Overview

The MATLAB® Simulink simulation represents a DOCSIS cable modem transmitting with four bonded upstreams at 16-QAM, 2560 kSym/sec (3.2 MHz). The cable modem has been modeled against the DOCSIS 3.0 specification, including:

- Reed Solomon Encoder
- Byte Interleaver
- Scrambler
- Preamble Prepend (QPSK 0/1)
- Grey Symbol Mapper
- Root-Raised Cosine Filter

Each channel has been up-converted to an RF frequency (Frequency Division Multiplexed) for transmission. Figure 1 illustrates the completed model. Much of the complex simulation is masked under the green block called "Cable Modem 4 Channel Transmitter". The FFT on the output of the transmitter provides a "clean" spectrum display of the four signals before any impairment is applied, which can be seen in Figure 2. Notice the four haystack signals (upper left-hand corner) which have roughly 60 dB carrier-to-noise ratio (CNR).

In this example, the signals are then passed through an additive white Gaussian noise (AWGN) source which imparts a CNR of 25 dB. The RX Signal can be seen in Figure 2 (lower left-hand corner) by the substantially lowered CNR of the haystack signals. Further, the impact on the cable modem's 16-QAM constellation diagrams is evident. The symbols in the constellations are randomly distributed, which is expected in the presence of an AWGN noise source.

Finally, Figure 3 shows how the simulation can be used to measure Bit Error Rate (BER). Since this is a simulation, different impairments can be applied and true BER can be measured on the system and correlated to real-world phenomenon. True BER is different than many test instruments which provide a "BkER" which is an implied BER based upon send "ping" messages or data messages and seeing what comes back. Forward Error Correction (FEC) can obscure real issues and not provide a true BER.
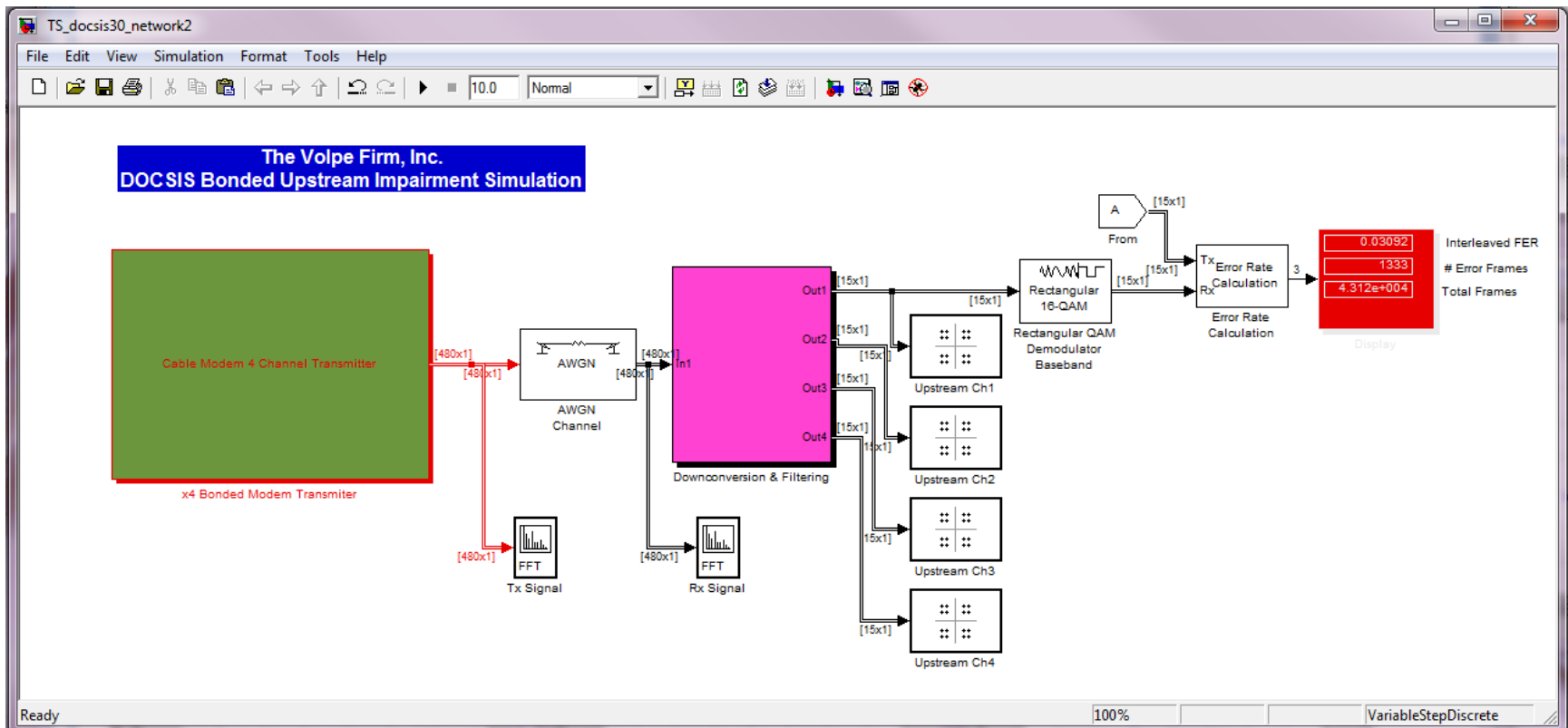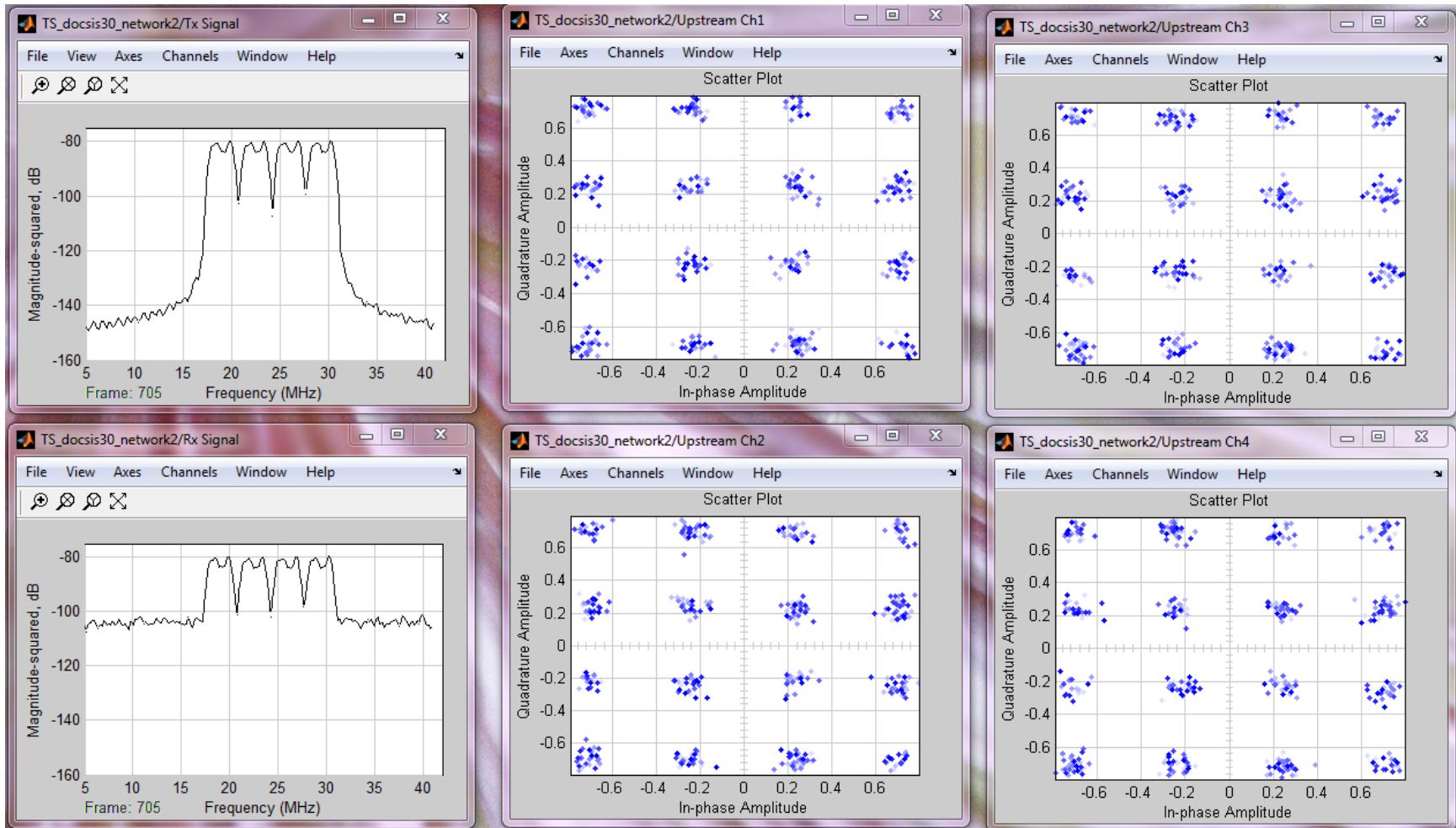
Figure 1. MATLAB Simulink Model

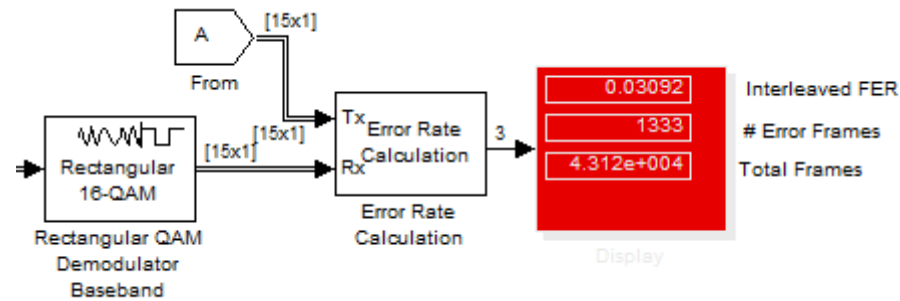Figure 2. MATLAB Simulink Model Output

Figure 3. Impact of Noise on BER

Summary

This represents one of many simulations The Volpe Firm performs on telecommunication systems. Example projects involve DOCSIS, MPEG2, spread-spectrum wireless, and WiFi communication systems, but not limited too. The value of modeling systems early in the design phase, ideally before design begins, enables Marketing and Engineering organizations to make many "what-if" decisions and determine if concepts are feasible. Further, a project which has been thoroughly modeled has been significantly de-risked, eliminating costly errors and reducing time-to-market.

An additional benefit is in the cost savings associated with not having to purchase and maintain MATLAB licensing fees which are substantial. Furthermore, your company will not be required to maintain the resources internally. MATLAB is a specialized field.

The Volpe Firm is not only an expert on MATLAB modeling, but is also an expert within the telecommunications industry. This means we understand the problems you and your customers are faced with and can then simulate them in a numerical modeling environment. Intelligent design!