# Bursts: Creation, impact and shaping

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# Bursts and impact on latency


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|---|---|
| 1 | **How may bursts occur in TSN?** |
| 1.1 | Bursty sources |
| 1.2 | Multiplexing chains |
| 1.3 | Other causes? |
| 2 | **Experiment: Burst impact on CBR stream** |
| 3 | **Summary and examples on how to deal with bursts** |

## Background: Burst discussion on January 802.1 meeting

- How may bursts occur in e.g. a fronthaul network?
- How may bursts impact the delay of traffic streams?
- Do we have an example on how the scheduler of a typical bridge may behave in real life?
  - How deterministic are the scheduling of the packets?

# Self queuing

- Self queuing in 802.1CM
- Lower figure shows non-guaranteed order among ports
- Experiment: How are packets scheduled in a bridge?
  - What is the Frame Delay Variation (FDV)?

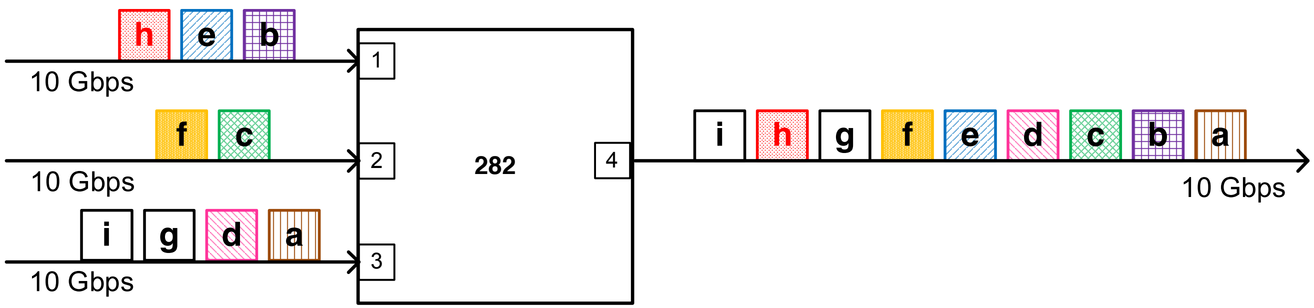


**Figure B-1—Self-queuing in case of assured time order among Ports**

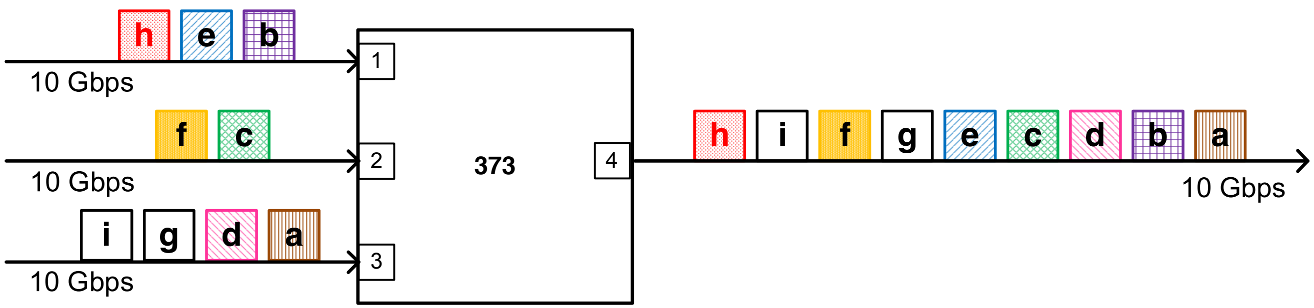


**Figure B-2—Self-queuing in case of non-guaranteed order among Ports**

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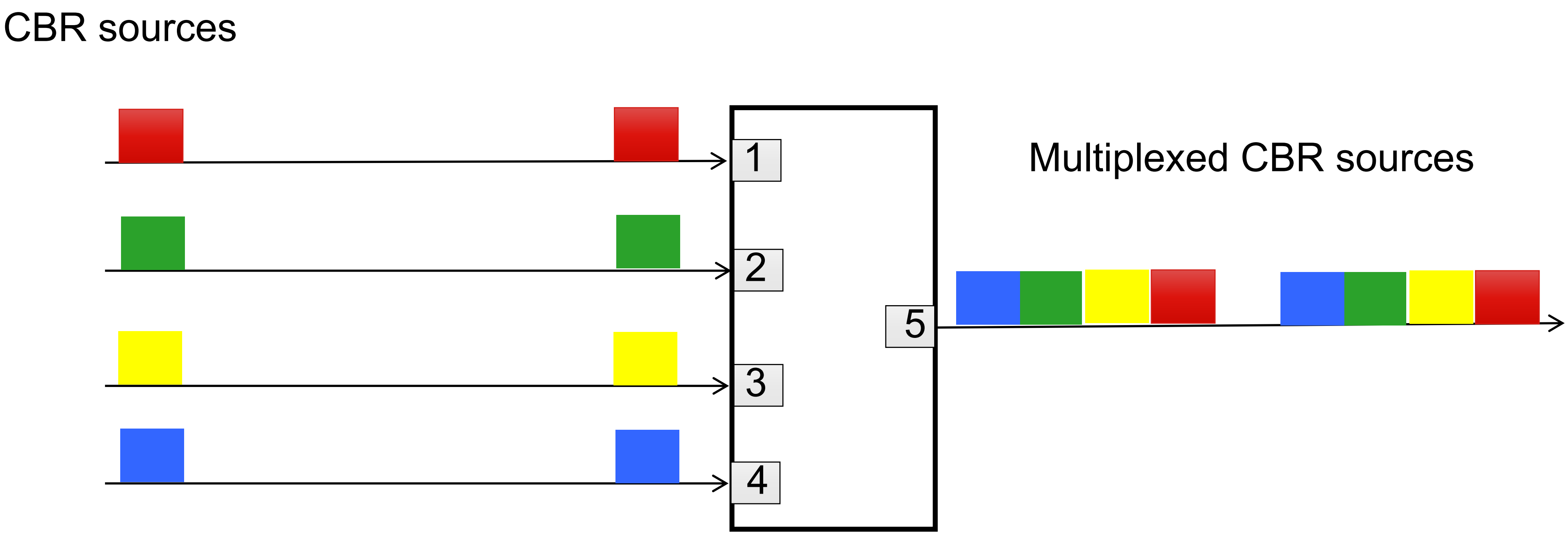
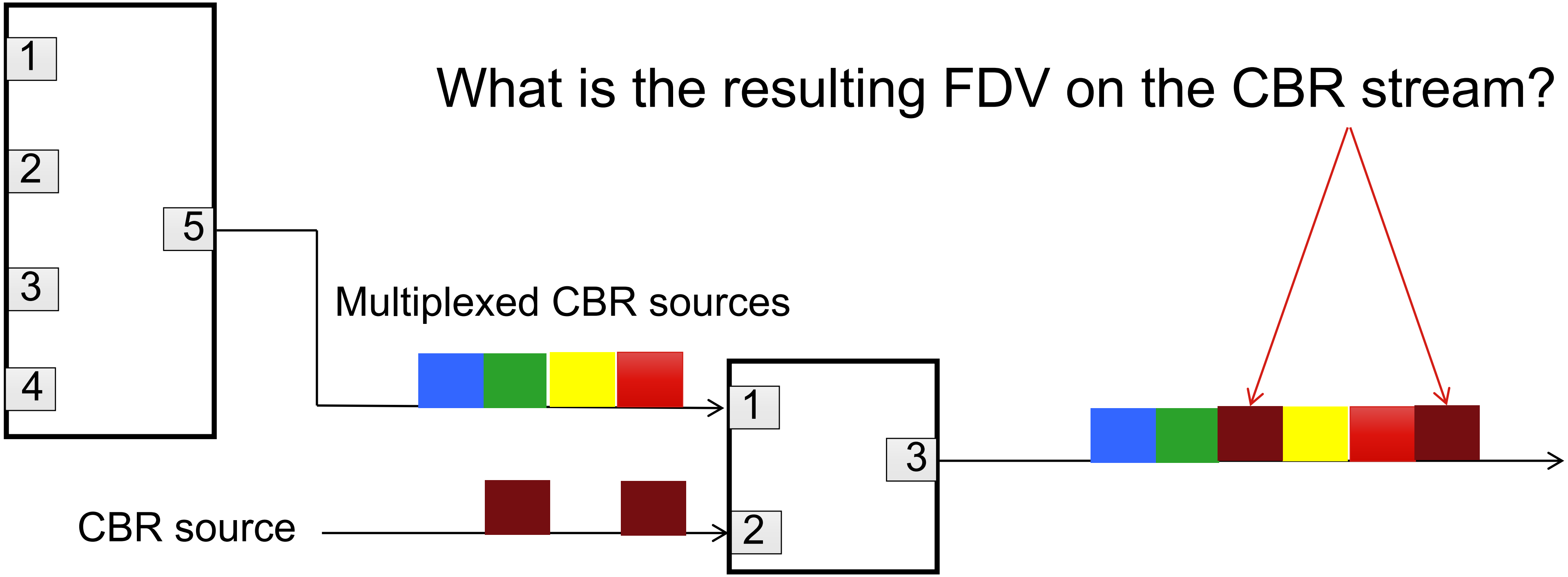
# How bursts may be created: Examples

- Bursty source
- CBR sources being multiplexed



## How bursts may be created: E.g. multiplexing chain

- Burst first created by multiplexing CBR traffic sources
- Burst is then multiplexed with a CBR source (or multiplex of these), CBR sources may have different rates
- Results in an extended burst
- Target of experiment: Find the latency impact on the CBR stream multiplexed with a bursty stream

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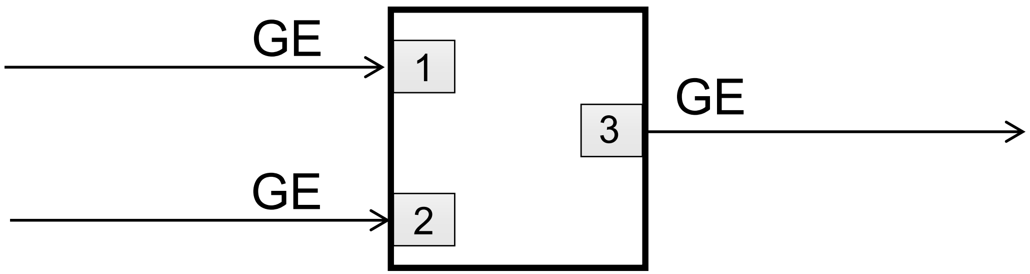
# Experimental setup: Self-queuing

- The experiment is only one example of performance and bridge behavior
  - Performance depends on scheduler implementation
- Performance is likely to vary between different type of bridges
- Typical 1U Ethernet bridge from well known bridge vendor
  - 48 x GE interfaces and 4 X 10GE interfaces
- Experimental setup
  - Two GE streams multiplexed into one GE output stream
  - Measure FDV on CBR GE stream for characterization of how deterministic the scheduler behaves

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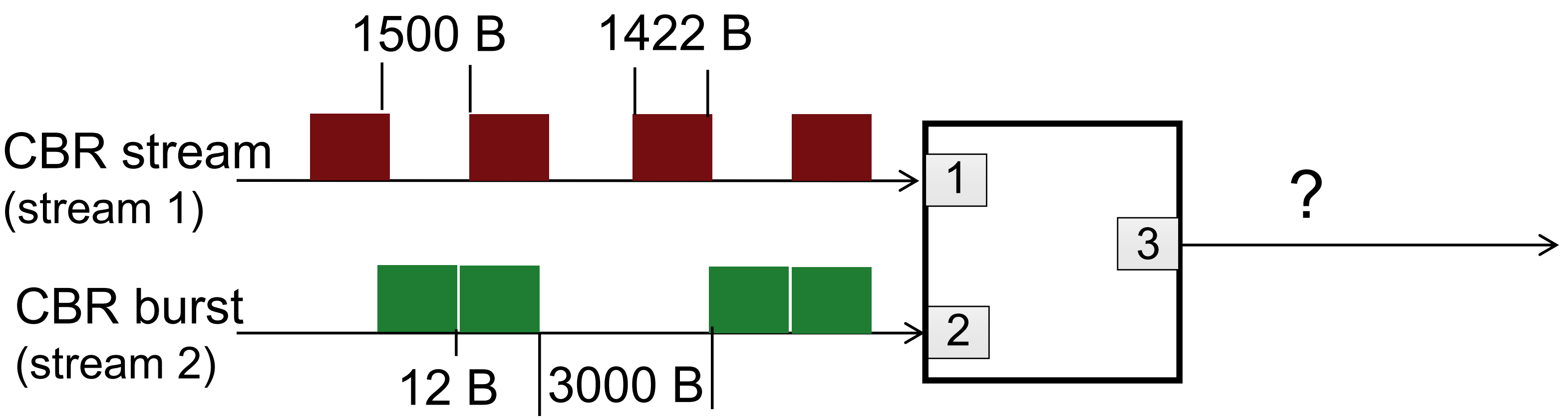
## Experiment: Measure impact on CBR stream (stream 1)

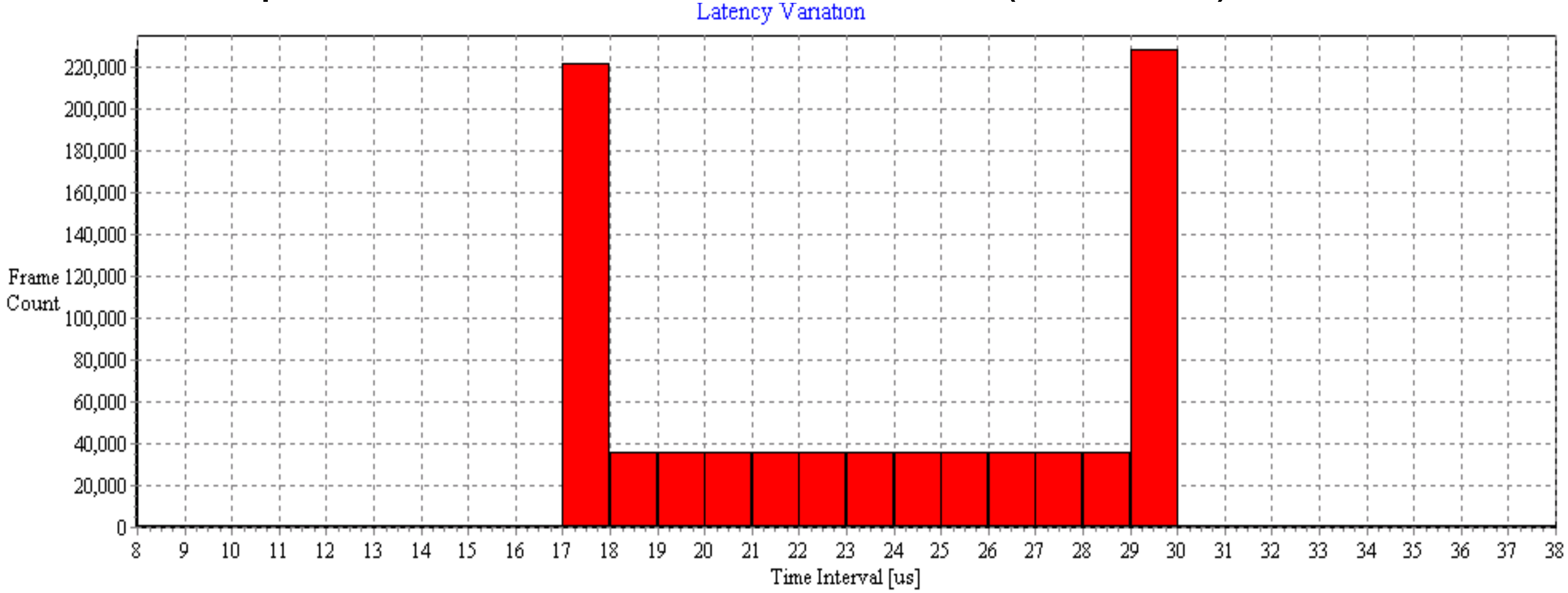
- How does the burst impact the FDV of the CBR stream?
- 1400 Byte of data in all packets (+ 22 byte overhead)
- Two streams at approx. 49 % load each
- Stream 1: CBR stream, 1500 Byte gap between frames
- Stream 2: CBR burst
  - Varying number of frames in burst “b”
  - Gap between frames in burst (IFG) = 12 Byte
  - Gap between bursts (IBG) = b X 1500 Byte.

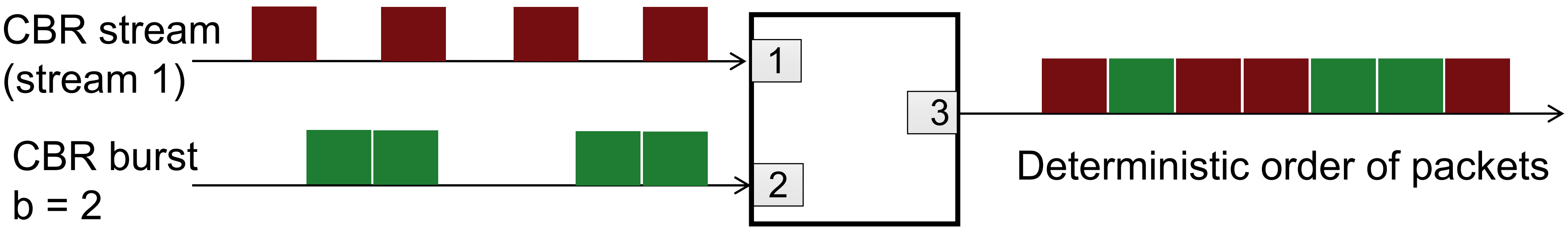



Example with burst length b = 2

# Experimental results b = 2: Deterministic scheduling

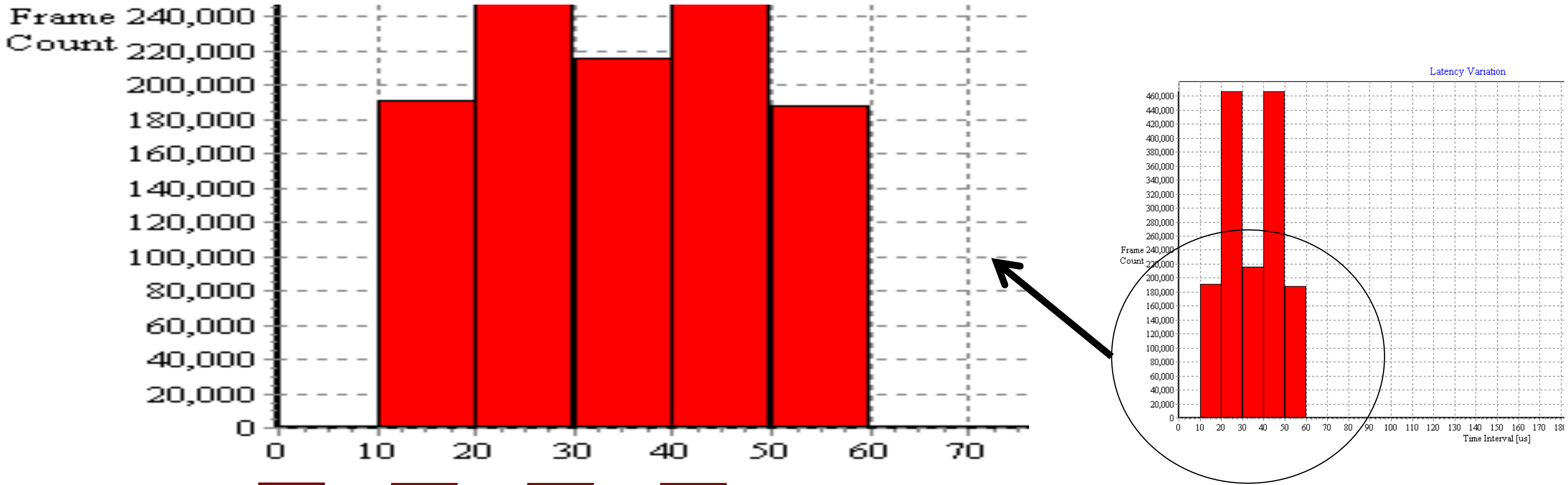
- Frame duration 12 us
- Measured Frame Delay Variation (FDV) = 13 us
- FDV corresponds to one or two frames from burst (stream 2) multiplexed in between CBR frames (stream 1)

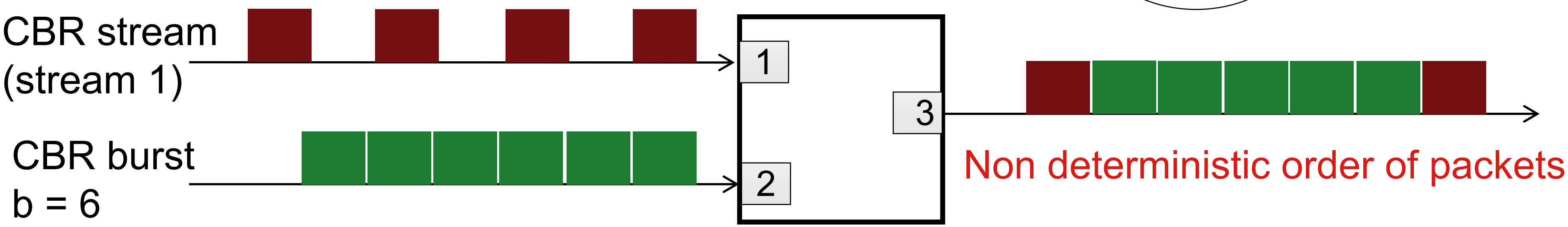


# Experimental results b = 6: Non-deterministic scheduling

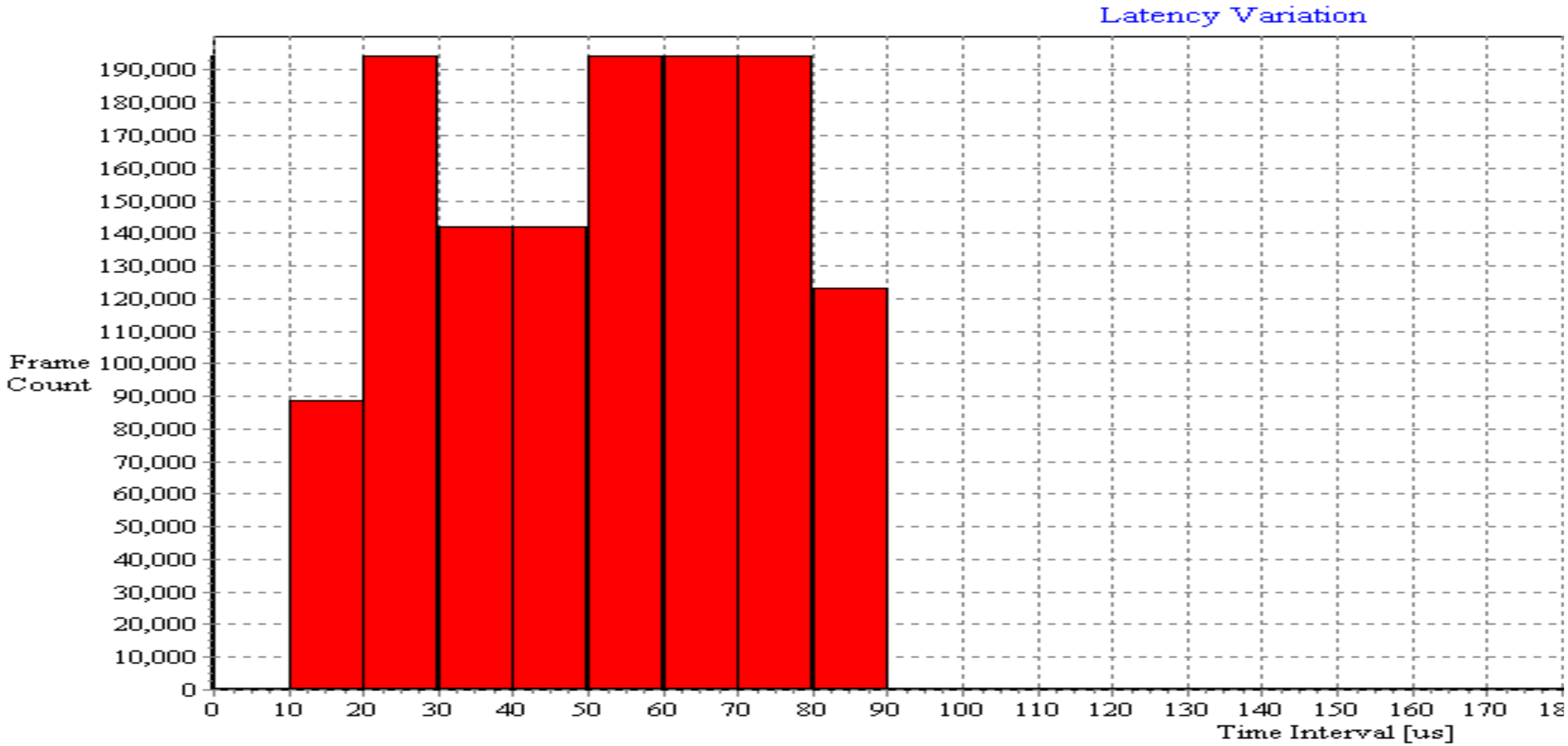
- Frame duration 12 us
- Measured Frame Delay Variation (FDV) = 50 us ( > 4 X 12 us)
- FDV value corresponds to five frames from burst *sometimes* multiplexed in between CBR frames



## Experimental results b = 12

- Frame duration 12 us
- Measured Frame Delay Variation (FDV) = 80 us
- FDV value corresponds to seven frames from burst sometimes multiplexed in between CBR frames

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## Summary of experimental results

- The results from the experiment should be seen as only one example of performance and behavior of a bridge
  - Results depend on scheduler implementation
- Order of frames within each stream is maintained
- Order among ports being served when a bursty stream is multiplexed with a CBR stream is not always deterministic
  - Bursty stream creates non-deterministic FDV on CBR stream
- FDV impact on CBR stream increases with burst length
- Creates non-deterministic latency characteristics

Do we need to cope with bursty streams?

## How to handle bursts - Examples

- Implement (and specify?) schedulers in bridges that serve ports in a deterministic way
  - Specification of FDV behavior may be required
  - Maintaining gaps in streams when aggregating streams minimizes FDV
- Shaper mechanisms in one or more bridges along a path smoothing out bursts, inserting gaps
- Minimize chains of multiplexers
- Minimize burst lengths from sources

Is there a need for new mechanisms and/or specifications?

# Deterministic scheduler for aggregation of packets

- Figure illustrates time-slot based scheduler for aggregation of packets
  - Sum of bitrate of aggregated streams < bitrate of aggregated stream
  - E.g. 10GE multiplexing into 100GE
- Ports are served in time-slots and round-robin
  - 802.1Qbv type of scheduler
  - Long bursts entering a port will be chopped in smaller pieces
- Packet gaps in stream preserved for minimizing FDV
  - Accurate reconstruction of stream after de-aggregation possible
  - Gaps in the streams are stored in the buffer together with packets