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The Case of Negative ABR Bandwidth: A Solution

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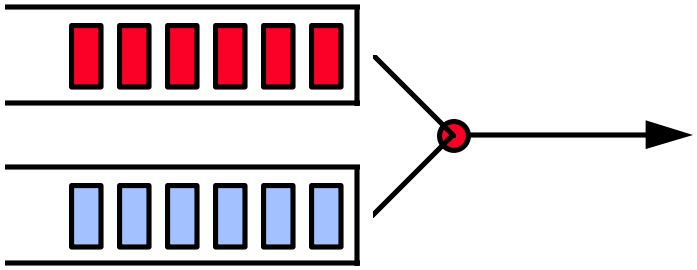
ABR Capacity



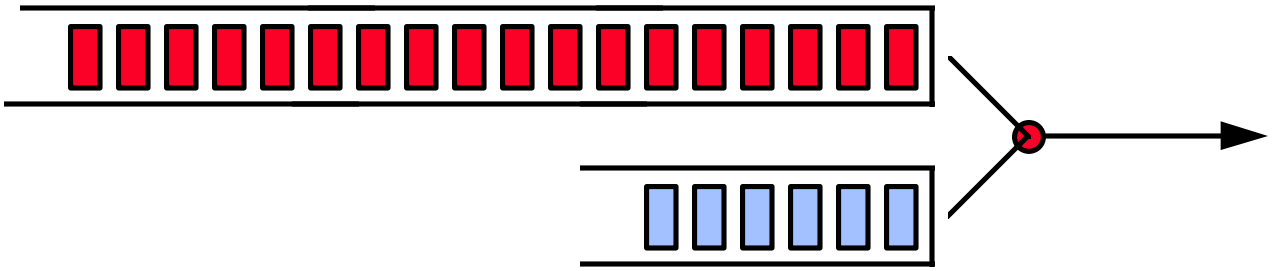
- ABR bandwidth
  = Capacity - CBR - VBR load
- VBR traffic declares SCR and PCR
- VBR may be overbooked

$$\Sigma \text{ PCRi} > \text{Link capacity}$$

$$\Sigma \text{ SCRi} < \text{Link capacity}$$

- VBR traffic may exceed the link capacity for some intervals $\Rightarrow$ Negative ABR capacity

Problem: ER=0



- If the explicit rate field is set to zero, the sources with MCR=0 will not be able to send any further RM cells
- Waiting Sources: Sources with ER=0
- Q: How and when to resume?

Problem: Low Rate Sources

- The inter-RM cell time can be large even on LAN with very short round-trip delays
- Sources put to low rate cannot come up fast
- The problem is worse on WANs. BECN does not help in increasing sources' rates.
- Solution: Allow sources the freedom to send RM cells at or below Nrm.

Solution

- Although VBR has a higher priority, the switches reserve certain minimum bandwidth for ABR.
- The switches never set ER=0. They always set to some non-zero value ER_{min} depending upon the number of active ABR VCs (or the total number of ABR VCs) and the switch's ABR reservation.
- When a source is running at very low rate, it can send RM cells more frequently than Nrm.
- Low rate = 1/Trm
- Allow Trm to be set according to desired responsiveness.
  Trm = 1 ms $\Rightarrow$ Guaranteed to see RM cells in 2ms
  $\Rightarrow$ Idle intervals of 2 ms or longer will be utilized by ABR.

Motion

- "Remove the following note from source/switch/destination specs:
  2) Trm shall be set to 100 (msec)."

Solution 1: Resume Cell

- The switch that sets ER=0 sends a "Resume cell" to the sources that it put to waiting state.
- Disadvantages:
  - Switch complexity: Switch has to remember all VC with ER=0
  - Too much traffic: Many switches on the path may send the resume cells
  - What if the resume cells are lost?

Solution 2: Probe Cells

- Sources that are waiting (at ER=0) are allowed to send "Probe Cells" periodically to find out if they can resume.
- Period: 100 ms is too late for most LANs
- Disadvantages:
  - Deciding the period is difficult for sources.
  - The period should be a function of the number of waiting sources so that the total traffic is bounded. Sources do not have this information.

RM Cell Frequency

- The unfairness problem was caused earlier by allowing sources to rise by fixed AIR on every RM.
- There were two solutions:
  - Make AIR a per cell parameter. The rate increase amount depends upon the number of cells since the last RM
  - Sources be not allowed to send RM cells before Nrm data cells

  The current proposal implements both.
- The source pays for the RM cells and should be allowed to send them whenever it wants.

Alternative

[Not Recommended]

- If sources are not allowed to send RM cells before Nrm data cells then:
  - Add an "NRM1" (Nrm One) bit in the RM cell.
  - The switches set the bit when they set ER to ERmin
  - On receiving an RM cell with this NRM1 bit on, the sources are allowed to send RM cells (at ERmin rate) without any intervening data cells.