Leveraging ON/OFF Traffic Model – Literature Example

Backup Material for the Presentation on Support for eCPRI in 802.1CM

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Examples from Related Literature

[1] B. József, Z. Heszberger, M. Martinecz. "A family of performance bounds for QoS measures in packet-based networks." *NETWORKING 2004. Networking Technologies, Services, and Protocols; Performance of Computer and Communication Networks; Mobile and Wireless Communications* (2004): 1108-1119.

[2] Yin, N., & Hluchyj, M. G. „Analysis of the leaky bucket algorithm for on-off data sources", *Journal of High Speed Networks*, *2*(1), 81-98, 1993.

[3] Akar, N., & Arikan, E. „Markov modulated periodic arrival process offered to an ATM multiplexer", *Performance evaluation*, *22*(2), 175-190, 1995.

[4] Malomsoky, S., Rácz, S., & Nádas, S., „Connection admission control in UMTS radio access networks", *Computer Communications*, *26*(17), 2011-2023, 2003.

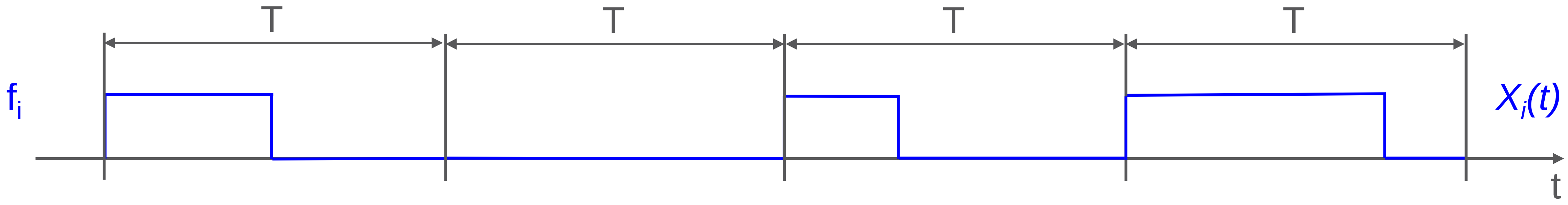
[5] Nádas, S., Rácz, S., Malomsoky, S., & Molnár, S., „Connection admission control in the UTRAN transport network", *Telecommunication Systems*, *28*(1), 9-29, 2005.

The Paper Discussed in the Following

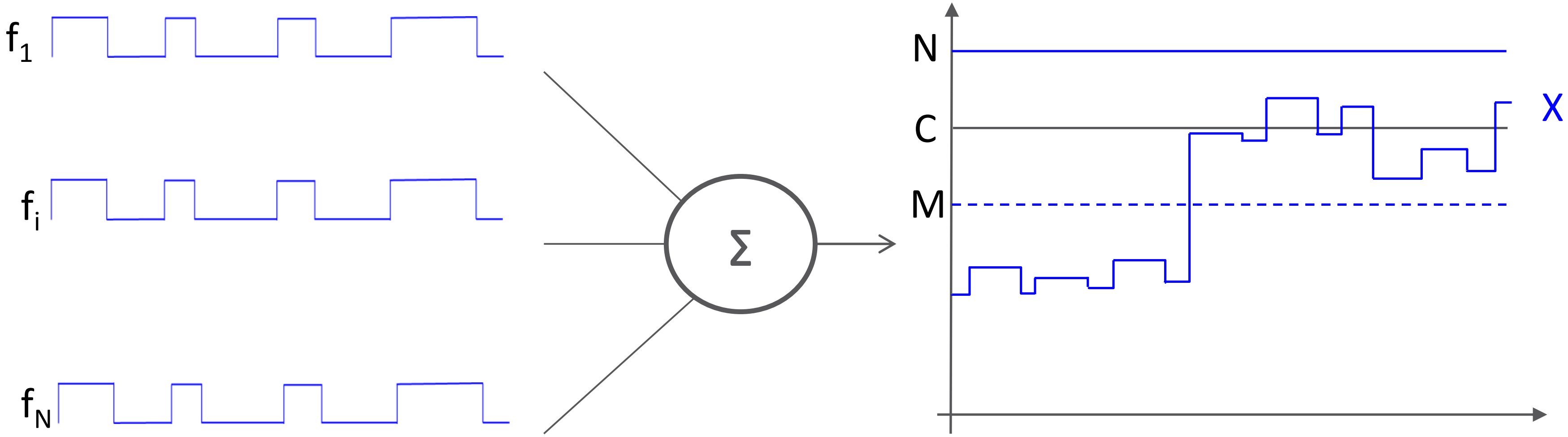
[1] B. József, Z. Heszberger, M. Martinecz. "A family of performance bounds for QoS measures in packet-based networks." *NETWORKING 2004. Networking Technologies, Services, and Protocols; Performance of Computer and Communication Networks; Mobile and Wireless Communications* (2004): 1108-1119.

Notations

- N = total number of flows
- f_i = a generic stationary, ergodic flow
- $X_i(t)$ = traffic generation rate of f_i at moment t
  - It is a stochastic variable
- $max\{ X_i(t) \}$ = peak rate of f_i – must be known
- $m_i = E(X_i(t))$ = average rate – must be known
- $M = \sum_{i=1}^{N} m_i$ – must be known (even if m_i is not known)
- C = service rate (link capacity)
- The flows can be observed periodically (T period)



Aggregated Flows



› If the flows are independent, then

$$Pr(X > C) \leq (\frac{M}{C})^{C} \ (\frac{N-M}{N-C})^{N-C} \leq \varepsilon \qquad [1]$$

› Typical use case:

- Tolerable loss rate ε, is given
- What C is needed?

Numerical Examples

Max FLR = 10^{-7} for IQ data in P802.1CM D0.7

Max FLR > ε + Pr {BER}, P(Pr{BER} = 6.6*10^{-8} [4])

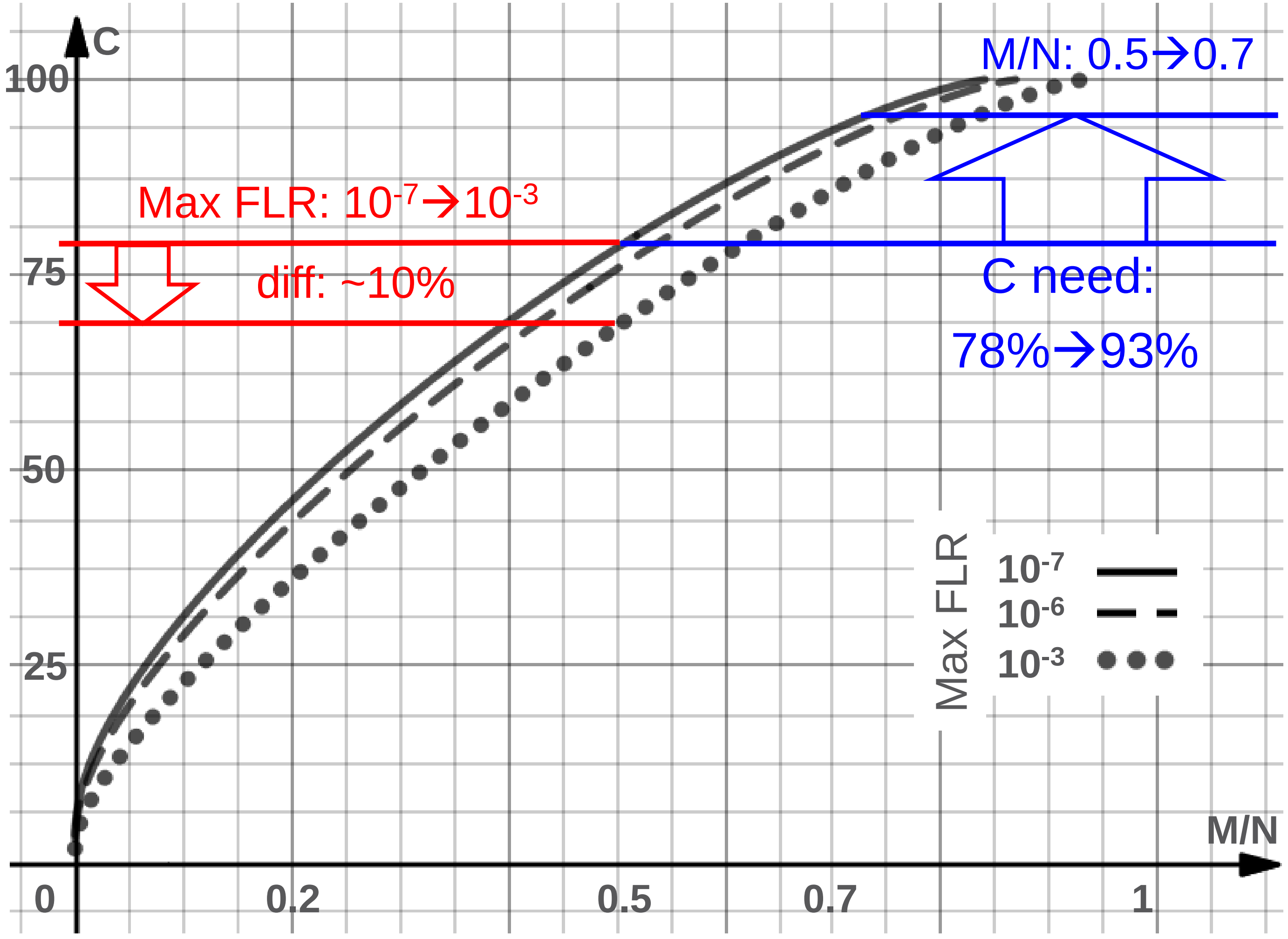
$$Pr(X > C) \leq \left(\frac{M}{C}\right)^{C} \left(\frac{N-M}{N-C}\right)^{N-C} \leq \varepsilon$$

C = f(M/N)

- *X axis*: normalized average arrival rate
- *Y axis*: C = capacity need for the aggregate
  - C corresponds to CIR
- Plotted for N = 100 flows
  - N corresponds to CIR + EIR
- Relaxing the loss requirement
  - Max FLR = 10^{-7} vs. 10^{-6} vs. 10^{-3}
- Capacity need difference if $\frac{M}{N} = 0.5$
  - Max FLR = 10^{-7} vs. Max FLR = 10^{-3} ➔ ~10% difference

Worst-case values:

$\frac{M}{N}$	*P(each flow is sending data)*
0.25	$6.22 \cdot 10^{-61}$
0.50	$7.89 \cdot 10^{-21}$
0.75	$3.21 \cdot 10^{-13}$



Graph generated with: https://www.desmos.com/calculator

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