Simplification of EPoC Upstream FEC

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Summary

- In Draft 1.1, three LDPC codes (long, medium, and short, or L-M-S scheme) are specified for EPoC upstream.
- Previous contribution studied efficiency for various coding schemes.

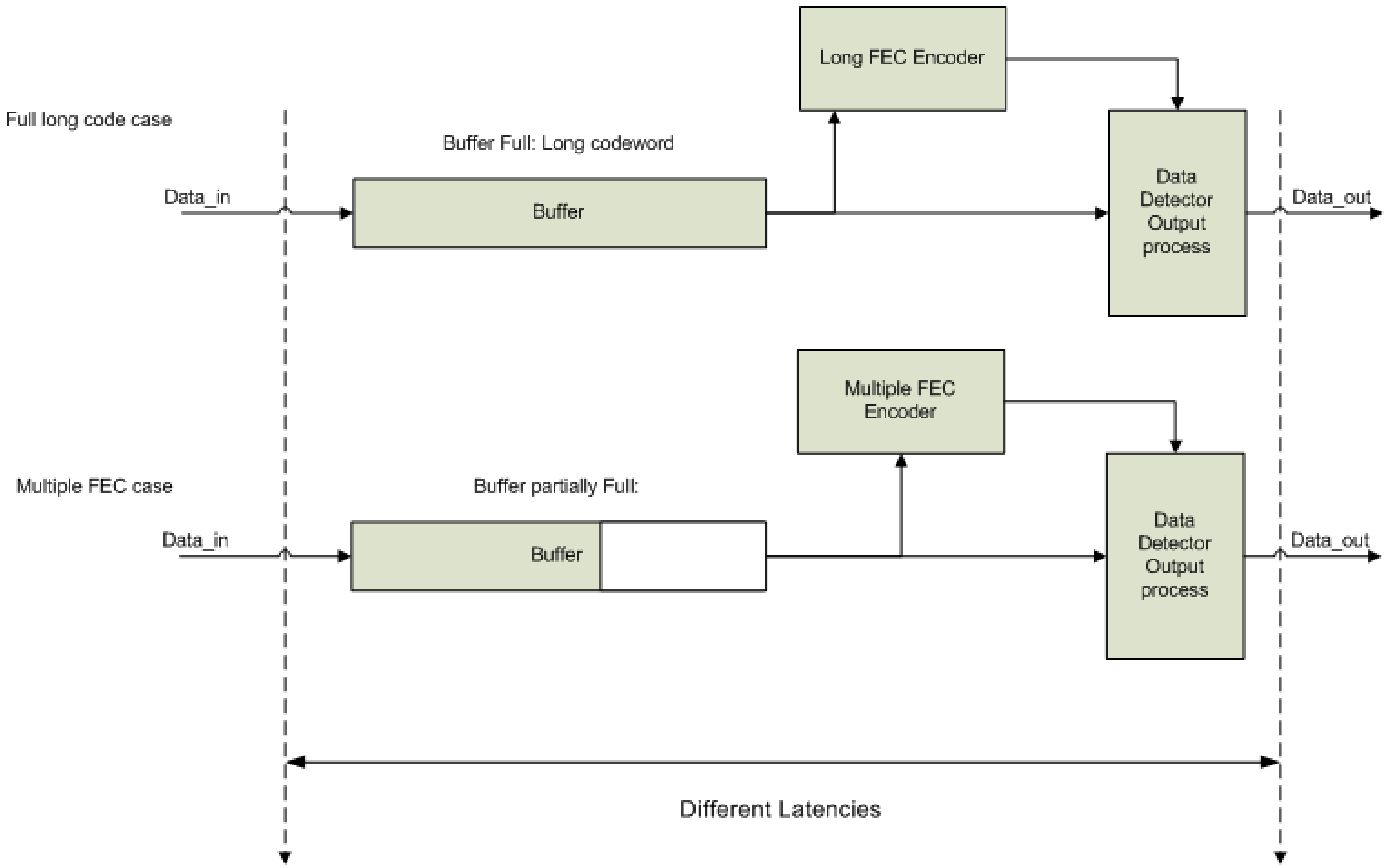
  http://www.ieee802.org/3/bn/public/may13/boyd_3bn_05_0513.pdf

- The All-3 coding scheme incurs very complicated implementation issues for the following modules
  - LDPC encoding/decoding
  - Data detector for terminating burst
  - MPCP control multiplexer for reorganization of start and termination of burst
- This contribution recommends the TF to consider single-length FEC code as an option, for example, medium only codeword.
  - The burst marker can be used to bear information for the coding scheme.

Why the L-M-S FEC Scheme Is Complicated for EPoC?

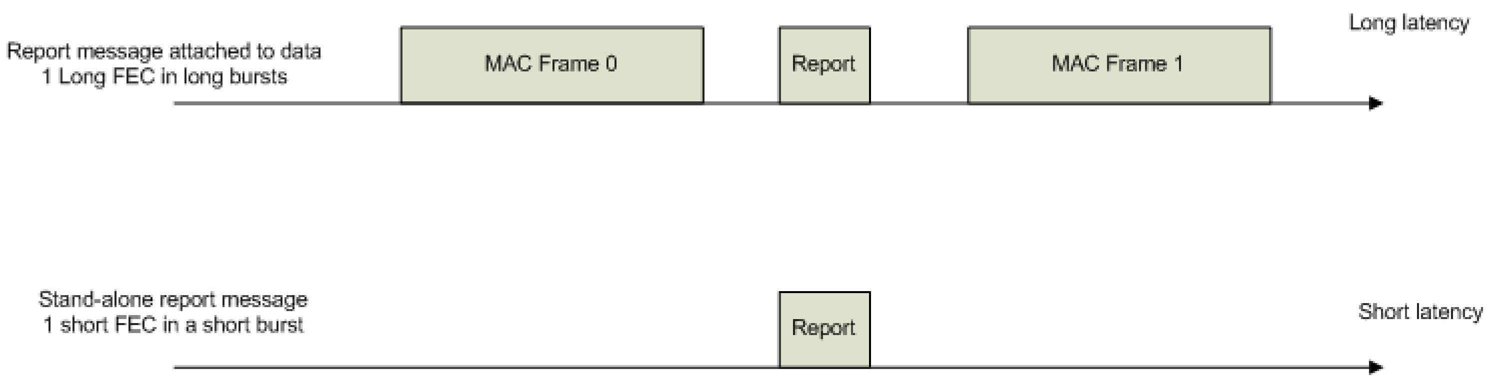
- Three LDPC Encoders and Decoders
- Latency and Unpredicted latency variation (jitter)
- Complicated state transitions for burst formation in MAC and PCS.
- Complicated Dynamic bandwidth allocation to turn the pending bytes into gate message.
- The benefit of L-M-S scheme is only limited for certain burst sizes.

Latency Issue



Example of Impact of Latency Variation on MPCP

- Different latencies may impact the MAC round trip time measurement.



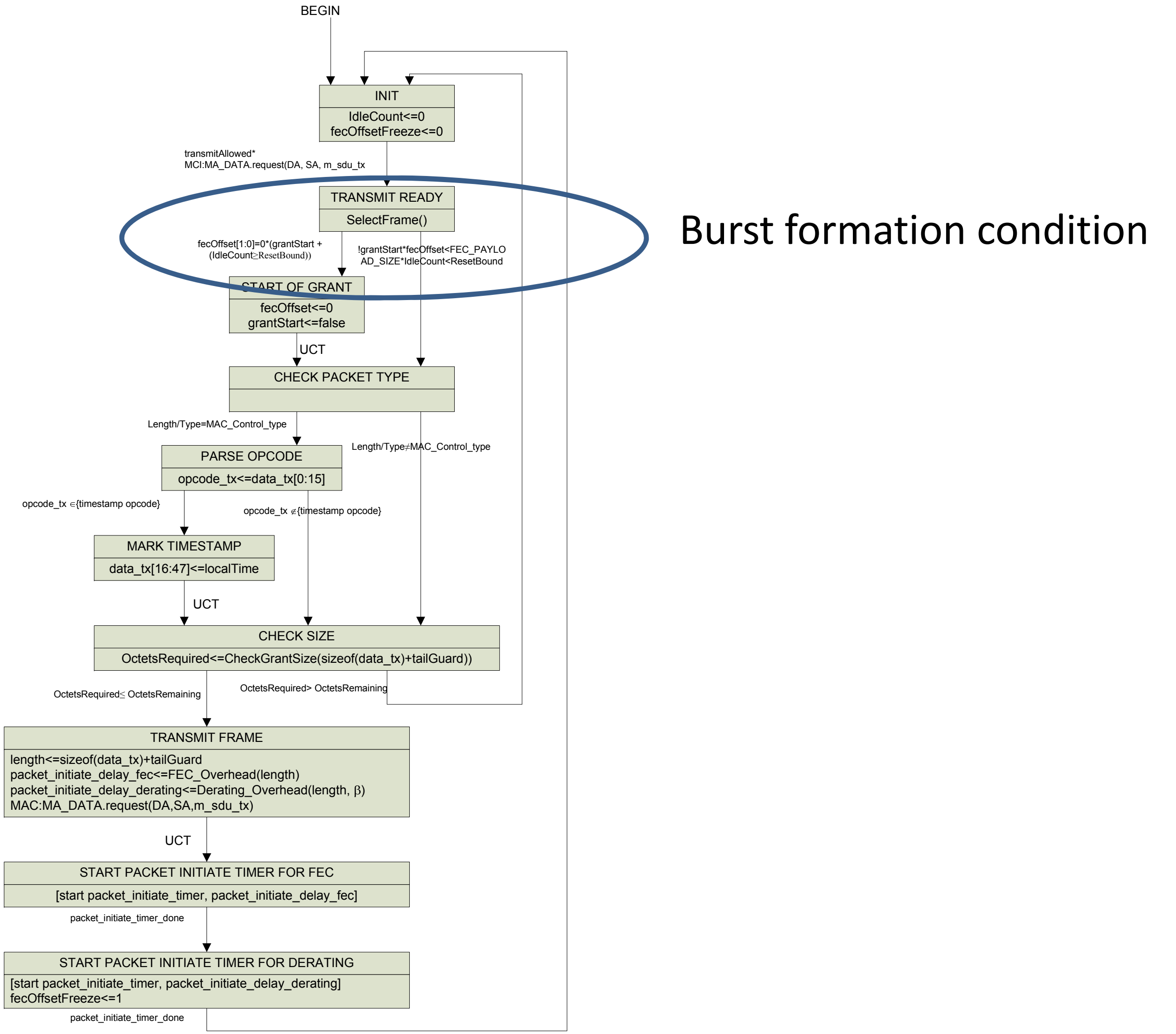
How to Remove the Latency Variation?

- Force all CNUs to have a fixed latency based on a particular implementation.
  - How to determine such an optimal latency?
  - The latency is implementation dependant. Should we recommend an implementation?
  - EPoC desires less latency
- Upon burst end, send all parities at the end
  - Proposed by Ed Boyd during socialization conference call.
  - Still have complexity issue for burst formation
- Single codeword length
  - No look-back, no latency variation.
  - Acceptable complexity for burst formation

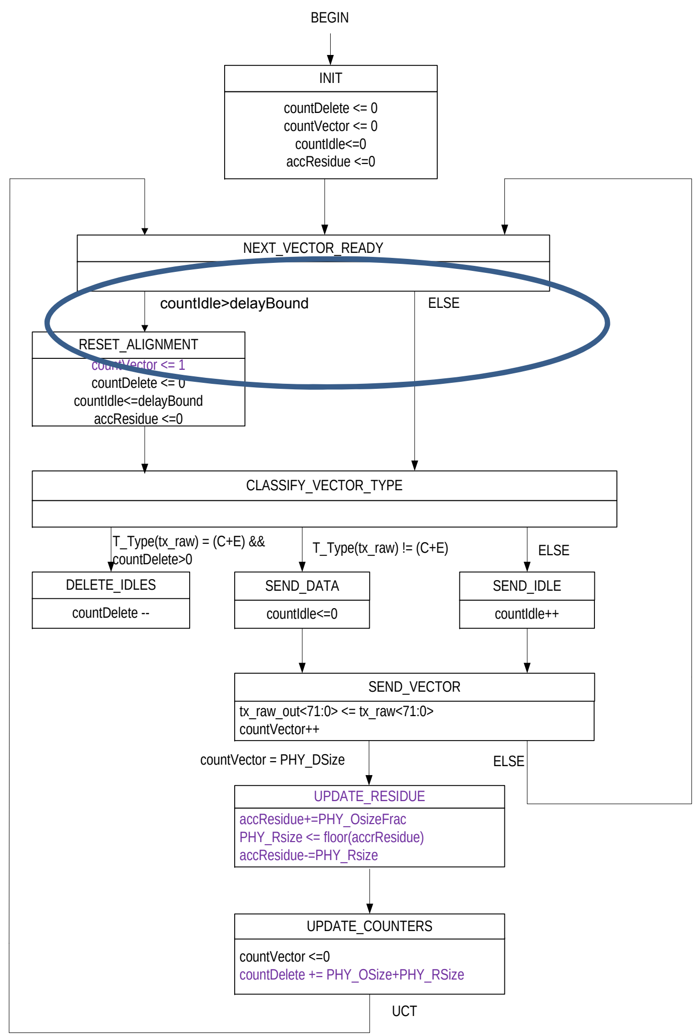
Burst Formation Issue

- Burst formation should be consistent for MPCP control multiplexer, Idle Deletion, and Data Detector.
- The condition is to count idle symbol (vectors) and compare it with threshold
  - For MPCP, the threshold is called ResetBound
  - For Idle deletion and data detector, it is called DelayBound.
  - A simple fixed threshold is desired for reasonable complexity.

Burst Formation at MPCP Control Multiplexer

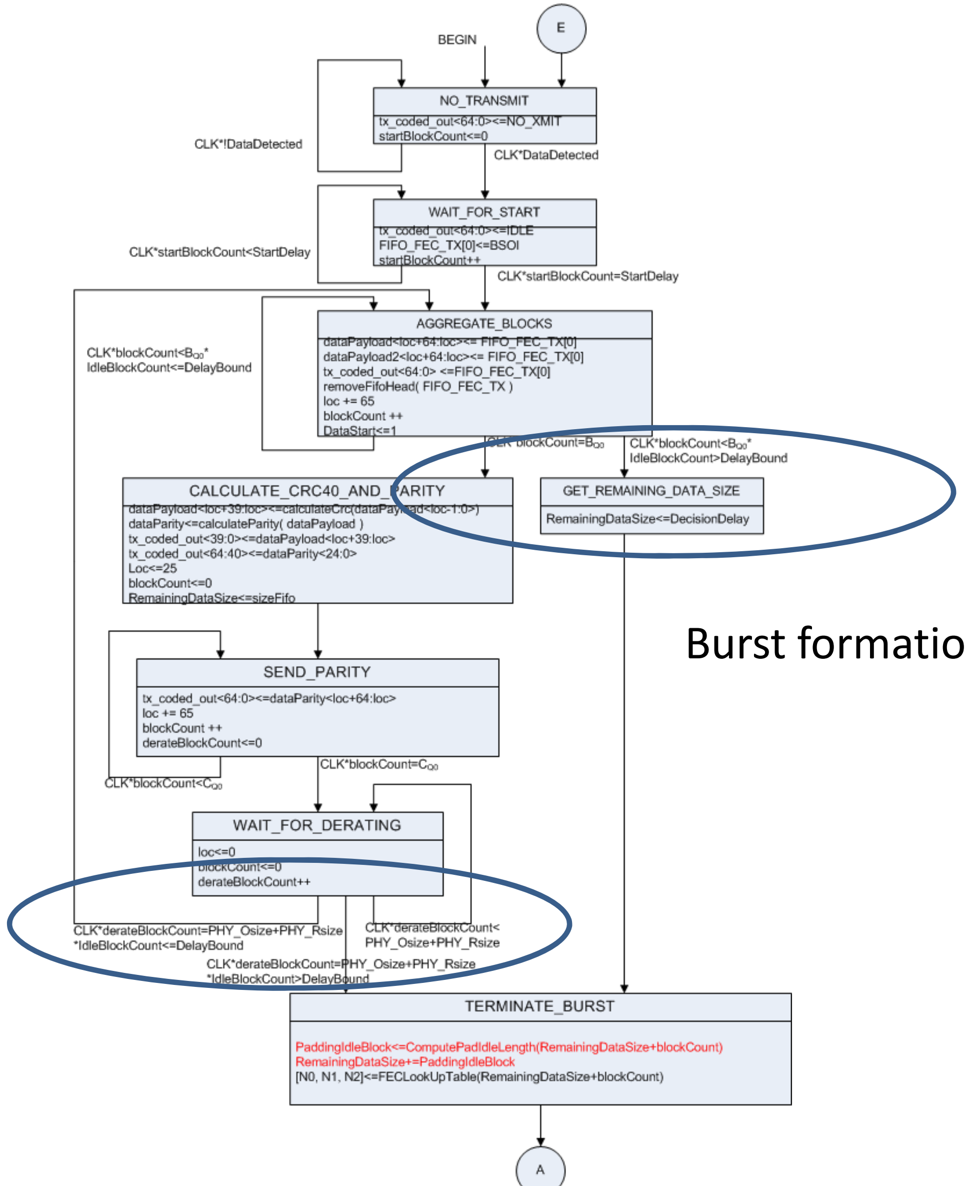


Burst Formation at Idle Deletion



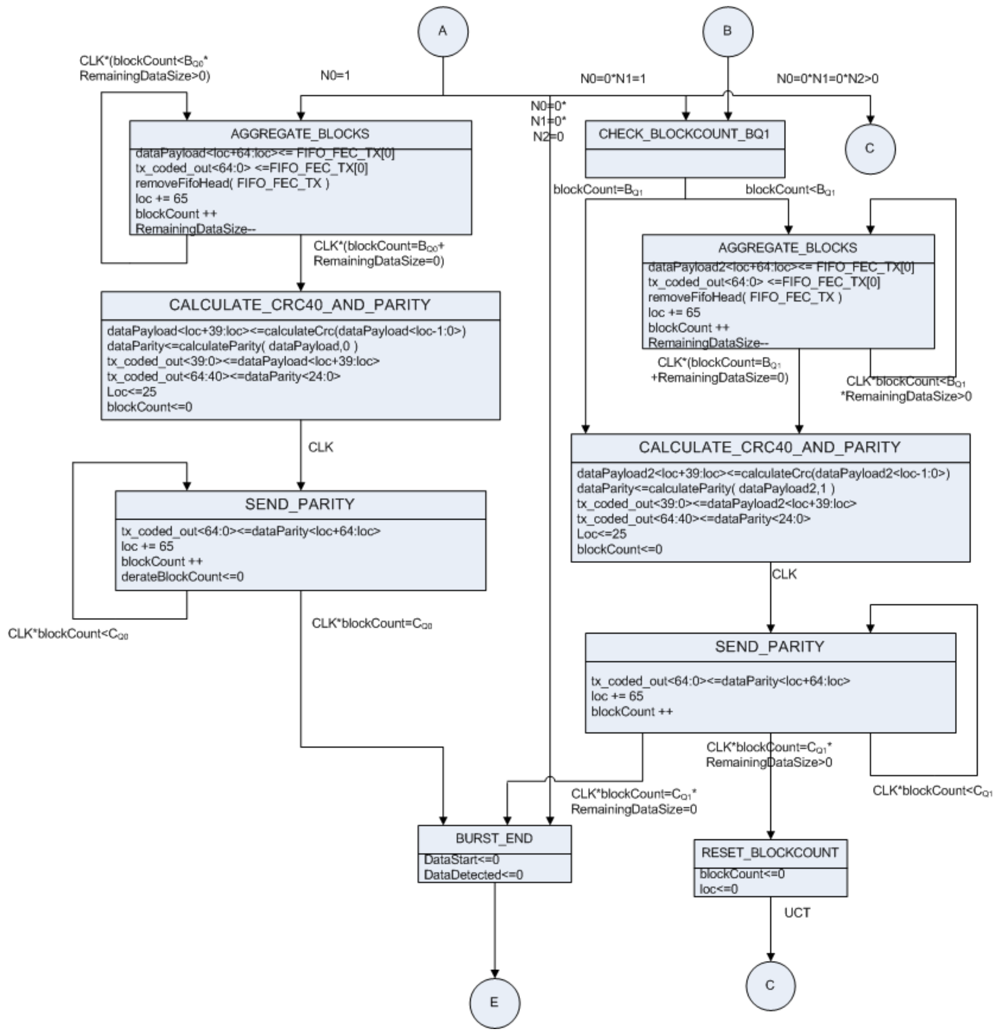
Burst formation condition

Data Detector Burst Formation (Tentative)

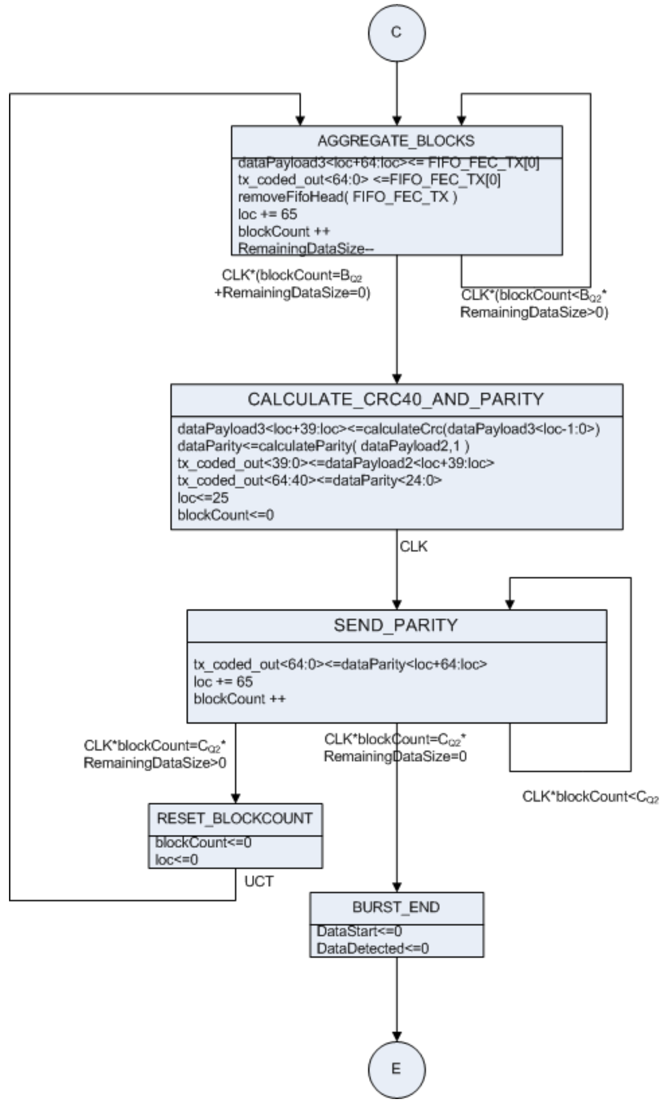


Burst formation condition

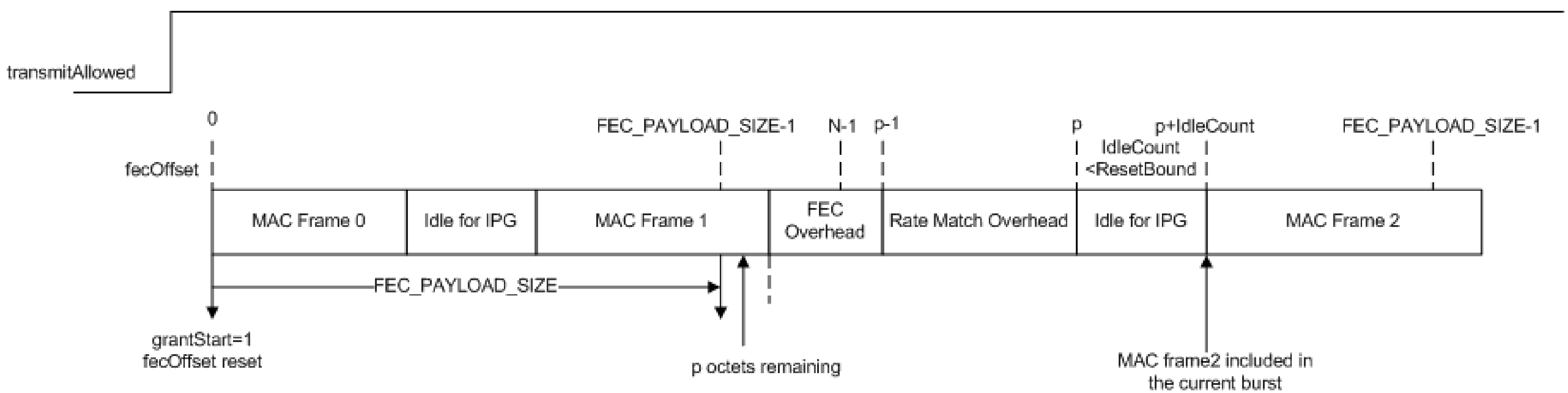
Data Detector Diagram with L-M-S FEC Code (II)

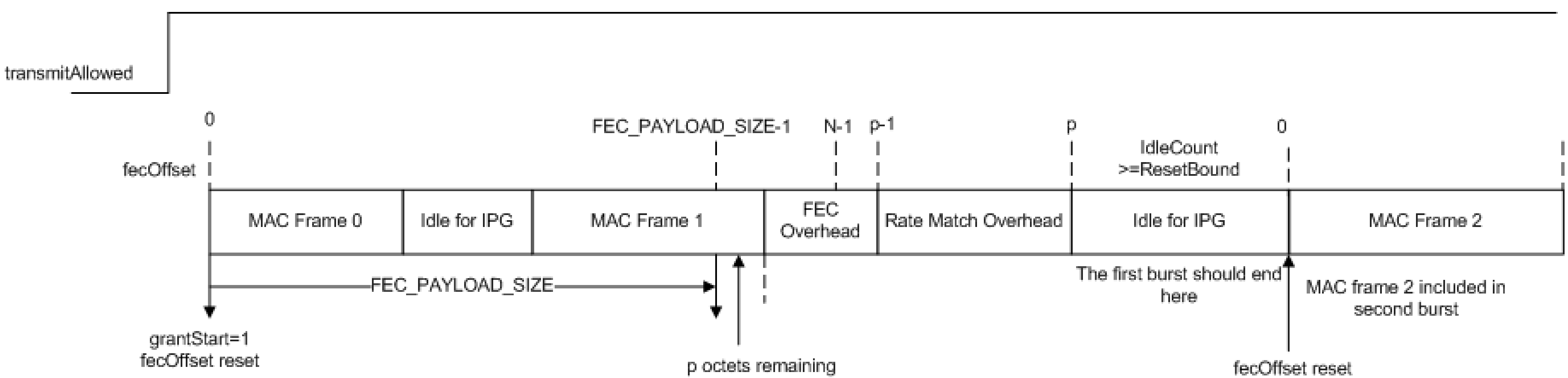


Data Detector Diagram with L-M-S FEC Code (III)



Example of Burst Formation at MPCP





Determine Dynamic Burst Formation Threshold

- Need to consider two parts:
  - Part 1: Cover the time used to transmit the remaining p octets from previous MAC frame

    p1 = f(p,β);//similar to CheckGrantSize function

    Should first decide how to transmit the remaining p octets, where 0<=p<FEC_PAYLOAD_SIZE
  - Part 2: an upper bound of the time used to transmit end marker and start marker
    - Worst case: p2=10 bits * (Number of REs for start and end markers)* β/8
- It is very complicated to implement the above function in three modules
  - Lots of additional branches in the state diagram for corner conditions in these three modules.
  - Might need to consider the worst case or upper bound
    - Worst case: the largest shorted long codeword need to be sent
  - The worst case essentially wipes out the benefit of multiple codeword.

Summary of Efficiency Result from Past Meetings and Conference Calls

- L-S vs LMS: LMS only has 10% advantage over 400~800 burst sizes.
- Peak efficiency:
  - M: 84% vs L: 88.6%
- M vs L-S:
  - M is 4.6% less efficient for long burst
  - M is less efficient than L-S for burst size < 400 bytes.
- Actual system efficiency difference is less than burst efficiency.

Conclusions

- The L-M-S scheme poses two major issues that become the bottleneck of the upstream PCS.
- It may take a fairly long time to verify the integrity of the state diagram with L-M-S scheme
- Use a single FEC codeword length as a basic option.
- We can still be able to use L-M-S scheme if later all state diagrams can be figured out.
- Use orthogonal burst marker to represent the FEC coding schemes.
  - This is a static configuration, not changing from burst to burst.

Straw Poll

- EPoC upstream shall include a single FEC codeword length as an option.

- Yes:
- No:
- Abstain: