

Motivations for Investigating Multiple MCS for EPoC

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- Kirk Erichsen, TWC
- George Hart, Rogers
- Curtis Knittle, CableLabs
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Before we begin...

- This presentation not intended to advocate mandating addition of Multiple MCS Profiles to 802.3bn (EPoC)
- Instead, intended to:
 - Clarify motivations for investigating viability of Multiple MCS Profiles to EPoC;
 - Advocate that we continue that investigation; and to
 - Wait until investigation completion to decide whether or not to include feature
- See 2 key benefits to Multiple MCS Profiles:
 - Take advantage of SNR distribution and not limit CNU's to the "lowest common denominator" for modulation and coding
 - Eliminate operational need for substantial SNR headroom, increasing spectral efficiency for all devices as a result
- There has been extensive debate about this feature
 - Most of the debate has focused on SNR distribution
 - Many MSOs have indicated that SNR headroom may be more significant
 - This presentation also seeks to clarify potential gains of SNR headroom reduction as motivation for continuing investigation of Multiple MCS Profiles

Definition of Multiple MCS Profiles

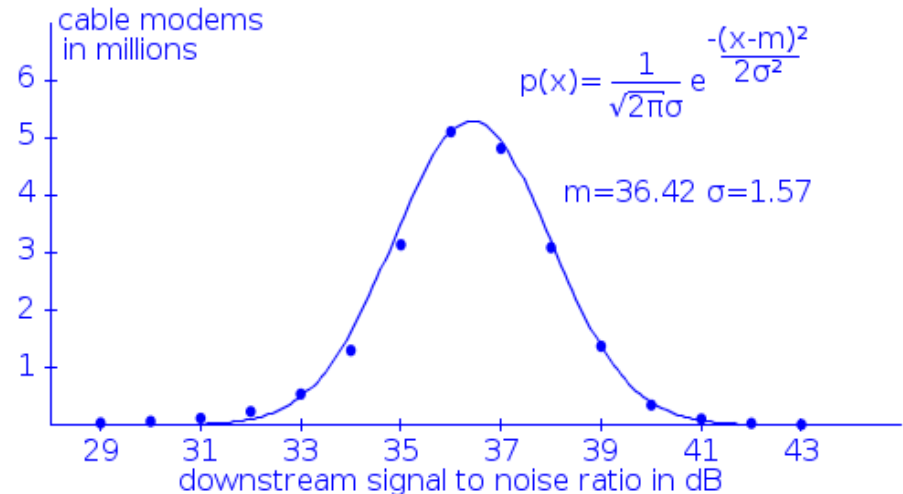
- Series of Profiles defined for the modulation and coding schemes (MCS) used for the EPoC Downstream
 - Each Profile contains a description of the modulation and coding to use on each OFDM sub-carrier (or group of sub-carriers)
- Limited number of MCS Profiles active at any given time (likely ~4 profiles)
 - Limit complexity (fewer profiles to track)
 - Improve FEC efficiency (better odds of back-to-back packets for the same profile, resulting in more long codewords)
- CNU's assigned to one or more of the active profiles based on their SNR and/or other capabilities
 - For example, one profile for unicast data, and another for multicast and/or broadcast messages
- CNU's only “listen” to their assigned profile(s) in the downstream; do not decode transmissions using other profiles
 - Therefore, a given CNU may not listen to all transmissions in the downstream

Operational Considerations

- When deploying CPE devices (DOCSIS CMs, STBs, etc.), usable SNR is typically the highest common multiple amongst all CPE devices minus the desired headroom
 - Headroom required to help ensure that CPE devices will not drop off line if conditions worsen
 - For several MSOs, this “SNR Headroom” is typically on order of 6-10 dB
 - Some MSOs may cut this headroom closer (as low as 3 dB), but most we are aware of use a headroom in the 6-10 dB range
 - For example, with headroom of 8 dB, if lowest common SNR among CPE devices is 35 db, usable SNR is actually 27 db (35-8)
- Key feature of “Multiple MCS Profiles” that CNU’s can “fall back” to more robust MCS Profile if issues encountered
 - Allows MSOs to operate CNU’s with minimal margin (e.g., 2 dB or less)
 - Devices stay online and manageable if SNR drops
 - Using 2 dB headroom with the 8 dB headroom average above, provides **6 dB** of SNR gain, equal to square modulation order improvement (~2 bits/symbol, minus FEC)
- Key motivation for several MSOs to encourage evaluation Multiple MCS Profiles viability for EPoC

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%)



- These gains just from SNR margin reduction
 - SNR Distribution will provide additional gains

Conclusions

- Multiple MCS Profiles enables significant gain due to SNR headroom reduction, in addition to gain from SNR distribution
 - Actual degree of gain from SNR distribution still a matter of debate
 - Gain expected to be more significant at higher frequencies
 - Requires channel model and specific proposal to quantify
 - Gain due to SNR headroom reduction *independent* of these factors; only dependent on MSO operational practices
- For these reasons, believe it is important for the 802.3bn Task Force to investigate the viability of “Multiple MCS Profiles” for EPoC
 - Acknowledge that it may or may not be appropriate for EPoC based on system design, complexity considerations, additional overhead, etc.
 - Believe potential gains make investigation worthwhile
- Suggest that we defer additional debate until we have a concrete proposal and channel model
 - Until then, we cannot determine actual gains or losses, complexity, etc.
 - Hope to have both by the January Interim meeting