NECESSARY BANDWIDTH

This exhibit provides information and calculation for the necessary RF bandwidth required to support wideband high data rate experiments for the development of new communication equipment.

The FCC spectrum mask requirements can be met if the transmitted baud rate is 3/4 of the allocated RF bandwidth. Thus, for RF bandwidth of up to 500 MHz the maximum baud rate must be less than 375 mega-baud and for 300 Mhz 225 mega-baud.

The modulation types to be used during experiments and test are QPSK, 8PSK and 16PSK with various code rates and modulation efficiencies.

Spectrum efficiency (η) is the transmitted bit rate (Rb) divided by the RF bandwidth (W),

$$\eta = Rb/W .$$

The relationship between the transmitted bit rate (Rb), baud rate (1/T) and the value of M (modulation states) is provided by the following equation.

$$Rb = (1/T)\log_2 M$$

Thus, the efficiency η, substituting for Rb, with the baud rate being 3/4W, becomes

$$\eta = 3/4 \log_2 M$$

where $\log_2 M$ is 2 for QPSK, 3 for 8PSK, and is 4 for 16QAM modulation. Hence, the spectrum efficiency is 1.5 for QPSK, 2.25 for 8PSK and 3 for 16QAM modulation.

The maximum transmitted bits per second for a 500 MHz RF bandwidth that is within the FCC mask requirements for the various modulations are

Transmtted Bit Rate = ηW
Bit Rate (QPSK) = 1.5(500MHz) = 750 mbps
Bit Rate (8PSK) = 2.5(500MHz) = 1125 mbps
Bit Rate (16QAM) = 3.0(500MHz) = 1500 mbps

The maximum transmitted bits per second for a 300 MHz RF bandwidth that is within the FCC mask requirements for the various modulations are

Transmtted Bit Rate = ηW
Bit Rate (QPSK) = 1.5(300MHz) = 450 mbps
Bit Rate (8PSK) = 2.5(300MHz) = 750 mbps
Bit Rate (16QAM) = 3.0(300MHz) = 900 mbps

Examples of the input data rates to the encoder for various code rates (α) and modulation overhead rates follow.

QPSK
For QPSK with a maximum transmit bit rate of 750 mbps and code rate 0.7 with a ten percent modulation overhead the input data rate to the encoder is

$$DataRate = R\alpha / 1.1 = (750mbps)(0.7) / 1.1 = 477mbps .$$

Thus, with 477mbps QPSK modulation, ten percent modulation overhead and a code rate of 0.7 the FCC spectrum mask for a 500 MHz bandwidth can be met.

16QAM

For 16QAM with a maximum transmit bit rate of 1500 mbps, code rate of 0.5 and overhead of 20 percent the input data rate is

$$DataRate = R\alpha / 1.2 = (1500mbps)(0.5) / 1.2 = 622mbps .$$

Thus, with 633mbps 16 QAM modulation, twenty percent modulation overhead and a code rate of 0.5 the FCC spectrum mask for a 500MHz bandwidth can be met.