



# Retransmission Management

## Highlights

- Effectively manage impulse noise with the latest techniques
- Deliver high-speed, reliable broadband to more customers
- Gain valuable insight into DSL performance on a line-by-line basis

## Mitigating impulse noise

DSL technology has greatly advanced over the years to deliver very high speeds over copper twisted pairs. To continue to leverage existing infrastructure and keep up with consumer demand, however, service providers cannot ignore the practical reality of fluctuating and unpredictable noise experienced by a significant portion of lines. A common interference is so-called “impulse” noise that comes in short bursts, and originates from common electrical and electronic devices and equipment.

The effects of impulse noise on a DSL can include severe transmission errors and even service outages, often leading to a very poor customer experience. This noise is exacerbated by degradation and other types of copper wiring impairment that can occur both inside the consumer’s residence and in the outside plant.

The technique of forward error correction (FEC) combined with interleaving has traditionally protected the DSL transmission from the effects of impulse noise. FEC adds “redundant” data bytes at the transmitter, which help the receiver correct errors occurring on the line. Interleaving changes the ordering of data bytes at the transmitter, and then restores the ordering at the receiver. The combination of these two techniques enables error correction from impulse noise bursts.

Many types of DSL equipment now support a new technique for combating impulse noise called physical layer retransmission. Data are grouped together in retransmission packets, and when such a packet is correctly received, an acknowledgement is sent to the transmitter. For this purpose, a retransmission buffer is used at the transmitter, and a second buffer is used at the receiver. This error recovery approach only generates an overhead when a fault actually occurs on the line.

There are two versions of physical layer retransmission:

- ITU-T recommendation G.998.4 (G.inp) defines requirements for a standards-compliant implementation currently used by many types of DSL equipment.
- PHY-R is the commercial name for a proprietary technique used by infrastructure and consumer-side hardware with DSL chip-sets by Broadcom.

## Choosing the best technique

The impulse noise protection provided by FEC and interleaving comes at the expense of additional transmission latency and a typically small loss of data rate. These “costs” are incurred at all times, even if the line experiences no impulse noise. With retransmission, a DSL experiences throughput degradation only for the duration of the noise bursts. In other words, the cost of protection is paid as needed. For this reason, retransmission is ideal for long noise bursts occurring relatively infrequently.

For a line experiencing very frequent and very brief noise bursts, the best protection is achieved by using FEC and interleaving, configured with a strong enough “code” to correct the frequent errors. Table 1 compares two example noise types, one for which FEC and interleaving is preferred, and one for which retransmission is preferred.

IMPULSE NOISE CHARACTERISTICS	RECOMMENDED PROTECTION SCHEME
Burst duration: Short, 50 microseconds or less Burst interarrival time: Very short, 2 milliseconds or less	FEC and Interleaving
Burst duration: Long, 1 millisecond or more Burst interarrival time: Long, 100 milliseconds or more	Retransmission

**TABLE 1.** Comparison of interference protection techniques.

Retransmission may serve as the preferred approach for mitigating impulse noise on certain lines. In other cases, it may cause adverse effects and should be replaced by traditional error correction methods (see Figure 1). Retransmission is a powerful new tool which needs to be managed dynamically to extract maximum performance and stability out of a DSL network.

## Retransmission management features

The retransmission management capabilities in ASSIA's DSL Express help service providers deliver high-speed reliable broadband connections. DSL Express includes features that take full advantage of the benefits of retransmission:

- Optimization of each individual line and selection between FEC/interleaving and retransmission
- Improved visibility into each line's actual performance when retransmission is used

DSL Express monitors each line individually, and optimizes its configuration to achieve the highest possible performance level. Configuration for retransmission includes many more parameters than configuration for FEC/interleaving. DSL Express optimization selects the best profile to use on each line, which includes a selection of the best protection scheme – retransmission or FEC/interleaving – and also a selection of the configuration parameters for that scheme.

In Figure 1, a DSL's retrain frequency is shown over a period of many days. The line originally used retransmission as the protection scheme, but was experiencing a large number of retrains per day, and occasionally as many as three or more retrains in

a 15-minute interval. The quality of the DSL service was obviously very poor. Retransmission was not the best choice for this line, and DSL Express changed the profile to instead use FEC and interleaving. As a result, the number of retrains was reduced dramatically, and the quality of service for the end customer quickly improved.

DSL Express also includes features for performance monitoring of lines using retransmission. With retransmission, a line experiencing frequent noise bursts can suffer significant throughput degradation. DSL Express collects data from each line to show the actual line throughput. Average line throughput is estimated within 15-minute intervals and for the previous 24 hours, thus giving a detailed view of how physical layer retransmission affects the connection's bandwidth. Metrics such as minimum error-free throughput and seconds with low error-free throughput recorded in 15-minute intervals are also available, in addition to the typical metrics of retrain counts, code violations and error seconds.

With such level of understanding of the performance and control of the retransmission characteristics, DSL Express lets the service provider roll out the most appropriate and successful retransmission technology, and ensure maximum return on investment.

Learn more about mitigating impulse noise in your network. contact ASSIA at

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Rev 030413 P/N MCE2-0111-01-00

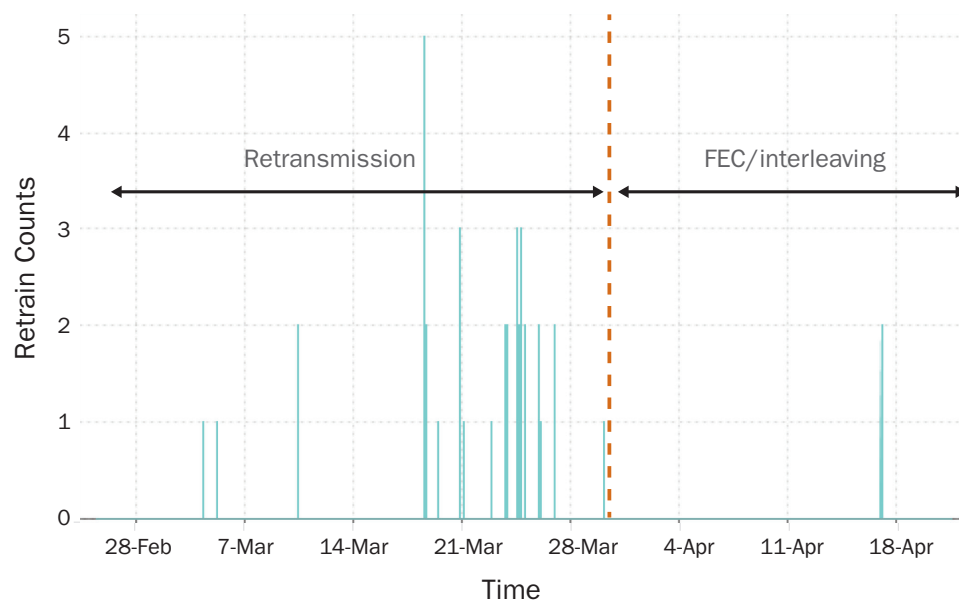


FIGURE 1. DSL optimized by DSL Express