

Optimum Implementation of TI-LFA and Segment Routing on SURFnet 8

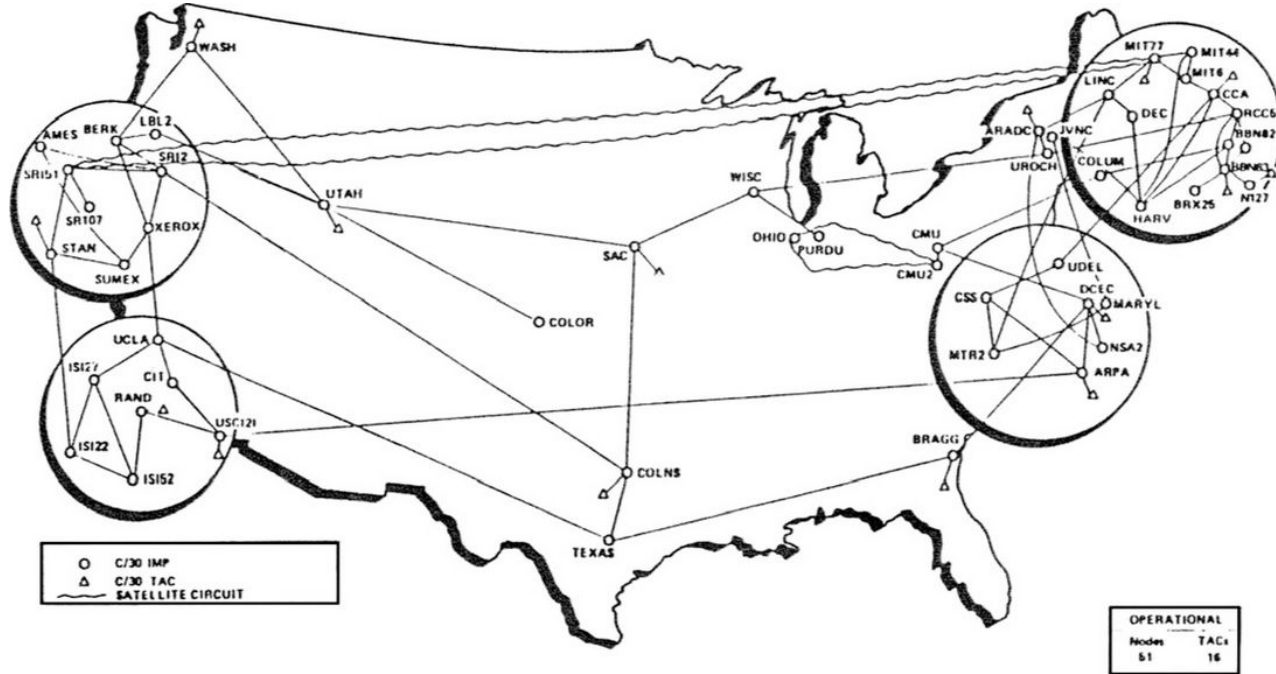
RP #22

Peter Prjevara & Fouad Makioui

Supervisors: Marijke Kaat & Wouter Huisman



The Goals of Networks



ARPANET - 1974

<https://en.wikipedia.org/wiki/ARPANET>

What IGPs Currently Offer?

- Sub-second convergence times (< 1000ms)
 - If effects BGP -> can take up to **3 minutes**
- **Reactive Approach**
 - Fault Recognition
 - Information Flooding

The Goals of Networks Today

- Real time services
 - VoIP / Video
 - Cloud Software
 - Financial Trading
 - Experimental

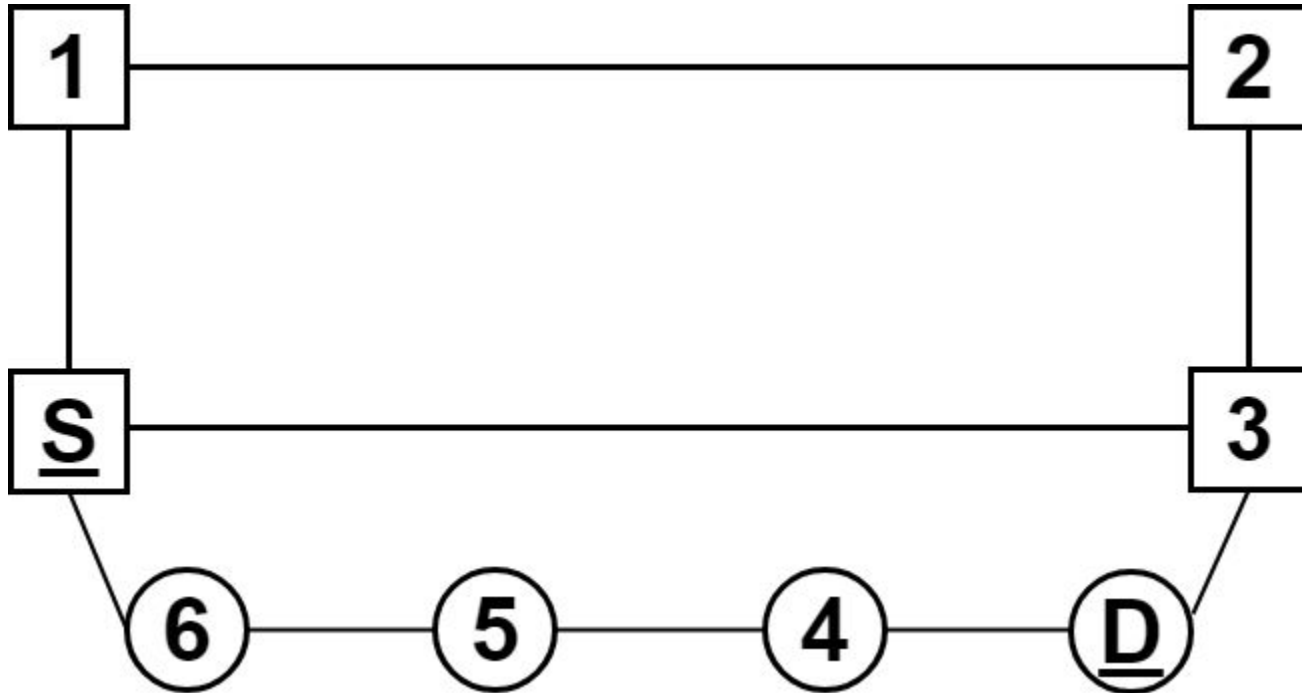
Not good enough



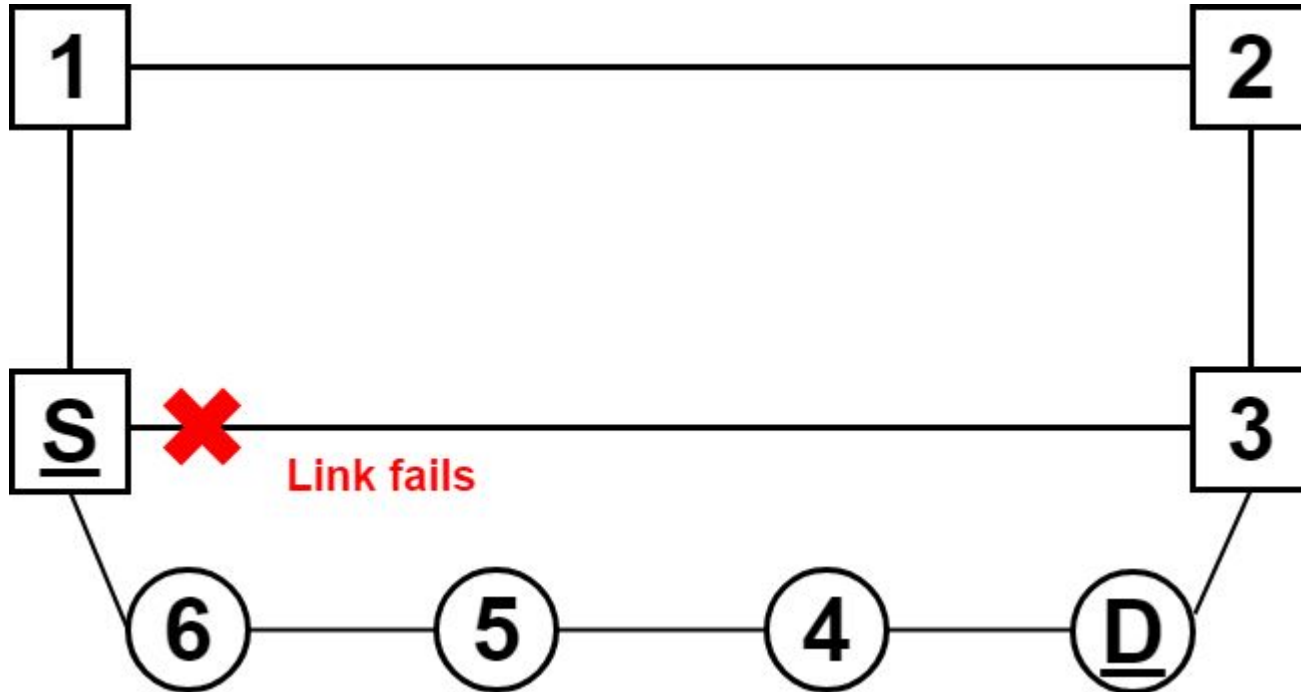
Where might virtual reality lead us?

David Ramos/Getty Images

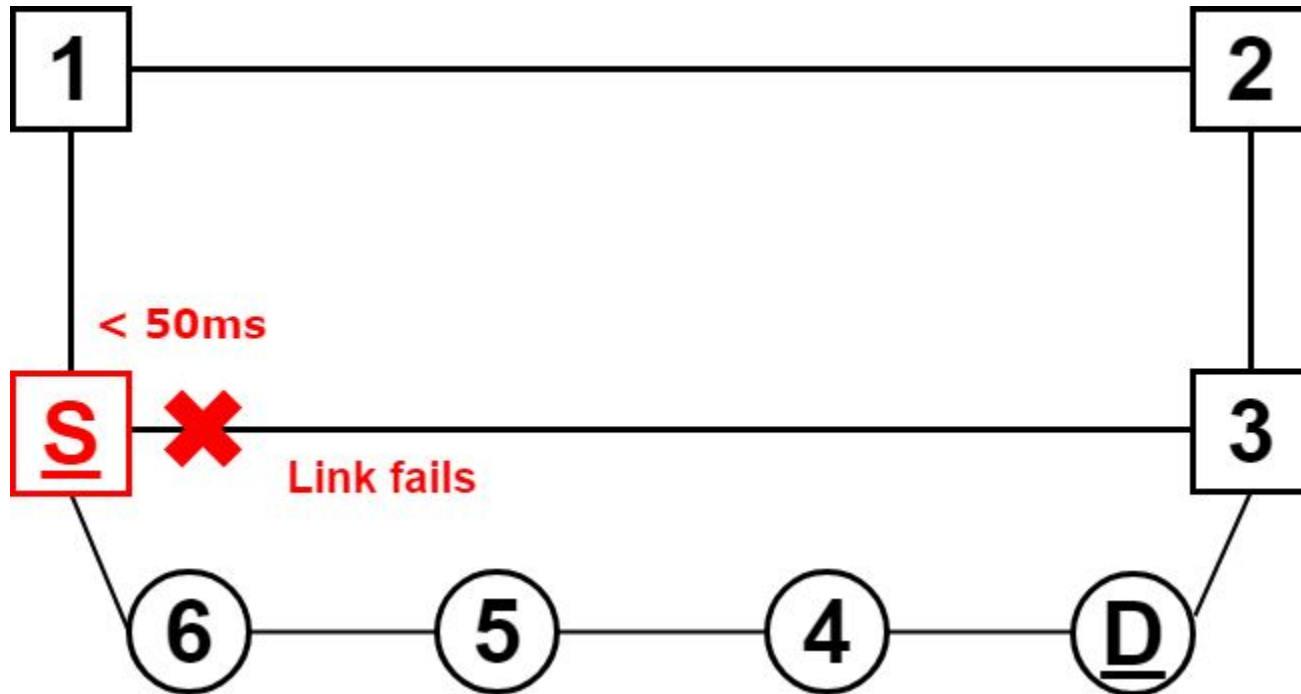
Network in a Normal State



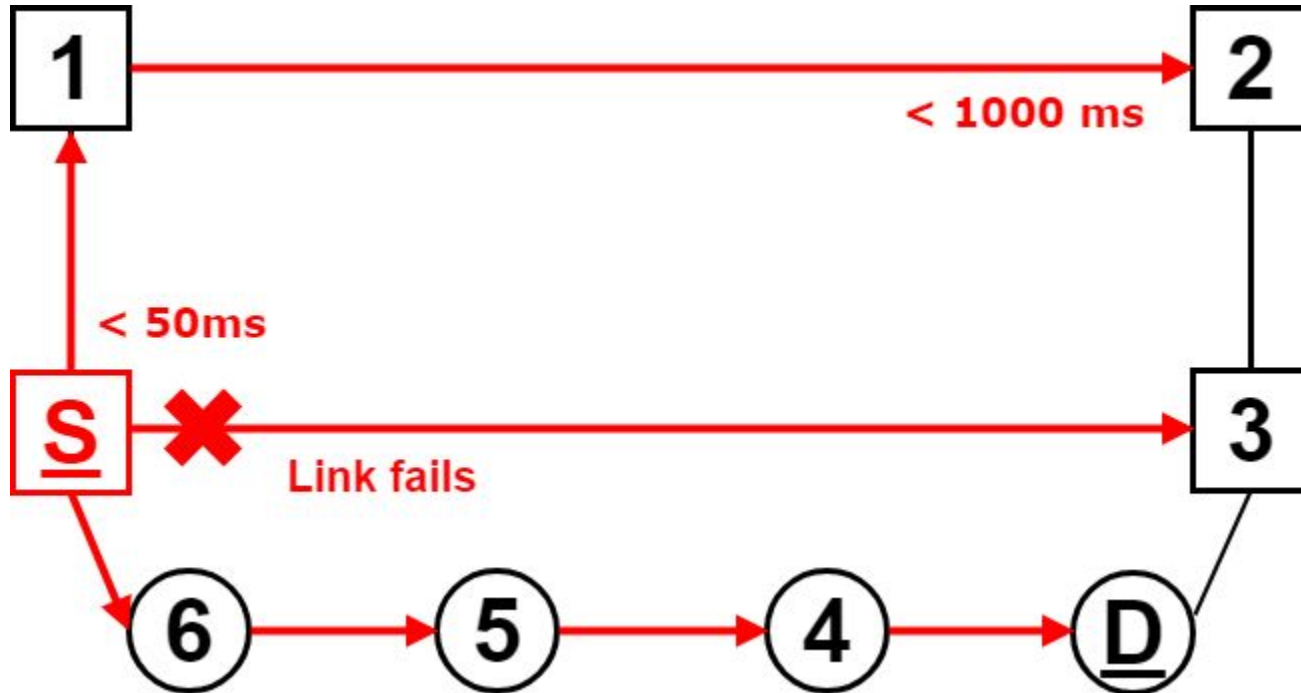
Failure Occurs



The Reactive Approach: Step 1

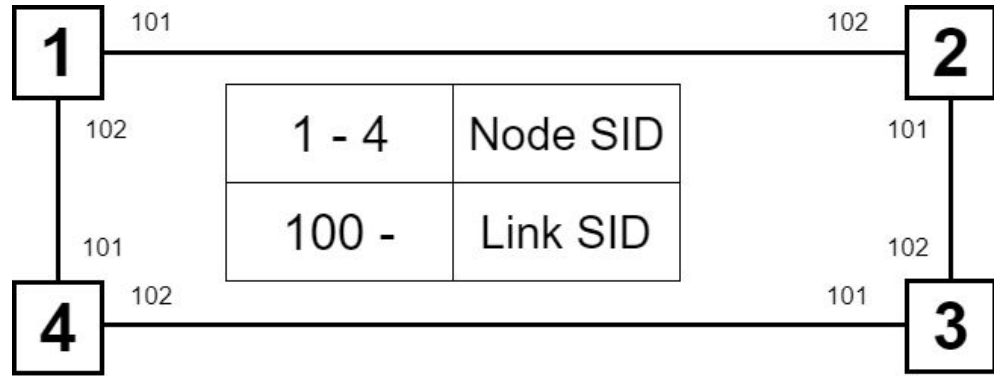


The Reactive Approach: Step 2

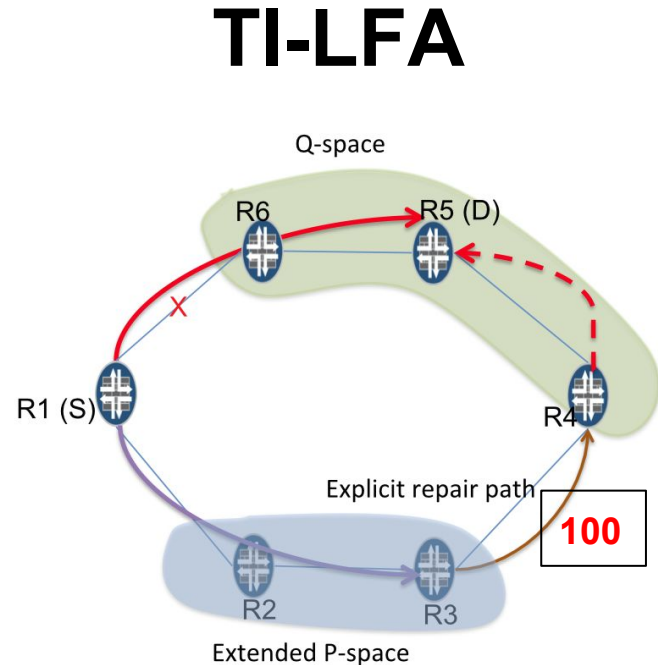
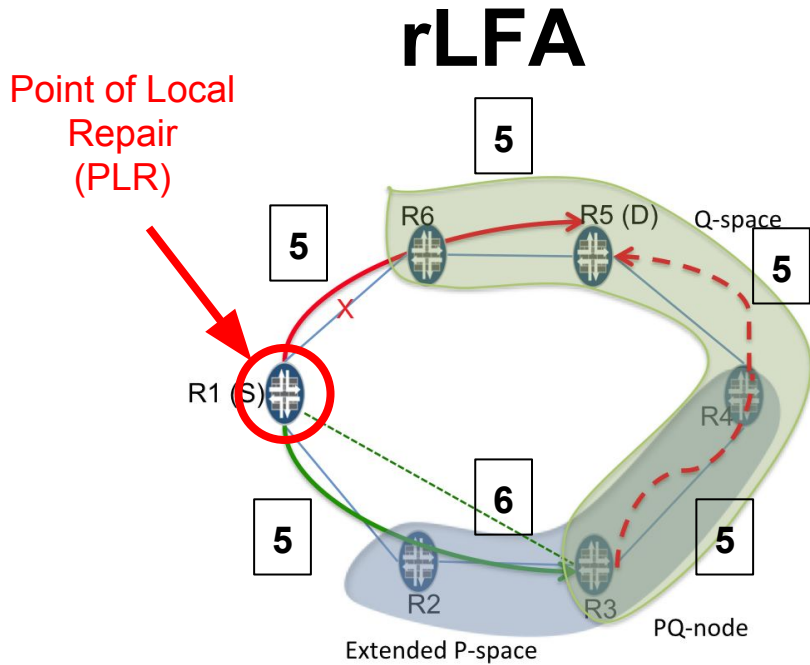


Segment Routing (or SPRING)

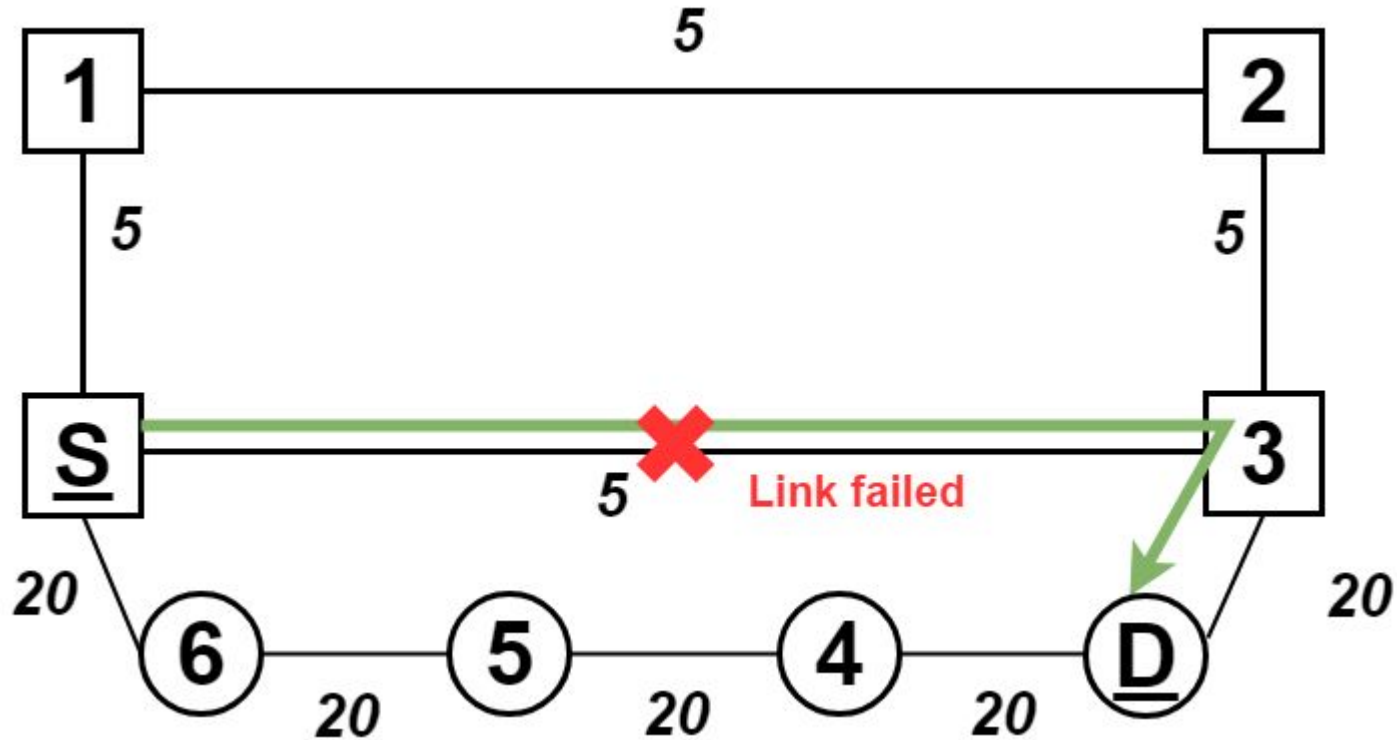
- Every node is labelled
 - **Node ID**
- Every link is labelled
 - **Adjacency ID**
- MPLS labels
- IGP to distribute Segment IDs (SIDs) creating a full mesh



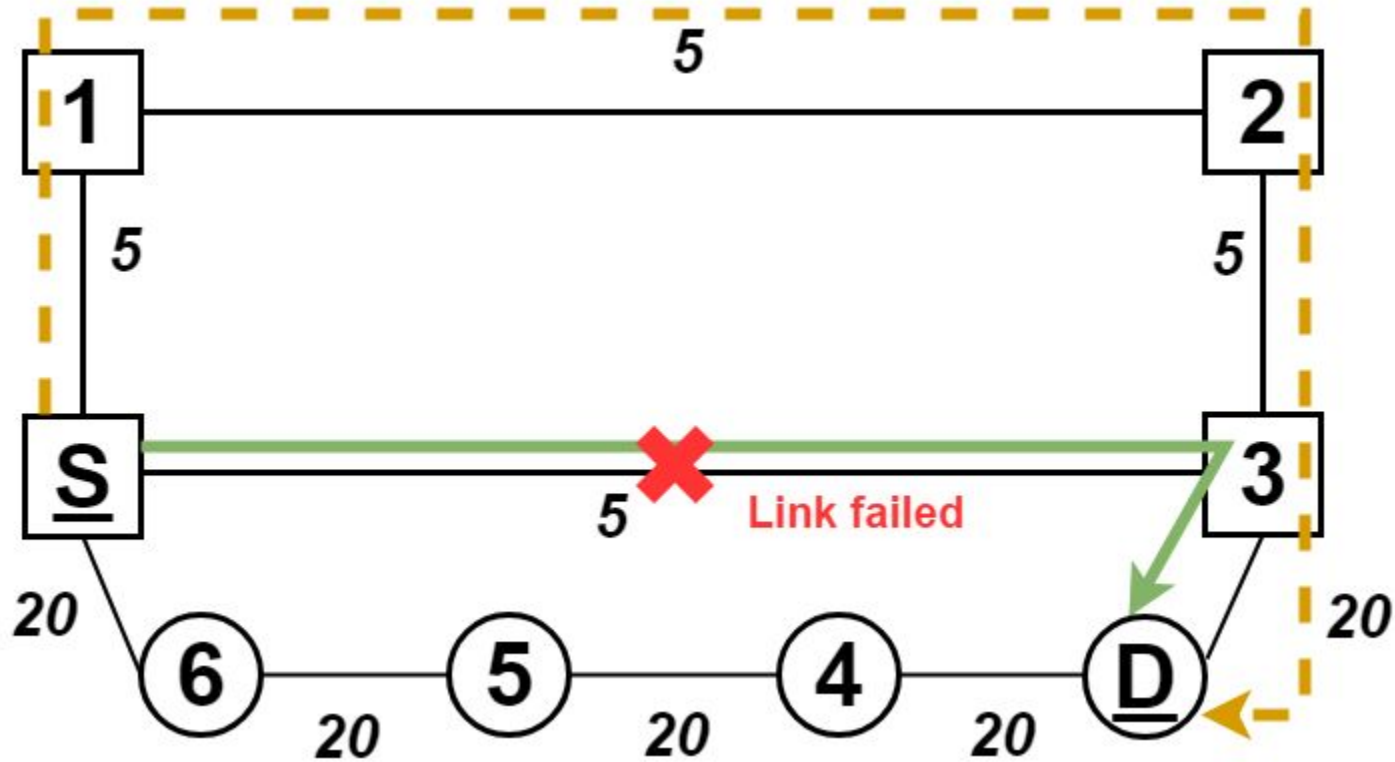
Protective Fast Reroute Solutions



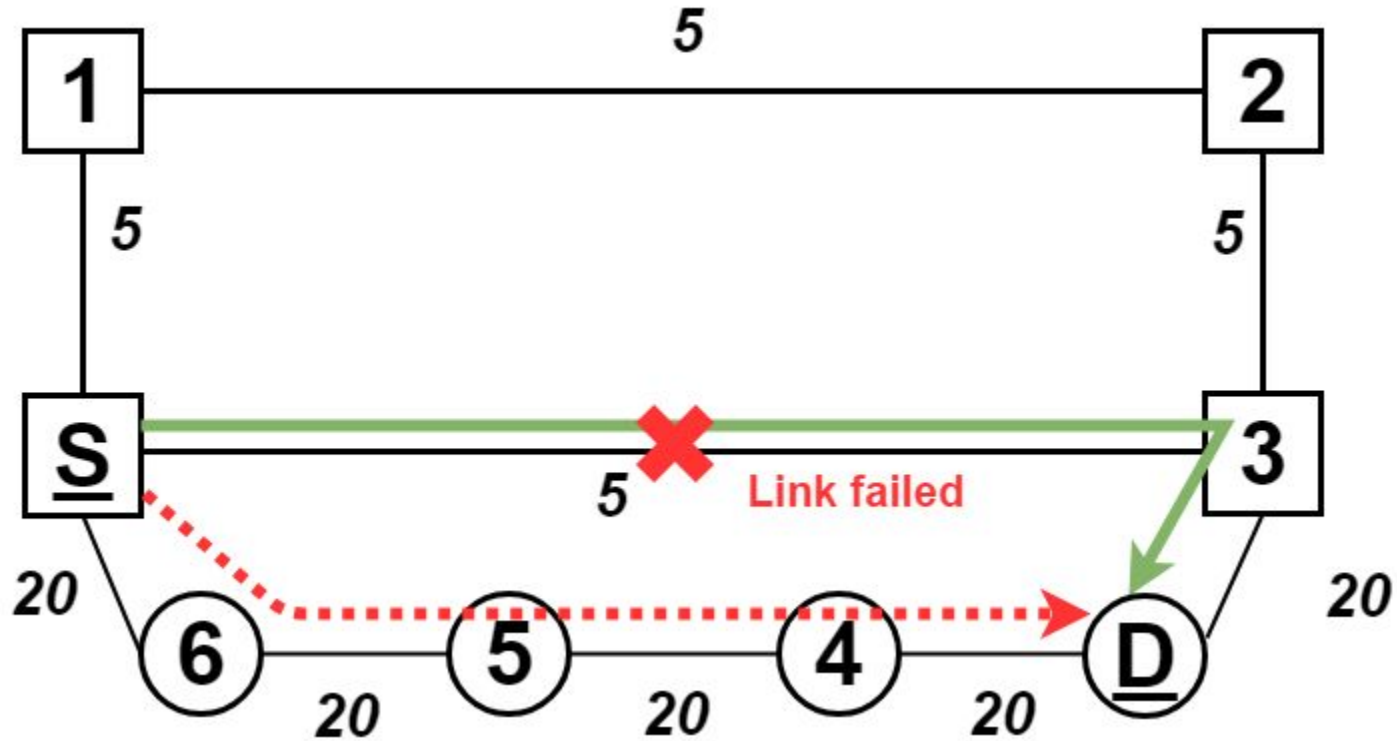
Feature Link / Node Protection



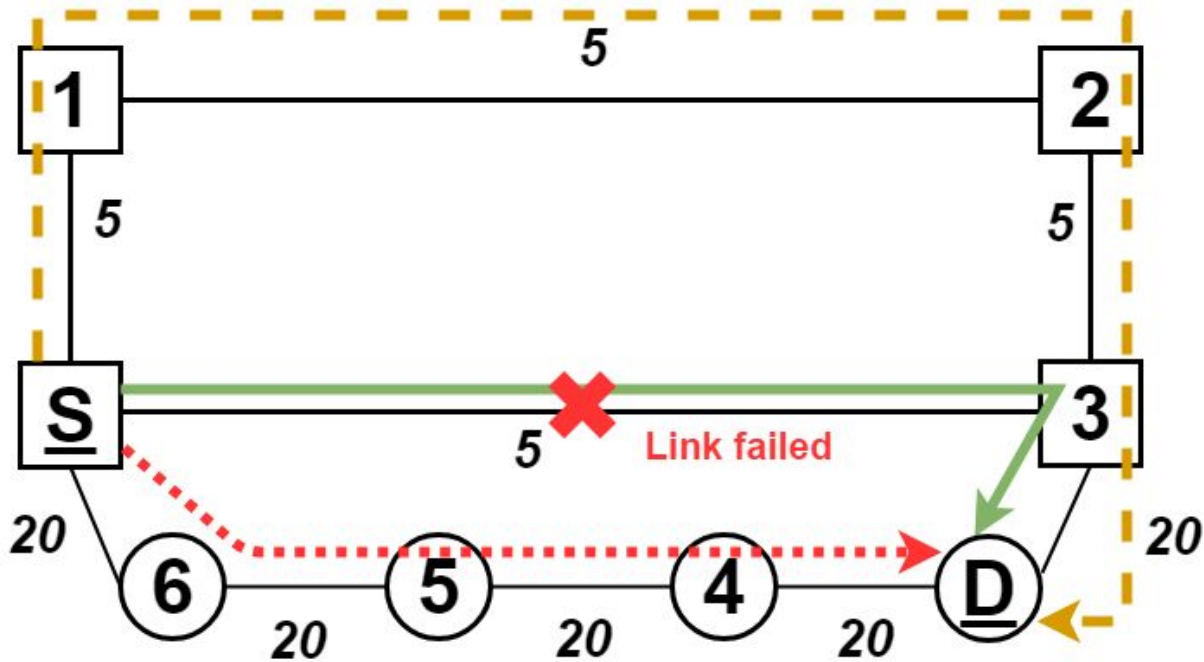
Link Protection



Node Protection



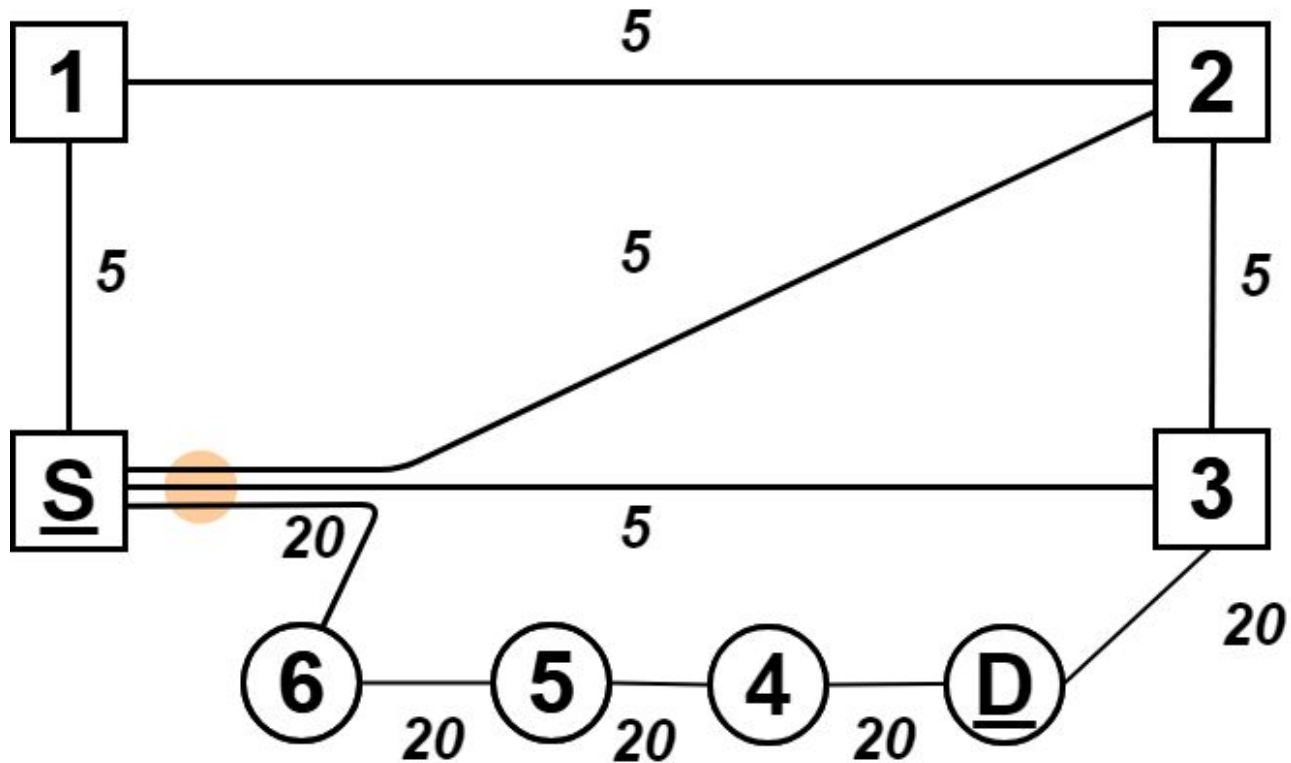
Link / Node Protection Summary



Topology legend	
	Original Path
	Link Protection
	Node Protection

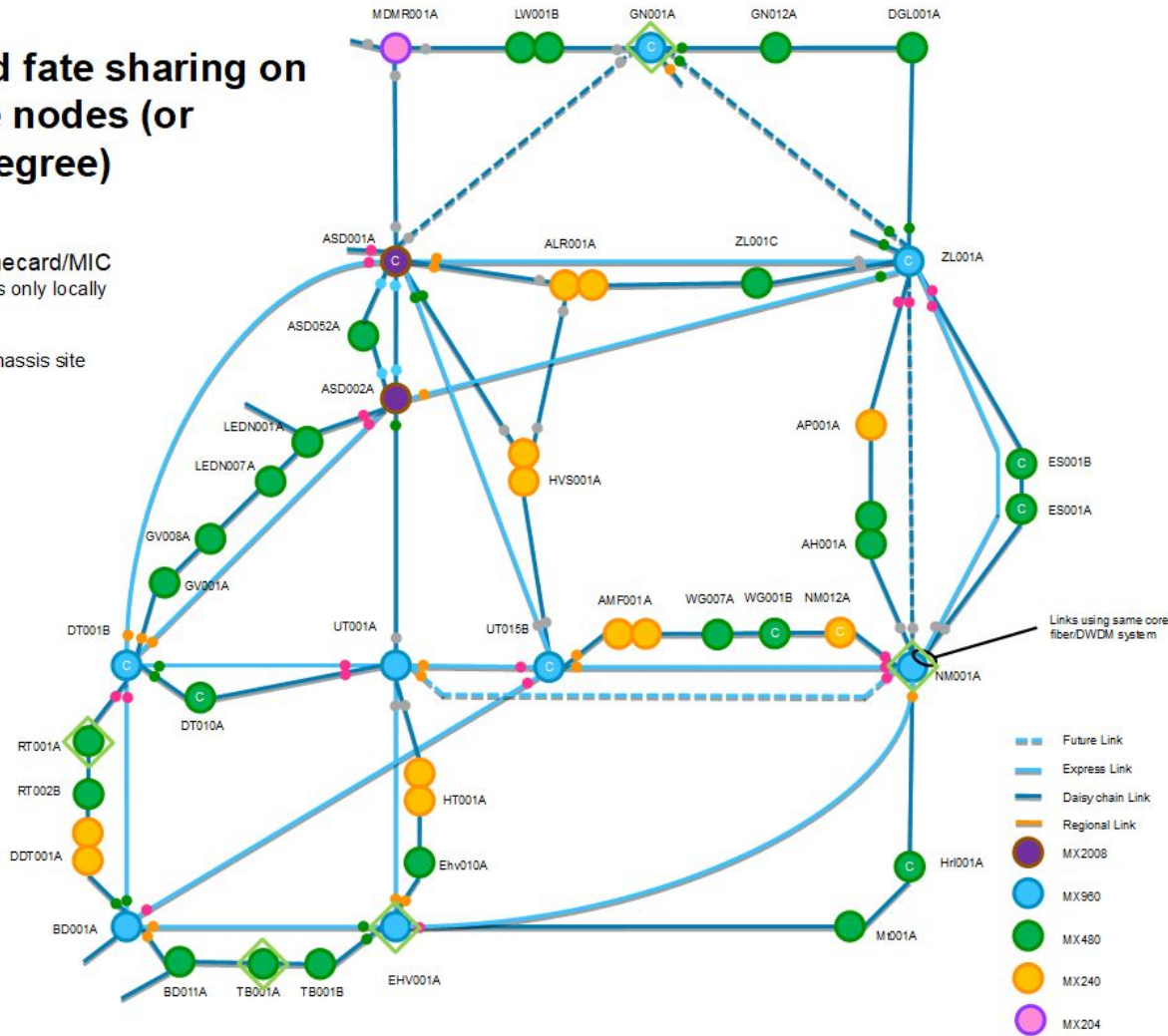
The IGP cost of links are displayed next to the links.

Fate Sharing



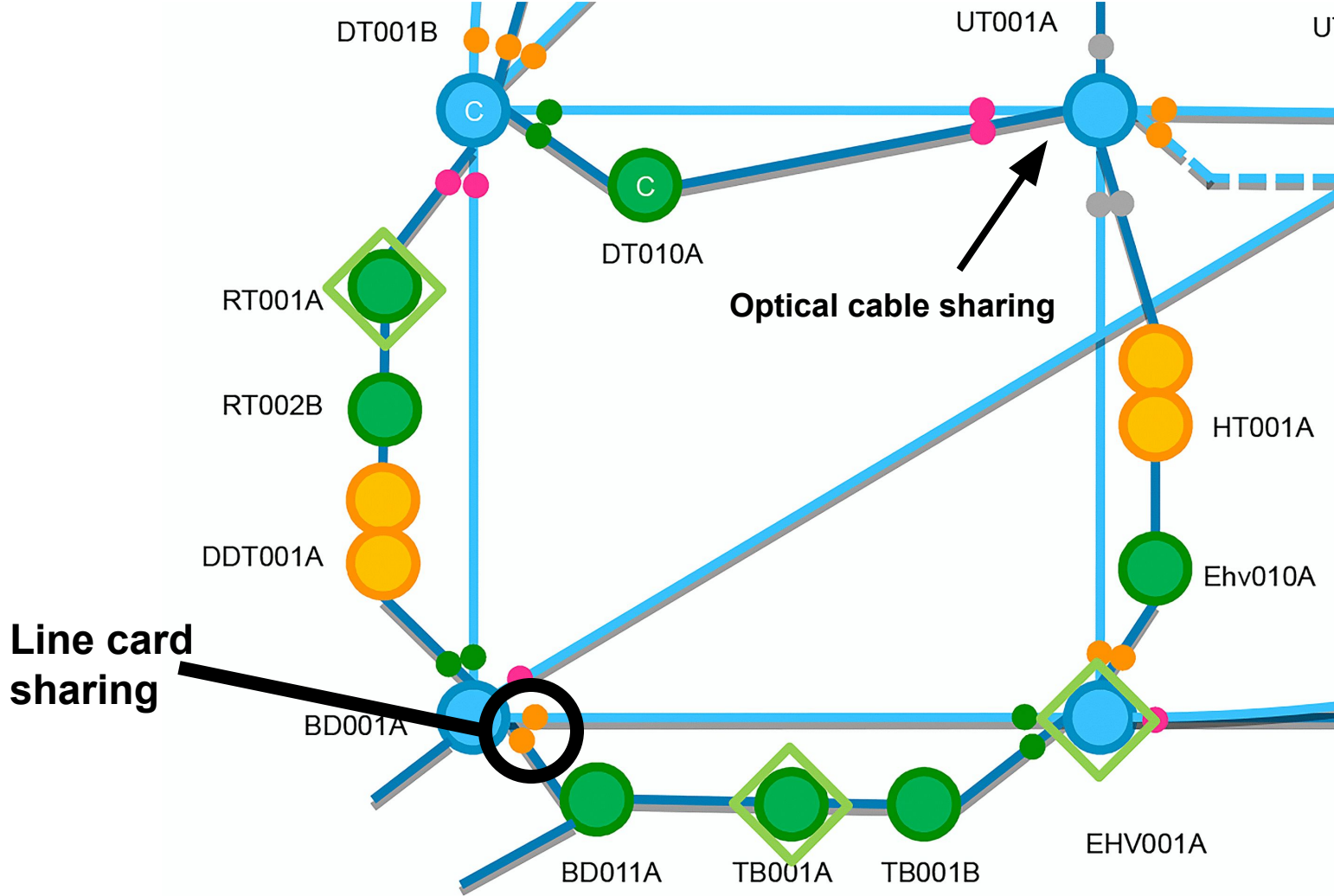
Line card fate sharing on 3-degree nodes (or higher degree)

- Sharing Linecard/MIC
- the colour has only locally significant
- significant
- ◇ Redundant chassis site (MX204)



SURFnet8 Topology

- Interfaces that share the same fate due to:
 - Line card sharing
 - Optical path sharing
- Juniper Routers used that support:
 - TI-LFA
 - SPRING
 - Node Protection
 - Fate Sharing

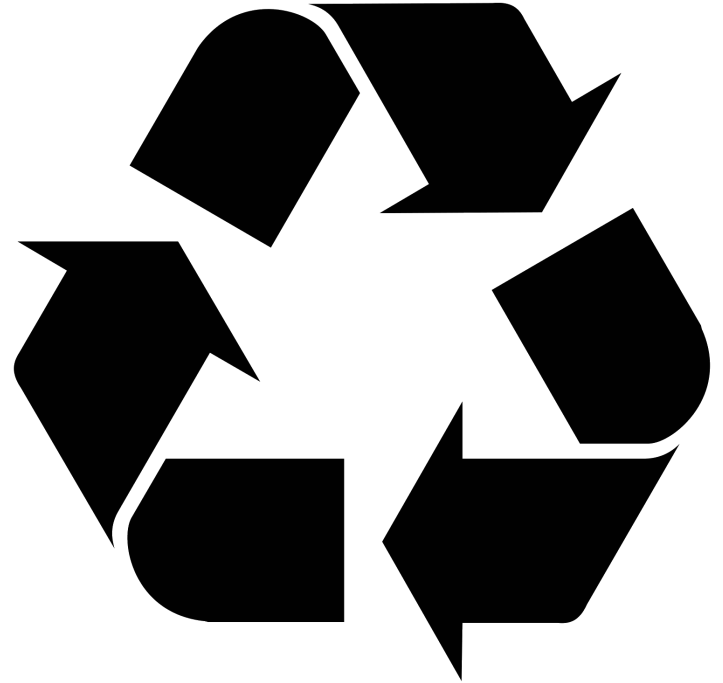


Research Questions

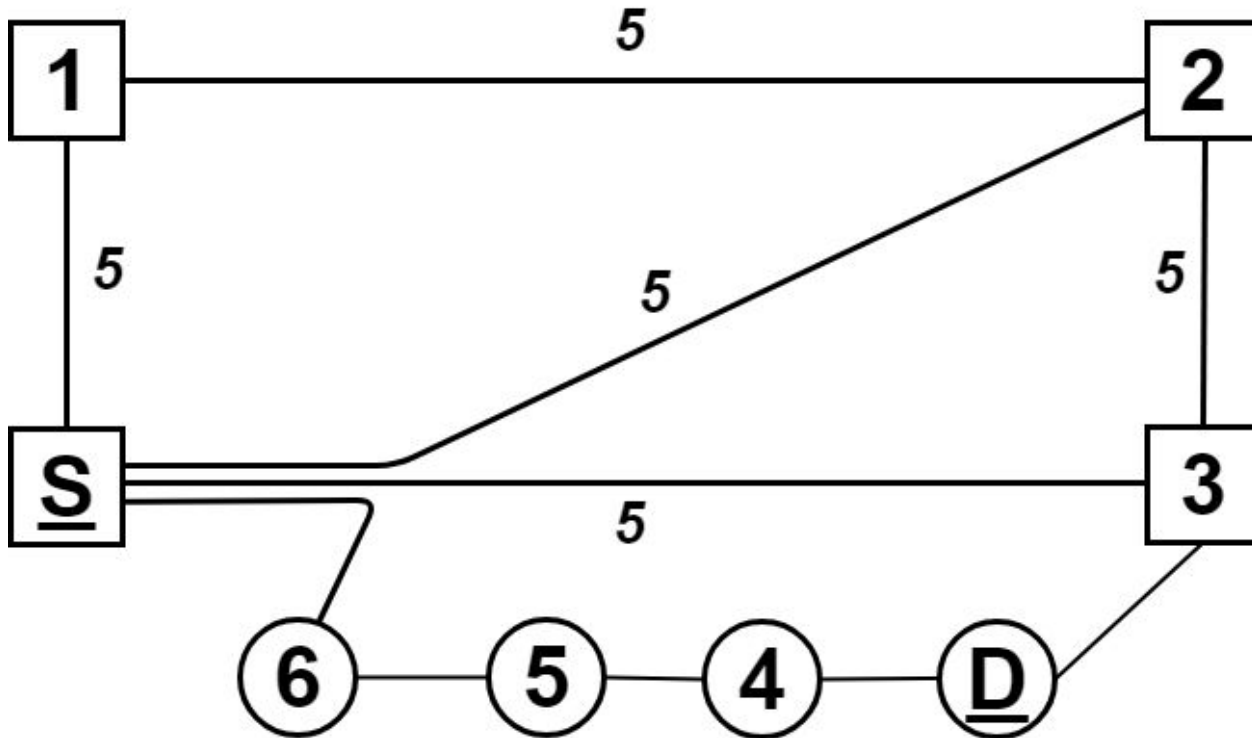
1. *How do different TI-LFA configurations perform when implementing Node / Link Protection and Fate Sharing?*
2. *How do they affect the proposed metrics in IGP?*
3. *Is fate sharing necessary for all links that share the same line card or optical layer?*

Methodology

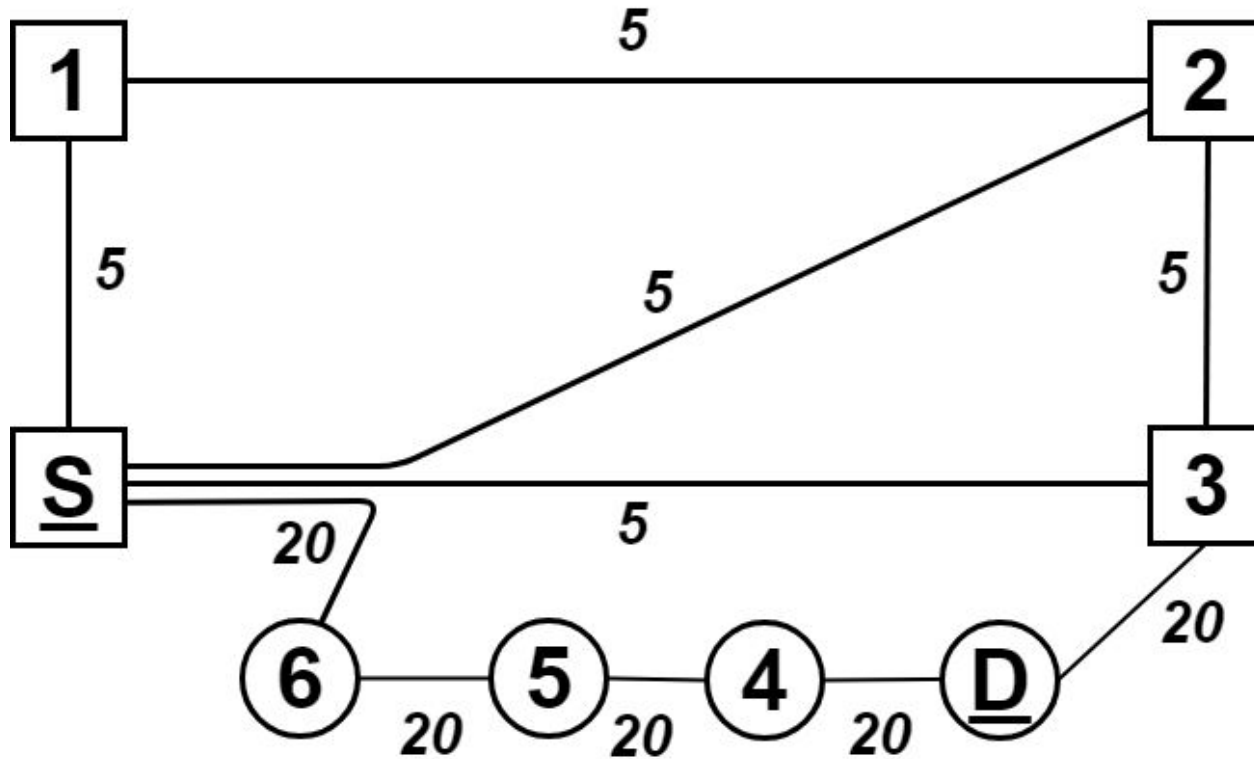
- Desk research
 - Understand novel concepts
- Define experiments
 - Create topology
- Analyse results
- Draw conclusions



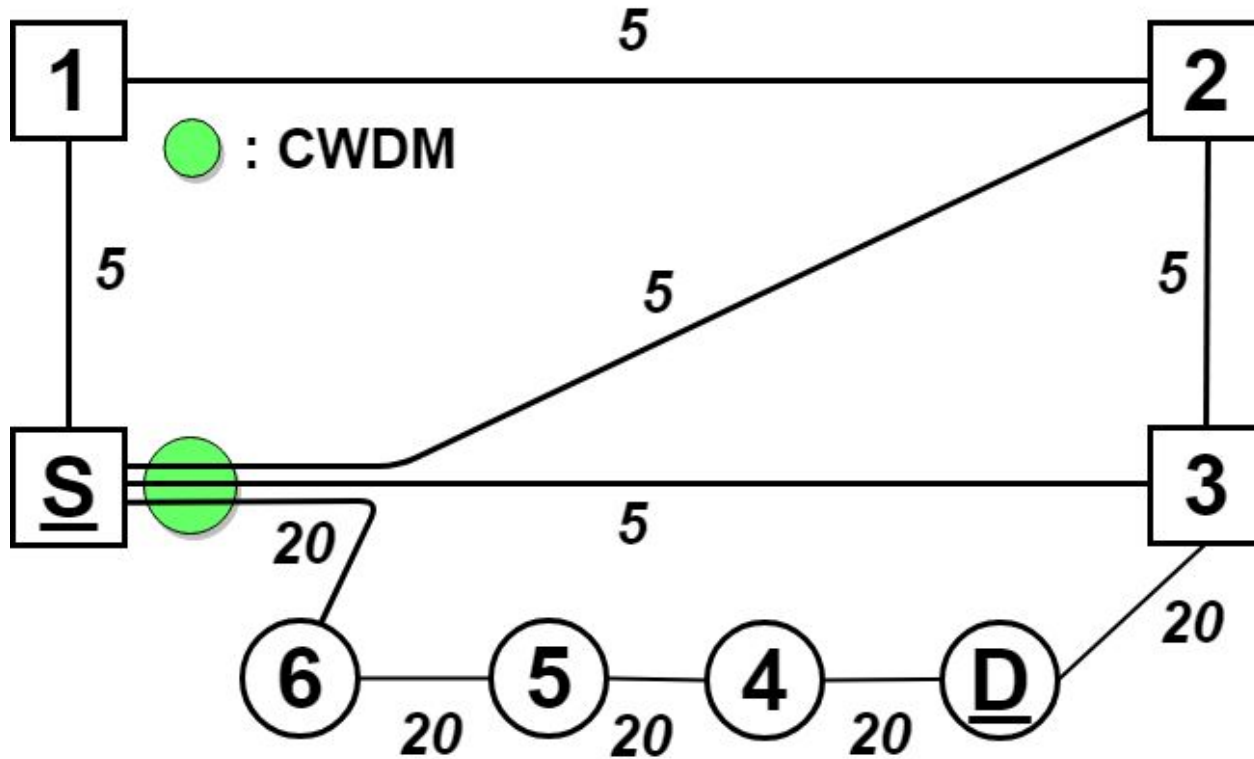
Our Test Topology



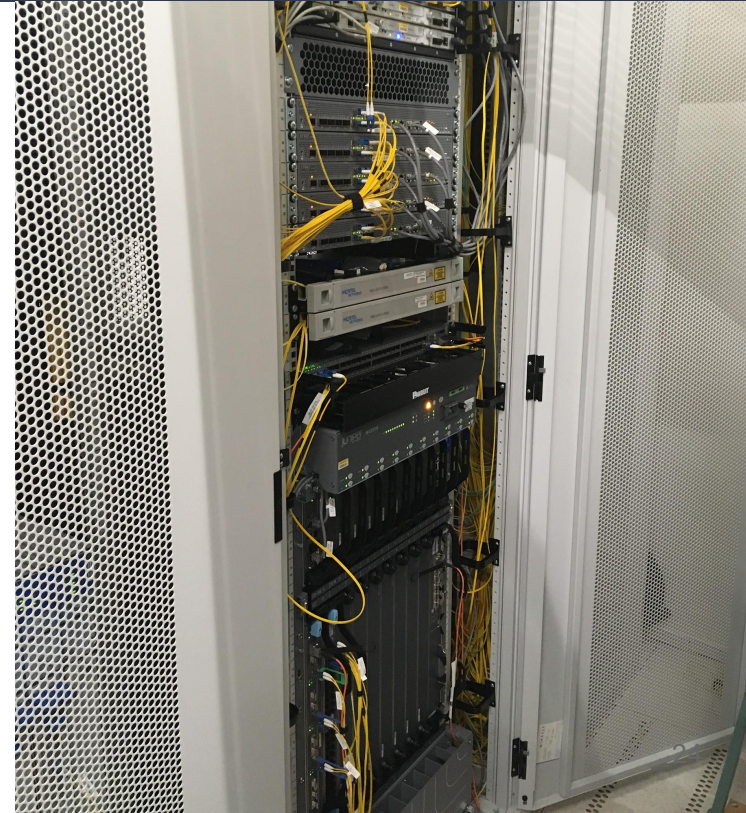
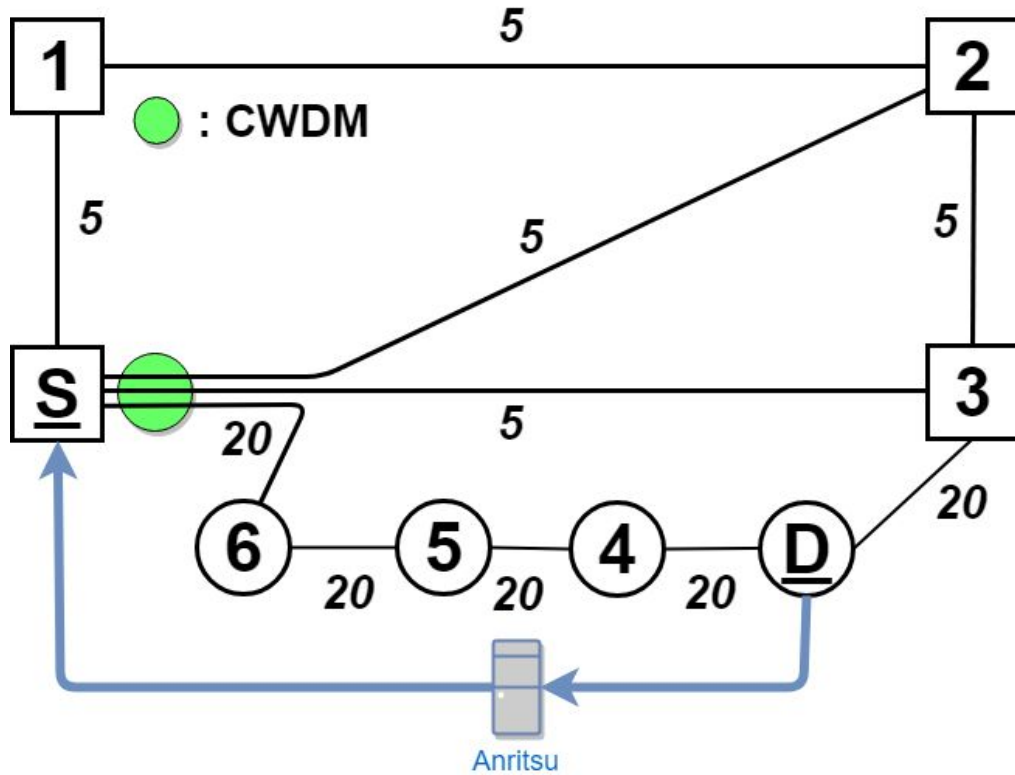
Our Test Topology



Our Test Topology



Our Test Topology

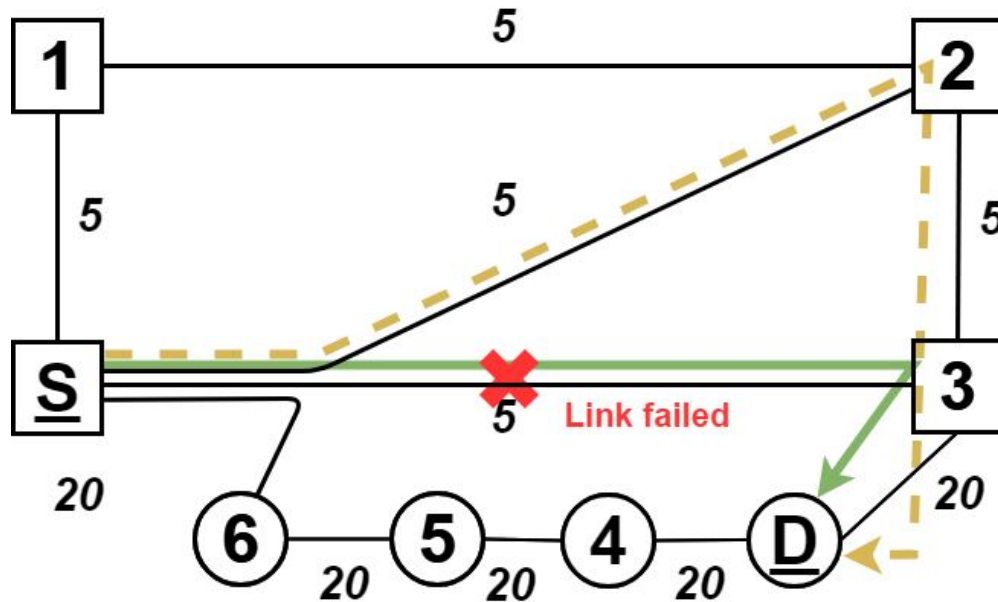


List of Experiments

<u>Experiment</u>	<u>Sub Experiment</u>
Baseline SR	Without TI-LFA
	With TI-LFA
Baseline SR with extra hop	Without TI-LFA
	With TI-LFA
Multiple link failures with source as PLR	With a single backup path
	With equal cost multi paths
	With fate sharing
Link/Node Protection	Observe the routing table on PLR
ECMP Metric Calculation	Python Script Simulation / Paper analysis

Baseline SR

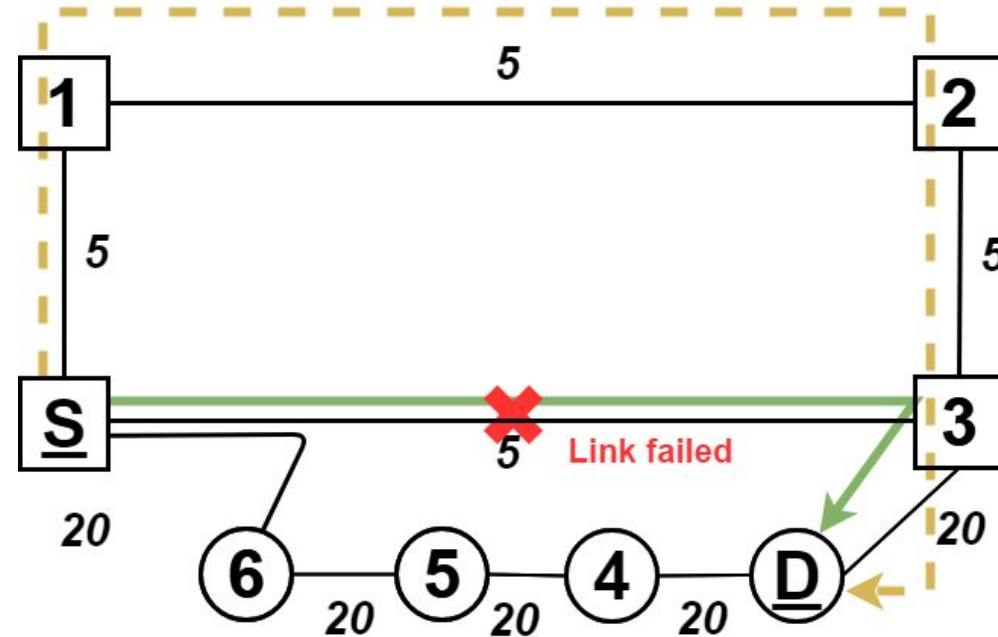
- SR without TI-LFA vs SR with TI-LFA



Topology legend	
	Original Path
	Backup Path
<i>The IGP cost of links are displayed next to the links.</i>	

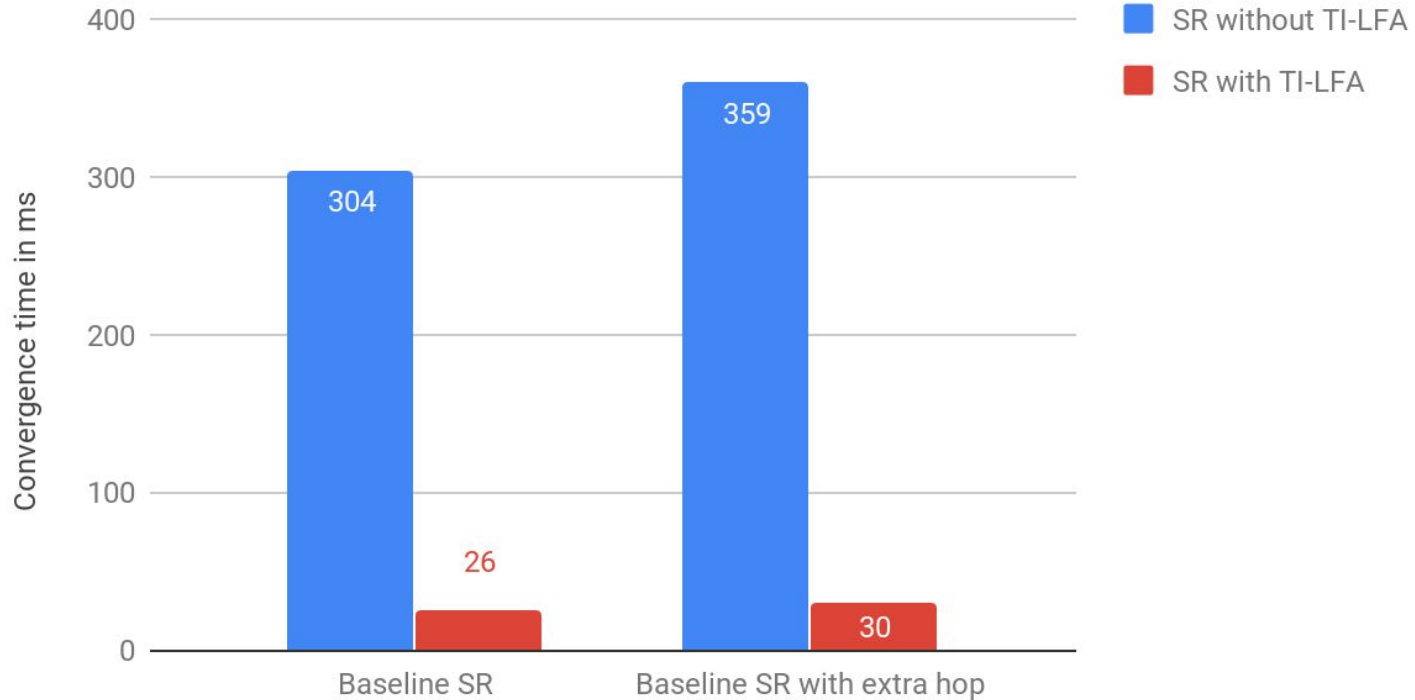
Baseline SR with Extra Hop

- SR without TI-LFA vs SR with TI-LFA (without crosslink)

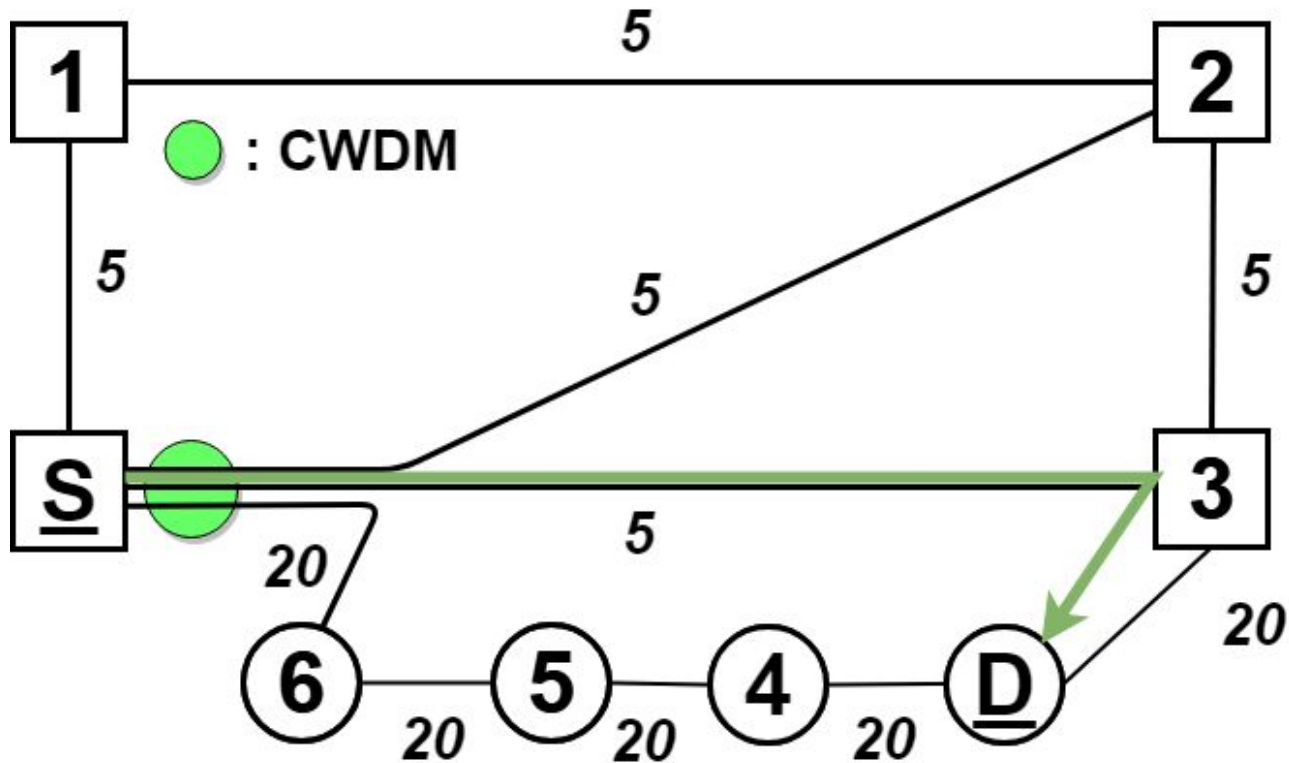


Topology legend	
	Original Path
	Backup Path
<i>The IGP cost of links are displayed next to the links.</i>	

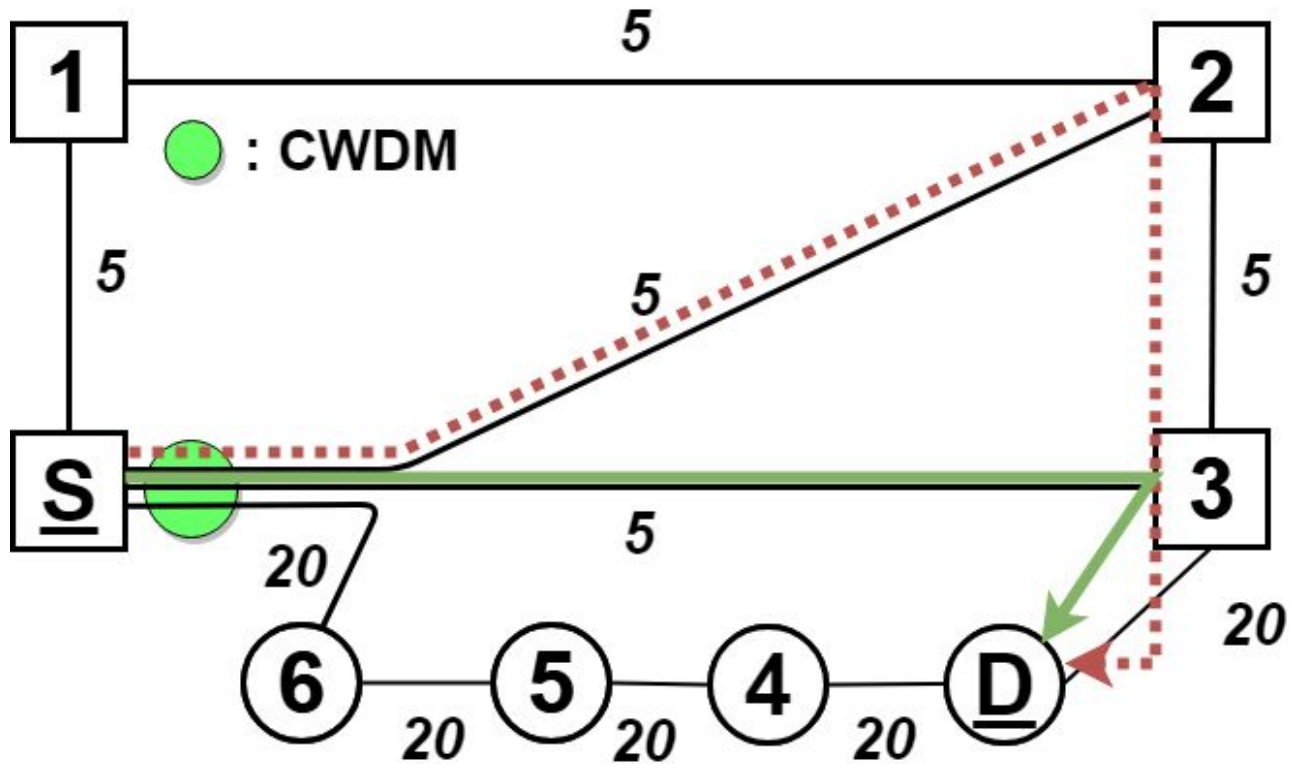
Results



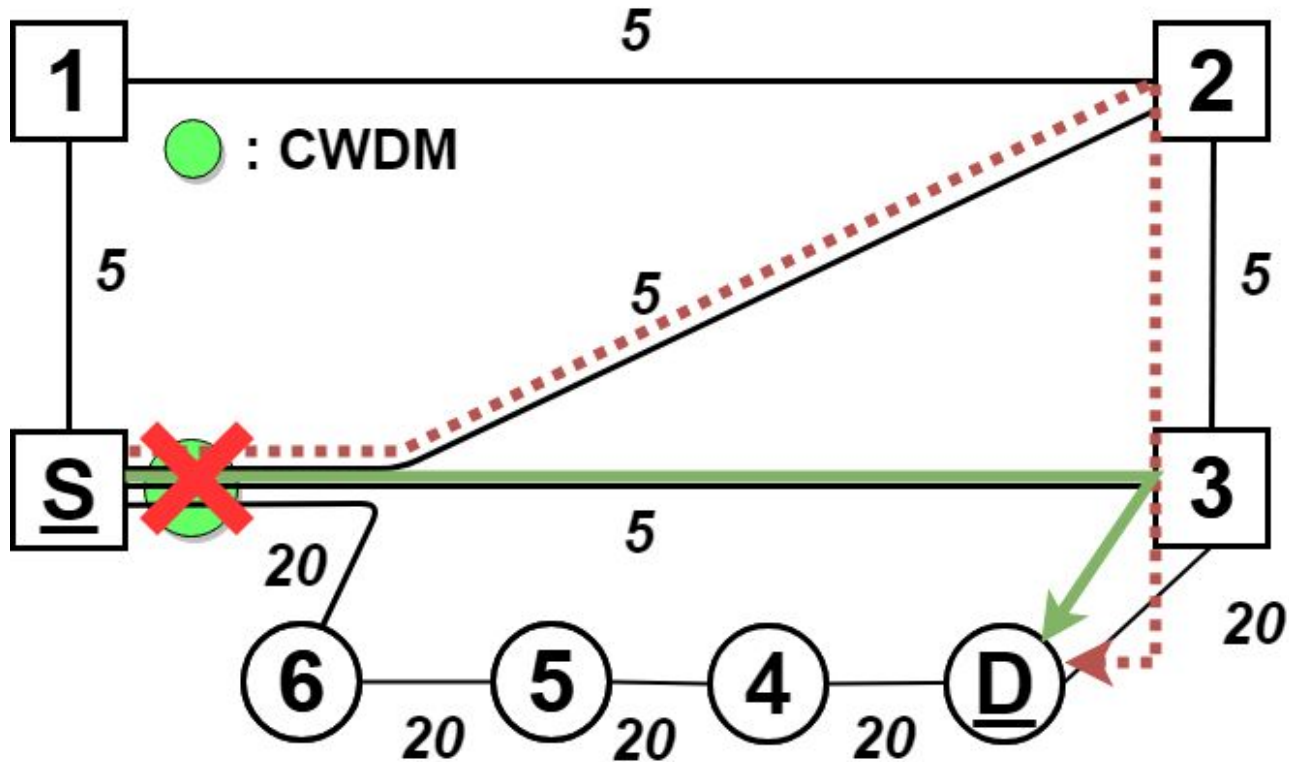
Multiple Link Failures 1



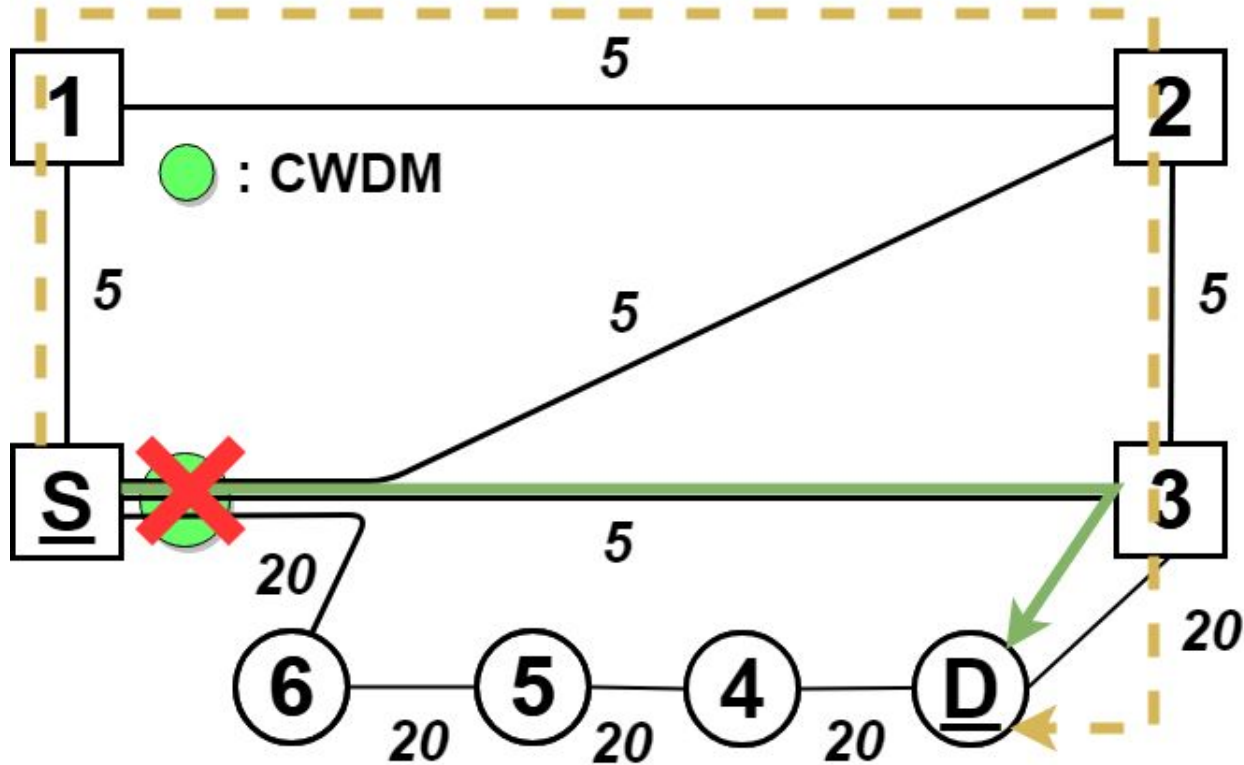
Multiple Link Failures 2



Multiple Link Failures 3



Multiple Link Failures 4

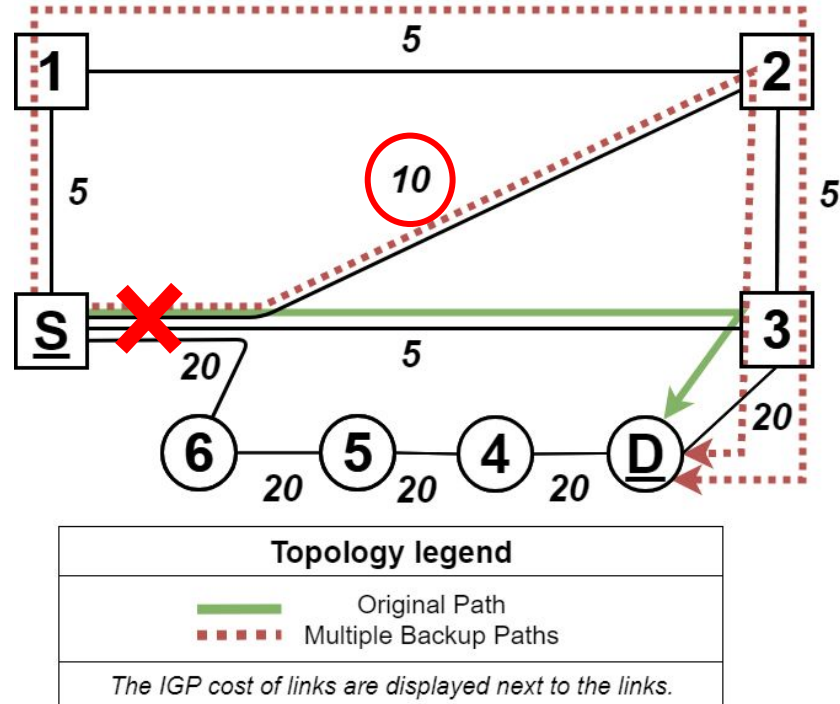


Multiple Backup Paths

Route output

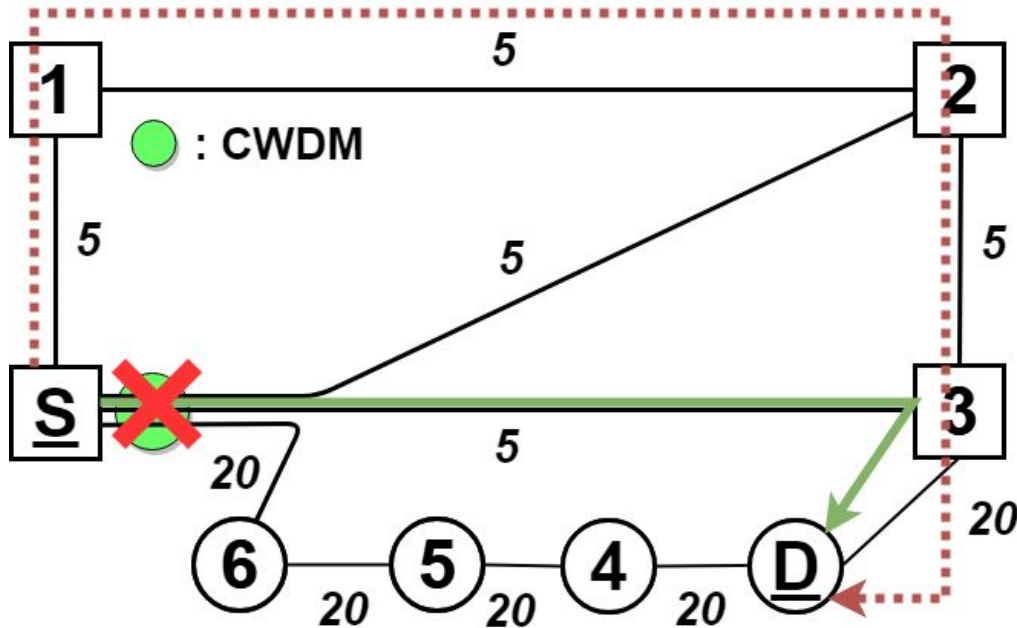
```
145.125.124.6/32 (2 entries, 1 announced)
*L-ISIS Preference: 14
Next hop: 145.125.176.59 via ge-2/3/0.0 weight 0x1, selected
Next hop: 145.125.176.18 via xe-2/0/2.0 weight 0xf000
Next hop: 145.125.176.0 via et-1/1/0.0 weight 0xf000
```

- Maximum 8 backup paths
 - Equal Cost Multi Path (ECMP)



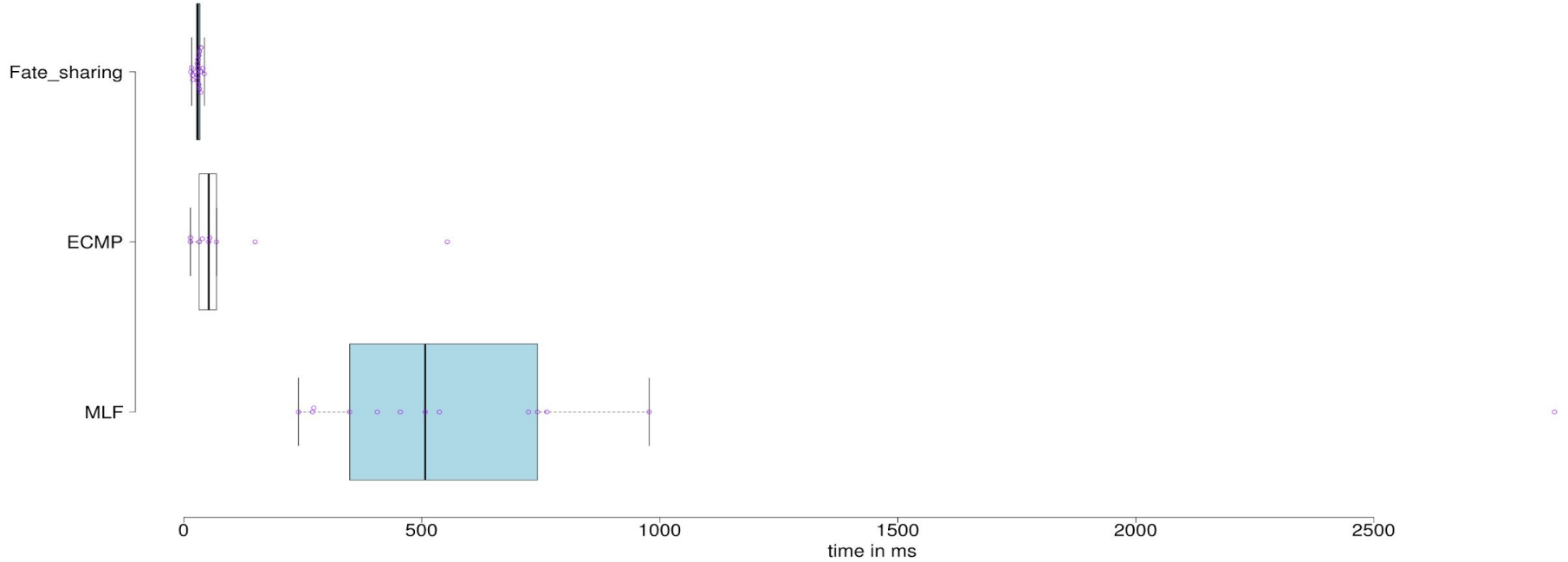
Experiment: Fate Sharing

- TI-LFA with fate sharing

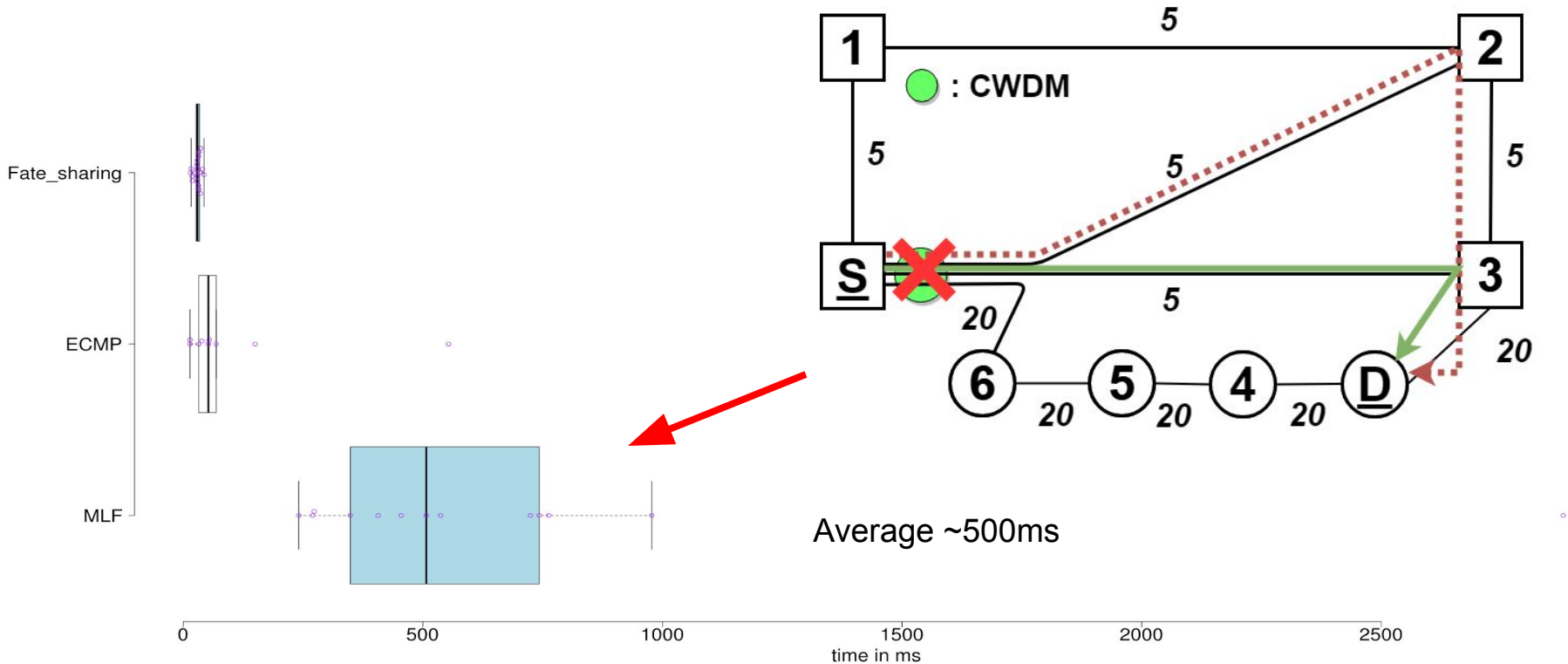


Topology legend	
	Original Path
	Backup path with Fate sharing
<i>The IGP cost of links are displayed next to the links.</i>	

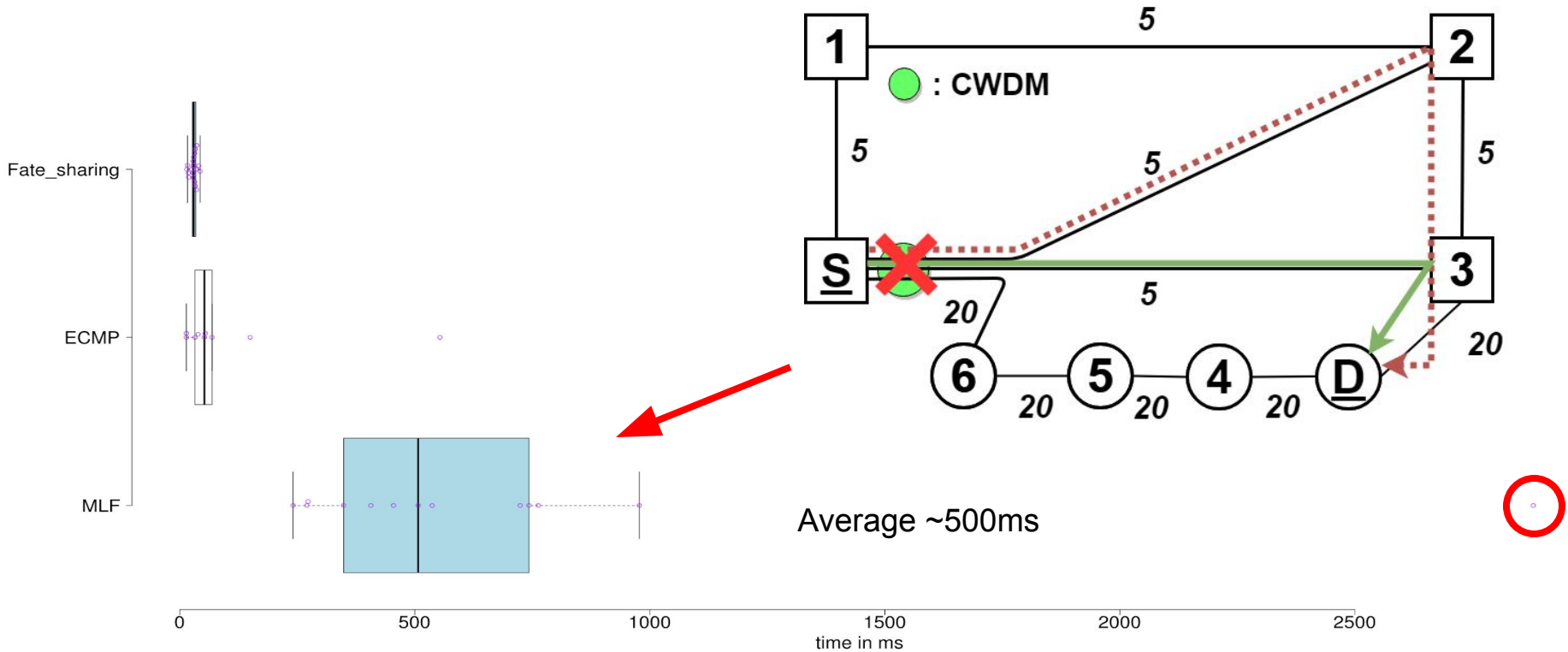
Results



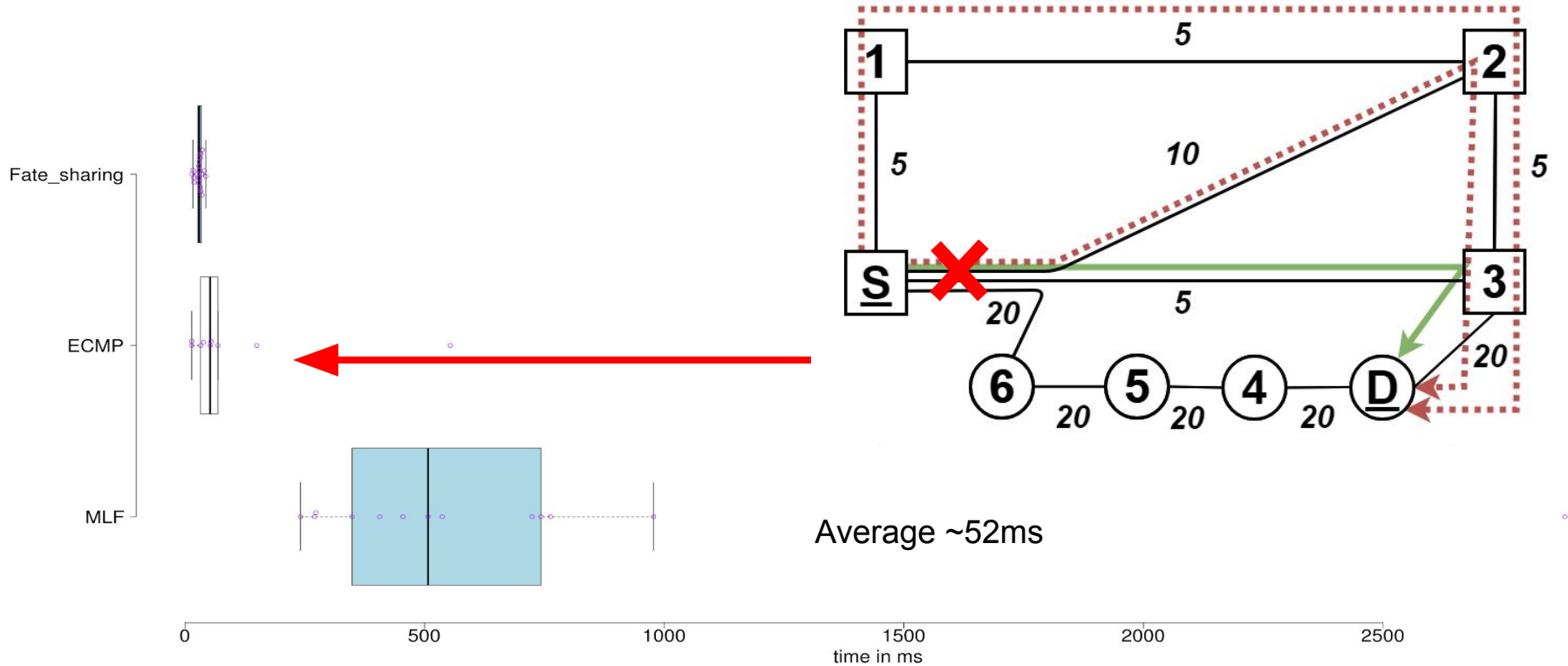
Multiple Broken Links



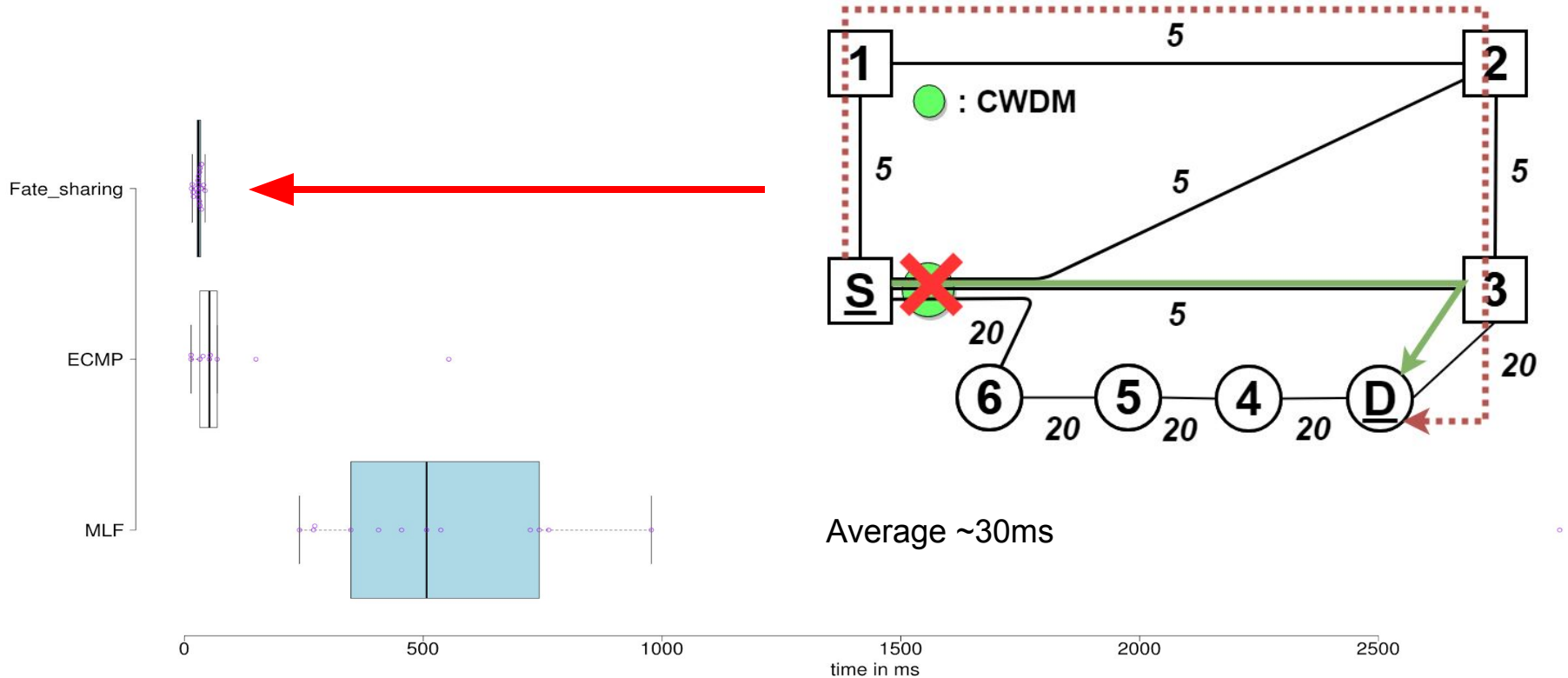
Multiple Broken Links



Multiple ECMPs



Fate Sharing Enabled



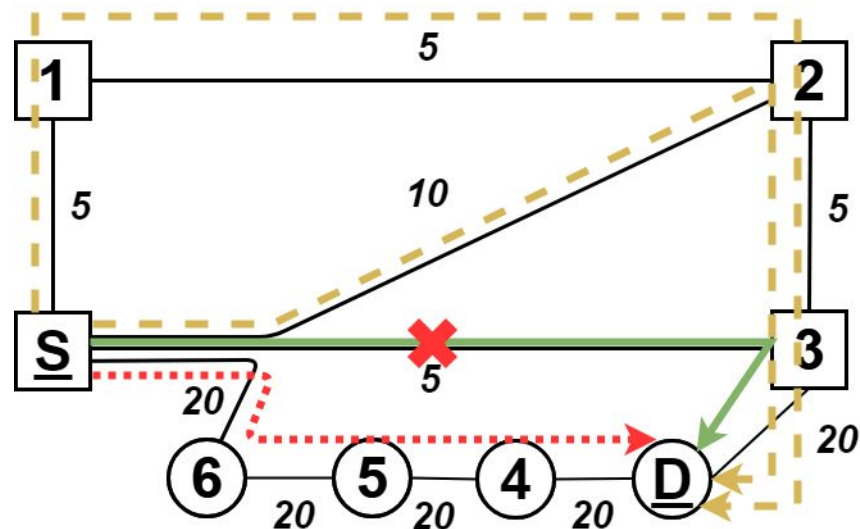
Link | Node Protection

Link protection

```
145.125.124.6/32 (2 entries, 1 announced)
*L-ISIS Preference: 14
Next hop: 145.125.176.59 via ge-2/3/0.0 weight 0x1, selected
Next hop: 145.125.176.18 via xe-2/0/2.0 weight 0xf000
Next hop: 145.125.176.0 via et-1/1/0.0 weight 0xf000
```

Node protection

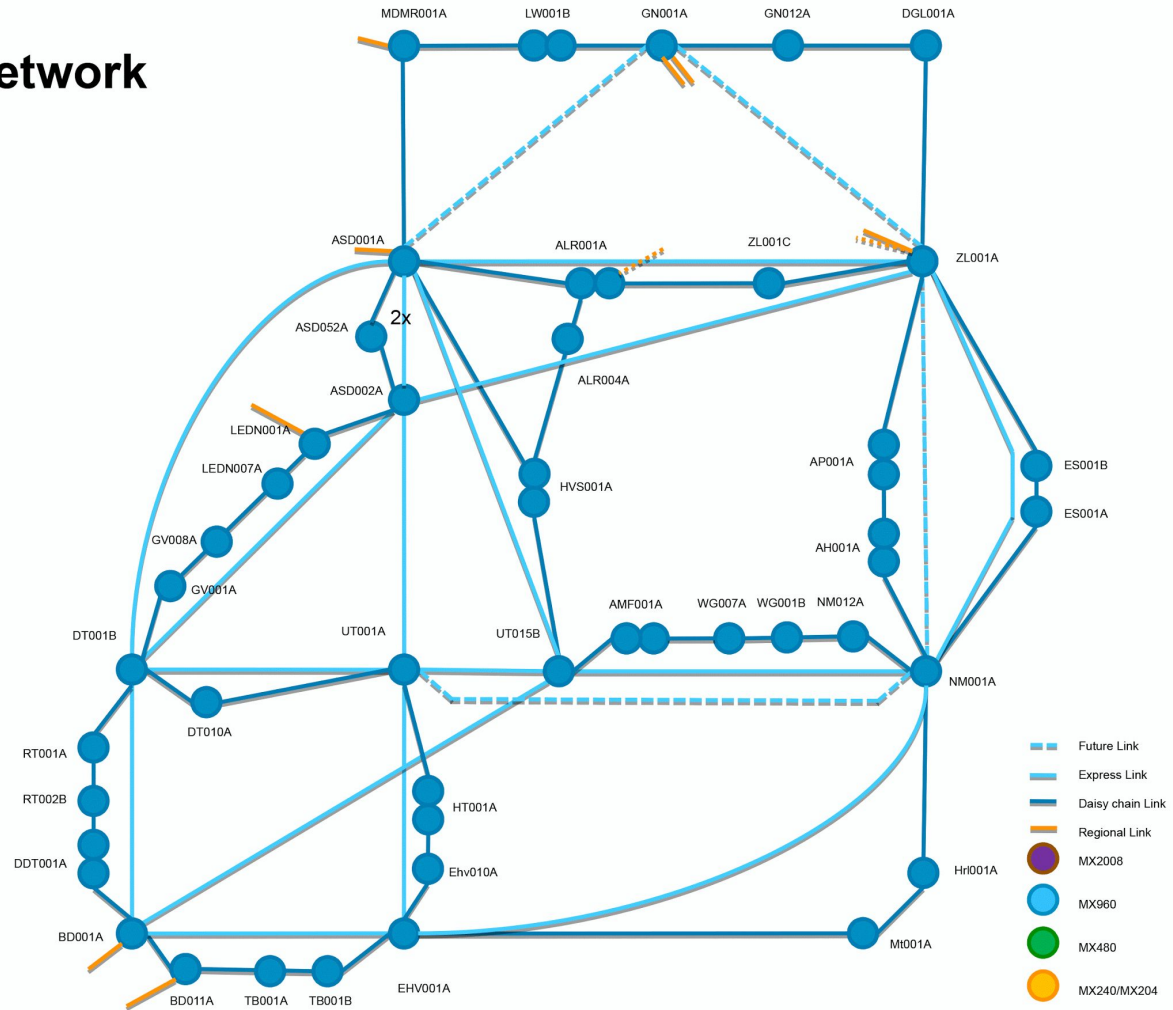
```
145.125.124.6/32 (2 entries, 1 announced)
*L-ISIS Preference: 14
Next hop: 145.125.176.59 via ge-2/3/0.0 weight 0x1, selected
Next hop: 145.125.176.61 via ge-2/3/1.0 weight 0xf000
Age: 51           Metric: 25
```



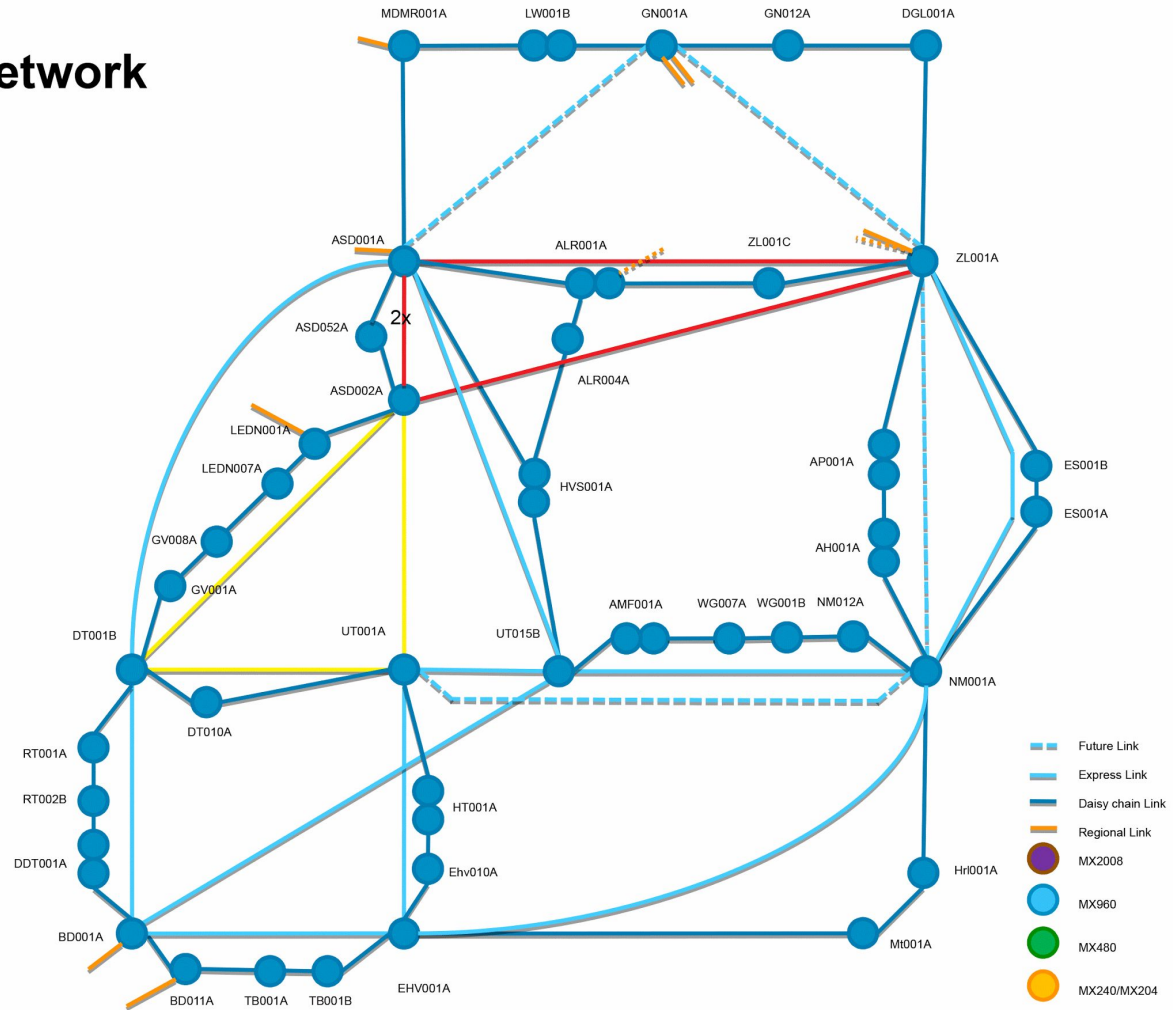
Topology legend	
	Original Path
	Node Protection Backup Path
	Link Protection Backup Paths

The IGP cost of links are displayed next to the links.

Core network



Core network



Discussion

- TI-LFA works well with ECMPs, so ECMPs should be implemented on SURFnet8
- Node protection effects ECMPs
- If fate sharing is enabled, routers might not use the post convergence backup path

Recommendations

- Use low metrics on links between core routers
 - Default metric on the daisy chain (default 10)
 - Increase number of ECMPs
- Implement fate sharing
- Do not use node protection

Future Work

- Improve failure detection speed
 - Bidirectional Forwarding Detection (1 - 10ms)
- How will SRv6 perform in comparison with SR on MPLS?
 - Currently not implemented yet

Acknowledgements

- Special thanks:
 - Marijke Kaat and Wouter Huisman
 - SURFnet Team



Q & A