Capacity Draft Update

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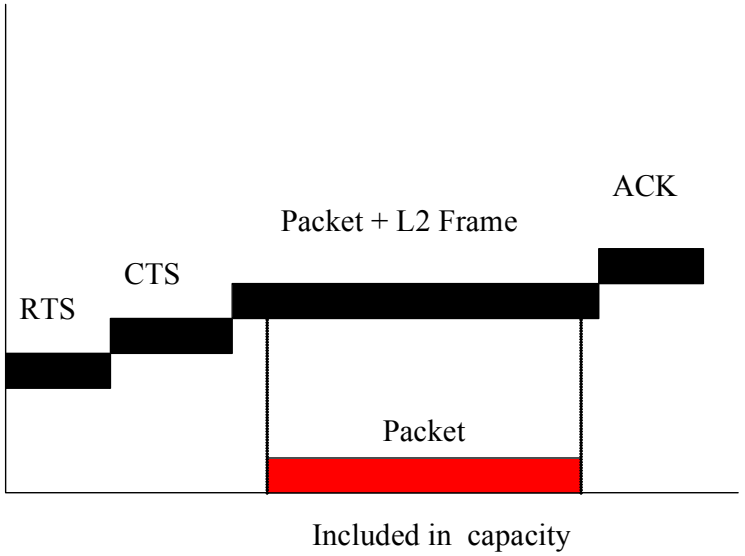
IPPM WG

Definition of Link Capacity

- IP Layer Link Capacity: Given a link L, a time T, a time interval I, and a source S and destination D, each directly attached to L, we define the IP Layer link capacity of L at time T, C(L,T,I), to be the maximum number of IP layer bits that can be transmitted from S and correctly received by D over the link L during the interval T to T+I, divided by I.

Capacity Definition: Example

- 802.11 example
  - No L2 usage of capacity is included
  - No L2 framing is included
  - Collisions, etc. not included.

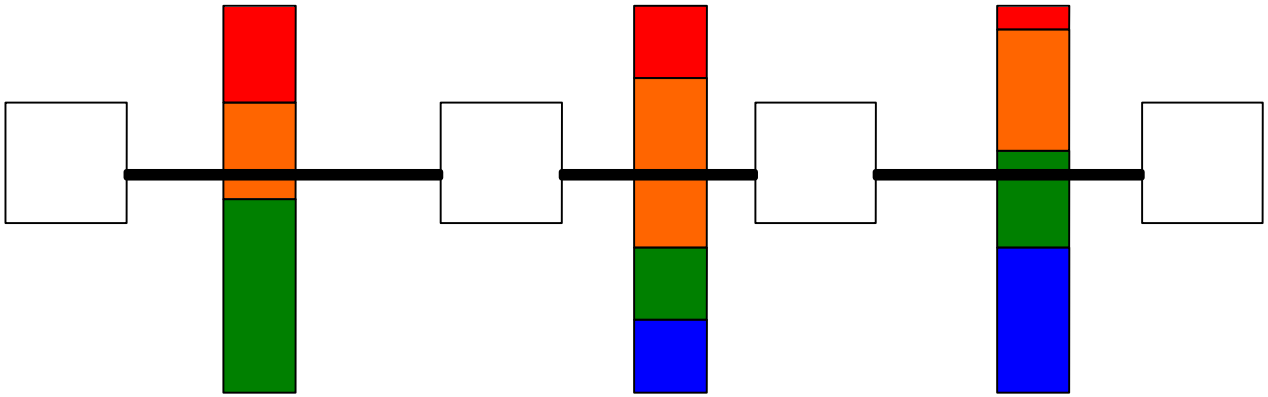


Definition of Path Capacity

- IP Layer Path Capacity: Given a path P consisting of a sequence of links (L1, L2, ..., Ln) connecting a sequence of nodes (N1, N2, ..., Nn+1), a time T, a time interval I and a source S=N1 and destination D=Nn+1, we define the IP Layer path capacity of path P at time T, C(P,T,I) to be the maximum number of IP layer bits that can be transmitted from S and correctly received by D over path P beginning at T and ending at T+I, divided by I

Type P Packets Example

- Multiple traffic classes on each link with guaranteed bandwidth (and perhaps peak limits)
- One strategy: saturate all classes simultaneously
  - May require a link-by-link approach to determine “map”
- Tight link is different on the path for each class
- What about class Blue? (scavenger class on link 1, eg.)



Tight Link: Orange Tight Link: Blue	Tight Link: Green	Tight Link: Red

Approaches to metrics

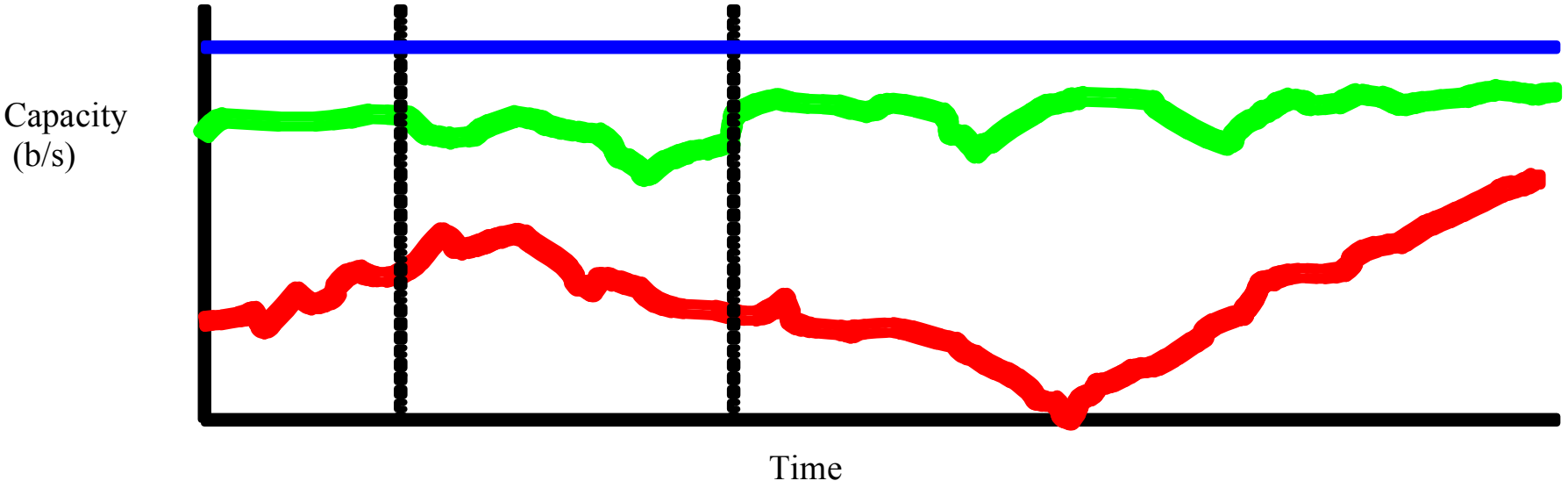
- Active measurement:
  - Sample link metric defined:
    - Depends on averages
    - Depends on being able to saturate the link
  - Sample path metric
    - Dicier: same dependencies, harder to realize
- Passive measurement:
  - Probably would have to have monitors on all links in the path.
  - Depends on the link being saturated for measurement

Average Capacity Used

- Average IP Layer Link Capacity Used: In order to define the available capacity we must first specify how much is being used. Thus, we define the utilization of a link L, Used(L,T,I), as the actual number of IP layer bits correctly transmitted from any source over link L from time T to time T+I, divided by I.
- Average IP Layer Link Utilization: AveUtil(L,T,I) = (Used(L,T,I) / C(L,T,I))

Illustration

- Area under red line = used capacity
- Area under green line = link capacity
- Red area ÷Green area = average utilization
- Blue line indicates nominal link capacity



Available Capacity

- IP Layer Available Link Capacity:
  AvailCap(L,T,I) = C(L,T,I) * (1 - AveUtil(L,T,I))

- IP Layer Available Path Capacity:
  AvailCap(P,T,I) = min {1..n} {AvailCap(Ln,T,I)}

Practical considerations

- Can't measure capacity and utilization at the same time.
- Introduces error in a varying environment (orange boxes)