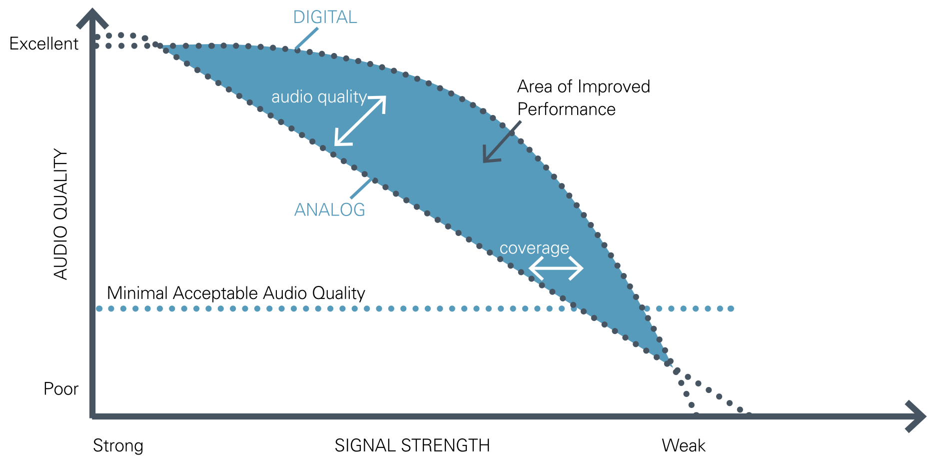
Need: Improved Fundamentals, Including Voice Quality, Privacy, Battery Life, and Additional Features

Professional two-way radio users depend on clear, unbroken, reliable voice communications. A missed call, user error, garbled message, or dead battery can mean lowered productivity, wasted time and money, unsatisfied customers, and lost business.

Due to the inherent nature of RF physics, analog radio can suffer from several limitations that affect the range and clarity of voice. In an analog system, everything in the environment that disrupts or interferes with the signal itself directly impinges on the voice quality at the receiving end. Although it's possible to boost and retransmit a degraded signal, there's no way to reconstitute the original voice quality. The most common result of this degradation is an increase in static and artifacts that makes the signal increasingly unintelligible as the user approaches the margins of the radio's effective range.



Digital voice retains better quality than analog as signal strength decreases.

Signal strength falls off exponentially as the distance from the transmitter increases, following the inverse square law. At the same time, the background RF "noise" level remains constant, so the signal-to-noise ratio declines by a factor of four with each doubling of the distance between transmitter and receiver. Environmental factors — such as line-of-sight obstacles and RF interference — can also severely degrade performance, further shortening the effective range at which analog radio performs with acceptable voice quality.

The only way to retain analog voice quality at the edge of the radio's effective range is to boost signal strength. But this quickly becomes impractical due to the added battery size and drain, the risk of cross-talk and other interference, and regulations governing radio power and spectrum use in various applications. Moreover, techniques that are applied to the analog transmission — such as compounding or voice scrambling for security — alter the quality of the voice signal itself, coloring the sound and adding artifacts that can make it difficult to understand what's being said.

Digital systems, by contrast, incorporate built-in error-correction techniques that reconstitute the voice at nearly its original fidelity throughout most of the RF coverage area.

Depending on the device design, digital systems can also improve field operations through longer battery life and additional features. For example, TDMA-based systems that provide 6.25 kHz equivalency in a 12.5 kHz channel use only half their transmit time to carry a single half-duplex conversation. Since transmitting RF signals is very power-intensive, this means digital systems place less drain on the battery than their analog counterparts. In fact, conversation-for-conversation, TDMA-based digital radios function about 40 percent longer on a battery charge than analog systems.

Moreover, the two-for-one channel capacity of a TDMA-based system can be used to carry a second conversation, to provide dispatch data in parallel with verbal instructions, to enable enhanced call-control and emergency pre-emption, and for a variety of other existing and future applications. In the same way that digital technology is creating new possibilities for wired and cellular communications, digital two-way radio gives mobile workgroups flexible access to more kinds of information — so they can work faster and more effectively than ever before.

Digital radio offers:

Enhanced voice communications over a greater range. While digital radio signals are subject to the same RF physics as analog, a degraded transmission can still deliver the digital content to its destination intact. Even though signal strength drops off exponentially — just as it does with analog radio — digital error-correction technology can reconstitute the voice with virtually no loss over a far greater area.

Static and noise rejection. Analog signals are often distorted in ways that produce audible static. This can be mildly annoying, or it can become progressively worse until the conversation is almost impossible to understand. By contrast, digital receivers simply reject anything they interpret as an error. Although a "dirty" signal can produce artifacts on a digital receiver — such as a brief dropout or mechanical-sounding burst of noise — they never result in the persistent static that can plague analog systems in difficult environments. If the receiver can understand the digital voice signal, it can decode it and reproduce the voice clearly. Moreover, some digital systems incorporate background noise suppression at the transmitter — so, for example, background crowd or traffic noise is never transmitted, and therefore never heard at the receiver.

Privacy without loss of quality. Digital systems can provide voice and privacy without requiring extra hardware or altering the quality of the transmission on the receiving end. Moreover, analog systems typically send information at the beginning of a call that is used by the receiver to descramble the voice — which means that someone who joins the call late doesn't get the descrambling information and can't understand the call. Digital systems, in contrast, repeat the descrambling information several times per second so that late entries can join a private call in progress. And digital systems allow you to easily separate users into private workgroups — each with its own encryption key — so one group isn't distracted by the operations of another.

Longer battery life. Because TDMA-based digital systems divide power-intensive transmissions into two independent time slots, each individual transmission uses only half the battery power of an analog system transmitting at the same wattage. Since transmitting is the most energy-intensive operation, digital two-way radios can typically function 40 percent longer between recharges compared to analog radios.

Flexibility. Digital radios can be designed to provide additional features in addition to two-way voice. For example, the second time slot in a two-slot TDMA-based system can be used for a second call, dispatch data, enhanced call control, emergency pre-emption, reverse-channel signaling, or other functions. Digital systems can be flexibly configured to meet the specific needs of each mobile enterprise, enhancing productivity and responsiveness in the field.

DIGITAL VOCODER

What is a digital vocoder?

- A digital vocoder reduces a complex speech signal into a small number of parameters.
- Rather than transmitting the analog speech in its entirety, which requires a relatively large amount of bandwidth, a digital radio transmits only the important parameters. Because these parameters can be represented by small number of digital bits they require less bandwidth.

The vocoding process

- The vocoding process begins by dividing the speech into short segments, typically 20 to 30 milliseconds in length. Each segment of speech is analyzed and the important parameters such as pitch, level, frequency response are extracted. These parameters are then encoded using a small number of digital bits.
- Before transmission, the encoded speech parameters are also protected by the addition of Forward Error Correction (FEC) bits.
- During reception, the FEC is used to correct bit errors that may have occurred due to RF channel impairments. While the FEC cannot correct all errors that may occur, it can completely correct a reasonable number of bit errors, providing minimal audio degradation through much of the coverage area.