

96-1173: Fairness, Call Establishment Latency and Other Performance Metrics

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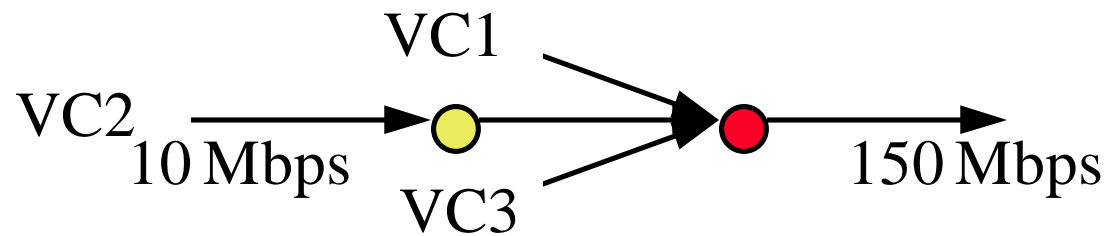
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- ❑ Throughput fairness
- ❑ Frame loss rate
- ❑ Maximum frame burst size
- ❑ Call establishment latency

Fairness



- ❑ Actual allocation: (T_1, T_2, \dots, T_n)
- ❑ Use any criterion (e.g., max-min optimality) to find the optimal allocation (O_1, O_2, \dots, O_n)
- ❑ Relative allocation: $x_i = T_i/O_i$

$$\text{Fairness} = \frac{(\sum x_i)^2}{n \sum x_i^2}$$

Example: $100/100, 4/40, 10.5/15 \Rightarrow 1, 0.1, 0.9$

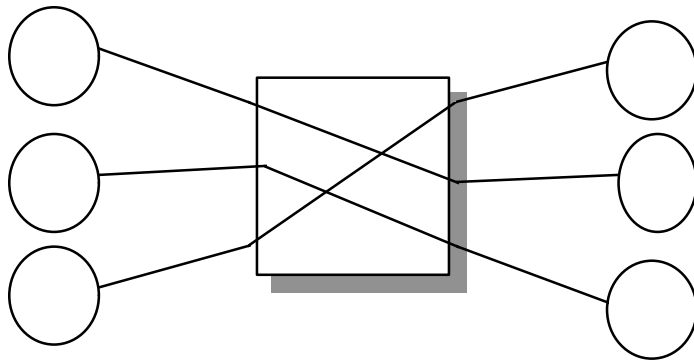
$$\text{Fairness} = \frac{(1+0.1+0.9)^2}{3(1^2+0.1^2+0.9^2)} = \frac{2^2}{3(1+0.01+0.81)} = 0.73$$

Fairness Index: Properties

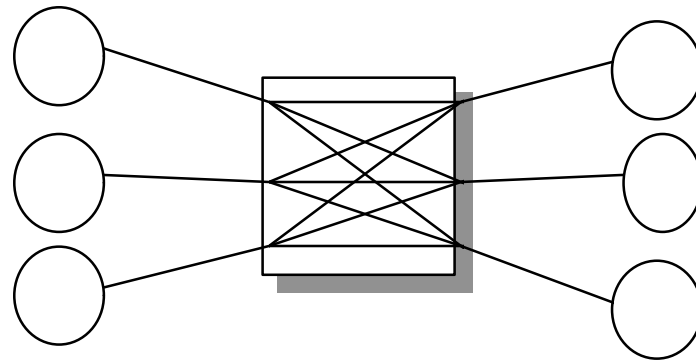
- ❑ Applicable for any number of VCs, even $n=2$
- ❑ Scale independent
- ❑ Bounded between 0 and 1 or 0 and 100%
- ❑ Direct relationship: Higher index \Rightarrow More Fair
- ❑ Continuous
- ❑ Intuitive:
 - ❑ For $(1, 0, 1)$ Index = $2/3$
 - ❑ For $x_i = 1, i=1,2,3,\dots,k$
= 0 otherwise
Index = k/n
 - ❑ If 80% of the users are treated fairly and 20% are starved,
index = 80%

Traffic Pattern

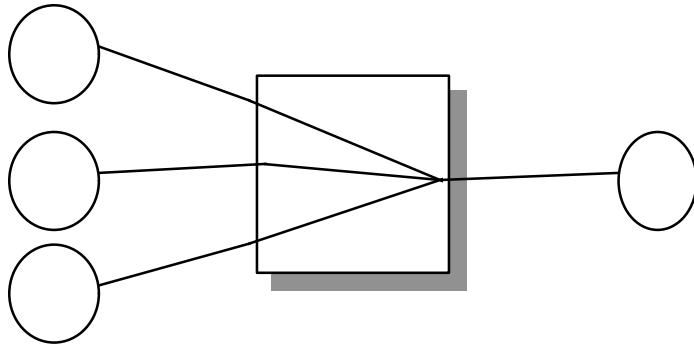
- n-to-n Straight: n Vcs
i to $i+1 \pmod n$



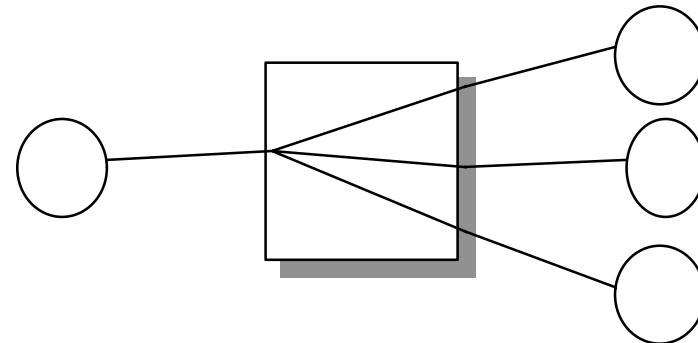
- n-to-n Cross: n^2 Vcs



- n-to-1: n Vcs



- 1-to-n Straight: 1 Vc



Statistical Variations

- ❑ Repeat throughput measurements NRT times for TRT seconds each. Default NRT = 30, TRT = 60 seconds
- ❑ i th repetition sample = $\{T_1, T_2, T_3, \dots, T_n\}$
- ❑ Fairness for i th repetition = F_i
- ❑ Mean Fairness = $(\sum F_i) / NRT$

Background Traffic

- ❑ With and without background traffic
- ❑ To be defined
- ❑ Without background traffic until then

Reporting Results

	Throughput								
Traffic	Lossless			Peak			Full-load		
Pattern	Mean	Std. Err	Fairness	Mean	Std. Err	Fairness	Mean	Std. Err	Fairness
n-to-n Straight									
n-to-n Cross									
n-to-1									
1-to-n									

Frame Loss Ratio

$$\begin{aligned}\text{Frame Loss Ratio} &= \frac{\# \text{ of Frames Input} - \# \text{ of Frames Output}}{\# \text{ of Frames Input}} \\ &= \frac{\text{Input Rate} - \text{Throughput}}{\text{Throughput}}\end{aligned}$$

- ❑ Measure at peak throughput and full-load for all four traffic patterns
- ❑ Need to measure input rate for peak throughput

Statistical Variations

- Repeat throughput measurements NRT times for TRT seconds each. Default NRT = 30, TRT = 60 seconds
- i th repetition throughput = T_i
- i th repetition input rate = R_i
- FLR for i th repetition = $FLR_i = (R_i - T_i) / R_i$
- Mean FLR $\neq (\sum FLR_i) / NRT$ because FLR is a ratio

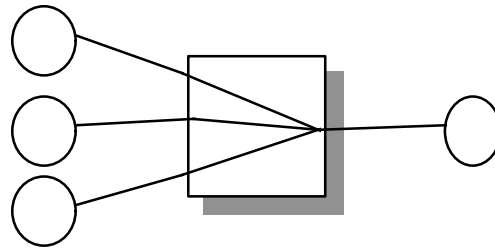
$$\begin{aligned} \text{Mean FLR} &= \frac{\Sigma\# \text{ of Frames Input} - \Sigma\# \text{ of Frames Output}}{\Sigma\# \text{ of Frames Input}} \\ &= \frac{\Sigma \text{ Input Rate}_i - \Sigma \text{ Throughput}_i}{\Sigma \text{ Input Rate}_i} \end{aligned}$$

Reporting Results

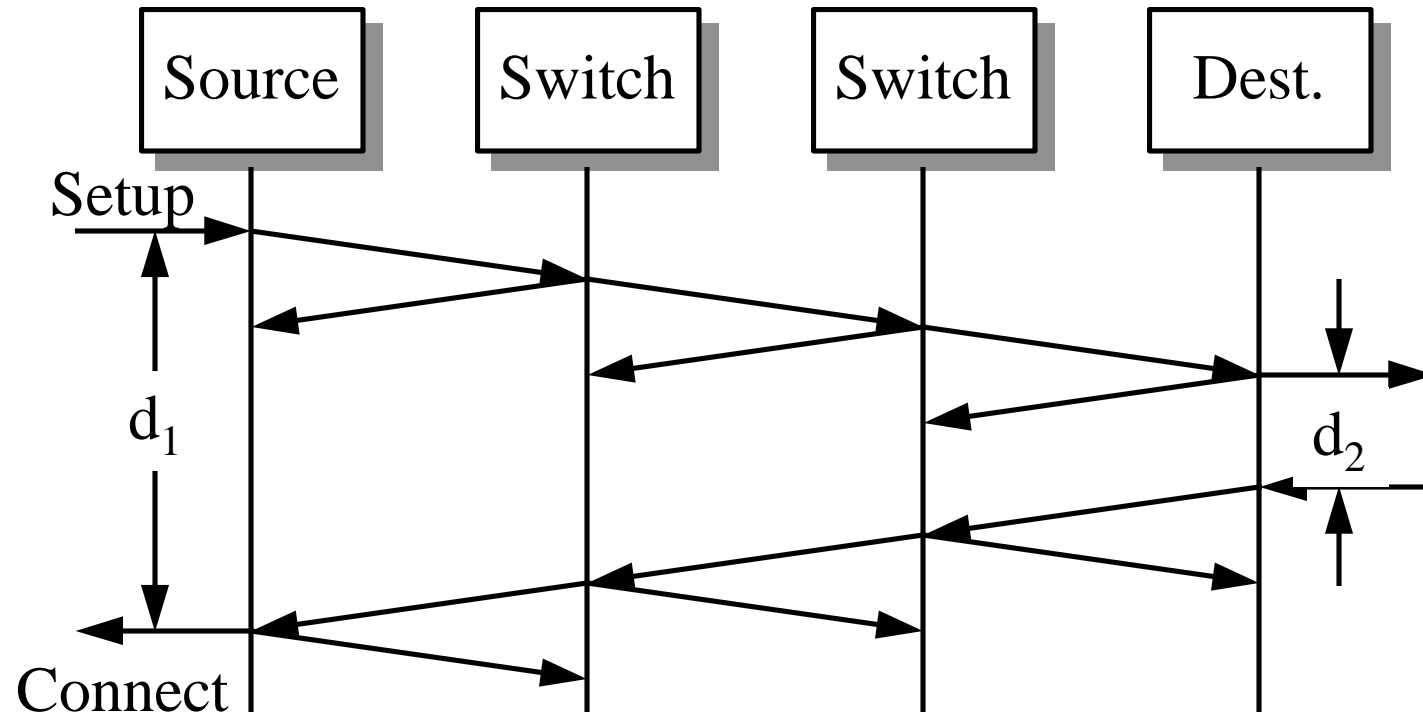
	Throughput										
Traffic	Lossless			Peak				Full-load			
Pattern	Mean	Std. Err	Fairness	Mean	Std. Err	Fairness	FLR	Mean	Std. Err	Fairness	FLR
n-to-n Straight											
n-to-n Cross											
n-to-1											
1-to-n											

Maximum Frame Burst Size

- ❑ Max # of frames that can be sent at peak rate without loss
- ❑ Measures data buffering capability of the system
- ❑ Important for many AAL applications
- ❑ Particularly relevant for UBR
- ❑ **Units:** Octets or Frames
Common sizes: 64, 536, 1518, 9188 octets
Octets = # of frames \times frame size \Rightarrow preferred if less variance
- ❑ **Statistical Variations:** Average of NRT repetitions
- ❑ **Traffic Patterns:** n-to-1 (most stressful)



Call Establishment Latency

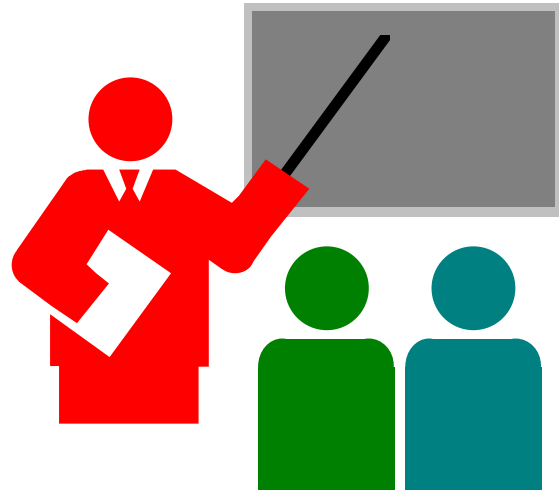


- Call establishment latency = $d_1 - d_2$
- Setup or connect message may be non-contiguous
⇒ MIMO latency for Setup + MIMO latency for Connect

Call Establishment Latency (Cont)

- ❑ **Units:** Time
- ❑ **Configuration:**
 - ❑ Latency varies with the number of switches and PNNI groups in the path.
 - ❑ Simplest configuration: Single switch
 - ❑ Other configurations: To be specified
- ❑ **Statistical Variations:** Average of NRT repetitions

Summary



- ❑ Throughput fairness = $(\sum x_i)^2 / (n \sum x_i^2)$
- ❑ Frame loss rate = $(\text{Input Rate} - \text{Throughput}) / \text{Input Rate}$
- ❑ Maximum frame burst size = # of back to back frames
- ❑ Call establishment latency
= MIMO latency of Setup + MIMO latency of Connect

Motion

- Adopt the text of 96-1173 for inclusion in the baseline draft

Motions

1. Adopt the text of *throughput fairness* section of 96-1173 for inclusion in the baseline draft
2. Adopt the text of *frame loss rate* section of 96-1173 for inclusion in the baseline draft
3. Adopt the text of *maximum frame burst size* section of 96-1173 for inclusion in the baseline draft
4. Adopt the text of *call establishment latency* section of 96-1173 for inclusion in the baseline draft