Tactical Traffic Engineering

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Strategic vs tactical resource optimization/management

• Conventional traffic engineering approaches for resource management used by RSVP-TE and SR-TE often leverage estimates of the ingress traffic demands, during path placement
  • Path placement strategy is to avoid potential congestion

• However, unforeseen and/or dynamic events, can skew these estimates by significant enough margins to result in unexpected network congestion
  • Recomputed paths that address the new demands may take a considerable amount of time, leaving the network in a sub-optimal state
Real time TTE (1/5)

• Set of mechanisms that would allow the network to react in real-time to avert congestion and optimize traffic flow

  • Recognizing congestion
  • FIB entries & backup paths
  • Activation / deactivation
  • Mitigating downstream congestion
  • Flow distribution & selection
Recognizing congestion

- When is link is nearing congestion and when has congestion abated
  - Each link that is protected by TTE is sampled periodically for its current utilization
  - The boundaries of acceptable utilization are defined by high and low utilization thresholds
  - To avoid oscillation, the link must be outside of acceptable utilization for some consecutive number of periodic samples before any action is performed
FIB Entry & backup paths

- **Flow manipulation**
  - TTE manipulates traffic flows by changing the IPv4 / v6 prefixes found in the Forwarding Information Base (FIB), or by changing label entries found the Label Forwarding Information Base (LFIB)

- Several mechanisms exist that potentially create backup paths for a single flow (LFA, FRR, TI-LFA, ...)
  - A key property of a backup path is that its loop free and avoids the same link that the primary path is using

- TTE makes use of backup paths by turning them into active paths in parallel with the primary path.
  - This creates an Equal Cost Multi-Path (ECMP)
Activation / deactivation

- Activation - TTE selects a flow and makes appropriate data plane changes so that traffic is balanced between the primary path(s) and the backup path(s)

- Deactivation - TTE shifts traffic away from its backup path(s) back to the primary path(s)
Mitigation further downstream congestion

- Any change to the traffic flow may have an impact in multiple places on the network
  - When TTE is activated, it may shift traffic to an entirely different path, not just around a single link, and the change may result in congestion along the new path

- Networks that are engineered to support protection against link failures should already take this into account
Prefix selection

• When a link is outside of its bandwidth thresholds, TTE must select certain paths to activate or deactivate

• Which paths and flows to select is a critical decision that affects how quickly TTE converges to a solution where the link bandwidth is within its thresholds
  • Random
  • No Elephants
  • Maximum fit
  • Best fit
  • Maximum fit with elephants
Thank you