Motivations for Investigating Multiple MCS for EPoC

Matt Schmitt (CableLabs) &
Jorge Salinger (Comcast)

Setting the Stage

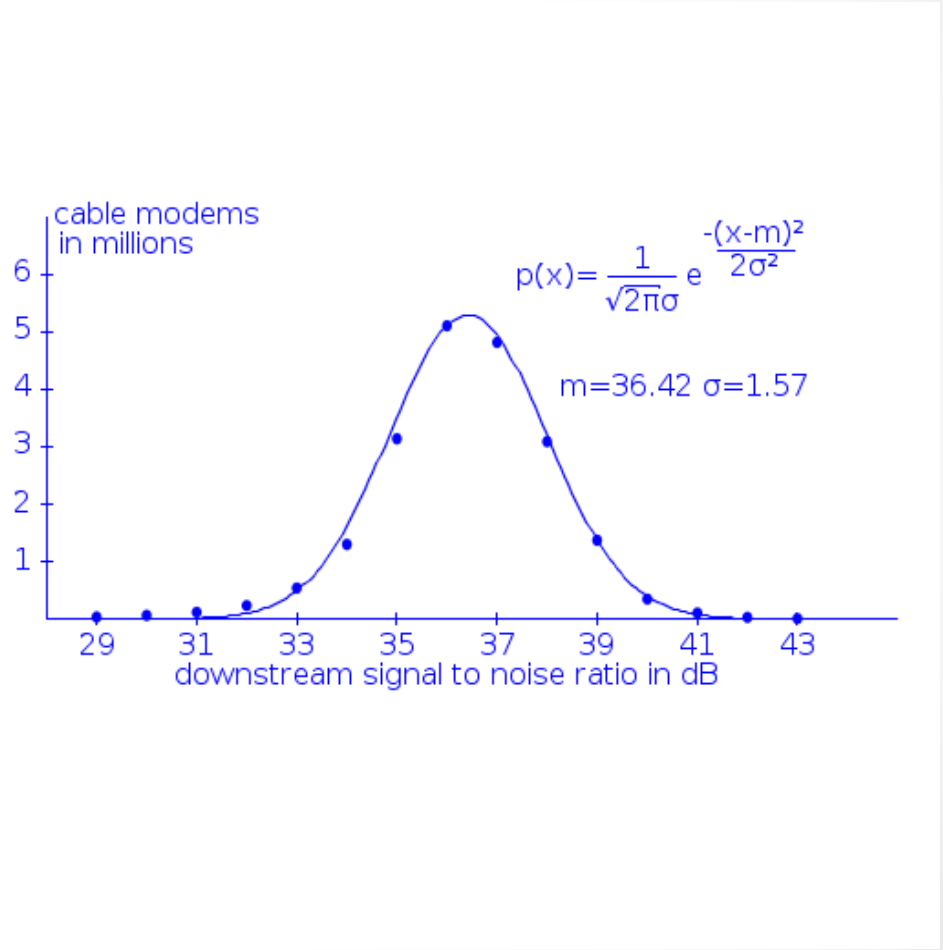
- When I refer to "Multiple MCS", I'm referring to:
  - Defining multiple Modulation and Coding Scheme Profiles for the EPoC downstream, where each profile contains a description of the modulation and coding to use on each OFDM sub-carrier (or group of sub-carriers)
  - CNUs would be assigned to one or more profiles based on their SNR and other capabilities
  - CNUs would only "listen" to their assigned profiles in the downstream, and not decode transmissions that are not using their profile
  - Multiple profiles would be in use at one time, meaning that a given CNU will not listen to all transmissions in the downstream
- There has been a lot of debate about the potential merits of this feature
  - Most debate has centered around the gain due to SNR distribution among a given population of CNUs
  - Several have argued that without more measurements and plant data, we cannot determine the actual gain
  - However, SNR distribution is not the primary motivation for several MSOs

Operational Considerations

- When deploying DOCSIS CMs, MSOs need to leave SNR "margin" or "headroom" during the installation
  - This is to help ensure that even if conditions worsen, the modems will not drop off line
  - For many MSOs, this "SNR margin" is typically on order of 6-10 dB of SNR
    - Some MSOs may cut this margin closer (as low as 3 dB), but most are around the 6-10 dB range
  - For example, using an average of 8 dB, if 27 dB is required for a given SNR, the target SNR for deployment is actually 35 dB (27+8)
- A key feature of "Multiple MCS" is that CNUs can "fall back" to a lower MCS Profile if they encounter difficulties
  - Allows MSOs to operate CNUs with minimal margin (say, 2 dB), because if they encounter issues they can fall back to more robust modulation and not fall off line
  - In the example above, this provides 6 dB of SNR gain, which gains a modulation order (~2 bits/symbol, minus FEC)
- This is the #1 reason why several MSOs would like us to evaluate the complexity impact of Multiple MCS

Example Scenarios

- At 33 dB
  - 8 dB margin allows 1024 QAM with 3/4 LDPC FEC (7.47 bits/s/Hz)
  - 2 dB margin allows 1024 QAM with 9/10 LDPC FEC (8.89 bits/s/Hz) with room to spare
  - 1.42 bits/s/Hz gain (19%)
- At 35 dB
  - 8 dB margin almost allows 1024 QAM with 5/6 LDPC FEC (8.31 bits/s/Hz)
  - 2dB margin allows 4096 QAM with 5/6 LDPC FEC (9.97 bits/s/Hz)
  - 1.66 bits/s/Hz gain (20%)
- At 37 dB
  - 8 dB margin almost allows 1024 QAM with 9/10 LDPC FEC (8.89 bits/s/Hz)
  - 2 dB margin allows 4096 QAM with 9/10 LDPC FEC (10.78 bits/s/Hz)
  - 1.89 bits/s/Hz gain (21%)



Conclusions

- In addition to gain from SNR Margin reduction, there may be gain for SNR distribution as well
  - Effect of this is expected to be more significant at higher frequencies
- For these reasons, we believe it is important for the 802.3bn Task Force to investigate the viability of "Multiple MCS" for EPoC
  - We acknowledge that it may or may not be appropriate for EPoC based on system design, complexity considerations, etc.
  - However, potential gains make investigation worthwhile
- Key will be having a concrete proposal to evaluate for complexity and gains
  - Hope to have one for consideration by the January Interim meeting