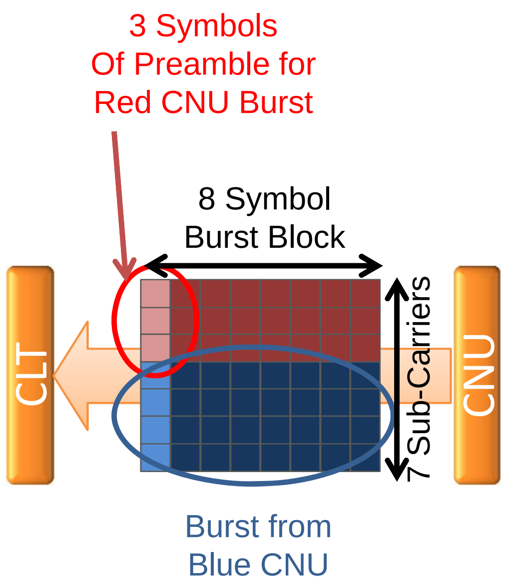
EPOC Upstream Burst Markers

Ed Boyd, Broadcom
Supporters
Duane Remein, Huawei
Hesham ElBakoury, Huawei
Bill Powell, Alcatel-Lucent

Disclaimer

- The drawings in this presentation show upstream bursts carried in fixed sized blocks with multiple symbols.
  - The burst blocks contain multiple data carrying symbols with 1 or more preamble symbols.
  - This is the most challenging scenario to describe and it makes a colorful picture.
- The need for preamble symbols, the number of symbols in a burst block, and the size of the upstream symbols are not discussed in this presentation.
- This methodology described can be used with single symbol blocks, multiple symbol blocks, or any number of preamble symbols (including 0).

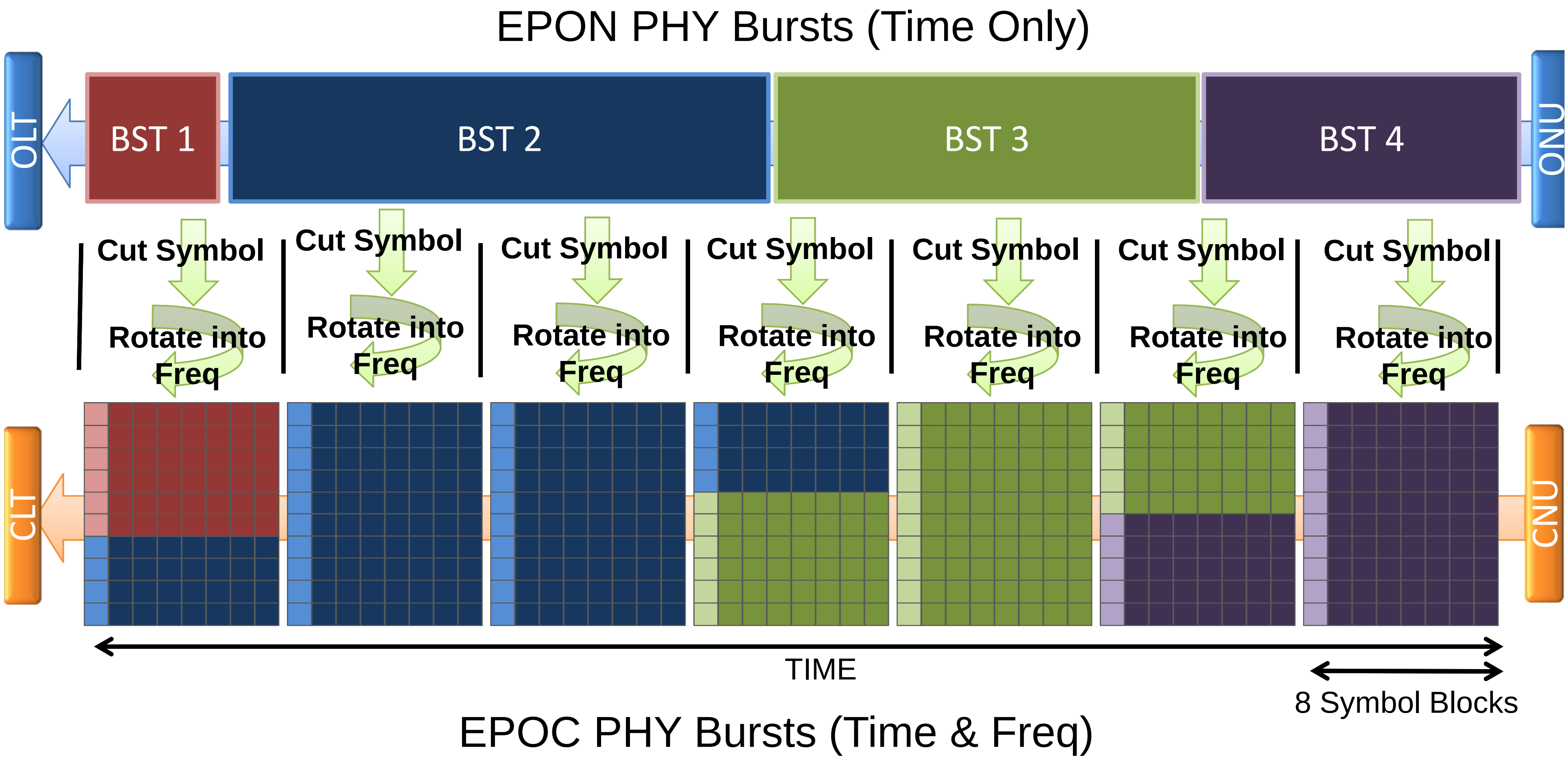


This presentation does not attempt to advocate or justify any particular PHY layer parameters.

Burst Anatomy

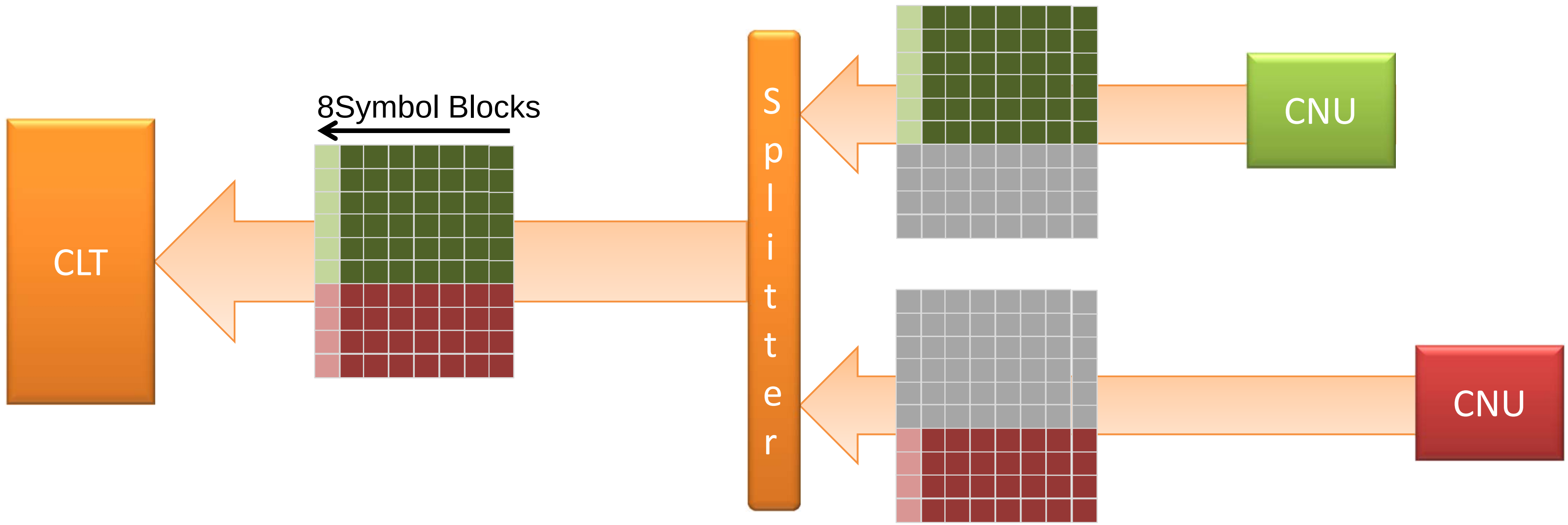
REVIEW OF 1D-TO-2D MAPPING

Rotating Bursts from Time to Time & Freq



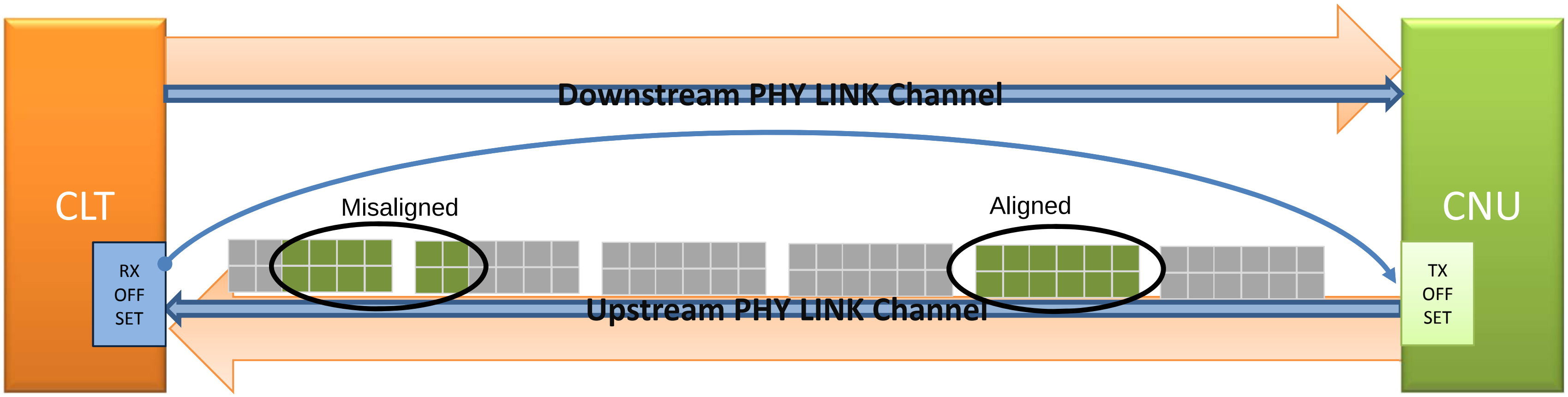
- TDMA EPON GATEs are mapped into time and frequency at symbol block boundaries.
- Symbol blocks are divided in frequency by allocating a subset of sub-carriers to bursts sharing the symbol time.

Upstream Symbol/Burst Alignment



- CNUs must transmit in different symbols or sub-carriers in a symbols to avoid collisions. [Small # of guard band carriers assumed but not shown]
- The CLT PHY must receive all symbol blocks with common alignment.
- CNU PHYs need frequency & phase alignment so symbol blocks are aligned at the CLT PHY. (within EPON 8 TQ jitter limit should be fine)
- MPCP Discovery will provide delay compensation to guarantee unique time slots but it will not align the symbol blocks.
- The CNU PHY must be aware of symbol block boundaries.

PHY Link for Symbol Alignment



- CNUs find and receive the downstream PLC.
- All CNUs have frequency lock for upstream symbol block timing from downstream PLC.
- CNU is configured with size of upstream symbol block from PLC.
- CNU delineates upstream symbol blocks without random phase at startup.
- CNU responds to Broadcast PHY Link on Upstream PLC aligned with CNU symbol burst boundary.
- CLT measures phase offset of Broadcast PHY Link response and sets offset for CNU to correct alignment.
- All CNUs have a common symbol block boundary after PHY Link completes.

Burst Anatomy

UPSTREAM BURST MARKERS

EPON Review

- The EPON OLT PHY locks to the upstream without information from the MAC.
- The PHY is able to determine 1G or 10G EPON operation by detecting signaling speeds in the preamble.
- In 10G, a start of burst pattern is used to identify the start of the first FEC block.
- In 10G, a end of burst pattern is used to identify the end of the valid data and the burst.
- The start of burst and end of burst are patterns that have a large hamming distance for existing data sequences.

EPON Burst Diagram

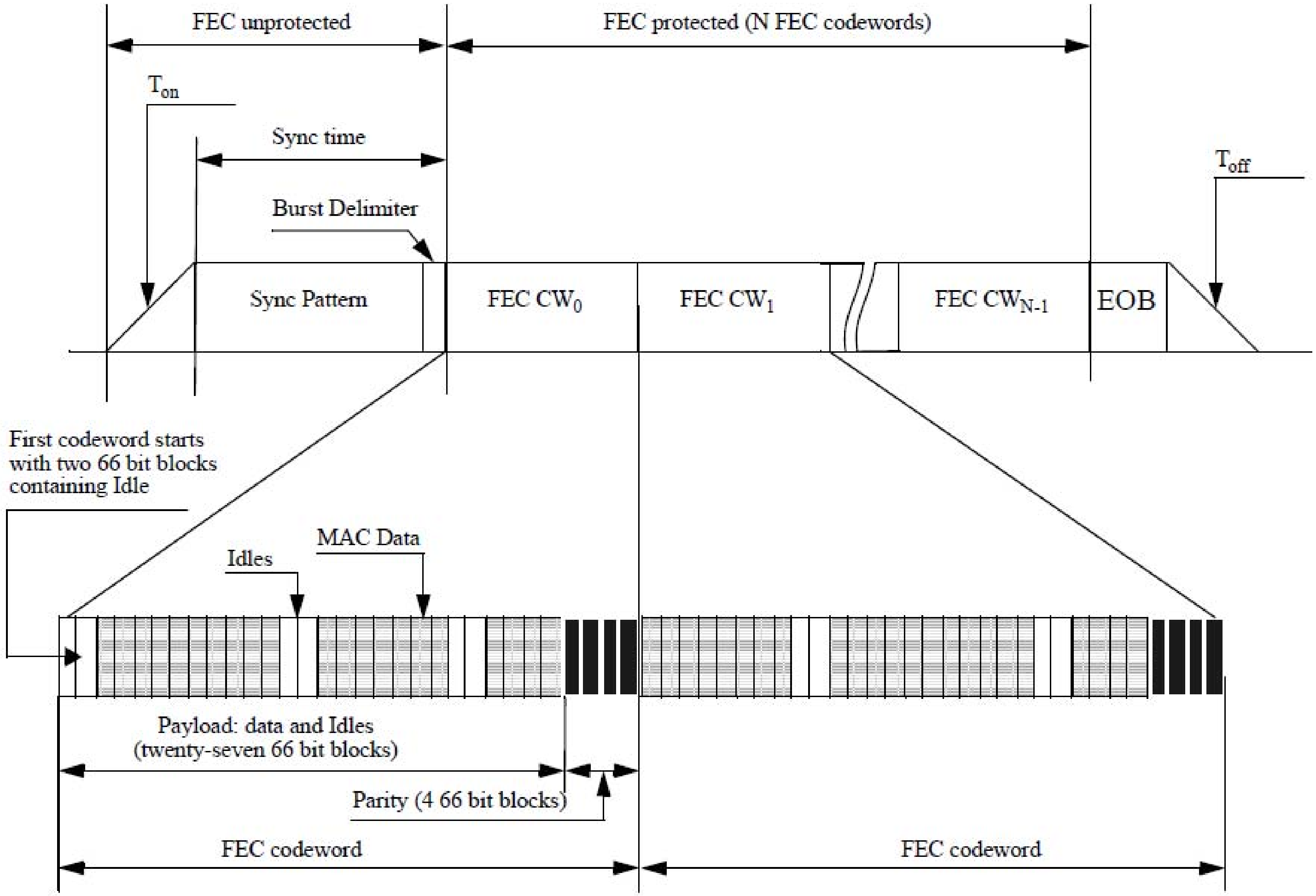


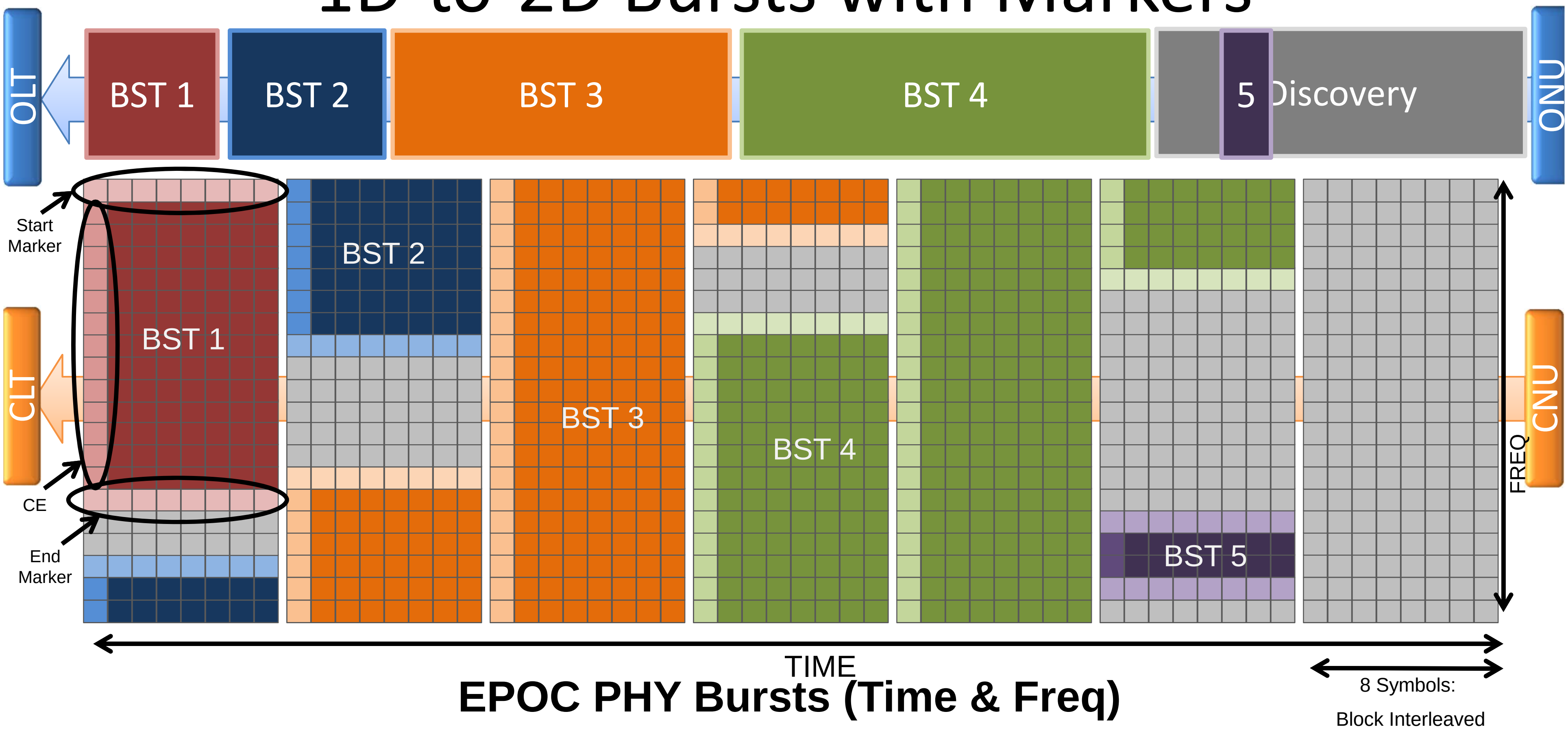
Figure 76–14—Details of burst composition

EPoC to EPON Challenges

- EPON MAC does not have an interface to tell CLT PHY where upstream bursts start and end.
- There is no way to signal the FEC block start and end.
- The EPON MAC upstream can jitter (8 TQ) so it is not always mapped to a known set of carriers.
- Discovery has a random offset in a large window of time.

The EPoC PHY needs a Marker to find burst boundaries

1D-to-2D Bursts with Markers



EPOC PHY Bursts (Time & Freq)

- 1D to 2D Mapping as described in earlier presentations.
- A small number of carriers or symbols are used at the start and end of bursts.
- Markers are a fixed PHY layer pattern that could be detected easily.
- PHY can identify burst start/end and then identify FEC block start / end

Burst Marker Overview

- The exact carrier of a burst start is determined by the “Start Burst Marker”.
- The exact carrier of a burst end is determined by the “End Burst Marker”.
- The number of empty carriers between bursts is unknown due to discovery, idle upstream, or slight upstream jitter in the MAC transmit slot.
- Data from the burst is decoded by FEC decoder and last block size for shortened code word is determined by the end marker.
- Burst Marker Decoding should be simple so it can be done in parallel (on all carriers) before block de-interleaver.

Burst Marker Definition

- Fixed Low Modulation Order Pattern (BPSK?)
- Easy to detect in bad channel conditions
- Simple Hamming Code to fix bit errors?
- Should be able to carry a small amount of data.
  - Profile ID that identifies the modulation profile used.
  - Different marker for each profile.
  - Distinct marker for start and end.
- Multiple Carriers for robustness?
- How can it be unique from normal data?
- Could we use a slightly different Channel Estimation Code or Pilots to signal the marker?

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.