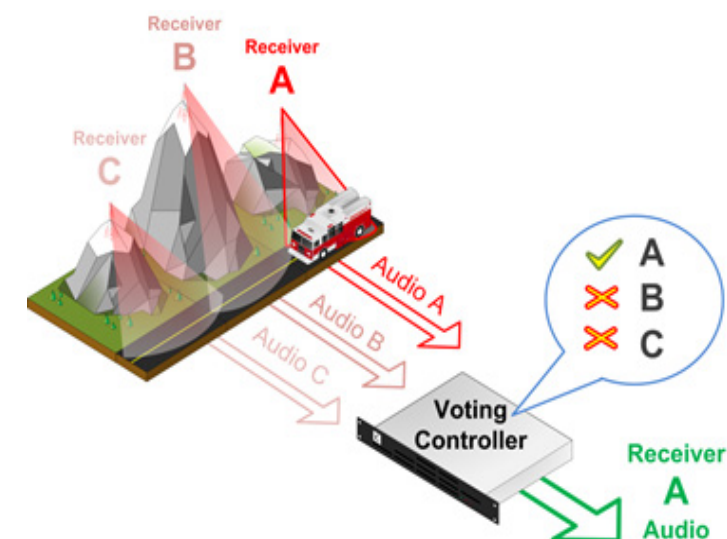


When the driver of the vehicle is driving near the beginning of the highway and tries to transmit, the signal is most strongly picked up by the nearby receiver A, poorly by the distant receiver B and hardly at all by the obscured receiver C. In this case, the voting controller chooses to ignore the audio received by receivers B and C, since the signal from receiver A has the least amount of noise and is therefore the strongest.

As the car moves down the highway, the signal at receiver B becomes the strongest, thus the voting controller ignores the audio from receivers A and C.

This functionality would be repeated as the vehicle moves into the range of receiver C, and so on.

The audio from the voting controller is then generally passed on for re-transmission; either to a central broadcast transmit site, multiple transmit sites on different frequencies, or to multiple Simulcast sites operating on the same frequency, as will be discussed in the next section.



## WHAT IS SIMULCAST

A simulcast configuration solves the problem of talk-out coverage by using multiple transmitter stations set to the same transmitting frequency to provide a more complete range of coverage rather than a single centrally located transmitter (Broadcast) or multiple transmitters using multiple frequencies (Multicast). Like in a voting system, the communication is managed by central control equipment that routes the audio signals to the transmitter sites via backhaul connections.

All of the stations transmit or re-transmit the same signal on the same frequency simultaneously. Since the transmitting frequency is the same at each station, a single channel can be used to receive the signal, regardless of which coverage area the mobile/handheld receiver finds itself in, meaning that the user does not have to change channels and frequency allocation requirements are kept to a minimum.

While this seems like a simple concept, the technical challenges involved in a Simulcast system can be significant, because when the same signal is transmitted from multiple points, there will likely be areas of overlap where a signal from multiple transmitters will be received at once. This is problematic because two signals of the same frequency received at a single point will add together; if they are in-phase the addition will make the signal stronger, if they are out-of-phase, the signal will be diminished or distorted. Since the transmitters vary in distance to a receiver finding itself in this overlap area, the signals will arrive at different times causing the latter destructive interference.

If one signal is much stronger than the others, the effect isn't pronounced because the receiver can inherently discern the stronger signal (known as capture effect), however if one or more signals are similar in strength the distortion can be significant.

To overcome the technical challenges posed by overlap in a simulcast system, there are a number of solutions that are employed in a Simulcast system design.

## SITE PLACEMENT AND PROPER DESIGN

The easiest way to avoid the problems that arise when areas of transmission overlap is to have an engineer analyze coverage and carefully design the radio system so that coverage is maximized and overlap is minimized. Varying the output power of the transmitters can also provide some control over overlap areas; this approach is constrained by equipment and regulatory limitations on power, and its effectiveness is a point of contention among experts.

## AUDIO PHASE DELAY

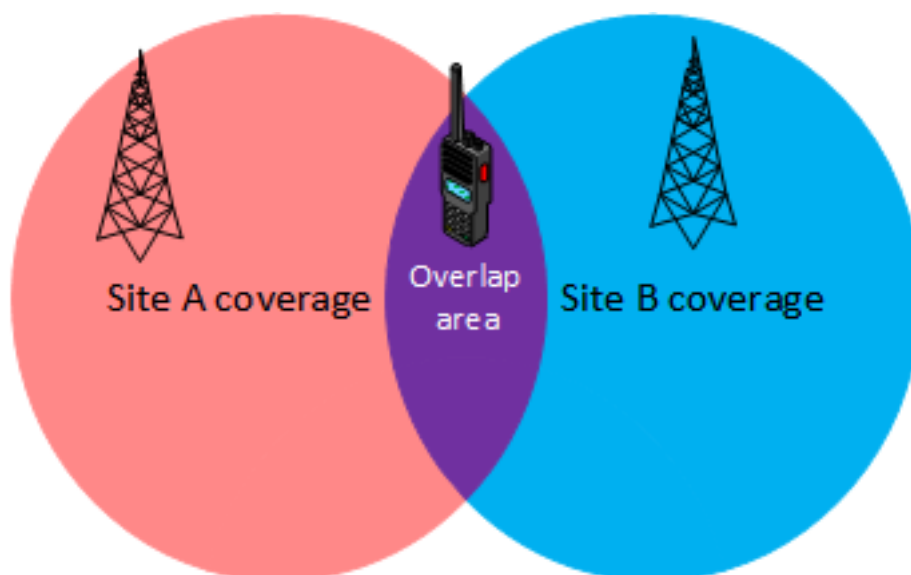
Introducing a calculated time delay into the transmissions can ensure that interference is not destructive at points of interest/heavy use that fall into areas of overlap. This is achieved by the addition of precise timing equipment to each transmitter station; often, this is a GPS receiver that receives a very high-accuracy timing signal produced and transmitted by Geosynchronous Positioning System (GPS) satellites that orbit the earth.

## AMPLITUDE EQUALIZATION

Interference can further be controlled by varying the amplitude of the input audio signal on each of the transmitting stations; in doing this, the received signal is uniform regardless of which station it is received from.

## RF FREQUENCY STABILIZATION

When multiple signals are apparent in the overlap area, destructive interference between RF signals will occur when the signals do not match in phase; the result is an audible “buzz” that can affect the quality of received audio from simply being annoying to the point of incoherence. This effect is mitigated by using transmitter equipment that has a very high frequency stability specification, or by adding equipment that eternally controls or disciplines the transmitter oscillator to produce a very stable frequency. Once again, a GPS receiver is used to discipline the oscillators in the transmitter equipment to a high-accuracy reference signal.





## THE CODAN SOLUTION

The Codan Voting + Simulcast solution is based on the robust, modular MT-4E series of LMR infrastructure products. By leveraging advancements in IP networking technologies and the APCO™ P25 Standard, we are able to offer an all-IP Voting/Simulcast solution using the MT-4E infrastructure platform that has become a staple in the North American radio communications industry.

Current users of Codan (Daniels Electronics) MT-4E infrastructure can easily incorporate voting and Simulcast into their existing system, allowing the reuse of existing spares and precluding the need for a “fork-lift” replacement of infrastructure. Users of other manufacturer’s equipment can rely on the interoperability provided by Codan’s development around the open APCO™ P25 Standard.

Custom application engineering and live support ensures that the new equipment is installed smoothly and is supported throughout the long life-cycle that has made Codan an industry leader. The result is a complete Voting + Simulcast Solution that is tailored to fit your application.



## ABOUT CODAN COMMUNICATIONS

Codan Communications is a leading international designer and manufacturer of premium communications solutions. We deliver our capability worldwide for the military, defence, humanitarian, peacekeeping, commercial, security and public safety markets.

Our mission is to provide communications solutions that enable our customers to be heard – to ultimately save lives, create security and support peacekeeping worldwide. With almost 60 years in the business, Codan Communications has garnered a reputation for quality, reliability and customer satisfaction, producing innovative and industry-leading technology solutions.

We know that every deployment of a communications solution is different, having deployed our solutions in more than 150 countries. And when lives are on the line, it's critical that each deployment is right and that every stakeholder is heard. That's why it's important to truly understand your situation, your infrastructure, your environment and your stakeholders.

At Codan Communications, that's what we're best at. Not fitting your situation into our products, but really understanding what's at stake. So whenever you work with Codan, you know that right from the start you'll be heard.

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