

INVENTION DISCLOSURE

1. Invention Title.

Using upstream scheduling for PAPR reduction

2. Invention Summary.

This invention proposes using the DOCSIS 3.1 CMTS's upstream scheduler to assign modems to transmit minislots with no data to reduce Peak to Average Power Ratio (PAPR).

3. Invention Description.

a. Describe the invention in detail.

In the DOCSIS 3.1 specifications, it would be possible to add a modulation type that would direct a modem to transmit a modulated signal with no data on a given minislot or minislots (which are the granularity of granting in DOCSIS systems). This would cause a modem to add energy to the upstream, thereby reducing the difference between the peak and average power levels (PAPR). The CMTS would be able to use its knowledge of which devices are transmitting when and information about their transmission power levels to determine when additional energy is needed to reduce PAPR. Because this is based on the existing granting mechanism in DOCSIS, it would be relatively easy to implement and signal, without requiring any new or special messaging beyond defining a modulation type that is used for sending a modulated carrier with no data.

b. Why was the invention developed? What problem(s) does the invention solve? How is it better?

One of the concerns with the use of OFDM is that you can get very high PAPR, which can cause problems in the cable plant (such as laser clipping, or forcing a lower average power that thereby reduces available SNR). An established way to address this is to inject additional energy into the system using modulated carriers that carry no data on a sub-set of sub-carriers or tones. However, the need to have a completely separate mechanism to signal when devices should do this is a contributor to making it undesirable. This invention proposes to use the existing granting mechanism in the DOCSIS specifications as the means to signal when to inject this additional energy; it also leaves the use of this mechanism completely in the hands of the CMTS scheduler, which has complete knowledge of which devices are transmitting when (and therefore when it is desirable for this to happen). While it does have one negative in that the granularity of how many sub-carriers to use for adding energy is less than in other mechanisms, the simplification of using existing mechanisms – plus the flexibility that is afforded to the CMTS in terms of when to use this mechanism – may make this preferable to such mechanisms.

This is intended as a simpler but yet very flexible mechanism for addressing PAPR than other proposals. It would provide operators the ability to use or not use this mechanism, for CMTS vendors to implement it or not, and to use this in an intelligent manner with minimal augmentation to a CM.

c. Briefly outline the potential commercial value and customers of the invention.

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This feature could prove beneficial to plant operations for cable operators in terms of mitigating the effects of a large amount of PAPR once DOCSIS 3.1 devices are deployed and OFDM is activated. There is a chance it could be included (or added at a later date) into the DOCSIS 3.1 specs.

4. **HOW is this invention different from existing products, processes, systems?**

As noted above, doing this on specific sub-carriers or tones is an established method for PAPR reduction, and in fact was proposed for inclusion in the DOCSIS 3.1 specifications. The key difference here is the use of the existing DOCSIS granting mechanism and the concept of minislots (the unit of granting in the upstream) to accomplish the same ends without significant modification to the CM, while still providing significant flexibility to the CMTS regarding if and when to use this capability.