Load-Dependent Flow Splitting for Traffic Engineering in Resilient OpenFlow Networks

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Motivation for LDFS

- Network failures are common in communication networks
  - Various reconfiguration and protection schemes exist today
- Network failures and Software-Defined Networking (SDN)
  - Data plane failures require control plane to react
    - Control plane may be affected by data plane failure as well
    - Pre-established backup paths can prevent traffic loss
- Short-lived traffic spikes can occur in network operation
  - Reconfiguration of the network is unattractive
  - Temporary redirection of excess traffic can avoid bottlenecks
Load-Dependent Flow Splitting (LDFS)

With LDFS traffic is sent dependent on the traffic load
- Normally: traffic is sent over the primary path
- On traffic overloads: split over the primary and backup paths
- If the primary hop fails, no traffic split is possible

LDFS policies
Traffic of a flow is split after a specified threshold is exceeded
1. Balance All Traffic (BAT)
   Traffic is split over both paths
2. Balance Excess Traffic (BET)
   Excess traffic is split over both paths
3. Redirect Excess Traffic (RET)
   All excess traffic is sent on the backup path
Implementing LDFS with OpenFlow

- LDFS requires
  1. Resilience
  2. Load balancing
  3. Local monitoring of flow rates

- OpenFlow 1.1 and later is required
  - Group tables enable advanced packet processing
  - Fast-failover type enables backup paths
  - Select type enables load balancing
  - Combination of fast-failover and select required

- Traffic rates can be measured using counters or meter tables (OpenFlow 1.3)
Network Scenarios and Traffic Models

Network scenario consists of simultaneous link failures and traffic overloads

The network scenario set $S^{l,o}$ contains network scenarios with up to
- $l$ simultaneous link failures
- $o$ simultaneous traffic overloads

Examples
- Failure-free case without overloads: $S^{0,0}$
- Non-simultaneous link failures and traffic overloads: $S^{1,0} \cup S^{0,1}$
- Simultaneous link failures and overloads: $S^{1,1}$

Traffic matrices are generated using the gravity model
Overloads are modeled using the hot spot model
GÉANT Network

► European research network
  ▪ http://www.geant.net/

► Topology
  ▪ 40 nodes
  ▪ 61 bidirectional links
Relative Required Network Capacity
Relative Maximum Link Capacity

SDNflex 2015: W.Braun - Load-Dependent Flow Splitting (LDFS)
Conclusion

► Proposed LDFS
  ▪ Traffic- and failure-aware load balancing for OpenFlow
  ▪ Combines resilience, load-balancing, and monitoring capabilities
    – Goal is to quantify the advantages of these capabilities

► Comparison of single and multipath routing and LDFS
  ▪ LDFS improves network and maximum link capacities
    – When traffic overloads and failures do not happen simultaneous
    – Up to 15% network capacity and 17 – 35% maximum link capacity
  ▪ Capacity savings diminish for LDFS when simultaneous failures and overloads occur
    – No load balancing can occur when the primary path fails
  ▪ Results are topology dependent
    – Other investigated networks show the same trend