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

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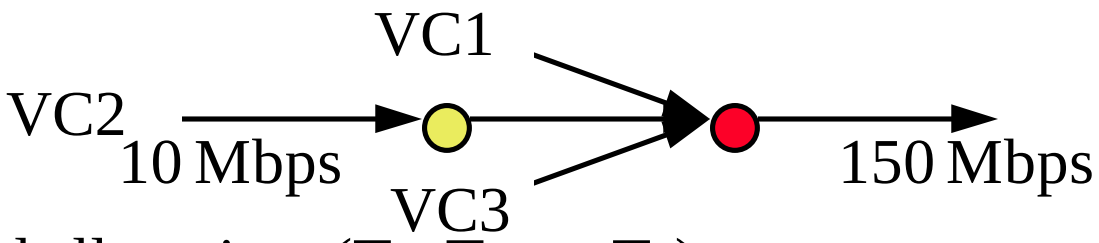
Overview

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

Fairness



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

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

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

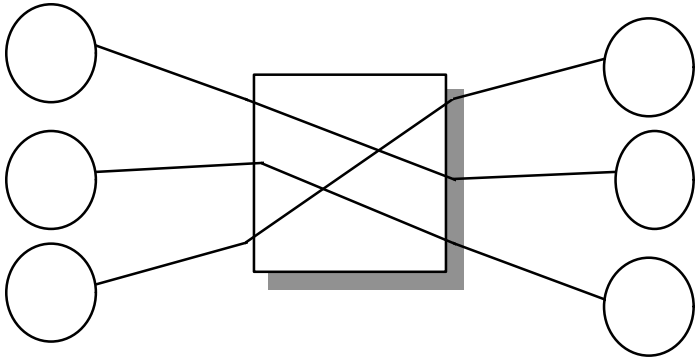
$$\text{Fairness} = \frac{(1+0.1+0.9)^2}{3(1^2+0.1^2+0.9^2)} = \frac{2^2}{3(1+0.01+0.81)} = 0.73$$

Fairness Index: Properties

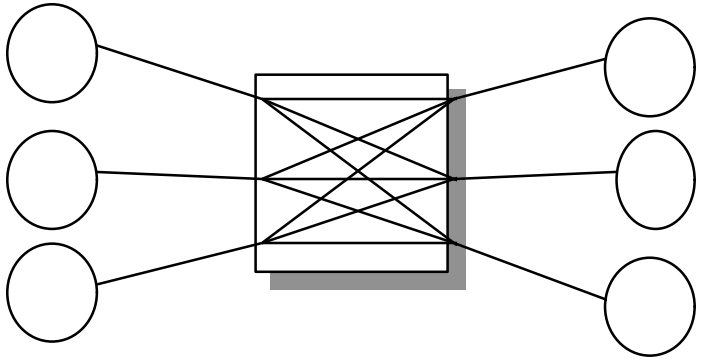
- Applicable for any number of VCs, even n=2
- Scale independent
- Bounded between 0 and 1 or 0 and 100%
- Direct relationship: Higher index $\Rightarrow$ More Fair
- Continuous
- Intuitive:
  - For (1, 0, 1) Index = 2/3
  - For $x_i = 1$, i=1,2,3,...,k
    $= 0$ otherwise
    Index = k/n
  - If 80%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

Traffic Pattern

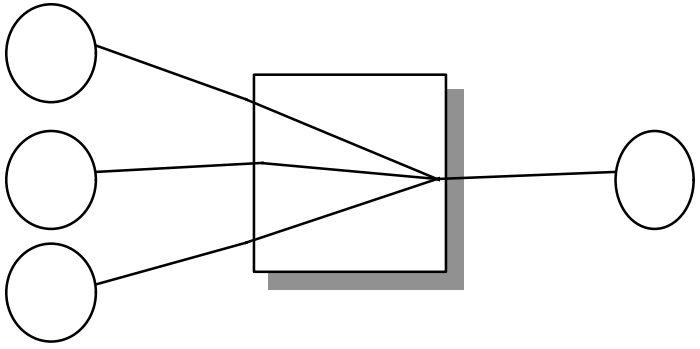
- n-to-n Straight: *n* Vcs
  i to i+1 mod n



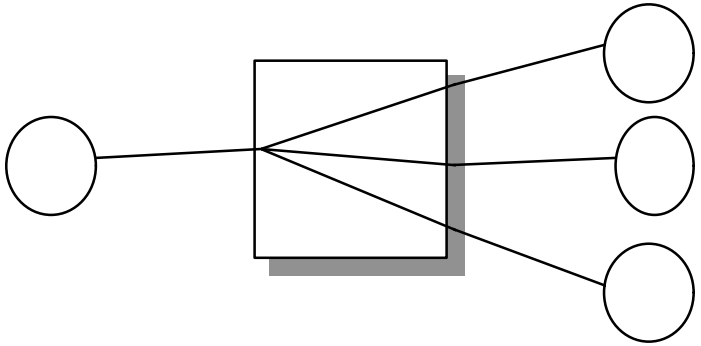
- n-to-n Cross: n^2 Vcs



- 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
- ith repetition sample = $\{T_1, T_2, T_3, ..., T_n\}$
- Fairness for ith repetition = F_i
- Mean Fairness = (ΣF_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

$$\text{Frame Loss Ratio} = \frac{\text{\# of Frames Input - \# of Frames Output}}{\text{\# of Frames Input}}$$

$$= \frac{\text{Input Rate - Throughput}}{\text{Throughput}}$$

- 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
- ith repetition throughput = T_i
- ith repetition input rate = R_i
- FLR for ith repetition = $FLR_i = (R_i - T_i)/R_i$
- Mean FLR $\neq (\Sigma FLR_i)/NRT$ because FLR is a ratio

$$\text{Mean FLR} = \frac{\Sigma\text{\# of Frames Input} - \Sigma\text{\# of Frames Output}}{\Sigma\text{\# of Frames Input}}$$

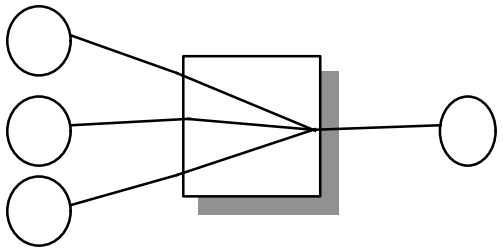
$$= \frac{\Sigma \text{ Input Rate}_i - \Sigma \text{ Throughput}_i}{\Sigma \text{ Input Rate}_i}$$

Reporting Results

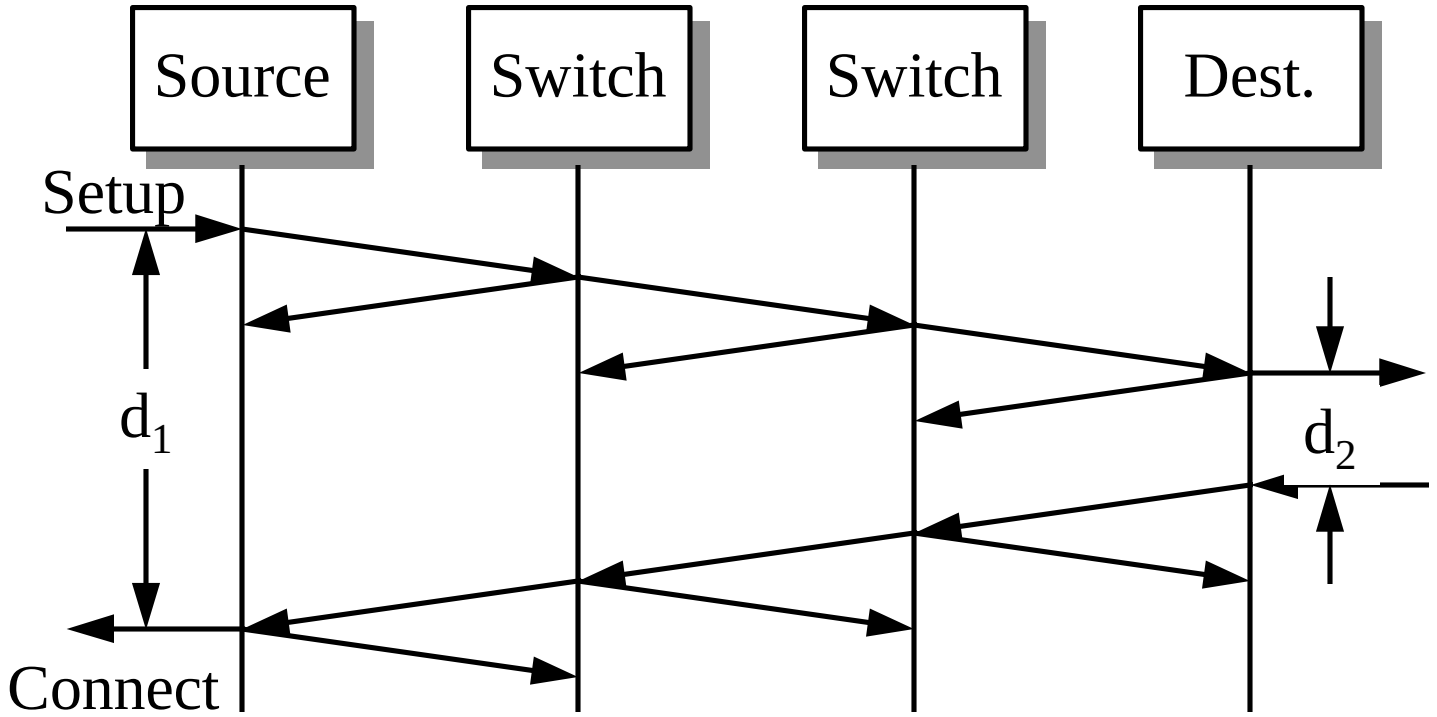
	Throughput										
Traffic	Lossless			Peak				Full-load			
Pattern	Mean	Std. Err	Fairness	Mean	Std. Err	Fairness	FLR	Mean	Std. Err	Fairness	FLR
n-to-n Straight											
n-to-n Cross											
n-to-1											
1-to-n											

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 × frame size ⇒ preferred if less variance
- **Statistical Variations**: Average of NRT repetitions
- **Traffic Patterns**: n-to-1 (most stressful)



Call Establishment Latency

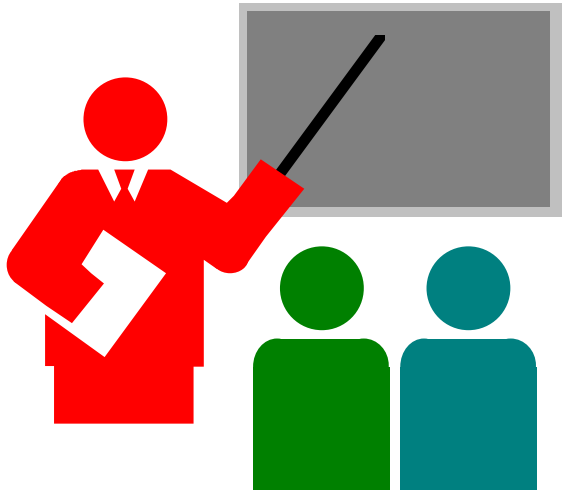


- Call establishment latency = $d_1 - d_2$
- Setup or connect message may be non-contiguous
  $\Rightarrow$ MIMO latency for Setup + MIMO latency for Connect

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 = $(\Sigma x_i)^2/(n\Sigma x_i^2)$
- Frame loss rate = (Input Rate - Throughput)/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