EPOC UPSTREAM TRANSMISSION: RESOURCE BLOCKS PROPOSAL

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IEEE P802.3bn EPON Protocol over Coax (EPoC) Task Force
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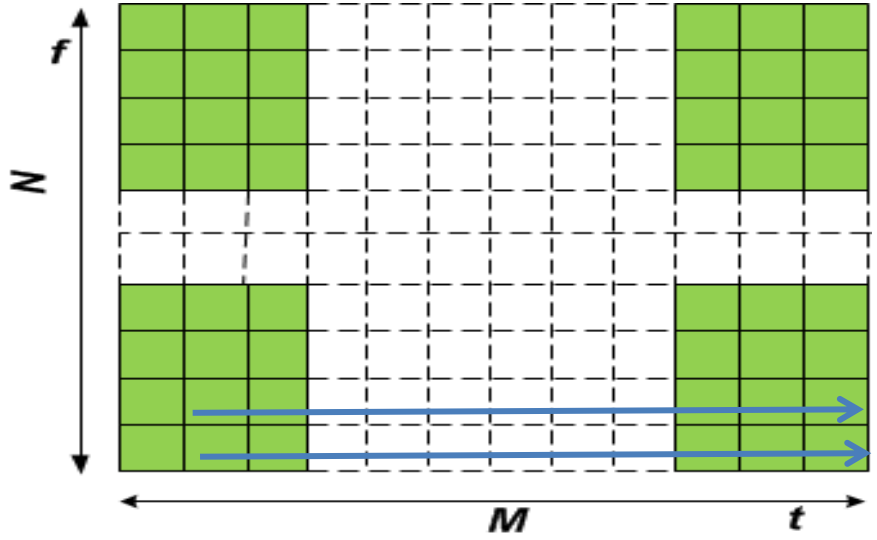
Outline

- Resource Blocks
  - How to translate from time domain to frequency domain
- Overheads involved with OFDMA transmissions
- Proposal for Resource Blocks and Pilot Patterns
  - Add one sub-carrier RB to exiting options

Resource Block in EPoC

- A PHY unit of allocation
  - OFDMA frame is comprised of Resource Blocks
  - Allocation unit comprised of N contiguous sub-carriers and M OFDMA symbols
  - Direct mapping between TQs to RBs
  - N*M Resource Elements (RE)
    - Previous proposals have 4 and 8 subcarriers per a RB
    - In this presentation we propose an option with a single number of subcarriers (N=1)
  - OFDMA frame is comprised of RB



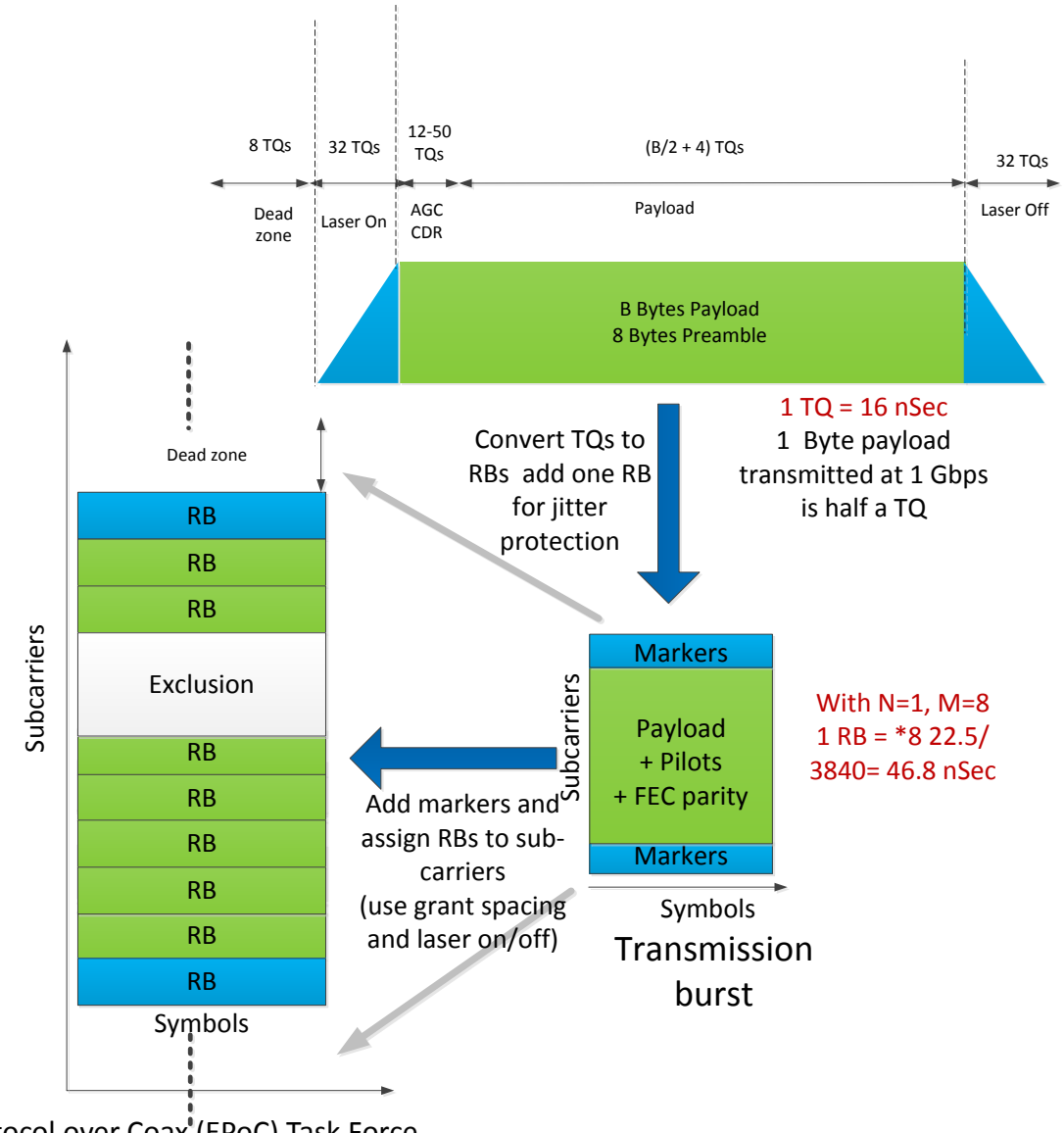
Resource Elements

- Resource Elements (RE)
  - A RE is the smallest time/frequency resource (one subcarrier in one OFDM symbol)
  - A RE contains a constellation symbol
  - A block of N*M REs composes a RB

- Types of REs:
  - Data REs
  - Pilot REs:
    - Known BPSK symbols used for frequency acquisition and channel estimation
    - Two pilots per sub-carries to improve channel estimation and protection against burst noise Interpolation can be used to avoid pilots on every subcarrier
  - Marker REs:
    - Used as delimiters of transmission bursts
  - Edge Pilot REs:
    - REs on edge subcarriers in a transmission burst used as pilots Typically shared with the marker REs;
  - Low constellation pilots:
    - Data symbol with a lower modulation order
    - On pilot subcarriers in the last OFDM symbol in the RB
    - Can be used for frequency estimation

Allocations over the Fiber and RBs over the Coax

- Allocation over fiber (TQ) is directly mapped to allocations over frequency (RB)
- Example
  - M=8, N=1, bpsc=10, N/4 pilots per RB
  - RB equivalent time unit: 46.8 nSec
  - RB/TQ = 2.925
  - Number of Bytes per RB = b*(M*N-N/4) *0.85 = 66 bits
- Minimum overhead over fiber is 88 TQs (~ 30 RBs) that can be translated into: granularity, markers and jitter protection
- If rate over Coax > 1 Gbps + net overhead over Coax translation always work no need to modify requested TQs
- If rate over Coax<1 Gbps + net overhead over Coax need to modify requested TQs



New Proposal: One Subcarrier Size RB

- Each RB contains M REs
- Only some of the RBs contain pilots
- Each RB is defined as pilot RB or non pilot RB
- Pilot spacing can be configurable
- Number of symbols in a RB can be configurable depending on the interleaver depth (TBD)
- Pilot structures
  - Symbol 1 always contains pilots
  - For M ≥ 2, symbol M contains low density pilots
  - For M > 5, symbol 3 has additional pilots and symbol M-2 has additional low density pilots
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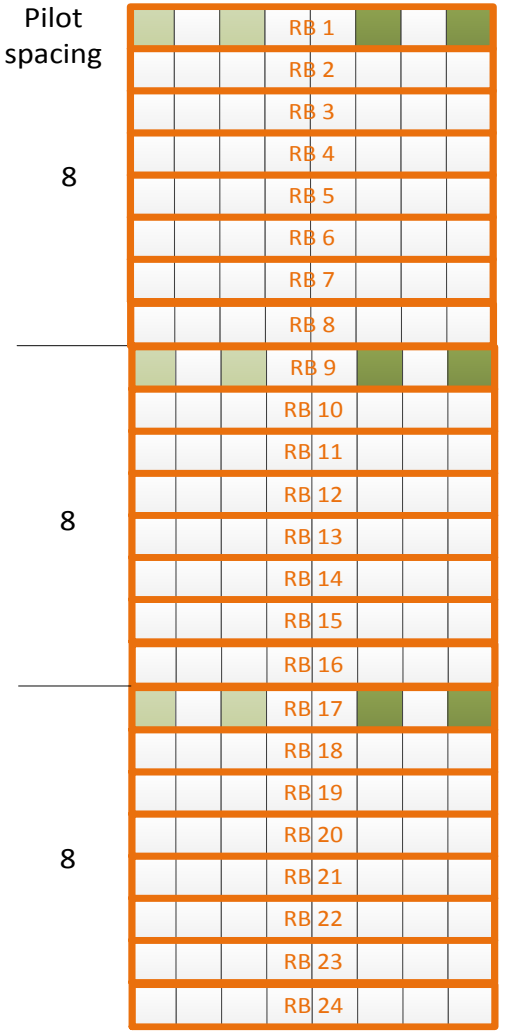

PROPOSAL FROM VICTORIA

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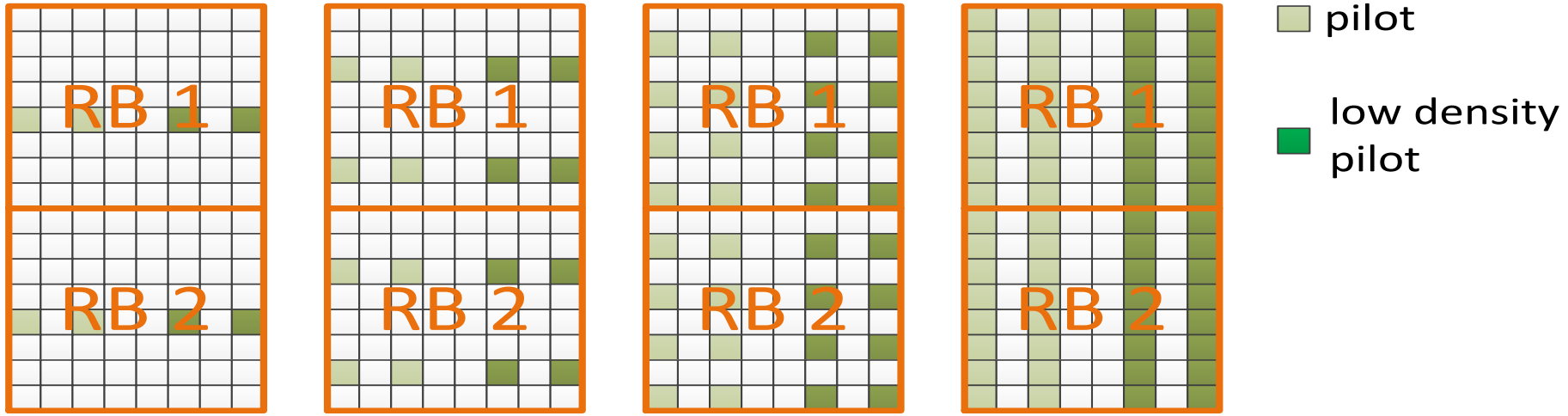
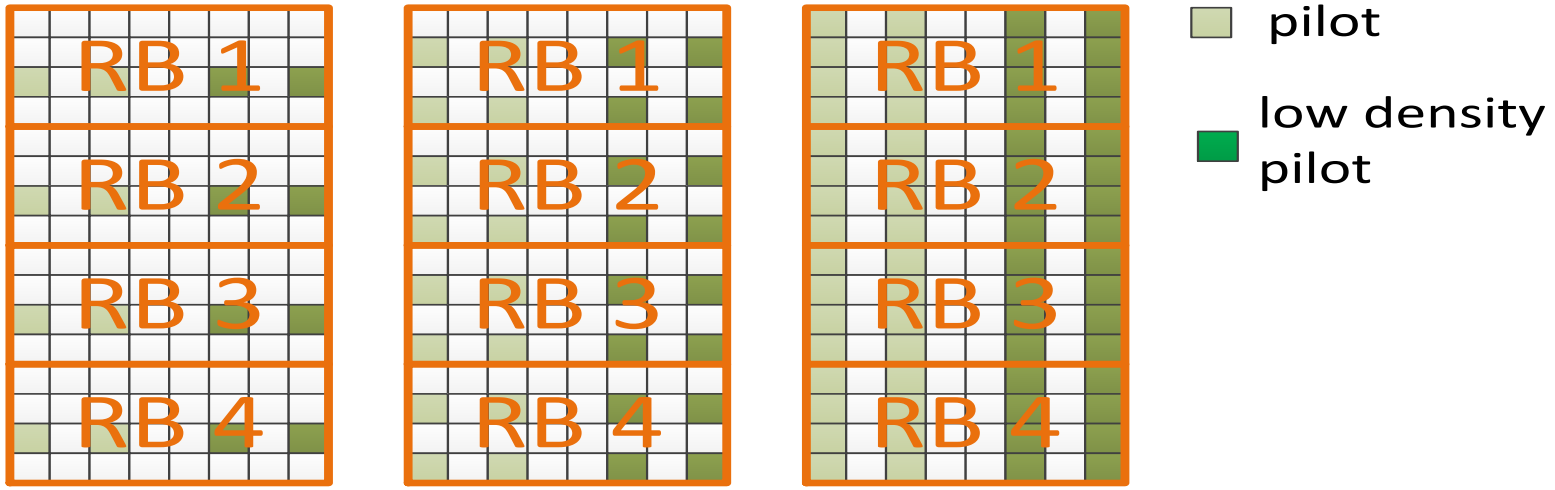
RB Size and Pilots Structure (II)



- A default RB configuration (CONF2) contains 8 subcarriers:
  - The pilot spacing can be 8, 4, 2, or 1 subcarriers
- The pilot spacing in frequency could be profile specific:
  - The choice of pilot spacing depends on pre-equalization quality and channel conditions
  - E.g. some CNUs use a pilot spacing of 8 while others use a pilot spacing of 4
- OFDM symbols in a RB where pilots and low density pilots are :
  - Symbol 1 always contains pilots
  - For M ≥ 2, symbol M contains low density pilots
  - For M ≥ 5, symbol 3 has additional pilots and symbol M-2 has additional low density pilots
- The values for M are 1 to 17 depending on interleaver depth

RB Size and Pilots Structure (III)



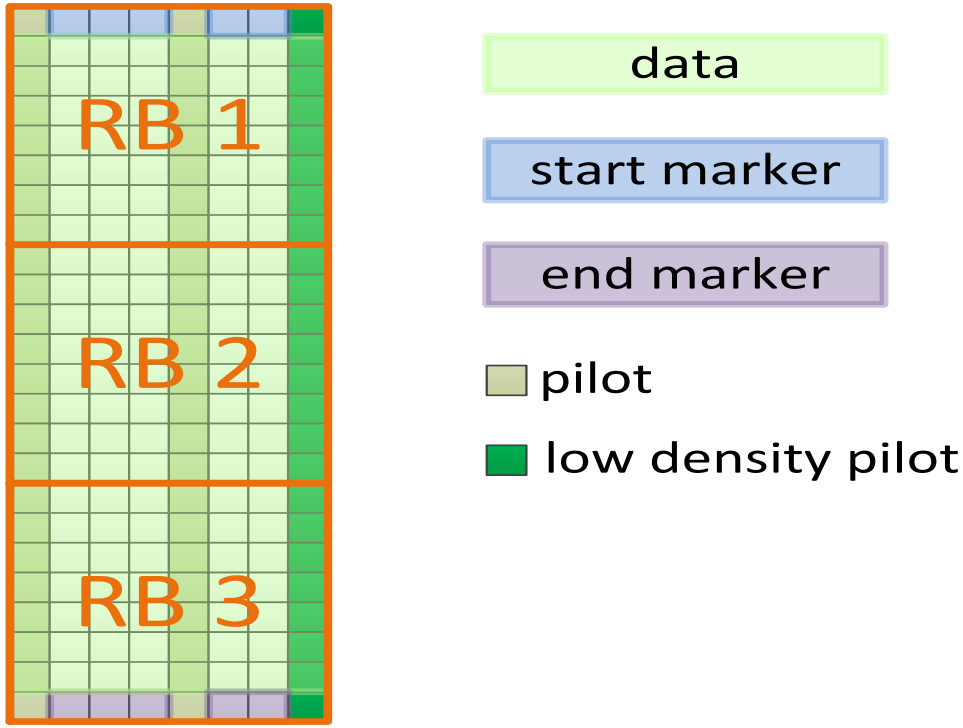
- An alternative RB configuration (CONF3) contains 4 subcarriers:
  - The pilot spacing can be 4, 2, or 1 subcarriers, but not 8 subcarriers
  - This configuration enhances granularity by making the RBs smaller
  - Suitable for plants where a pilot spacing of 8 subcarriers is not possible
- The MSO decides which RB configuration is suited for their plant
  - Tradeoff between RB granularity, pilot spacing, and pilot overhead
  - Example 1: If M = 4 (interleaving across 4 OFDM symbols), an RB with N = 8 is favorable
  - Example 2: If M = 17 (need for long time interleaver), an RB with N = 4 is favorable

RB size and Pilot Spacing

- Configurable number of OFDM symbols
  - {1 to 17} with 20 uSec symbols
    - 17 corresponds to 400 uSec interleaver depth
  - {1 to 9} with 40 uSec symbols
    - 9 corresponds to 400 uSec interleaver depth
- Configurable number of subcarriers per RB: {1,4, 8}
- Configurable pilots spacing in frequency (Ps): {1,2,4,8}
- Still open for discussion:
  - Do we need the special case M = 1? Could probably be removed.

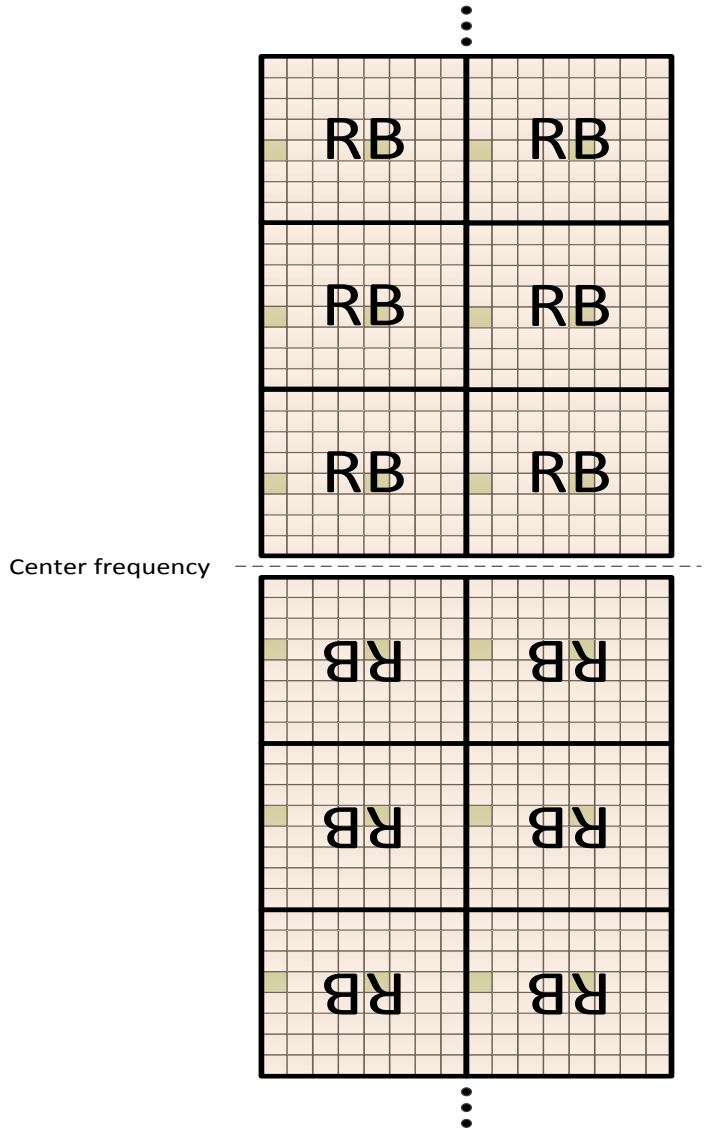
Burst Markers

- Start and End Markers indicate the boundaries and profile of a transmission burst
- The markers are detected incoherently, without prior knowledge of the transmission profile
- Number of profile is TBD
- Markers are contained in the first and last RB and do not overwrite pilots
- Marker structure and number of marker REs is TBD



RB Placement For TDD Top split

- RBs are placed symmetrically around the center frequency:
  One RB covers subcarriers ±Nn+1 to ±N(n+1) where
  n is the RB index counted from the center frequency



EPoC Upstream Pilots

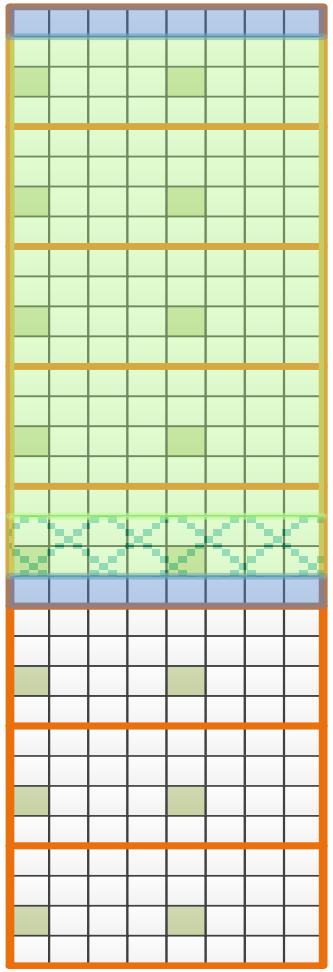
THANK YOU

Update on EPoC Upstream Pilots

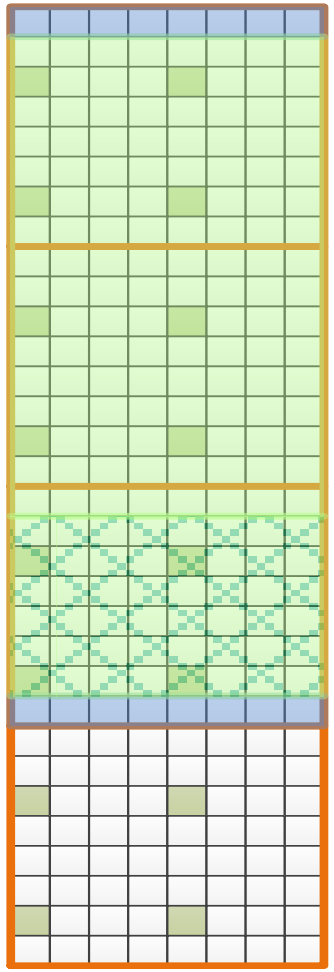
BACKUP

Granularity and RB Size

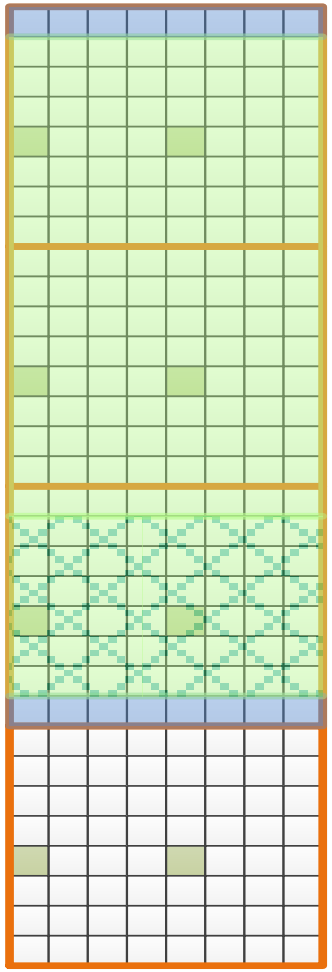
SC per RB: 4
Ps: 4



SC per RB: 8
Ps: 4



SC per RB: 8
Ps: 8



data

overhead

marker

pilot

- For a pilot spacing of 8 SCs the finest granularity is 8 SCs per RB.
- A pilot spacing of 4 SCs allows for RBs of 4 and 8 Scs.
- A lower pilot spacing is favorable over smaller RB size.
- The figure here shows the required resources for an example of set of data that requires 112 REs for the data

RBs and TQs