Performance Analysis of Truncated ARQ Links in Ka-band[1]

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The future deep space links are migrating towards higher frequency bands such as Ka-band and optical. These links are susceptible to fast and slow fading effects such as atmospheric turbulence, scintillation, antenna mis-pointing, jitter, etc. Some of these link disruptions cannot be effectively mitigated by forward simple error correction coding and/or interleaving. One way to ensure reliable communication is by using Automatic Repeat Request (ARQ) protocol, where the receiver acknowledges to the transmitter whether or not a data unit is successfully received. If a data unit is not successfully received (such as after a pre-set time-out), the transmitter would then re-transmit the lost data unit to the receiver.

In a previous paper, we derived a link analysis method of finding the optimal operating Signal-to-Noise Ratio (SNR) and estimating the latency of an ARQ scheme, assuming no limits on the number of retransmissions. In this paper, we consider the more practical case of a truncated ARQ scheme, where there is a limit on the number of retransmissions. We derive the error probability, the optimal SNR setting, and the latency statistics of the correctly received frames of the truncated ARQ schemes. We discuss the truncated ARQ link analysis principles using the Gaussian assumption for SNR distribution with a large variance to model the fading phenomenon of a Ka-band channel. The results in this paper can be applied in the design of reliable communication systems such as the Consultative Committee for Space Data System (CCSDS) File Transfer Protocol (CFTP) and the Delay Tolerant Network (DTN).

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