**DOCSIS 3.1 Basics**

**OFDM BASICS**
- **Orthogonal Frequency Division Multiplexing**
  - OFDM is a transmission technique that consists of multiplexing multiple individual Sub-carriers with precise frequency spacing.
  - For DOCSIS 3.1, these Sub-carriers are QAM modulated.
  - Orthogonality enables Sub-carriers to be closely spaced together, without interfering with each other.
  - Precise control of Spectrum usage
- **OFDM is used in other transmission technologies:** Wireless LAN, LTE, Digital Broadcasting DAB/DVB, DSL

**OFDM Sub-Carriers**
- Multiple OFDM Sub-carriers can be packed close together, without interfering with each other.
- Sub-carriers have precise frequency spacing
- Much more spectrum control:
  - 25 kHz or 50 kHz Sub-carriers
  - Sub-carriers are grouped to form an OFDM channel that can be from 24 to 192 MHz wide

**MULTIPLE OFDM SUB-CARRIERS**
- OFDM PHY Channel consists of multiplexed Sub-carriers
  - Can be from 24 to 192 MHz wide
  - Sub-carriers are individually configurable
  - 25 kHz or 50 kHz Sub-carriers
  - Modulation order: QAM-256, QAM-512, QAM-1024, QAM-4096
  - Sub-carriers can be On or Off depending on:
    - Spectrum availability: co-existence with legacy services
    - Plant conditions
    - Noise disturbance, such as LTE interference

**LDPC**
- **Low Density Parity Check**
  - Advanced FEC technology which provides performance close to the Shannon Theoretical Limit
  - Uses frequency and time interleaving for robustness against interferers and bursts
  - Greater spectral efficiency

**SPECTRUM and CAPACITY**
- **Backwards compatibility support of DOCSIS 3.0 bonded channels**
- Time and frequency methods are used to support multi-user transmission and for backwards compatibility with 0.0 US channel bonding
- More efficient US bandwidth

**RF TABLE**
- **Parameter**
  - **Value**
  - Pre-EQ
  - Post-EQ
  - Symbol

**SPECTRUM and CAPACITY**
- **Throughput (bps)**
  - **Spectrum (MHz)**
  - **Equivalent # of Channels**
  - **Modulation QAM-64**
  - **QAM-256**
  - **QAM-1024**
  - **QAM-2048**
  - **QAM-4096**

**HIGHER ORDER QAM**
- **DOCSIS 3.1 supports multiple modulation profiles:** base modulation and higher modulation profiles
- **Different profiles can be used depending on customer line quality**
- **Higher quality lines can utilize higher modulation profiles**
- **Dynamic adaptation to line conditions**
  - When an impairment appears, the affected OFDM Sub-carrier can downshift to a lower order modulation to help ensure robust, error-free transmission

- **DOCSIS 3.0 bonded channels**
  - 4 to 8 bonded DOCSIS 3.0 channels
  - 1 to 2+ DOCSIS 3.1 OFDM channels

**OFDM Channel Capacity**
- **Channel Capacity = Spectral Efficiency x Channel Bandwidth**