

WHITE PAPER:

# Comparing and Contrasting Analog and Digital Two-Way Radios

## Executive Summary

Analog two-way radios have been used for business applications as far back as 1933, and they were originally placed into service by the U.S. military 20 years before then. Today, two-way radio technology is so widespread, it has become nearly as common as a household appliance. This time-saving communications tool has now become a favorite choice for commercial, industrial, military, and even personal use.

The history of the two-way radio is long and well defined, but the question still stands as to whether the analog radio is strong enough to offset the advantages of the feature-rich digital devices that are growing in popularity.

Because the analog two-way radio has been around for as long as it has, the ceiling of innovation has been reached. But with the emergence of the digital platform, a new era of radio technology has now arrived. From varying price points and the distinction in sound quality, both technologies have significant differences beyond just their signal types. And even though it offers numerous advantages, the digital radio will not completely replace its analog sibling. The traditional analog radio still has the upper hand for many applications.

Decide for yourself as you discover where the two-way radio has been, its possibilities for the future, and whether analog or digital technology best suits your needs.

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## Understanding the Past, Present, and Future

Since the initial development of wireless communications, analog has been the primary technology platform for two-way radios. The majority of radio systems today still run in analog mode. But as digital technology progresses and transforms—for example, as it has with music and television—it is beginning to play a major role in professional two-way radio communications.

Because the analog radio system has been around for so long, the limit of innovations has virtually been met. However, with the digital platform, new levels of productivity and performance can be explored. Greater calling capacity, enhanced voice clarity, higher-quality coverage, and the availability of software applications are only a few examples of how the advent of digital two-way radio technology will make a difference in the coming years.

## Defining the Differences

A traditional two-way radio with an analog signal is not feature rich on its own. Standard analog radios usually offer push-to-talk, scanning, simple group conversations (one-to-many), and limited encryption capabilities.

But the analog two-way radio has a strong history. It has been around long enough for engineers to find ways to enhance its functionality with a number of useful features. Chances are, if you want your analog radio to perform a certain task, someone else has already found a way to make it happen. This could be considered a negative issue for the new digital two-way radios, as they have not been in use long enough for the proper “tinkering time.” However, this will undoubtedly change as the popularity of digital communications devices grows. For example, remember when cellular phones were first introduced? They were all analog in the early days. But as more and more people became dependent on their cell phones, digital devices were introduced, and the rest, as they say, is history.

Two-way radios with a digital signal offer all of the same features as analog radios—and more. However, the features of digital radios offered by the leading manufacturers don’t differ all that much. Some radios promise affordable components, ease of repair, and ease of use, while other manufacturers offer features such as enhanced text messaging, IP connectivity, and ruggedized design for harsh environments. All digital radios enable a 30-50 percent longer battery life than traditional analog radios, because the digital radio transmitter is not constantly on.

*“Because analog radios have proven themselves over time, they won’t leave the scene anytime soon. But the digital platform offers a unique opportunity for innovation. From enhanced calling features to greater performance and productivity, the current advancements in two-way radio technology will have as much impact as the first wireless device did when it was introduced more than a century ago.”*

**Mark Kroh**  
Vice President  
Sales & Service  
Motorola



To determine your best option, you should carefully review each type of radio system available today to decide which is the best fit for your specific needs. For example, in order to leverage wireless spectrum most efficiently, you can use simple, local peer-to-peer radio systems for wider coverage.

What exactly is an analog signal and what is a digital signal? Take a look at the similarities and differences between both:

- **Analog:** Analog signals have a sinusoidal, or continuous, value. Today's analog systems use frequency modulation (FM). The frequency modulation produces a continuous wave with the voice signal. By integrating such a simple system into a single chip, the cost of this radio has dramatically reduced. Analog signals are commonly used in many systems today, but the uses for analog signals are declining with the introduction of the more reliable digital signal.
- **Digital:** Digital signals are represented by binary numbers: 1 or 0. The 1 and 0 values can correspond to different discrete voltage values. Any signal that doesn't quite fit into the scheme is rounded off. By using a binary signal, error correction-embedded signaling and control bits are possible in each packet transmitted. A packet contains an assembly of bits. The software contains an algorithm that understands the differences between voice and background noise, and in return, cancels

### Analog vs. Digital

*The illustration above depicts how a two-way radio signal degrades as the radio moves further and further away from the transmission point. A typical analog signal will continuously deteriorate as it advances toward its maximum range, until only white noise is heard. In contrast, a typical digital signal will stay strong and clear until it reaches its maximum range, at which point it will completely die.*

the unwanted background noise and unwanted audio. The wireless digital signal provides the same levels of reliability and control as a wired digital signal.

### **Reviewing the Advantages and Disadvantages**

A common misconception about two-way radios is that it is a fading technology. With benefits such as instant private communication, one-time purchase incentives, one-to-one or one-to-many call options, durability, and flexibility of communication in almost any environment, the two-way radio is still a very popular choice for communications in virtually all markets. These include a variety of business, commercial, and industrial applications, as well as more high-risk environments, such as public safety, military, security, and government.

Both digital and analog technologies offer many of the same popular features, but their differences set them very far apart. Decide for yourself which technology is the best fit for your situation as we discuss the advantages and disadvantages to both systems.

The advantages of analog two-way systems include:

- Analog systems use the natural voice, which is a feature preferred by many users.
- Because analog has been around longer, the number of products and accessories offered is much larger and provides for more options than does digital.
- Analog systems make good use of bandwidth and are well understood by the general public.

The disadvantages of analog two-way systems include:

- Typically, only one two-way conversation can occur at a time on each channel.
- Analog systems require hardware receivers and transmitters that are designed to fit the particular transmission. Analog devices can be upgraded with features but not technology.
- No software-driven business applications are available for analog radios.

The advantages of digital two-way systems include:

- More simultaneous talking paths are possible, and information such as unit ID, status buttons, and enhanced text messages can be embedded into a single digital radio channel.
- Bandwidth consumption is reduced.

*“Today’s digital technology can be configured to offer advantages such as better noise reduction, greater voice quality, more efficiency, and integration with legacy systems. Moreover, many of the newer radios make better use of available spectrum via analog logic trunked radio capability. Operators can place three to four times the previous number of users on a system, increasing the flexibility of the user’s currently licensed spectrum.”*

**Chris Lougee**  
Vice President  
Icom America

- Digital signals can be handled by standardized antenna systems and existing infrastructure equipment.
- The digital conversion of a user's voice reduces external background noises. And the digital technology platform is ideal for reducing environmental noise levels during transmission, such as inside noisy manufacturing and processing plants or outside in windy conditions.
- A number of new software applications are available for use with the digital platform.
- The digital platform provides a migration path that allows for simultaneous use of digital and analog radios.

The disadvantages of digital two-way systems include:

- Digital radios, like all new digital technology, can be somewhat more expensive.
- Due to the additional features and enhanced functionality, a learning curve exists for first-time users.
- Digital signals are intolerant to radio frequency (RF) noises, and in the presence of too much RF noise, the signal can result in an error.

In addition to the various advantages and disadvantages listed above, the sound quality for both analog and digital is very high within their peak performance areas. An analog radio will produce a clear signal—accompanied by the standard white noise—within its peak performance range. Once the signal moves further and further away from the transmit (center) point, the audio will slowly fade out until it is unrecognizable. By contrast, the digital signal will stay strong and clear to the limits of coverage.

### **The Bottom Line**

Deciding which signal is better or worse is a dependent variable, reliant on the factors surrounding the environment and usage of the technology. A digital system requires components that are generally more expensive, but moderate prices often accompany lower-end digital systems. And as digital technology becomes more popular, the prices will become even more affordable. Also, a digital system can more easily be integrated into the rapidly expanding wireless IP network world.

Analog is best suited for situations that have no use for the enhanced features offered by digital technology. In reality, many two-way radio users need only a simple, reliable method of communication. Analog radios are still the most popular choice for those who would not benefit from feature-rich or software-

*“The advent of the digital two-way radio is having a dramatic impact on users of wireless technology. It has opened up a new world of possibilities for significant, innovative enhancements in communication.”*

**Mark Crosby**  
President & CEO  
Enterprise Wireless Alliance

*“Some digital two-way radio systems can operate in both analog and digital modes and are easily integrated with legacy communications infrastructures. Customers using these systems can improve basic functionality, add new features, and increase capacity at their own pace, while leveraging their prior investments in traditional analog radios, which will remain a viable alternative for many years.”*

**Holt Hackney**  
Managing Editor  
Today's Wireless World

enhanced equipment. For example, someone in the retail industry would probably not have a need for enhanced text messaging or GPS services, nor would the typical school teacher.

Analog two-way radios prove themselves daily, in countless installations. Unfortunately, analog technology has reached its limits of innovation, and a new platform is now required to help achieve new levels of performance and efficiency. A user looking for an improved analog radio will still find the same functions—plus much more—with the improving digital technology.

Although it may look like the world is turning digital, the analog radio will most likely continue to be the prominent choice for most businesses and organizations, at least for the next few years. The general cost of the digital two-way radio systems will deter some potential customers who do not see the need for the digitally enhanced feature sets. But as the digital platform becomes more cost effective and common, most users will eventually replace their analog radios with their digital counterparts. Just as we have seen network television morph into cable and satellite TV and old, clunky cell phones evolve into today's sleek, e-mail seeking smartphones, our society is quickly becoming accustomed to the ever-evolving digital world.

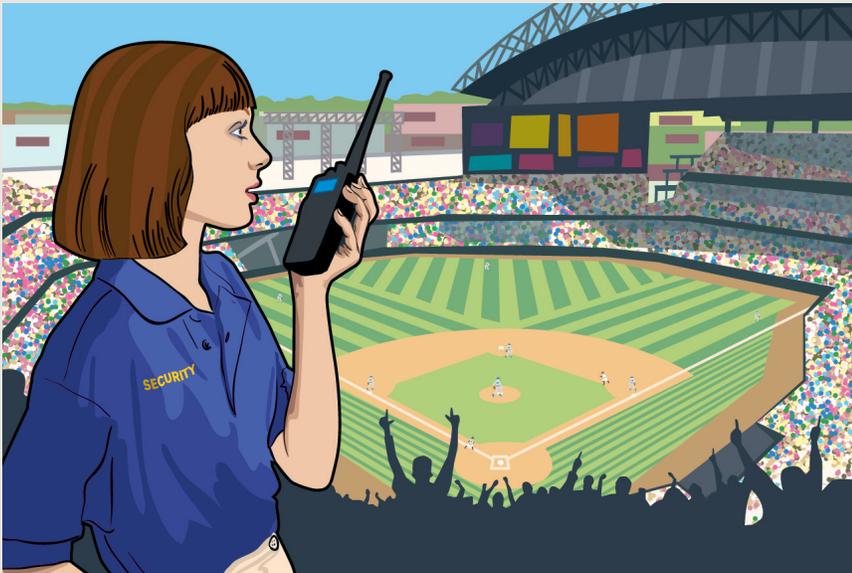
*“Brisk developments in radio communications have ushered in an era of advanced, tactical radios capable of real-time transfer of voice, data, images, and video, with data rates higher than ever before. These sophisticated gadgets further possess software-defined modules that aid interoperability and increase connectivity.”*

**Advances in Radio Communications for Aerospace and Defense**  
Frost & Sullivan

For more information about comparing and contrasting analog and digital two-way radios, please contact BearCom at **800.527.1670** or **Solutions@BearCom.com**.

SUCCESS STORY:

## Seattle Mariners and Safeco Field



### The Customer

In the spring of 1977, Major League Baseball returned to Washington State when the Seattle Mariners played the California Angels in the Kingdome. More than 22 years later, the Mariners began a new chapter in club history by opening its new open-air ballpark, Safeco Field. Sweeping views of Seattle's dramatic downtown skyline and breathtaking sunsets over Puget Sound—combined with excellent views of game action from all angles—give the fans at Safeco Field an experience unequalled in all of Major League Baseball.

### The Challenge

With a seating capacity of nearly 50,000 patrons in a stadium area over one million gross square feet, Safeco Field needed a stable communications system to facilitate not only the widespread area and large crowds, but also the dozens of departments that run behind the scenes. The current fleet of 250 analog two-way radios had been in use for more than nine years. The radios were operated year round for games, stadium tours, guest services, engineering, maintenance, and housekeeping. Additional channels were desired, and the antennas on the repeaters were not getting the widespread coverage the staff needed. Only three repeaters had been installed, and that compounded the problem.

*"Helping to lead the way into the digital world is a very exciting opportunity for BearCom and our many customers. For example, the MOTOTRBO platform from Motorola offers users the ability to continue operating in analog mode until the time is right for the transition to digital technology. And as the digital platform becomes more popular and affordable, BearCom will continue to provide our customers with the right custom-tailored solutions, whether analog or digital, that best fit their needs—for today and well into the future."*

**Jerry Denham**  
President & CEO  
BearCom



### The Solution

Continuing its decade-long relationship, the Mariners brought BearCom in for advice. After a detailed analysis of the stadium and the needs of the management and staff, BearCom recommended upgrading the communications infrastructure using the Motorola MOTOTRBO solution, consisting of six digital repeaters, two repeater antennas, and a multi-coupler/combiner. For the immediate future, the MOTOTRBO repeaters will run in analog mode so they can interface with the existing fleet of analog radios, but a transition to digital mode is anticipated in the near future.

### The Results

During a recent out-of-town game, BearCom helped the Mariners test two MOTOTRBO portable radios. When asked for his thoughts about the new digital two-way system and BearCom's role in helping to implement it, the Seattle Mariners' Security Supervisor, Erik Hackmann, said, "I really don't want to work with anyone other than the people at BearCom. They know the equipment and the level of service we require, and they always deliver the solutions we need."

*"I really don't want to work with anyone other than the people at BearCom. They know the equipment and level of service we require, and they always deliver the solutions we need."*

**Erik Hackmann**  
Security Supervisor  
Seattle Mariners



**BearCom provides a broad line of high-performance wireless communications products, services, and complete mobility solutions. Founded in 1981, BearCom is America's only nationwide dealer of wireless equipment, serves customers from 26 branch offices located throughout the U.S., has several affiliated offices around the world, and employs approximately 400 people. For more information, visit [www.BearCom.com](http://www.BearCom.com).**

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