

## *Why Some Digital Trunked Radio Systems Are Perceived As Failures*

Over the past five years, I've had the opportunity to study many digital trunked radio systems used for public-safety communication. Though I am sure there are some success stories, my interest has focused on the systems that have problems or do not meet the expectations of their users. A very high percentage of the Nation's digital trunked radio systems are in this category.

There is a clear pattern of problems with digital trunked radio systems that are endemic to the nature of the technology.

- Vocoder characteristics (Poor background noise rejection)
- Frequent dropouts and garbled audio caused by multipath interference
- Software defects
- Long key-up delay and high latency
- Unacceptably low battery life for handheld radios
- Poor system administration practices

An equally high percentage of problems are attributable to poor judgment in the initial system design and configuration.

Radio systems may be optimized at design time for high capacity, wide area service, or good in-building coverage, but they are almost never optimized for all three because of the extraordinarily high cost. There is a trend to assume that optimization must favor high capacity and wide area service even when there is no compelling business case to do so. Many contemporary digital public-safety radio systems are deemed inadequate by police and fire users because first-responders in metropolitan and suburban areas expect (and truly need) excellent in-building coverage, even though their digital trunked systems were not designed to provide it. Specifications for good in-building coverage are almost always compromised in favor of high capacity and wide area service because of economics. This has resulted in numerous communities not providing their police officers and firefighters with adequate communications equipment which is essential to employee safety and welfare.

The perceived need for wide-area radio interoperability fosters the justification to compromise in-building coverage. There is rarely sufficient money to do both. In reality, police officers and firefighters in metropolitan and suburban areas rarely need to communicate by radio over long distances, and rarely need to roam very far out of their jurisdiction. Reliable communication at the scene of critical incidents is essential, and rarely extends beyond a few square block area. Life safety of first responders is frequently dependent on effective radio communication on the fireground and in police tactical situations. Why has the emphasis in radio system design shifted away from constructing systems that provide this level of service?

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In most of the cases I've studied, the police and fire executives who were involved in the system procurement honestly thought they would be getting a radio system that provided excellent in-building coverage and are surprised when it is not the case. Some refuse to believe there is a problem and rely on the excuse that the system is performing in accord with its design specifications.

Signal quality for digital radio systems is often represented as a number between 1 and 5, and referred to as Delivered Audio Quality, or simply as DAQ.

- DAQ 1 Unusable. Speech present but not understandable.
- DAQ 2 Speech understandable with considerable effort. Requires frequent repetition due to noise/distortion.
- DAQ 3 Speech understandable with slight effort. Requires occasional repetition due to noise/distortion.
- DAQ 3.4 Speech understandable without repetition. Some noise/distortion present.
- DAQ 4 Speech easily understood. Occasional noise/distortion present.
- DAQ 5 Speech easily understood. No noise/distortion present.

The most common coverage specification I've seen for digital trunked radio systems requires a minimum DAQ of 3.4. 98% of the time, over 95% of the defined coverage area. This is a very weak specification that will fall short of the expectations of almost all first responders. This could be interpreted to mean that it is acceptable for 2 minutes out of every 100 minutes of radio traffic to be unintelligible. Or it could mean that it is acceptable to have an unintelligible signal in 5 square city blocks out of every 100 square city blocks. Such a coverage specification is woefully inadequate.

For comparison, the generally accepted expectation for the municipal law enforcement radio systems in San Mateo County, California is for a 100% full-quieting analog signal (equivalent to DAQ 5) to and from a mobile radio 100% of the time when the vehicle is parked or in motion on a city street within its jurisdiction. Nothing less is acceptable. The expectation for portable radio coverage inside residential buildings and when above grade is for easily understood communication in both directions at least 99% of the time. I believe this is typical of what most metropolitan and suburban police officers and firefighters expect and need. Perhaps coverage specifications for digital trunked radio systems should be expressed in terms that police and fire officials can truly understand.

Why is it that digital trunked radio systems are rarely held to the same or higher standard of performance? Perhaps it is because the systems would be too expensive to afford and too complex to reliably maintain. Coverage specifications must be marginal in order to keep the cost low enough to initially sell the system. Of course, consultants and manufacturers will always be available to sell additional infrastructure to improve coverage.