More Distance with Error Correction

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IMPROVING RADIO CHANNEL PERFORMANCE IS A CHALLENGE that concerns every radio-system designer and user. In particular, wireless data systems can realize a significant radio channel performance improvement through the application of error control techniques. In a time when radio channel bandwidth and transmitter power are being reduced, improved receiver sensitivity through the introduction of powerful error correction methods is mandatory.

Receiver Sensitivity

Receiver sensitivity is normally the minimum received signal required to produce a specified output signal having a specific signal-to-noise (S/N) ratio times the mean noise power. Receiver sensitivity determines the minimum detectable signal and is an important element in any link design. As the level of the receiver noise floor increases, the sensitivity degrades and causes a loss of radio coverage. In fact, it is possible to have a noise floor increase to such an extent as to deliver diminishing returns on improved receiver sensitivity. This is particularly true within the unlicensed radio bands.

One of the largest detriments to system performance is interference. For example, in order to double the coverage distance in a typical line of sight or telemetry system requires an increase in receiver sensitivity of 6dB. Unfortunately, the price you normally pay for improved sensitivity is increased susceptibility to noise.

A significant advantage in using error correction to improve receiver sensitivity is that no increase in noise susceptibility is realized. Error correction improves receiver sensitivity by directly reducing bit errors within the received data message attributed to noise. This allows a receiver to operate closer to the noise floor without the usual drawbacks of increasing sensitivity.

Error Control Techniques

*** Cyclic Redundancy Check**	(C R C) Error Detection
*** Forward Error Correction**	(F E C) Error Correction
*** Automatic Message Retry**	(A M R) Message Retry
*** Automatic Repeat Request**	(ARQ) Selective Message Retry
*** Data Interleaving**	Multi-path fade & burst error reduction

Error Correction and Interleaving

Error correction codes are normally designed to correct for random errors distributed uniformly in time. Burst errors tend to punch holes within the data stream and are difficult for most block and convolutional forward error correction schemes to deal with. The effects of burst errors can be reduced by interleaving or redistributing the data over the length of the message before transmission and de-interleaving at the receiver. This re-ordering of the data increases the error correction codes probability of successfully correcting all errors within a data transmission.

Calculating Fade Margin

The link budget is a summation of all the gains and losses in a communications system. The result of the link budget is the transmit power required to present a SNR (Signal to Noise Ratio) at the receiver in order to achieve a target Bit Error Rate (BER). I have a tendency to use statistical probability of a successful message for describing radio channel reliability, as it relates more directly to a user's application. In the case of Land Mobile Radio, it is sufficient to consider factors such as path loss as a function of frequency, noise from all sources, Tx/Rx antenna gains and cabling/system losses including receiver sensitivity for a given measurement bandwidth.

Figure 1 shows a simple method for calculating fade margin in a mobile or point to point telemetry data system. This considers the use of a 5 Watt transmitter over a 10 mile range at 460 MHz. We were transmitting at 12 kbps within 12.5 kHz channels. The 12db SINAD of the receiver was .28 uv (-118 dBm). We found the 99% data reliability point of the data to be a -116 dBm at .35 uv with error correction enabled and -108 dBm without error correction. RFNeulink's NL6000 radio modems were used and showed an 8-9 db of channel performance improvement with error correction enabled.

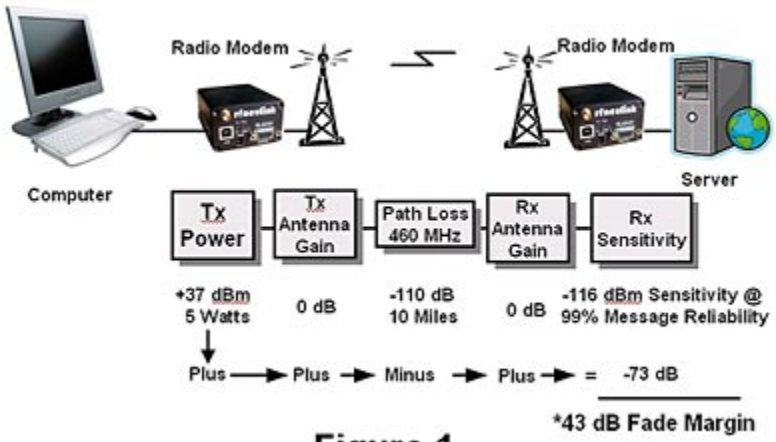

Figure 1

Summary

Through the use of error correction techniques, it is possible to detect and correct errors within a serial data bit stream in real time. The goal of this process is to improve the overall radio channel performance. This performance gain may be realized as increased reliability or extended radio coverage. Error correction is an elegant solution when transmit power is restricted and increased channel performance is required.