

95-0973R1

**Out-of-Rate RM Cell Issues
and Effect of Trm, TOF, and
TCR on Low Rate Sources**

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- ❑ Transient response time
 - ❑ Time to rise from “Low Rate” to “High Rate”
- ❑ Effect of Trm
- ❑ Effect of TOF, ICR
- ❑ Effect of TCR
- ❑ Corrections to the behaviors and pseudocode

Trm

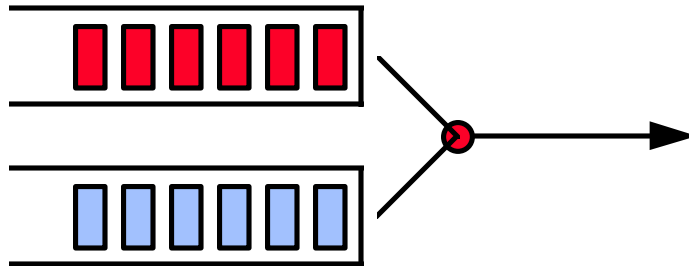
- ❑ Source Rule 3 (simply stated):
Send one FRM cell after every Nrm cells **or** at least Trm ms and Mrm cells
- ❑ In all base vectors Trm = 100 ms
- ❑ At low rate, every 3rd cell is an FRM cell.
At high rate, every 32nd cell is an FRM cell.
Higher Trm \Rightarrow Less overhead
- ❑ Sources may get a low rate due to
 - ❑ Heavy VBR traffic,
 - ❑ Large # of ABR sources, or
 - ❑ Low bottleneck link speed (T1 links)

Effect of Trm

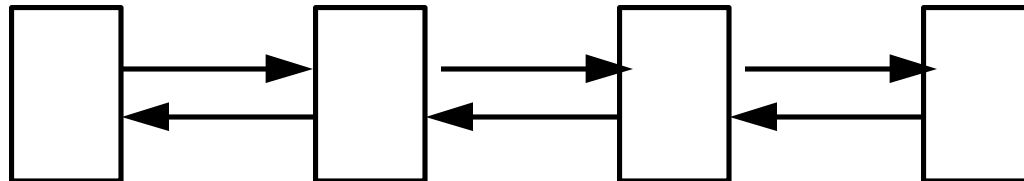
- ❑ Trm allows low rate sources to sense the network state more frequently than normal
- ❑ When the bandwidth becomes available, network may not be able to allocate the bandwidth at all until it sees an RM cell.
- ❑ Network may allocate the bandwidth unfairly if all active sources are not seen
- ❑ Lower Trm
 - ⇒ Lesser time between RM cells
 - ⇒ Faster transient response time
- ❑ Choice of Trm also depends upon link speed (OC-12)

Traffic Pattern: VBR + ABR

- ❑ Actual VBR cells are generated, queued, and share the link and switch resources
- ❑ VBR gets a preferential treatment
ABR gets only left-overs

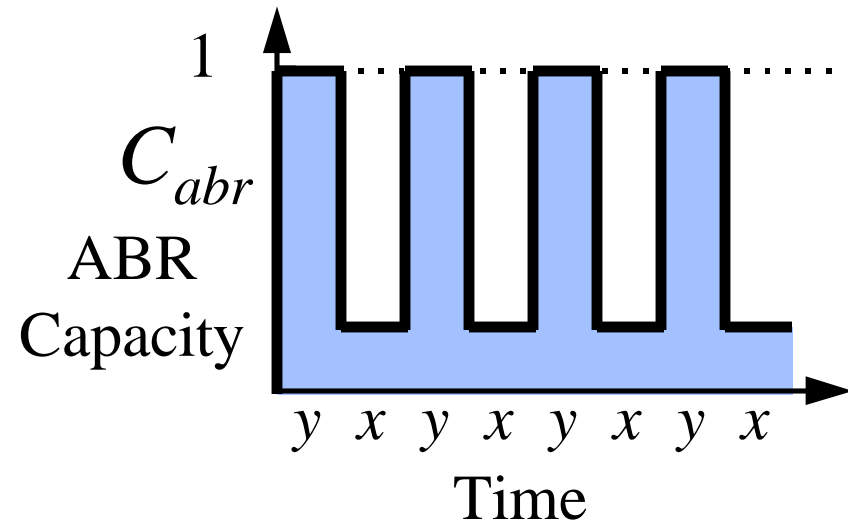
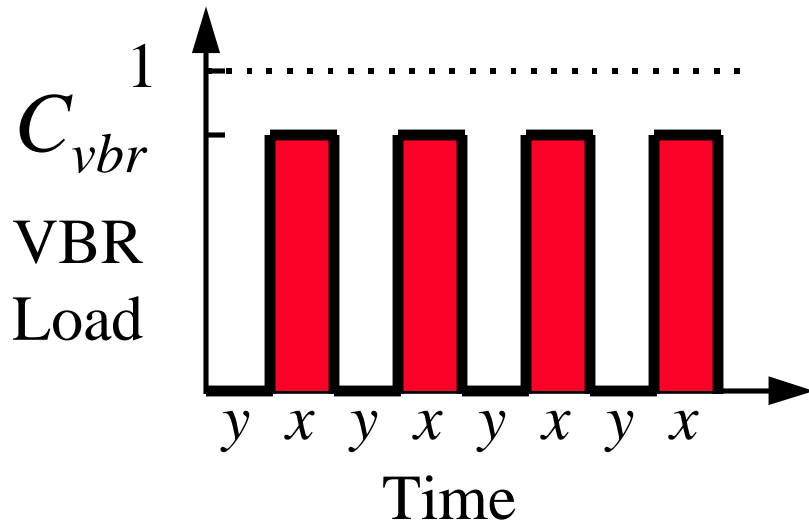


- ❑ Bi-directional Traffic



A Simple VBR Model

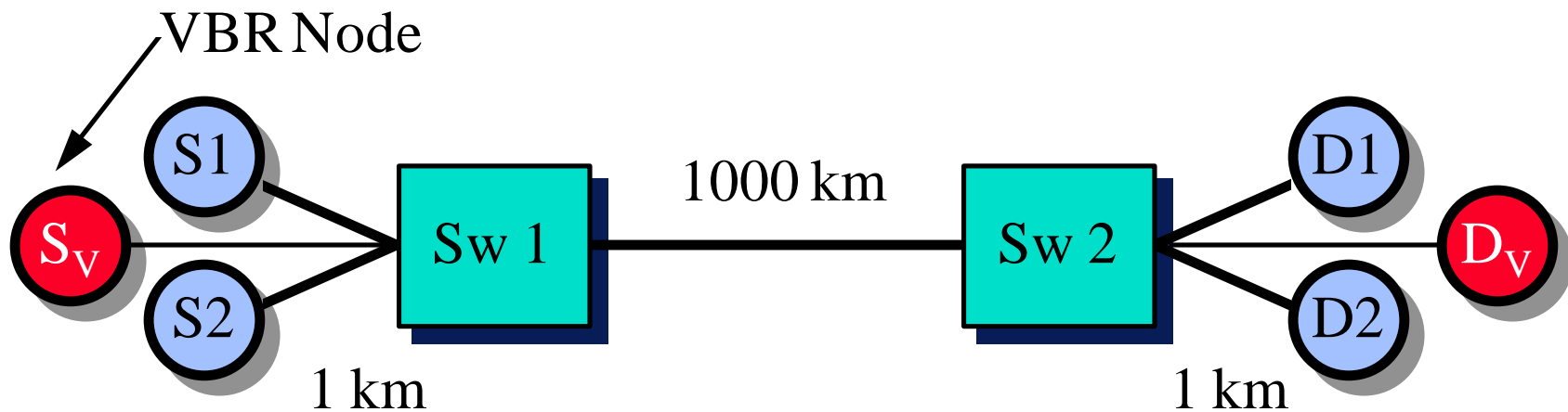
- ❑ On for x ms and off for y ms
- ❑ When on, VBR uses up C_{vbr} bandwidth
- ❑ In practice, x , y , C_{vbr} are random variables. We assumed constants.



Simulation Parameters

- ❑ Source: Parameters selected for fast response
 $N_{rm} = 32$, $RDF = 256$ cells, $TOF = 2$, $X_{rm} = 32$,
 $XDF = 1/16$, $TCR = 10$ cps , $ICR = PCR/20$
 $T_{rm} = 1, 10, 100$ ms
 $AIRF = 1 \Rightarrow$ Increases are not limited by AIR
 $TDF = 0 \Rightarrow$ TOF decreases disabled
- ❑ Traffic: ABR: Infinite source, Bi-directional
VBR: 20 ms off, 20 ms on, 89%, Bi-directional
VBR starts at 2 ms \Rightarrow On 2-22, 42-62, 82-102, ...
- ❑ Switch:
Target Utilization = 90%
Averaging interval = $\min\{100 \text{ cells}, 1 \text{ ms}\}$

Two-Source Configuration



- ❑ All links 155.52 Mbps
- ❑ ABR sources go down to 0.8 Mbps when VBR comes on and go up to 70 Mbps when VBR goes away.
- ❑ Goal: Measure rise time for ABR sources

Simulation Results

- ❑ Available capacity may go unused for as long as 100 ms. (In our simulation, VBR comes back up every 20 ms and so unused time is 20 ms).
- ❑ Lower Trm \Rightarrow More frequent RM cells
 \Rightarrow Faster response

TOF

- ❑ Source Behavior 5a (Simply stated):
If the time T since last FRM cell was **sent** is greater than $TOF \times N_{rm} \times (1/ACR)$ then decrease by $ACR \times T \times TDF$ down to ICR.
- ❑ $TOF = 2$ in all base vectors

Effect of TOF

- ❑ Effect 1: Rule triggered if the source rate is less than $1/\text{TOF}$ of ACR. Use it or loose it.
 - ⇒ ACR (and CCR) are close to source rate.
 - (Some switch schemes are sensitive to this)
 - ⇒ Lower values of TOF are preferable.
- ❑ Effect 2: The rule is triggered on rate increase. Can't increase rate by more than a factor of TOF. Slows down ramp-up.
 - ⇒ Larger values of TOF provide faster transient response.

Simulation Parameters

All parameters same as that for Trm except:

- ❑ Source Parameters:

- ❑ $T_{rm} = 100 \text{ ms}$

- ❑ $TOF = 2, 20, 100, 200$

- ❑ $ICR = PCR, PCR/20, PCR/1000$

Simulation Results

- ❑ With $ICR = PCR$, TOF has no effect.
(TOF is effectively disabled for this ICR)
- ❑ With $ICR = PCR/20$, the sources push themselves back to ICR whenever network asks them to go up.
Network and sources are at odds
⇒ Oscillations
 - ❑ TOF too low
 - ❑ Formula gives large decreases
- ❑ Higher values of TOF help avoid these oscillations by triggering the decreases less often
- ❑ With $ICR = PCR/1000$, situation is worse.

Conclusion

- ❑ Higher values of TOF do provide better transient response for low ICR sources.
- ❑ The formula gives decreases that are too large

TCR

- ❑ Source Rule 11 (Simply stated):
Out-of-rate FRM rate \leq TCR
- ❑ TCR = 10 cps in all standard vectors

Effect of TCR

- ❑ Out-of-rate FRMs are **not optional** for sources (NICs). They are the only means to get out of $ACR = 0$ situation.
- ❑ Out-of-rate BRMs are **not optional** for destinations (NICs). They are the only means to control unidirectional ABR VCs.
- ❑ Use of out-of-rate RMs at non-zero ACR **is** optional and may improve transient response.

TCR Tradeoffs

- Higher TCR \Rightarrow More frequent feedback
 \Rightarrow More responsiveness
- Lower TCR \Rightarrow Less out-of-rate cells
 \Rightarrow Less overhead

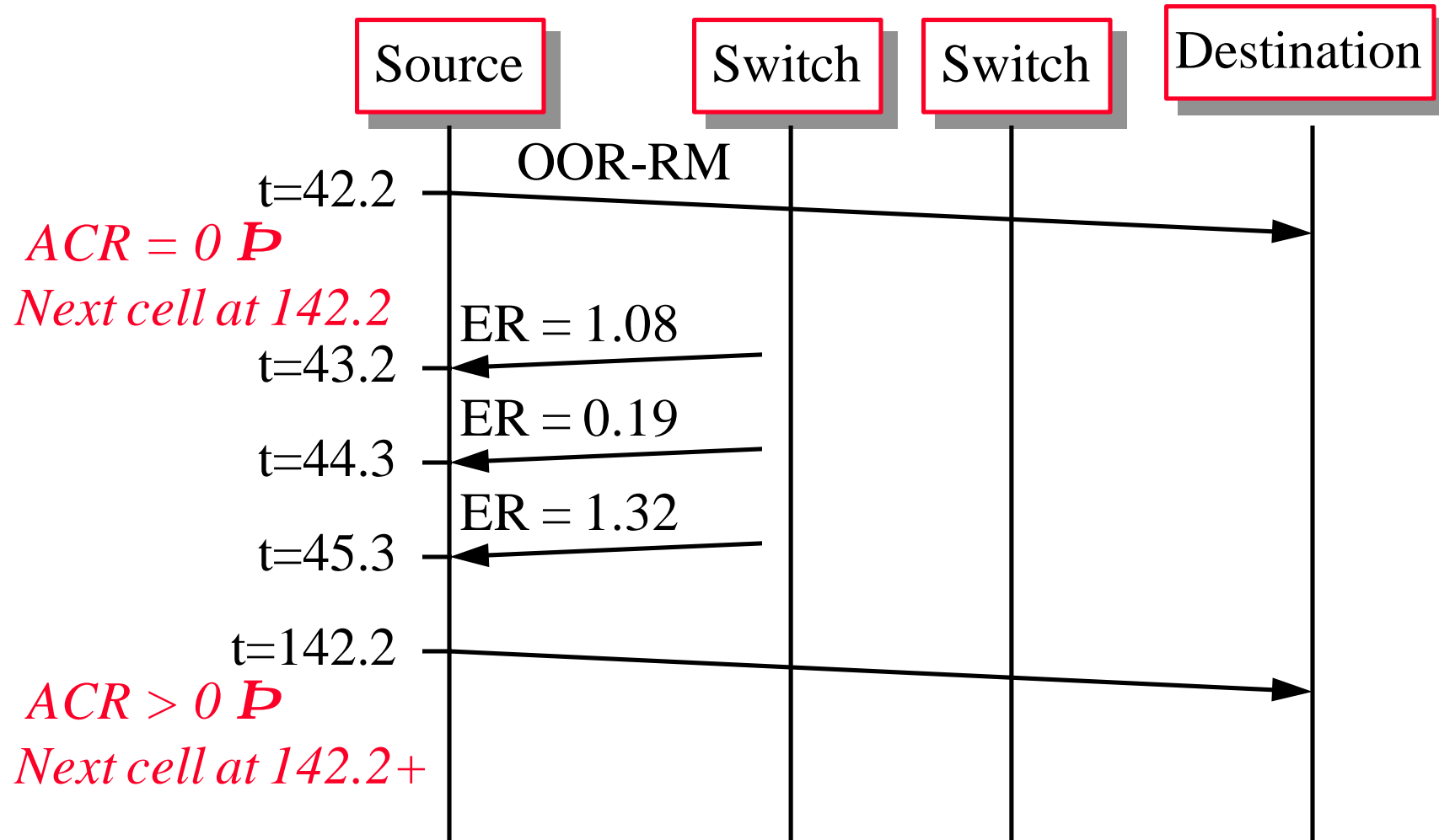
Simulation Parameters

- All parameters same as that for Trm except:
 - Source Parameters:
 $T_{rm} = 1 \text{ ms}$
(To avoid confusion with $TCR = 10 \text{ cps}$)
 - Switch Parameters:
Averaging interval = $\min\{30 \text{ cells}, 1 \text{ ms}\}$
 - Traffic Parameters:
In one interval, we force VBR to use **90%** of PCR
 - ⇒ Available bandwidth for ABR = 0
 - ⇒ Out-of-rate mechanism is triggered

Simulation Results

- ❑ The source, once stopped, is unable to use the bandwidth for 100 ms even when the bandwidth becomes available.
- ❑ This is not because there are no RM cells but because network feedback is ignored

Event Trace



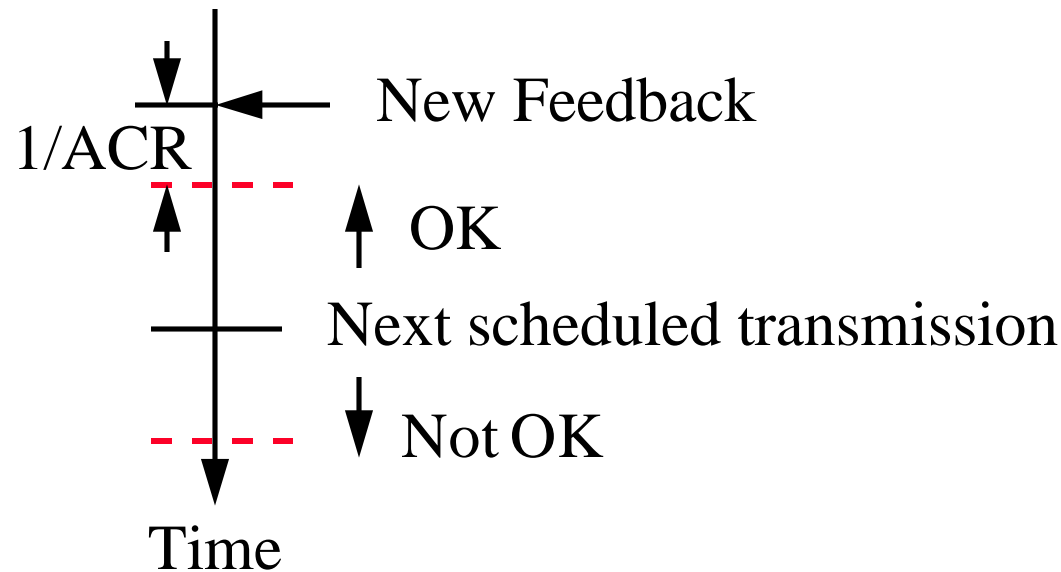
Issue 1

- ❑ The text says nothing about how to schedule or reschedule the next cell
- ❑ The pseudocode chose to not reschedule cells on rate increases or decreases
- ❑ Four Possibilities: Reschedule if new rate will result in

Earlier Transmission	Later Transmission	
No	No	Pseudocode
No	Yes	Keep putting it off
<i>Yes</i>	<i>No</i>	<i>Recommended</i>
Yes	Yes	Keep putting it off

Recommendation 1

- ❑ Reschedule if the new ACR permits earlier scheduling (One late cell can make a big difference for the source)
- ❑ Do not reschedule if the new ACR will delay it further (One early cell can't hurt the network)



New Pseudocode

- Add the following to End-System Pseudocode - Receive (page 87 of ATMF95-0013R6):

IF $\text{time_to_send} > (\text{now} + 1/\text{ACR})$

THEN $\text{time_to_send} \leftarrow (\text{now} + 1/\text{ACR})$

Issue 2

- ❑ Source behavior requires interspersing FRM, BRMs and data even at low rate, the pseudocode does not implement it
- ❑ The pseudocode sends only OOR-RMs at $ACR < TCR$ (no BRMs or data)

Issue 3

- ❑ Source behavior 11 permits OOR even if $ACR > TCR$
- ❑ Pseudocode does not implement it

Issue 4

- ❑ There are no guidelines on how to space out-of-rate RM cells. There are several possibilities:
 - ❑ Equally spaced 100 ms apart
 - ❑ 100 cells at 1ms then nothing for 9 s
- Are both choices valid?

Issue 5

- ❑ Is $ACR = 0$ legal?
- ❑ ATMF 95-0013R6 Section 5.10.3.1 (page 53) states that minimum ACR is 1 cps.
- ❑ The source or switch behavior say nothing about it
- ❑ Pseudocode does not impose this lower limit

Issue 6

- Source behavior 3a:

The next in-rate cell shall be a forward RM-cell if and only if, since the last in-rate forward RM-cell was sent

i) either at least M_{rm} in-rate cells have been sent

or

ii) at least T_{rm} seconds have elapsed, or $N_{rm}-1$ in-rate cells have been sent.

- Pseudocode:

If (Count \geq N_{rm}) **or**

((count $>$ M_{rm}) **and** (now \geq last-RM + T_{rm})) ...

Recommendation

- Update source behavior:

The next in-rate cell shall be a forward RM cell if and only if, since the last in-rate forward RM-cell was sent

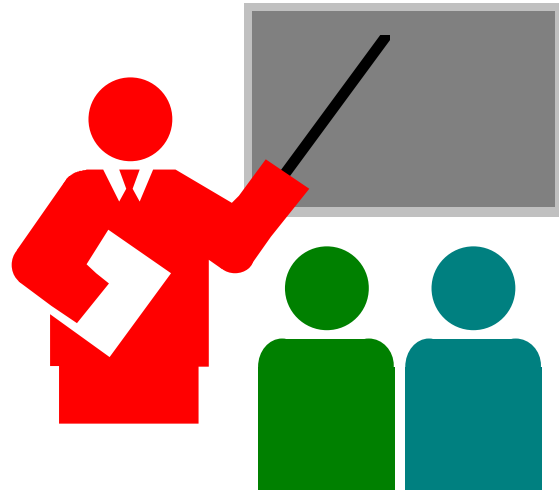
*i) either at least M_{rm} in-rate cells have been sent **and** at least T_{rm} seconds have elapsed, or*

ii) $N_{rm}-1$ in-rate cells have been sent.

Issue 7

- ❑ Do Nrm and Mrm include out-of-rate RM cells?
- ❑ Source behavior does not include them. Specifically asks for in-rate cells.
- ❑ Pseudocode includes out-of-rate cells in “count”

Summary



- ❑ Lower Trm gives better transient response
- ❑ TOF = 2 and low-ICR may cause oscillations
- ❑ OOR-RMs are not optional for NICs.
- ❑ Reschedule on rate increase.
- ❑ Numerous issues with low rate sources

Motion

- Add the following to the source behavior:

15. If ACR is increased according to Source Behavior #8, the source may use the new rate immediately even possibly rescheduling next scheduled transmission.

- Add the following to End-System Pseudocode - Receive (page 87 of ATMF95-0013R6):
IF $\text{time_to_send} > (\text{now} + 1/\text{ACR})$
THEN $\text{time_to_send} \leftarrow (\text{now} + 1/\text{ACR})$

Motion

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