Will my marginal ALERT sites come in better if I upgrade to ALERT2™?

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Will my marginal remote ALERT sites come in better or worse with ALERT2? Great question! The early experiences of agencies implementing ALERT2 suggest it is better. Why is that? With a little research, here are the best answers I could find.

ALERT2 uses several radio transmission and data encoding techniques also used by cellular and deep space communications systems. These techniques reduce data transmission errors, which results in more good messages received.

Three things can cause errors in data transmissions: random noise, burst noise, and collisions with other messages.

First, let's start with some bad news; faster is not necessarily better. ALERT transmits at 300 bits per second while ALERT2 transmits at 4800 bits per second or 16 times faster. However, assuming the same radio transmission power, every bit sent using ALERT2 has only 1/16th of the energy of each bit sent using ALERT. In radio terminology, it results in a -12 dB signal loss using ALERT2 instead of ALERT.

There's a little more bad news. ALERT2 messages have more bits, which means more opportunities for error.

With the bad news out of the way, things get better. Next, let's look at the modulation scheme or how the ALERT2 radio waves are shaped. ALERT uses Audio Frequency Shift Keying (AFSK) while ALERT2 uses the more advanced Frequency Shift Keying (FSK) with Raised Cosine filtering. That's a mouthful but the bottom line is that ALERT2 modulation gains about +6 dB.

Software improvements create additional gain. It's called coding gain and is the reduction in bit transmission energy required to achieve the same bit error rate. ALERT2 uses two techniques for coding gain: convolutional coding and Reed Solomon encoding (R-S).

Convolutional coding converts each bit of payload data to two bits of data transmission. Convolutional coding helps to correct individual bit errors that are from random errors. The net gain from convolutional coding is about +5.7 dB. Now we're nearly back to where we were with legacy ALERT.

Reed Solomon encoding is a Forward Error Correction algorithm that contains information used to detect and correct errors that usually result from burst noise. Enhancements to R-S performance are achieved by shortening certain message components or blocks; in this case from 255 bytes down to 24 for header blocks and 32 for follow on blocks. The net result is a +11 dB gain. And there's more! If there is an uncorrectable error, the algorithm tells you so you won't use a bad message.

The result from all of these ALERT2 improvements is that ALERT2 has a net +10.7 dB gain. Factoring in the negative side of longer message, the net result of applying the gain from improved bit error rates is that an ALERT2 messages is about twice as likely as an ALERT message to get through without an error.

The previous analysis covers random noise and burst noise, but there is another major difference between ALERT and ALERT2 implementations. Legacy ALERT messages are transmitted using ALOHA, a protocol where each gauge transmits randomly with respect to the others. The most common form of ALERT message failures during storm events are random radio message collisions with other ALERT transmissions. The more ALERT transmissions in a given time period, the more likely data will be lost due to collisions. Unfortunately, that will likely occur during a big event when you need the data the most.

ALERT2 uses Time Division Multiple Access (TDMA) as the preferred network configuration. TDMA design gives each transmitter its own GPS-regulated time slot so that no two sites will transmit at the same time. For ALERT2, this eliminates any data loss due to collisions.

When you put everything together, it is clear why ALERT2 should perform better than ALERT. Looking at interference from either random or burst

noise, ALERT2 messages are twice as likely to arrive unscathed. In addition, the potential for high numbers of ALERT data message collisions is eliminated. ALERT2 TDMA results in zero message collisions.

In theory and now in practice, ALERT2 messages are more likely to arrive error free. Isn't that what we wanted to know in the first place?

ALERT2 is trademarked by the National Hydrologic Warning Council.

References:

ALERT2 TWG (2012), ALERT2 AirLink Layer Specification Version 1.1, National Hydrologic Warning Council ALERT2 Technical Working Group Public Interest Documents.

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My sincere apologies for any errors or omissions in the above article. JRL.