November 8th, 2024

FEC for SCHC

draft-pelov-schc-fragmentation-fec-rule-format-00

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Presenter: Alexander Pelov

Agenda

1. What / Why FEC (context)
2. High-level idea
    1. Use-case: Smart Metering, Complement for No-Ack and others (fewer downlink messages)
    1. FEC Fragment Rule Format
    2. FEC-before-Fragment

Italgas rolling out 7,5 mln gas meters with SCHC in Italy and Greece.

What / Why Forward Error Correction?

1. Forward Error Correction
    1. On the PDU level, not on the symbols / bits level
2. In (very) asymmetric links, sending several uplinks to save a downlink can be (very) beneficial
    1. Reducing the number of total messages (uplink+downlink) can also be (very) beneficial
3. Two modes
    1. Ships in the night
    2. FEC before frag

“Ships in the night” – a.k.a. “SCHC FEC Rule Format”

- New Rule type - “FEC Fragment Rule Format”
  - It is linked (bound) to a classical Fragmentation Rule
  - The Fragmentation Rule is oblivious to the FEC Fragments
- Send Fragments as usual, then build and send a FEC Fragment ever *n* Fragments
  - Upon reception, FEC Fragments are used to recover missing Fragments

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  10: { [compression] },
  20: { [fragmentation] },
  30: { [fec],
    FragRuleID: 20,
    FECAlgorithm: xor,
    [DTag, W, FCN],
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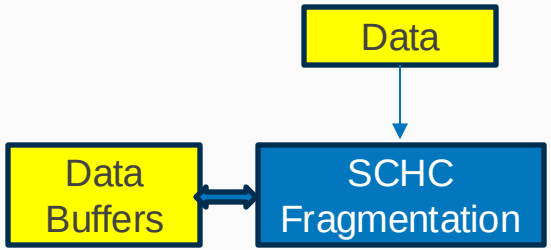


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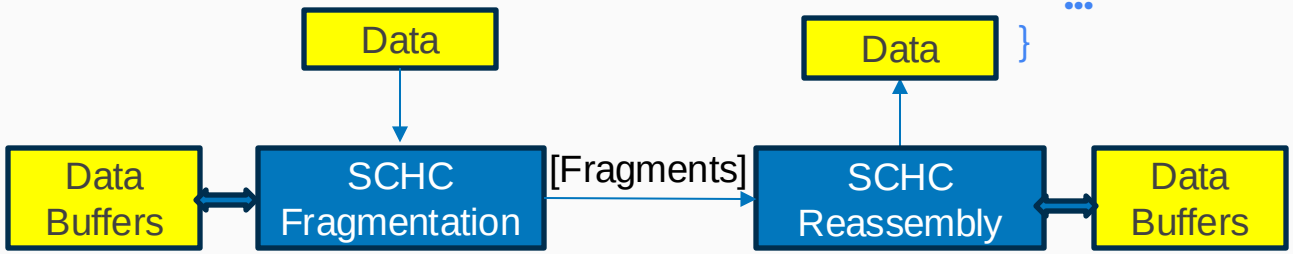

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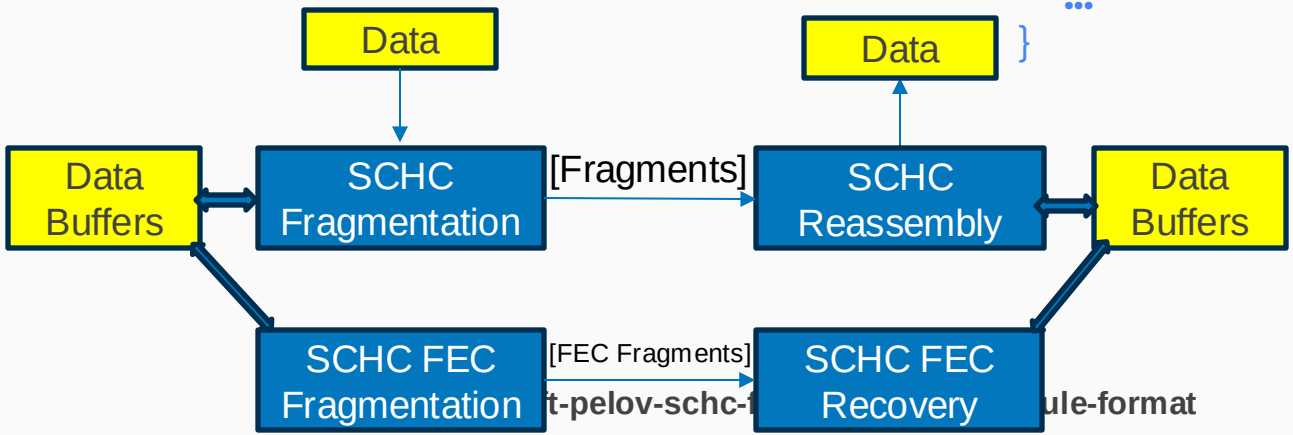

Fragmentation
MTU = 5 tiles

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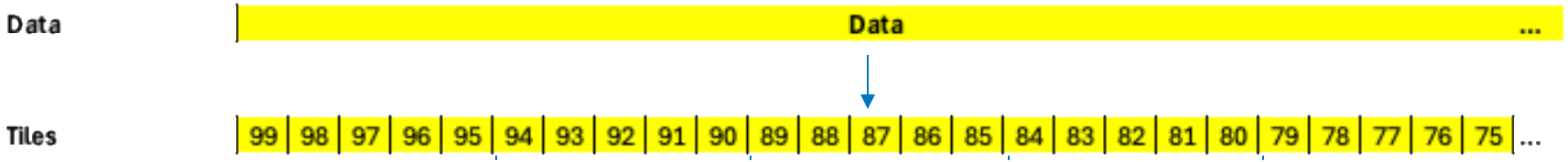

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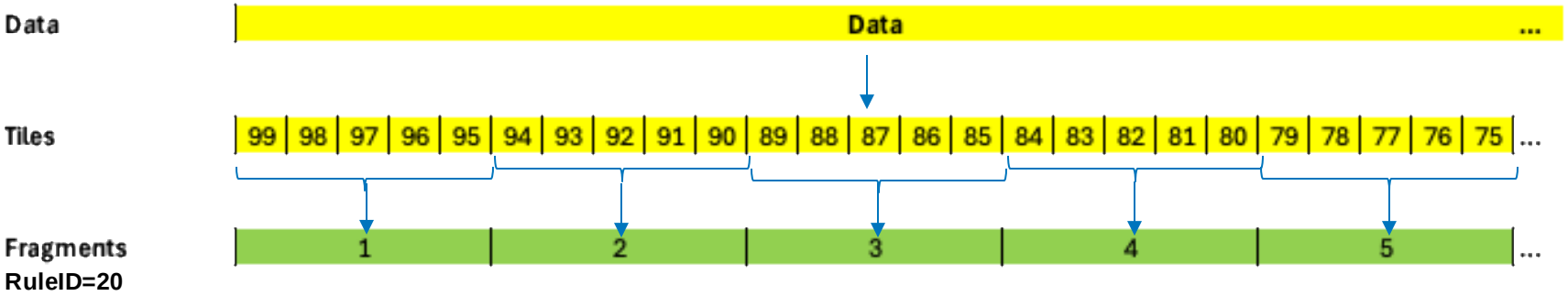
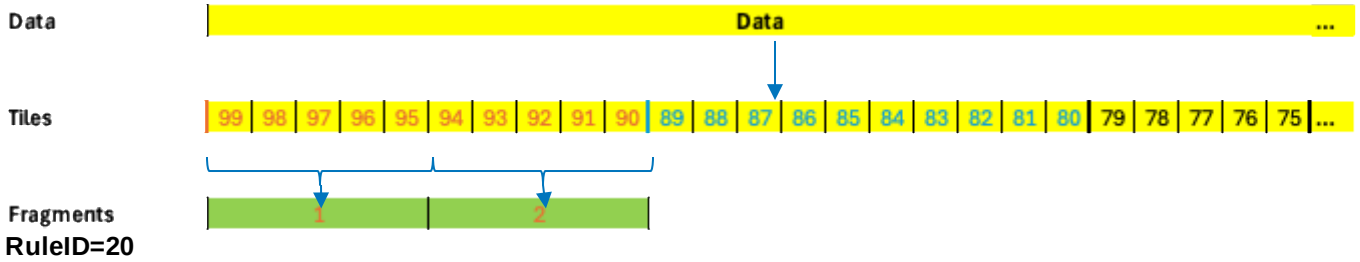


Fragmentation with FEC Fragments
MTU = 5 tiles, FEC Window = 10 tiles



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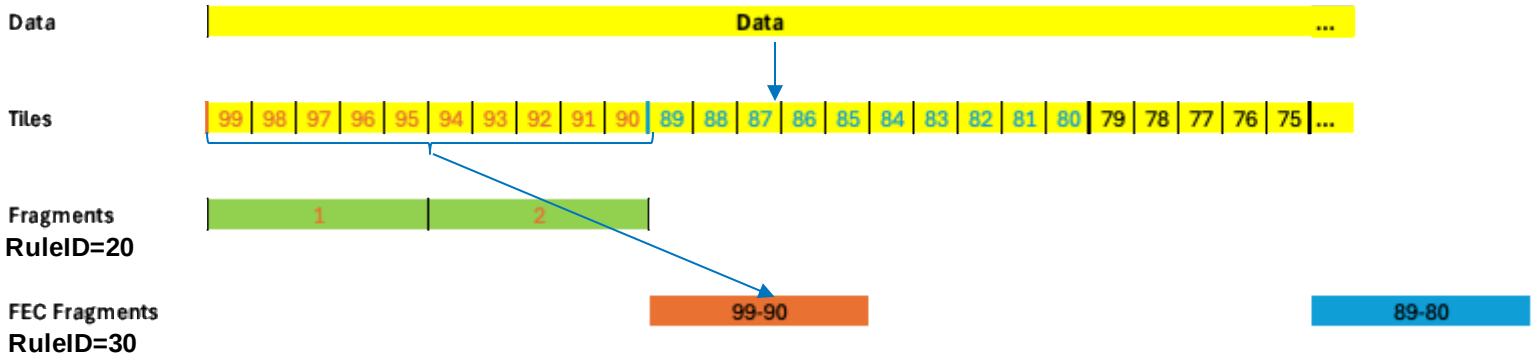

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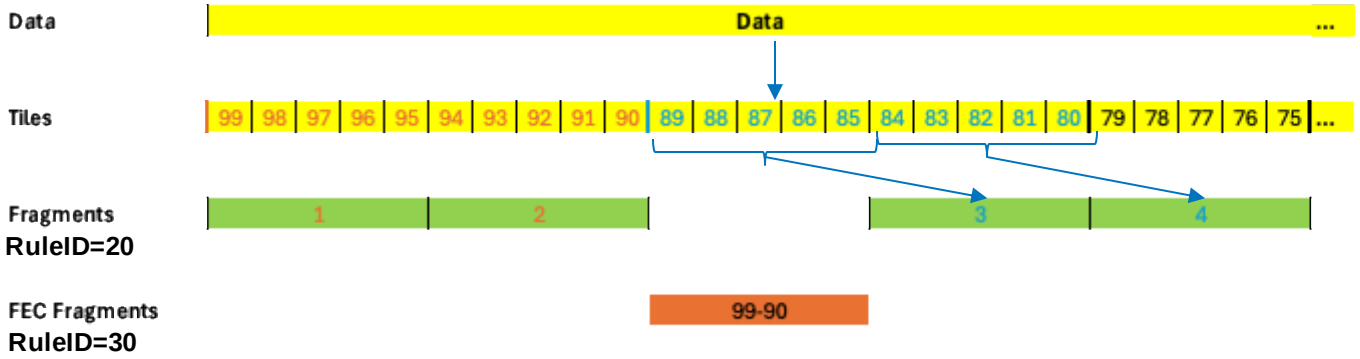

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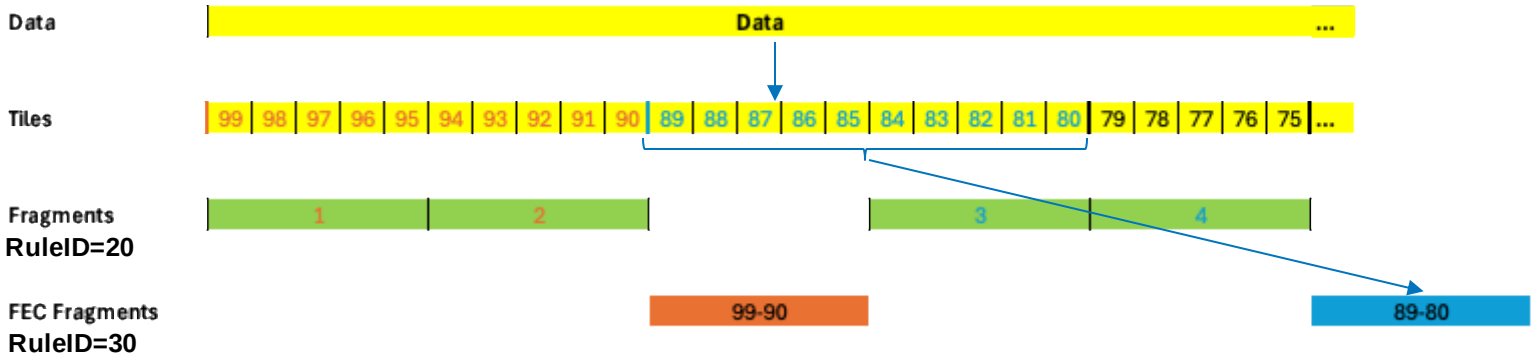

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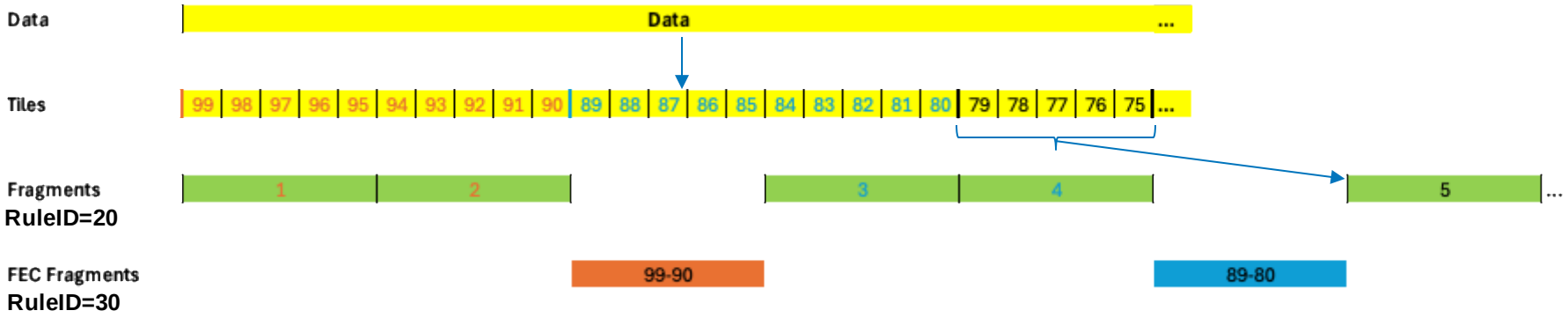
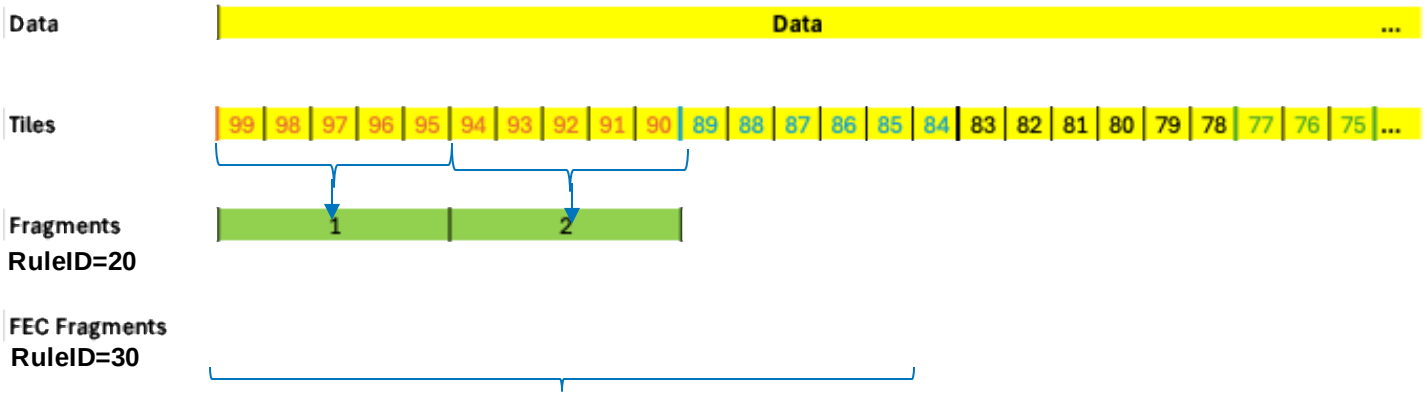


Fragmentation with FEC Fragments and MTU Change
FEC Window = 2xMTU tiles



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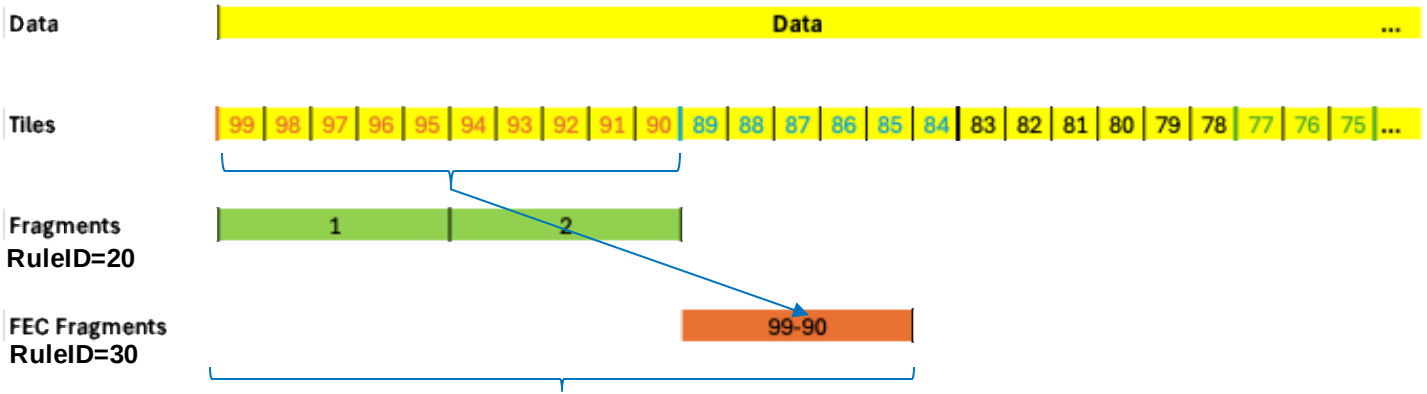

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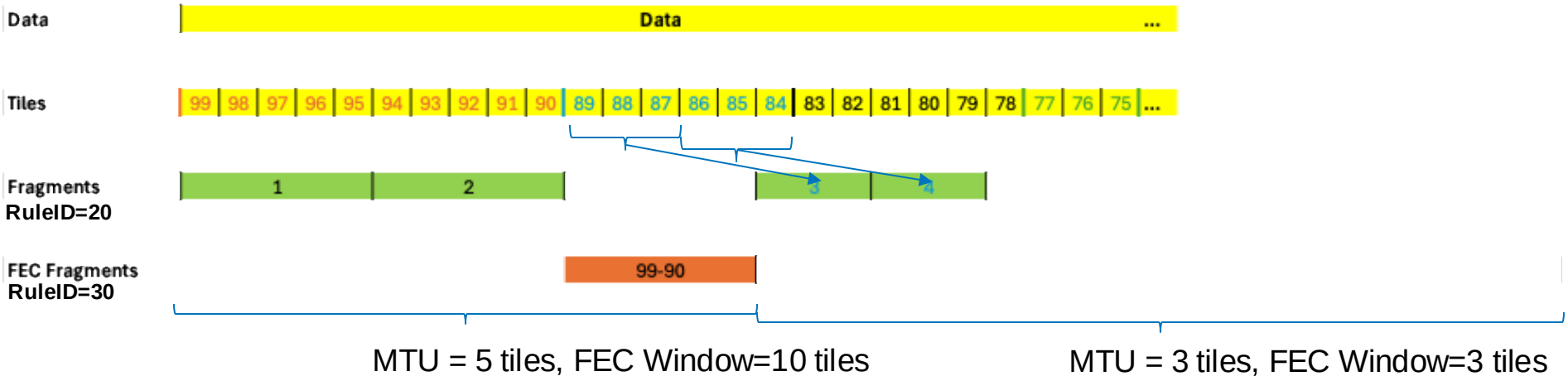

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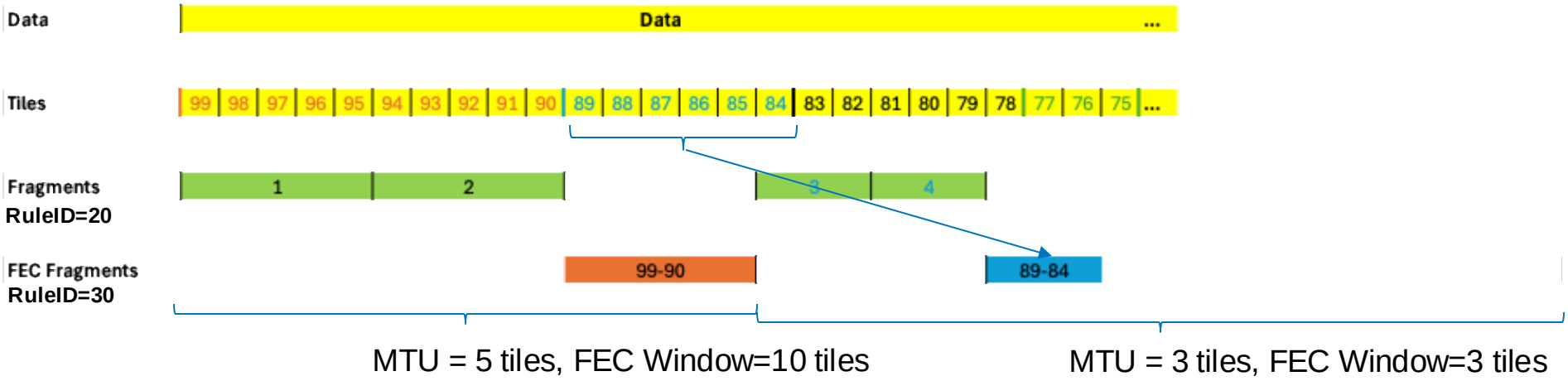

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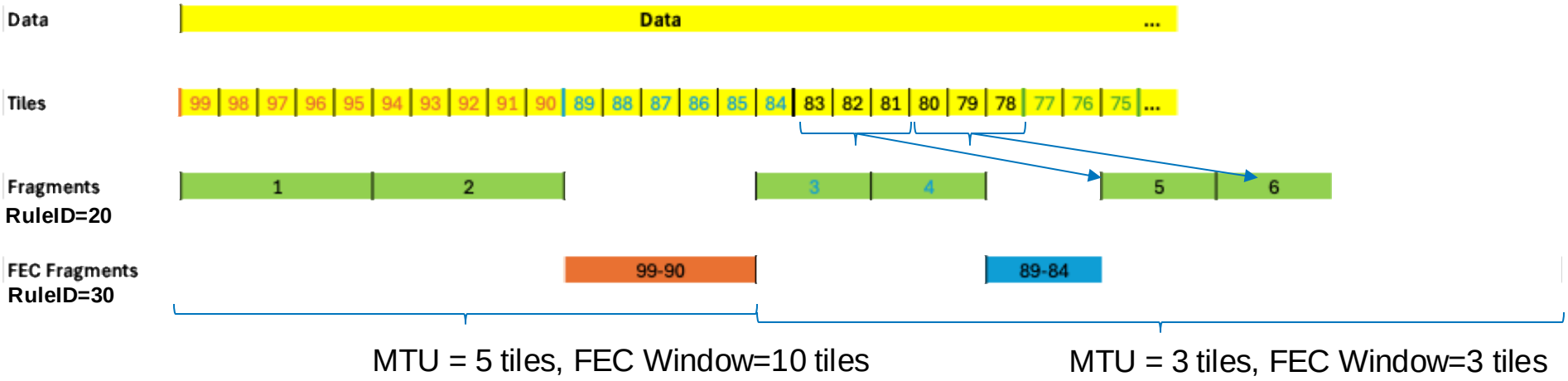

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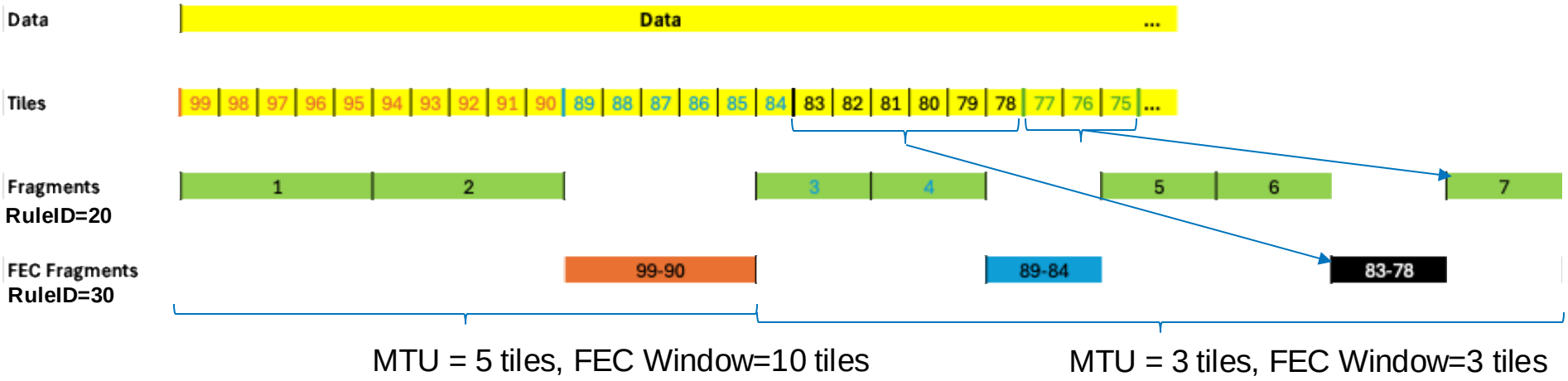
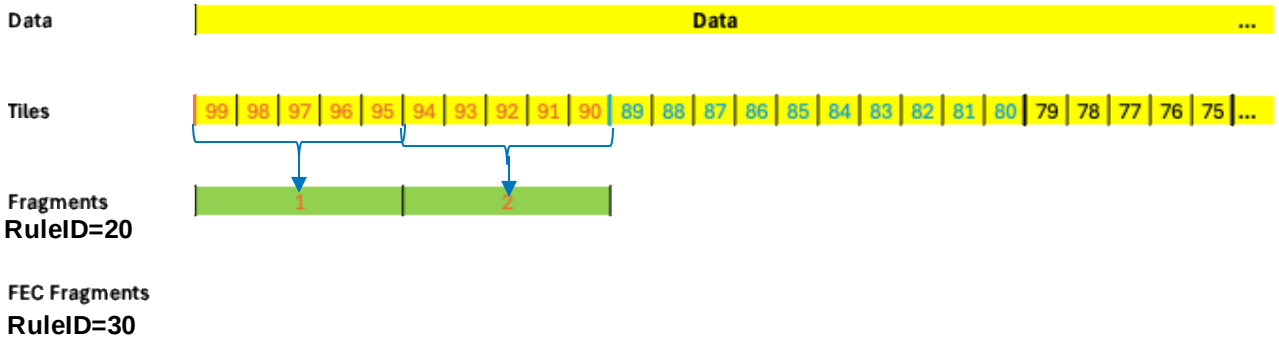


Fragmentation with FEC Fragments
FEC Fragments can be sent at any time



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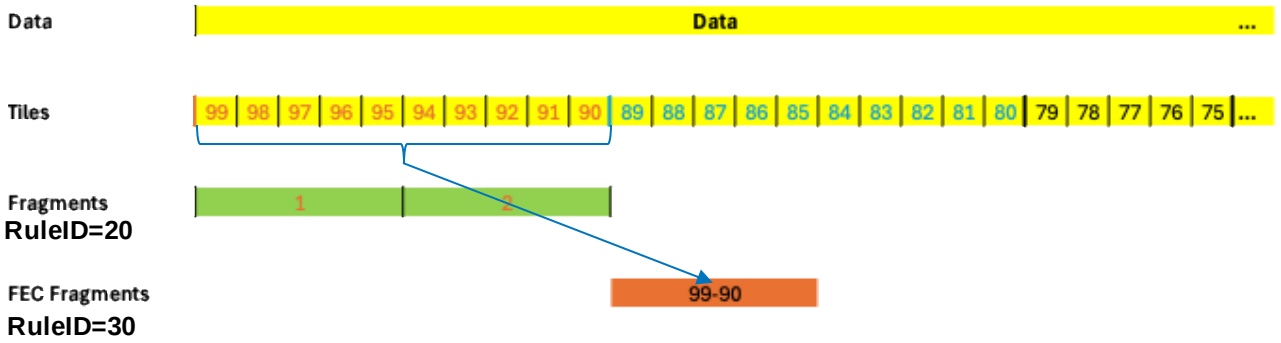

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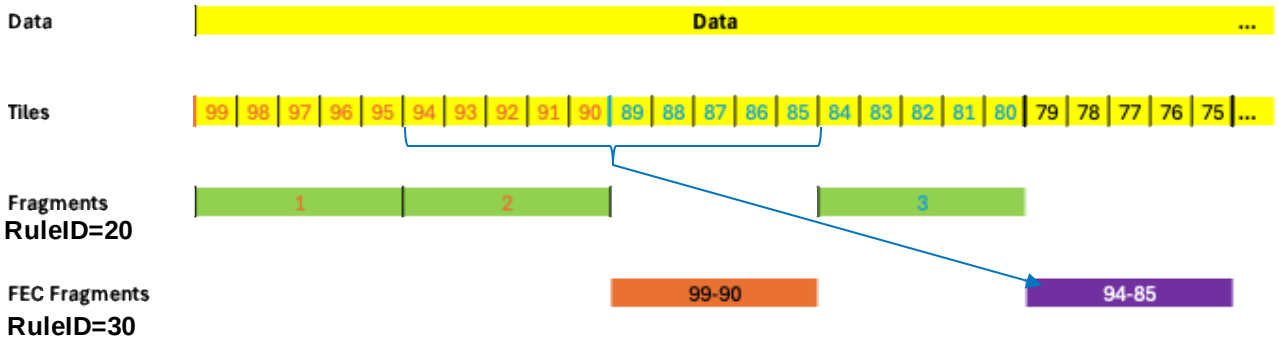

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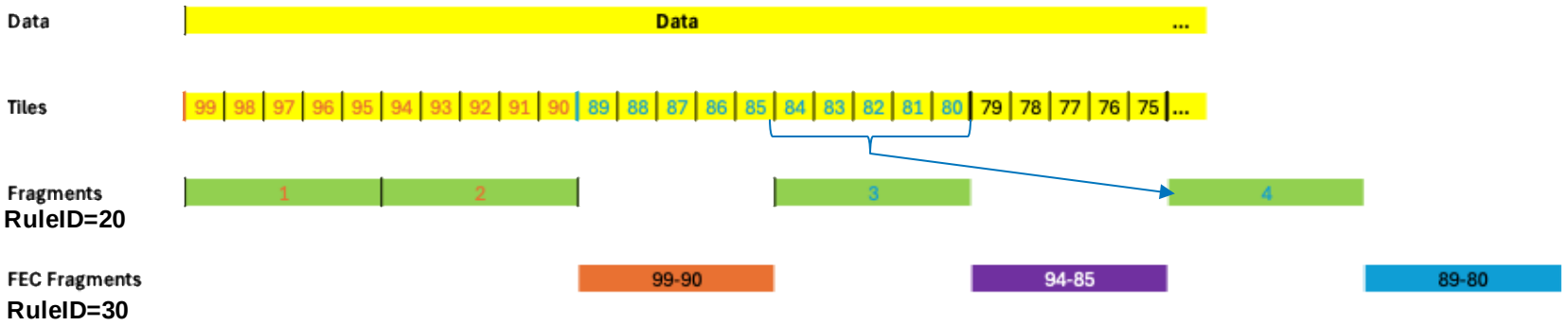

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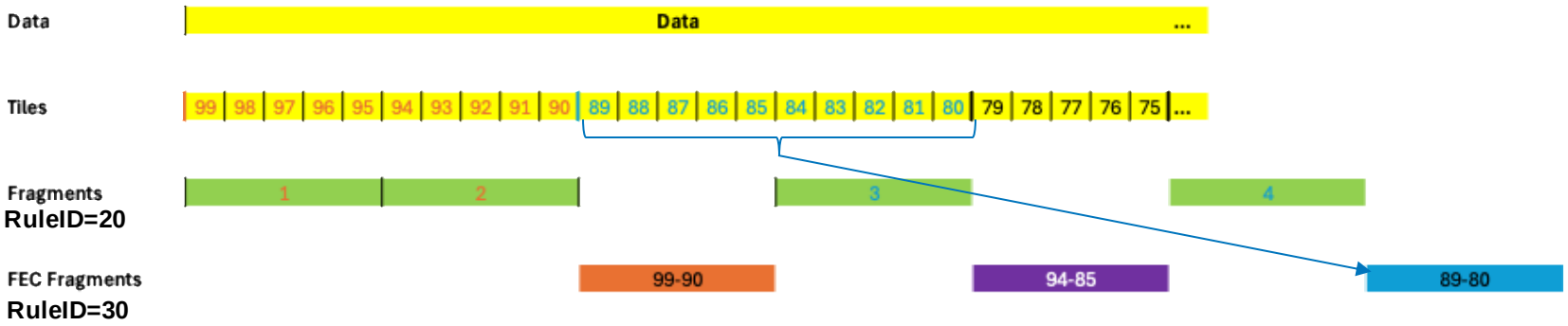
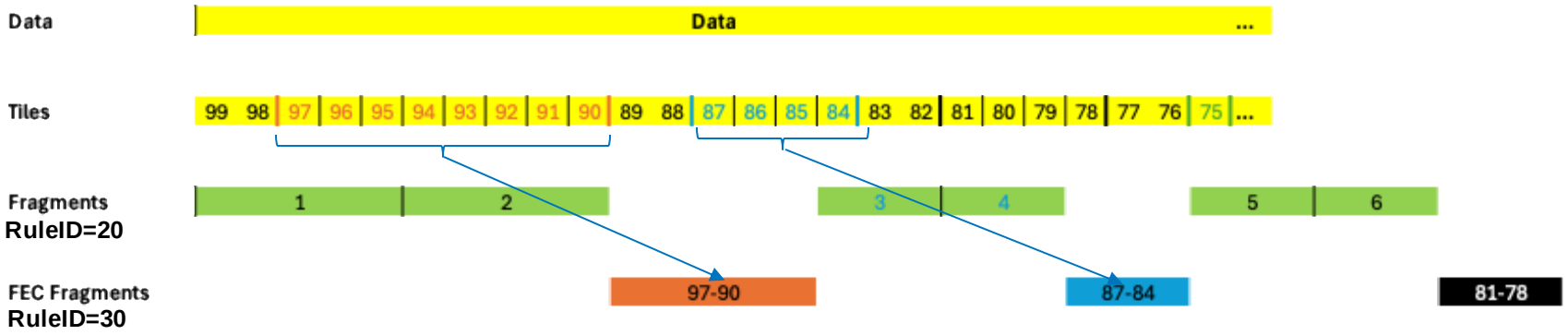
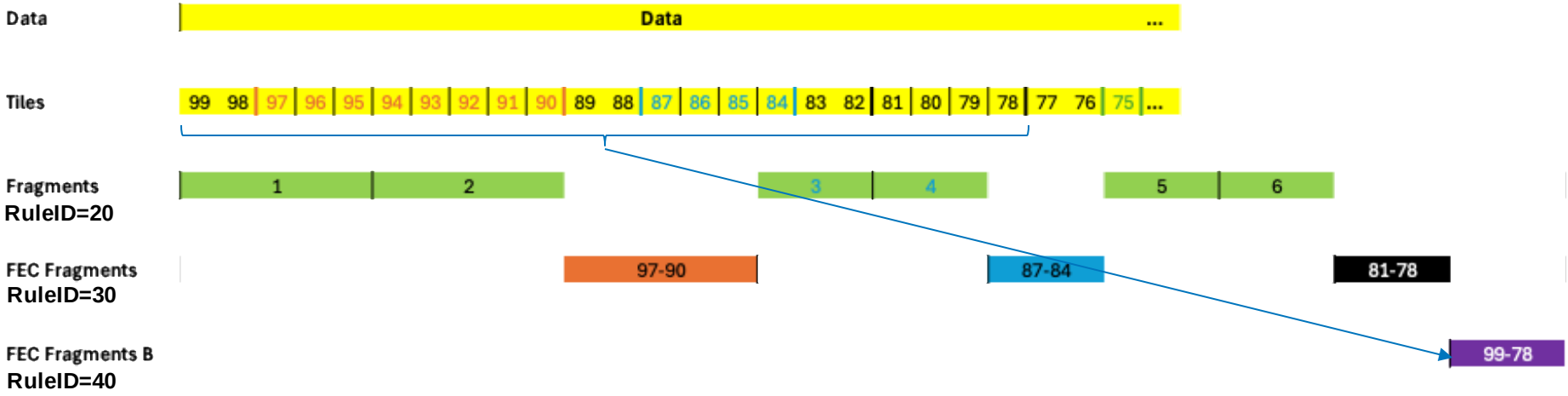


Fragmentation with FEC Fragments and MTU Change
FEC Window < 2xMTU tiles



Fragmentation with FEC Fragments and MTU Change
Adding Ships in the night – bound to the same base Fragmentation



“FEC before Frag”

- Apply FEC algorithm to data, then use existing Fragmentation modes to send the data
  - Requires adding a parameter to existing fragmentations - % of tiles necessary to consider reception successful
  - If received fragments carry more than % of tiles, OK
- From architectural perspective – FEC can be treated as a CDA
  - But then we cannot do SCHC Compression -> FEC -> SCHC Fragmentation
  - Consider the possibility to “chain” SCHC operations
    - SCHC Compression -> SCHC Compression (FEC) -> SCHC Fragmentation
    - Others?

RuleSet {
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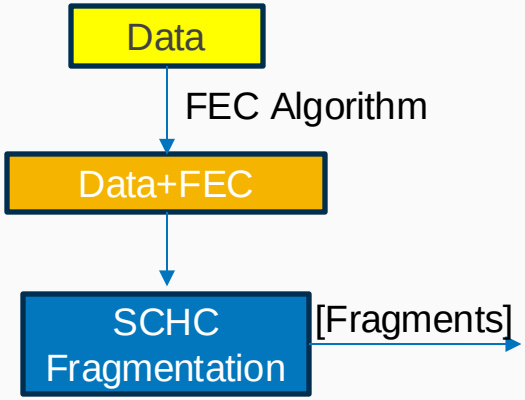

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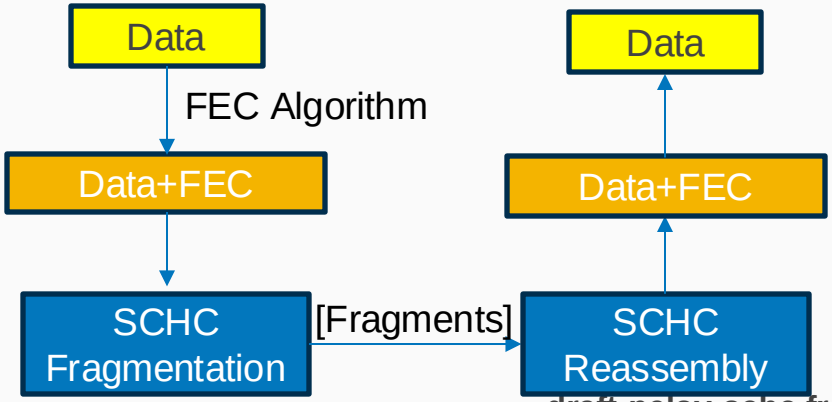

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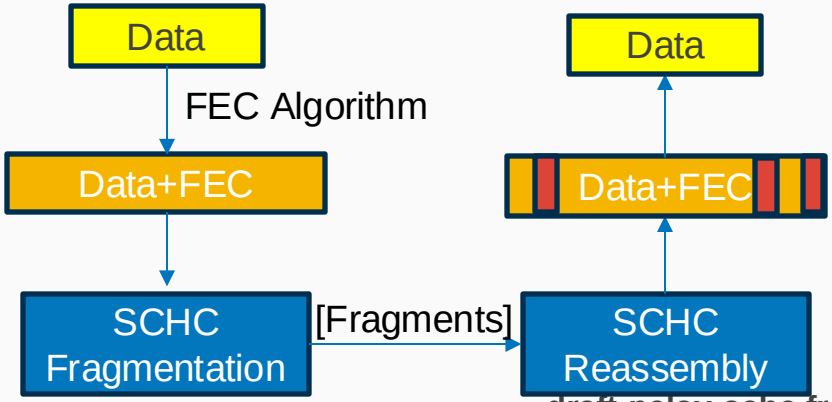

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“FEC before Frag”
Architecture considerations

- From architectural perspective – FEC can be treated as a CDA
  - But then we cannot do SCHC Compression -> FEC -> SCHC Fragmentation
- Consider the possibility to “chain” SCHC operations
  - SCHC Compression -> SCHC Compression (FEC) -> SCHC Fragmentation
- Alternatively, define new Fragmentation modes
    - E.g. Ack-On-Err-With-FEC
- Other approaches?

Ships in the night vs FEC before Frag

Ships in the night

Pros:

- ✓ Backwards compatible with RFC8724.
- ✓ Simple to implement – no change to fragmentation
- ✓ Less buffer memory on sender and receiver
- ✓ Flexible (can send FEC Fragments at any time)
- ✓ Can be used for reliability of small messages (TBD)

Cons:

- ✓ Need to specify FEC other than XOR
- ✓ Need to specify strategy when to send FEC Fragments (trivial exists, e.g. every 2 fragments)
- ✓ MTU change behavior suboptimal
- ✓ Accessing fragmentation buffer from FEC needs to be done with care

FEC before Frag

Pros:

- ✓ Simple to implement – minor changes to fragmentation state machine
- ✓ No need for FEC fragment emission strategy

Cons:

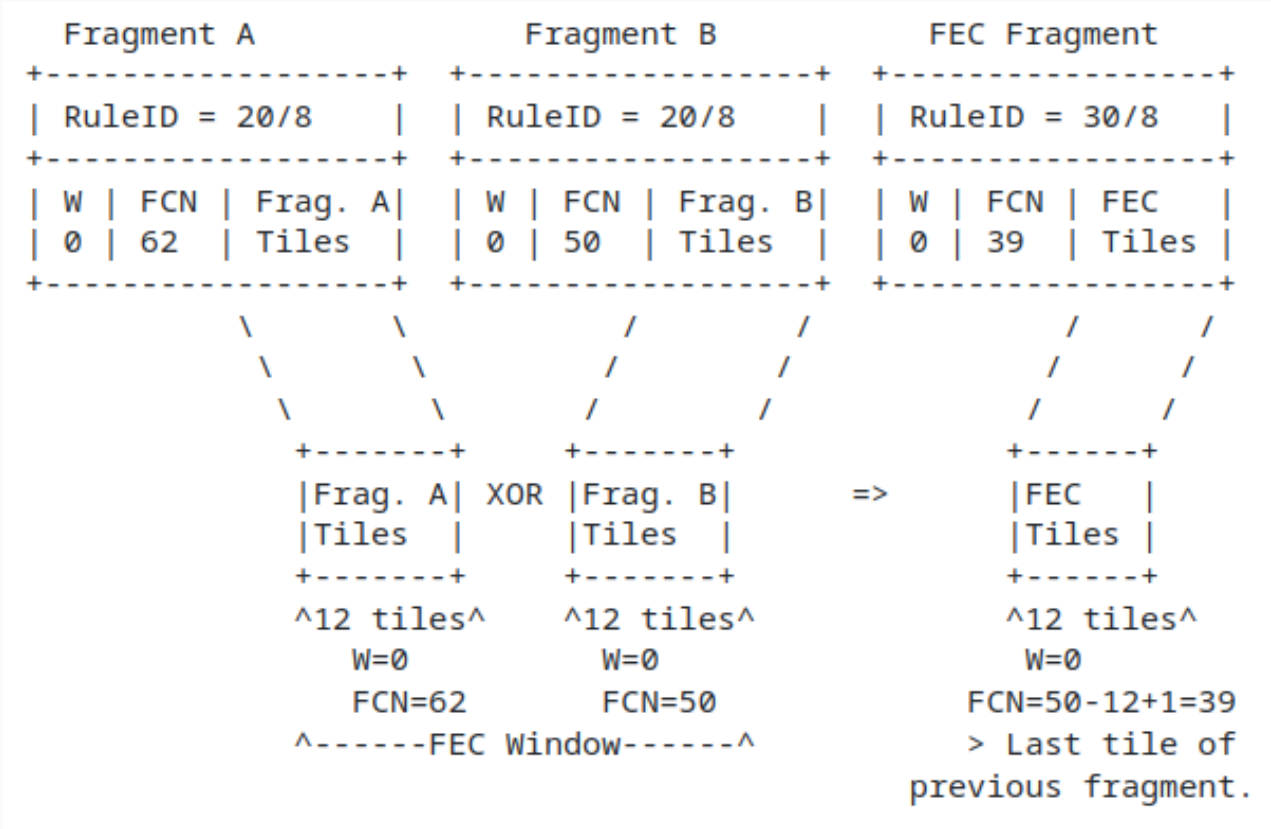
- ✓ Not backwards compatible with RFC8724.
- ✓ Need additional RAM for Data+FEC buffer
- ✓ Increased latency – necessary to receive all Data+FEC fragments before processing them

TODOs and Questions?

- Will change name of draft, as it has additional FEC mode
  - ”FEC for SCHC”
- Write YANG models for both modes
- Currently selecting FEC algorithm for “FEC before Frag”
- Specify use of “Ships in the night” for isolated small messages
  - Fragmentation used for Reliability
- Specification for NoAck, Ack-On-Error, Ack-Always
- Use-cases – need feedback
- Running code

- Questions ?

FEC Fragment Rule Format (draft)



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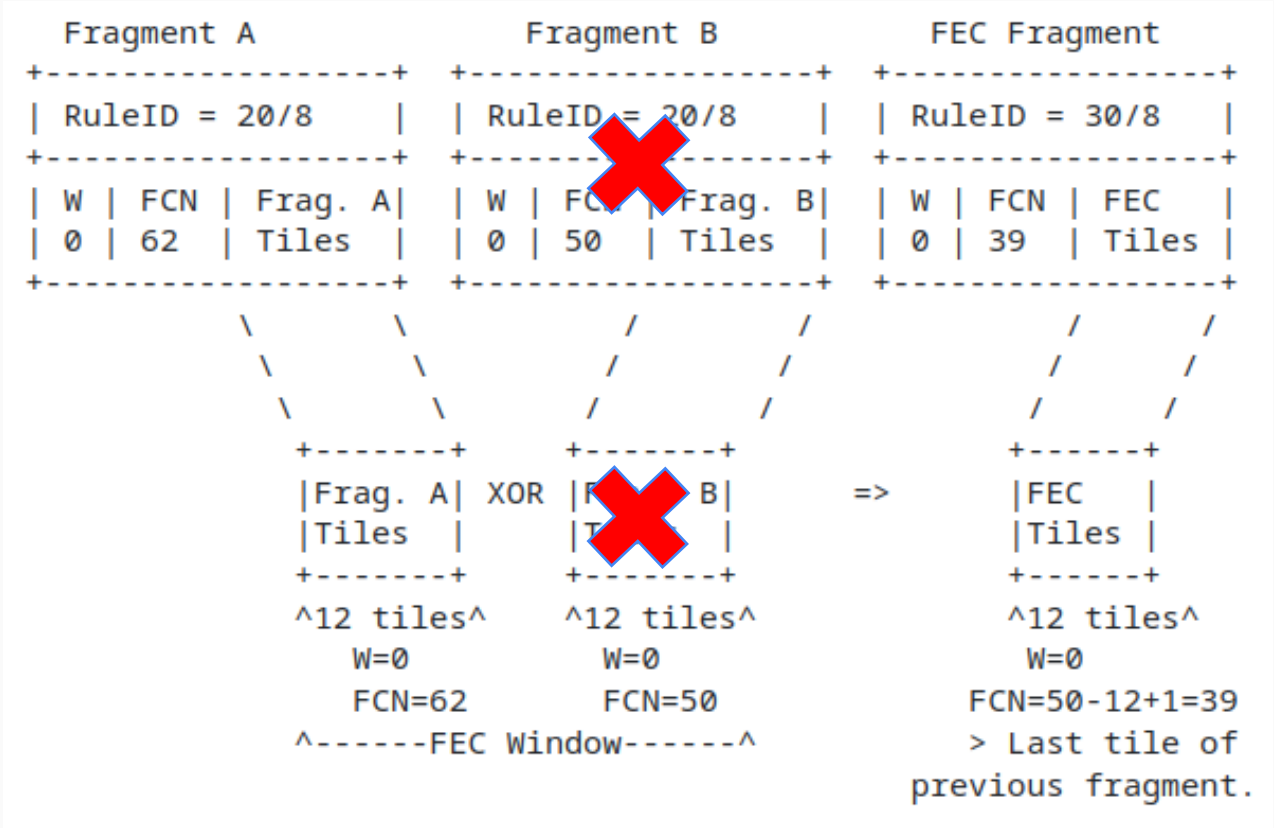

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