EPOC Upstream Multiple Modulation Profiles

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Burst Anatomy

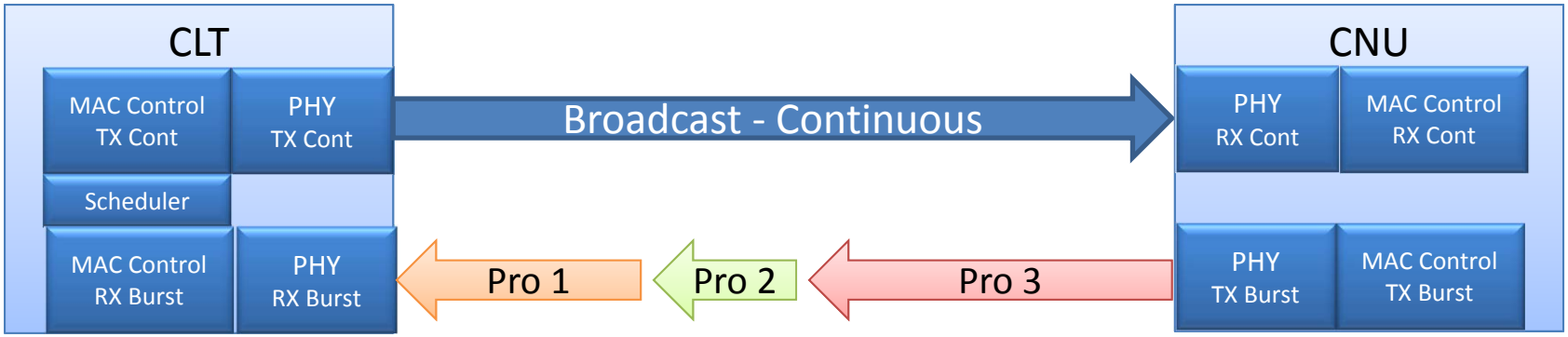
MULTIPLE MODULATION PROFILES

Overview

- These slides describe a solution for multiple modulation profiles (MMP).
- If MMP is determined to be useful, these slides describe a possible solution.
- MMP has implementation, compatibility, and specification challenges on a continuous downstream.
- For this reason, MMP will not be specified for the EPoC FDD downstream.

MMP is significantly easier on a burst interface so it can be considered

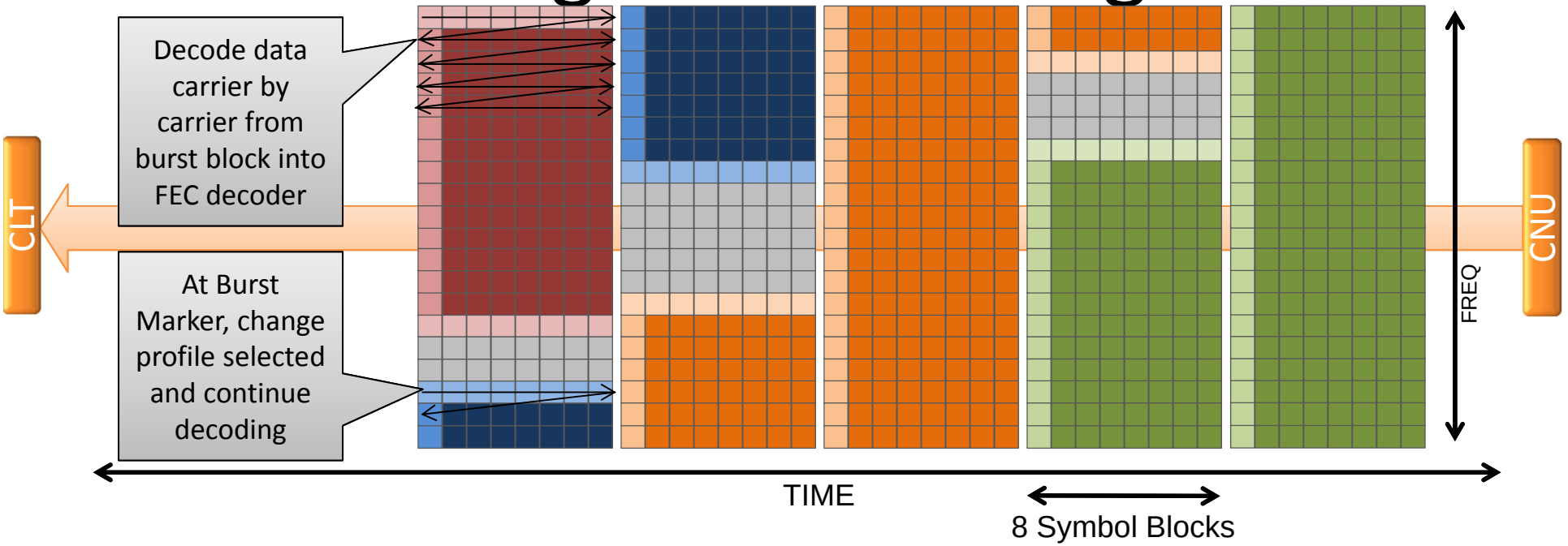
Upstream MMP



- Upstream Bursts contain packets for a single modulation profile since they come from a single CNU. (Packet sorting is not required)
- Upstream Bursts will always end the FEC block so there is no additional penalty for shortened code words.
- Every CNU would store a single modulation profile for the upstream.
- CNUs on different profiles would have a different conversion equation from Byte to TQ. Only one conversion needed.
- CLT PHY needs to detect and decode multiple profiles.

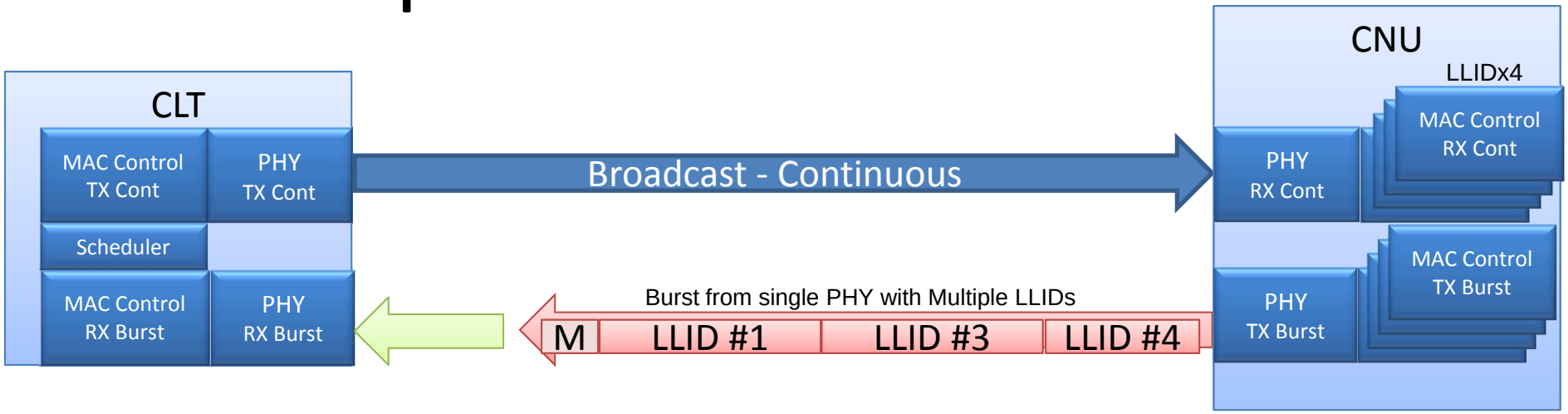
CNU PHY should be simple, CLT PHY is more complex

Detecting and Decoding MMP



- Upstream Burst Markers could contain a small amount of information (2 bits or 1 byte?) that identifies the modulation profile.
- CNU PHY adds Burst Marker with configured profile (Constant data per CNU PHY, no need for delay to add to the front of burst)
- CLT PHY decodes Burst Marker to select one profile from table.
- CLT PHY continues to use profile until next Burst Marker.

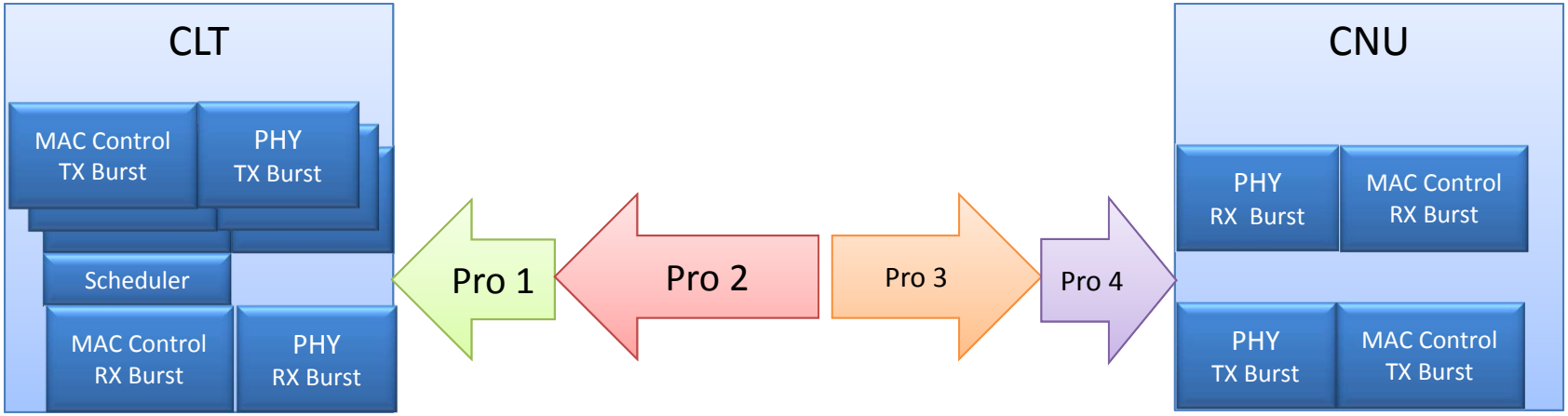
Multiple LLIDs and EPoC Bursts



- Multiple LLIDs on an EPON ONU share a single optical transceiver.
- Multiple LLIDs on a CNU should share a single EPoC PHY.
- Every LLID is a unique MAC Control Client but they should merge to a single XGMII interface and share a single EPoC PHY.
- Multiple LLIDs would use the same burst profile (per CNU PHY not LLID)
- Multiple LLIDs could share the same upstream burst if CLT GATEs are close enough.

Multiple LLIDs can be efficient and transparent to the EPoC PHY

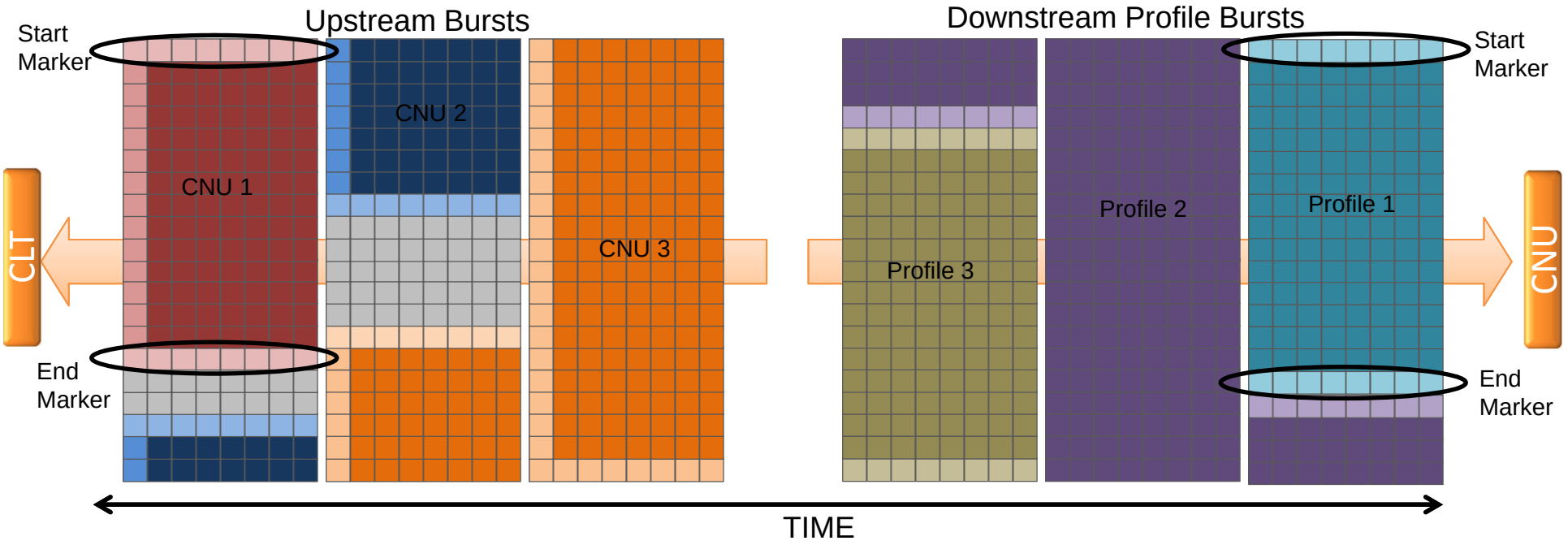
TDD MMP



- TDD uses the EPoC Burst PHY for both upstream and downstream.
- Upstream FDD methodology could be applied to both TDD upstream and downstream.
- Downstream TDD could be represented as a logical MAC & PHY for each modulation profile.
- CLT Scheduler will schedule upstream bursts for each CNU and downstream bursts for each profile (group of LLIDs).
- CNU will need to decode 2 profiles in the downstream

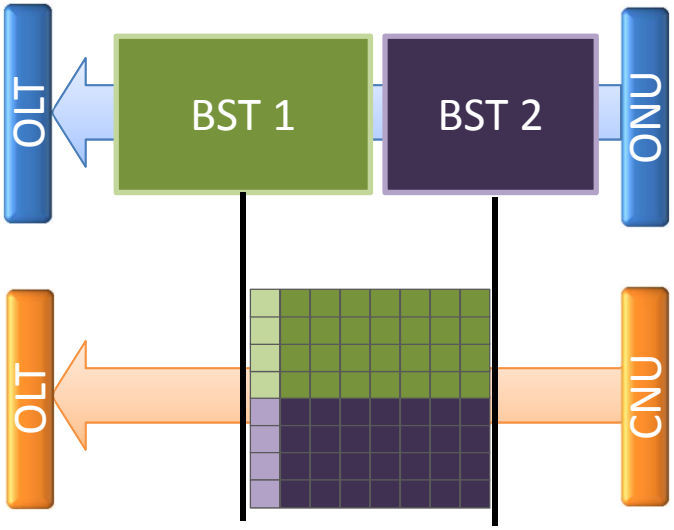
Burst PHY MMP should work for TDD

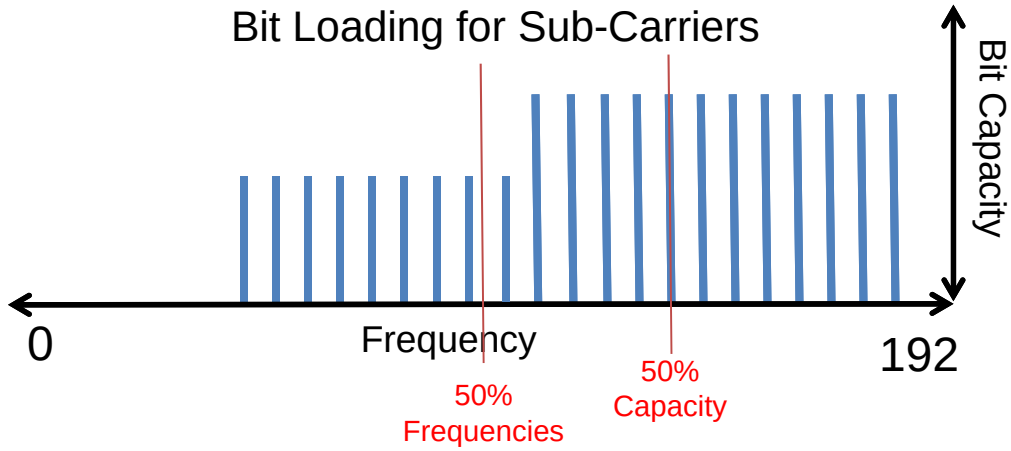
TDD Downstream



- Upstream Burst Markers are used in the downstream to define profile boundaries for Downstream Profile Bursts.
- Downstream Profile Bursts could be scheduled without upstream guard band between bursts.
- As an optimization, a back to back “End Marker” and “Start Marker” could become a single “Start Marker”.

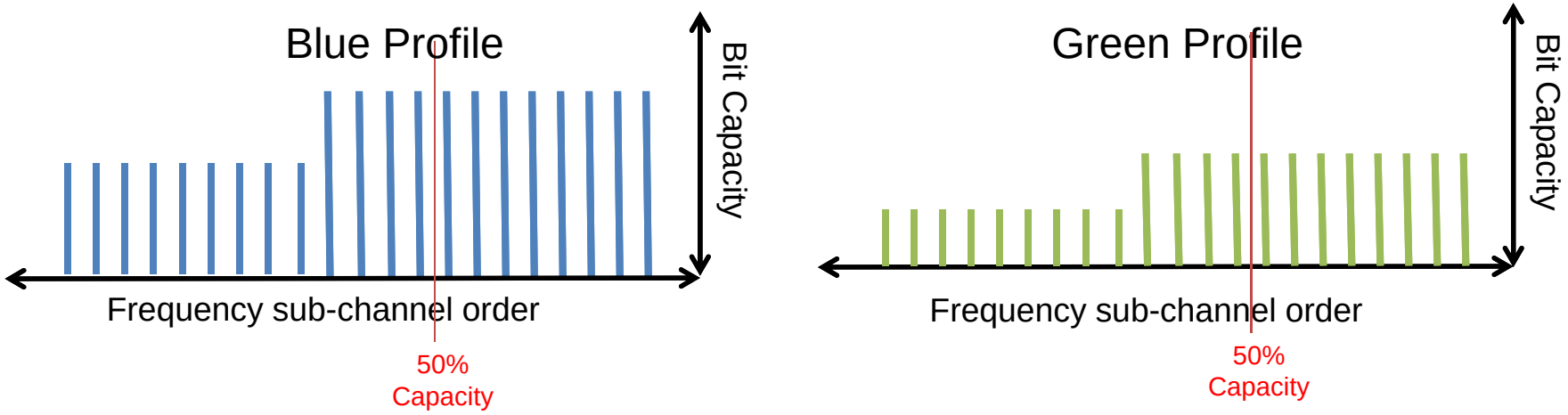
Time to Frequency Conversion





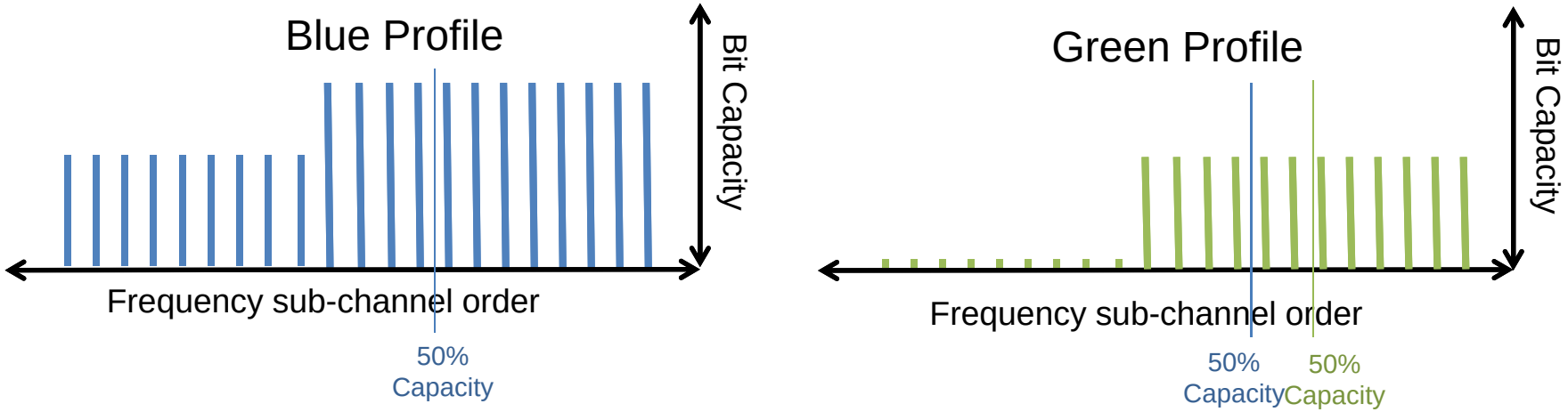
- Bursts boundaries not on symbols block boundaries will split sub-carriers within the symbol block.
- Directly splitting sub-carriers within the symbol block proportional to time will not equally split capacity.
  - For example, Burst 1 ending at 50% of symbol time is mapped to sub-carriers for 50% of the spectrum.
- Sub-carriers within the symbol block must be split based on the carrying capacity of symbol block.

Supporting Two Upstream Profiles



- CNUs determine their average data rate by dividing the total carrying capacity of the symbol burst block by the time of the symbol burst block.
- CNU use the average data rate to convert bytes to Time Quanta.
- If 2 CNUs have different modulation profiles due to different SNR, they will have different average data rates.
- These CNUs will request different time slot size from the OLT based on the average data rates.
- If the 2 profiles are only proportionally different, they will have the share the same carriers for a given percentage of capacity.
- In this scenario, only different average data rates per CNU are required to support different profiles.

Shuffling for Multiple Profile Support



- If the profiles have very different distributions, the percentage of capacity positions can be very different.
- Differences in the percentage capacity require additional overhead between bursts.
- To minimize the differences, the data loading/unloading order into the carriers can be modified to be better align the capacities.
- In the example above, the Green profile has nulled carriers at the lower frequencies.
- If the order of loading/unloading is changed to spread the nulled carriers, the percentage of capacity positions would better align so the overhead between bursts would be minimized.

Summary

- Markers provide a simple method to identify burst starts, burst ends, and profiles in the PHY receiver.

- The same method could be used for all modes of the EPoC Burst PHY: FDD Upstream, TDD Upstream, and TDD Downstream.
  - The benefit of MMP for these modes should be evaluated in other contributions.

- Many more details need to be worked out but MMP seems feasible if required for burst PHY operation.