Preemptive Transmission advantages

Is it worth the effort?

Rev. 1

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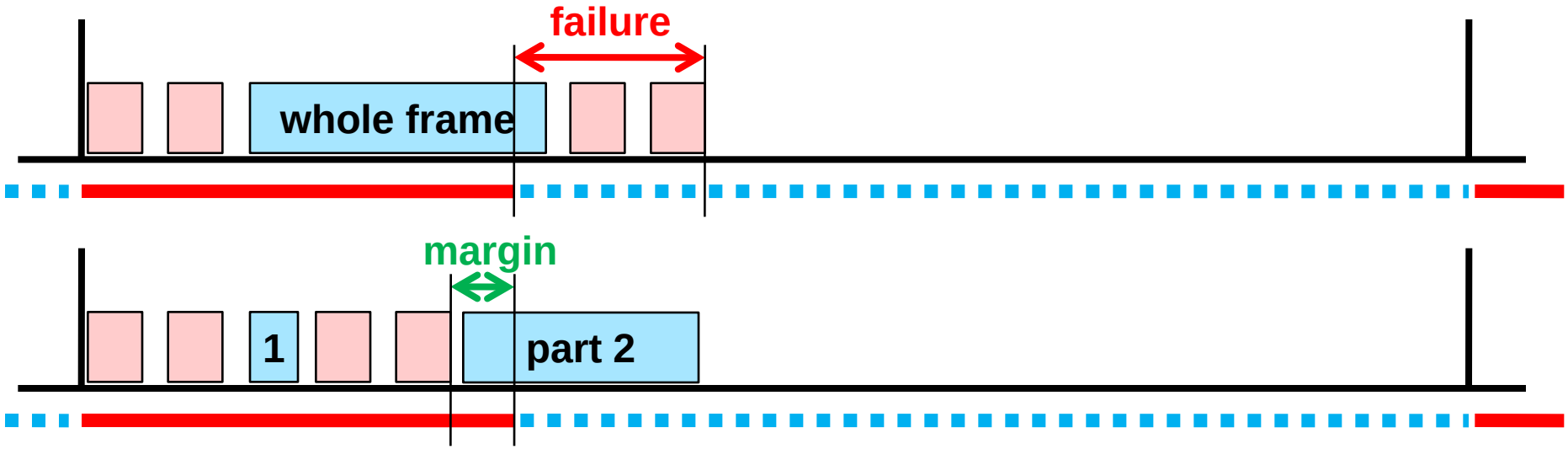
http://www.ieee802.org/1/files/public/docs2012/new-avb-nfinn-preempt-advantage-0112-v01.pdf

Scheduling is required for real-time nets

- The real-time network scheduling model is:
  communicate, **compute**, communicate, **compute**, ...

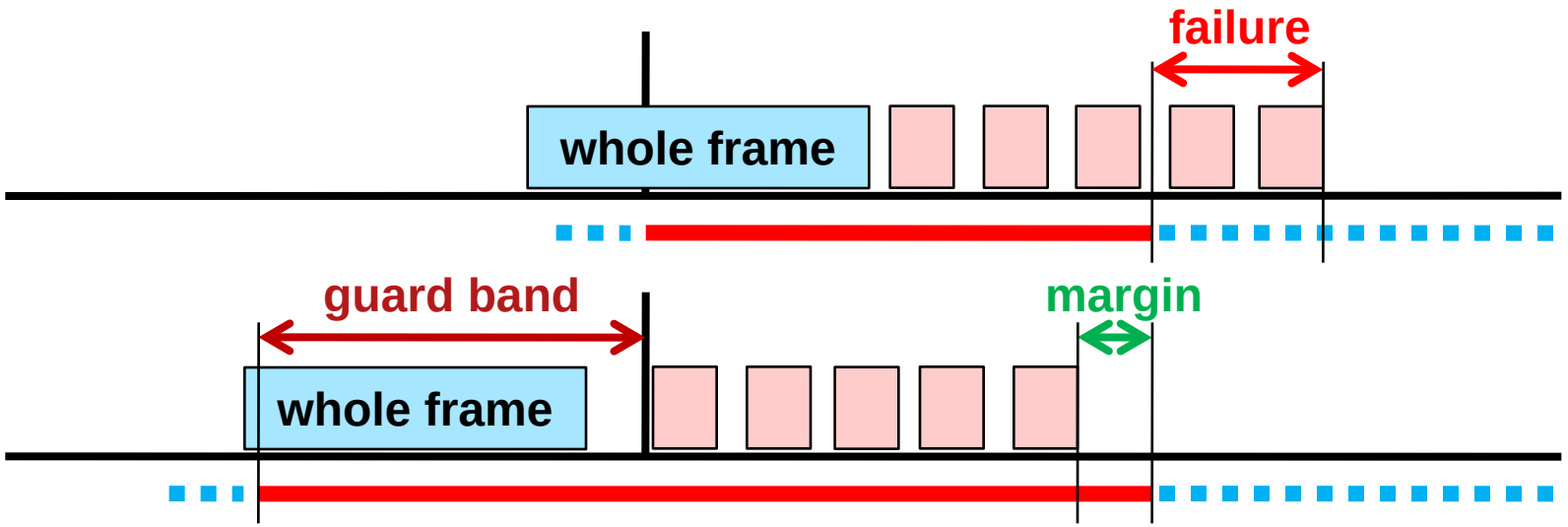
- Communication occurs at specified times.
- The timing is driven by the requirements of the critical application.
- Only by **strict scheduling** can we guarantee, **no matter what happens**, that we will respond to external events in a timely manner.

Preemption helps



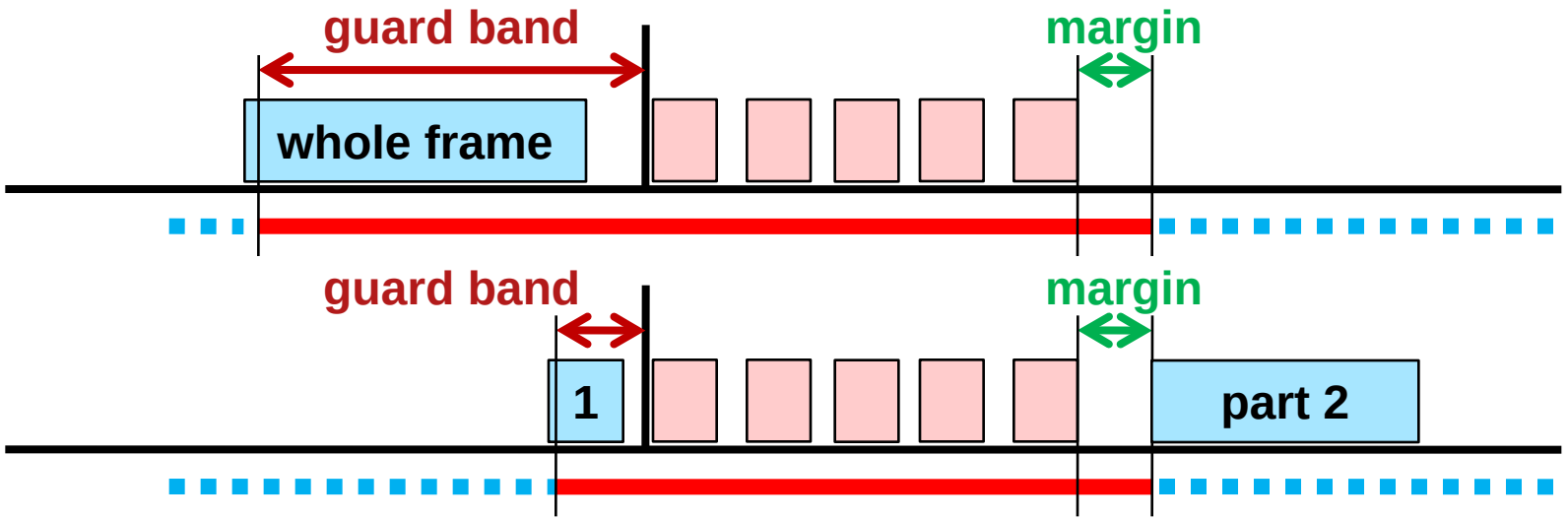
- Small gaps inevitably occur between critical frames because they take different paths through the network.
- Preemption prevents large non-critical frames from acting as a wedge to stretch out the critical communications period.
- Queuing delayed critical frames prevents excessive wedge insertion.

Guard bands



- If an interfering frame starts transmission just before the start of a reserved time period, it can extend critical transmissions outside the window.
- Therefore, a **guard band** is required before the window starts, equal in size to the largest possible interfering frame.

Preemption helps



- If preemption is used, the guard band need only be as large as the largest possible interfering fragment, instead of the largest possible interfering frame.
- It is easy to see that **the smaller the size of the time-reserved windows, the larger the impact of preemption.**

Some numbers

- Let us assume that the time-critical data frames are typically small, say 128 bytes.
- Let us assume that standard 1522-byte data frames are permitted for all other traffic.
- We will use the standard 20 bytes for preamble, start of frame delimiter, and inter-frame gap.
- Let us assume that preempting a frame adds only an extra 20 bytes; this is the minimum practical penalty.
- We will assume that the worst case frame size is 127 bytes, which cannot be preempted. A 128-byte frame could be preempted and separated into two 64-byte fragments.

Some numbers

- In the first example, the time window is sized for **four 128-byte frames** with a margin of 4 more such frames (50% utilization of the window).
- The basic window size is 8 * (128 + 20) = 1184 byte times.
- Without preemption, we require a (1522 + 20) byte guard band, for a total window size of 2726 bytes.
- With preemption, we require a (127 + 20) byte guard band, for a total window size of 1331 bytes.
- Thus, whatever percentage of the total bandwidth is allocated to time-critical traffic, it requires **more than twice as much time** (2726/1331) be reserved for that traffic if **preemption** is **not utilized**.

Some numbers

- In the second example, the time window is sized for **one 128-byte frame** with no margin. This is perfectly possible if we assume that the switch will store a time-critical frame very briefly, and then transmit it at the appropriate moment.
- The basic window size is (128 + 20) = 148 byte times.
- Without preemption, we require a (1522 + 20) byte guard band, for a total window size of 1690 bytes.
- With preemption, we require a (127 + 20) byte guard band, for a total window size of 295 bytes.
- Thus, whatever percentage of the total bandwidth is allocated to time-critical traffic, it requires **more than 5.7 times as much time** (1690/295) be reserved for that traffic if **preemption** is **not utilized**.

Summary

- Clearly, preemption makes a big difference (a factor of 2 to 5) in how much time must be allocated to time-critical data when that data is mixed with other traffic.
- The difference is the same factor no matter what the line rate of the medium. Of course, as the data rate required for time-critical data increases, the bandwidth left for non-time-critical traffic declines much more rapidly on low-bandwidth media.

Percent of time reserved for critical data

Link speed	Mbits/sec required for critical data and gaps	(no guard band)†		with preemption		no preemption	
		1184 B* window	148 B* window	1184 B* window + guard	148 B* window + guard	1184 B* window + guard	148 B* window + guard
100 Mbits	0.1	0.23%	0.12%	0.26%	0.14%	0.53%	1.32%
	1	2.31%	1.16%	2.60%	1.38%	5.32%	13.20%
	10	23.13%	11.56%	26.00%	13.75%	53.24%	132.03%
	30	69.38%	34.69%	77.99%	41.26%	159.73%	396.09%
1 Gbit	1	0.23%	0.12%	0.26%	0.14%	0.53%	1.32%
	10	2.31%	1.16%	2.60%	1.38%	5.32%	13.20%
	100	23.13%	11.56%	26.00%	13.75%	53.24%	132.03%
	300	69.38%	34.69%	77.99%	41.26%	159.73%	396.09%

*** Half of 1184-byte window is reserved for margin; none of 148-byte is margin.**

† "No guard band" shows wastage from margin, preamble and inter-frame gap.