IEEE Globecom 2019

December 11, 2019

Slice-Aware Service Restoration with Recovery Trucks for Optical Metro-Access Networks

Sifat Ferdousi[1], Massimo Tornatore[1,2], Sugang Xu[3], Yoshinari Awaji[3], and Biswanath Mukherjee[1]

[1]*University of California, Davis, USA* [2]*Politecnico di Milano, Italy* [3]*National Institute of Information and Communications Technology, Japan*

Session: ONS3: *Intelligent Optical Networks*

Introduction

User demands and services are evolving…

A new generation of optical metro networks is needed to turn the vision of "Smart Cities" into reality

- From a **rigid ring-based aggregation infrastructure** to a **composite network-and-computing ecosystem** to support next-generation 5G services

- Several technical enablers:
  - Increased reconfigurability enabled by **SDN**
  - **Integration of optical and wireless** access networks
  - Metro nodes becoming edge data centers (**edge computing**)
  - **Network slicing** to logically partition network, computing, and storage resources
  - …

Metro-Access Networks

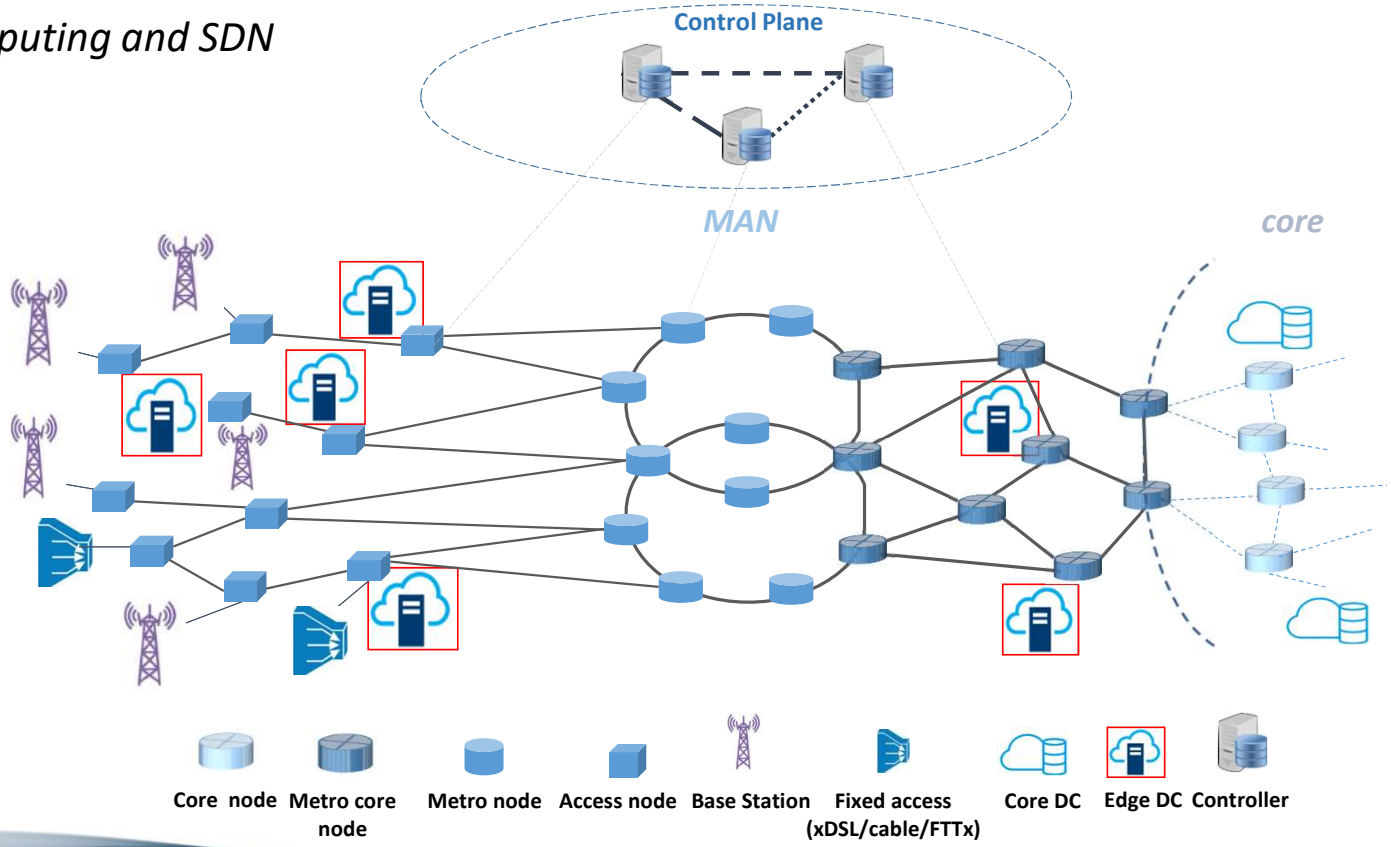
User demands and services are evolving…

so is the network

- 75% of total metro traffic is terminated within the metro network, as video, data and web content is increasingly generated at the metro networks

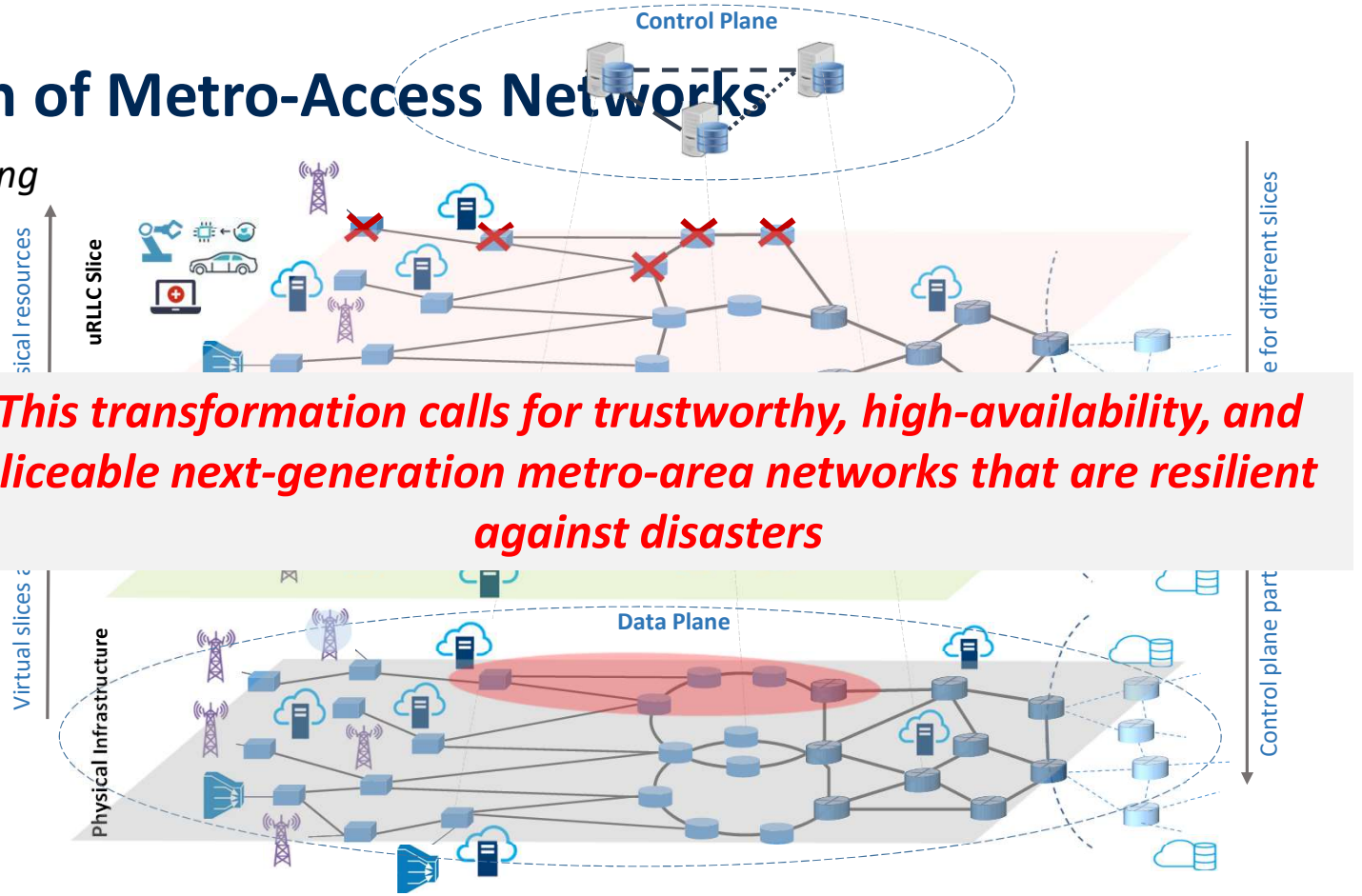
Evolution of Metro-Access Networks

Edge computing and SDN



Evolution of Metro-Access Networks

Network Slicing



This transformation calls for trustworthy, high-availability, and sliceable next-generation metro-area networks that are resilient against disasters

Disaster affecting underlying infrastructure

Recovery for Metro-Access Networks

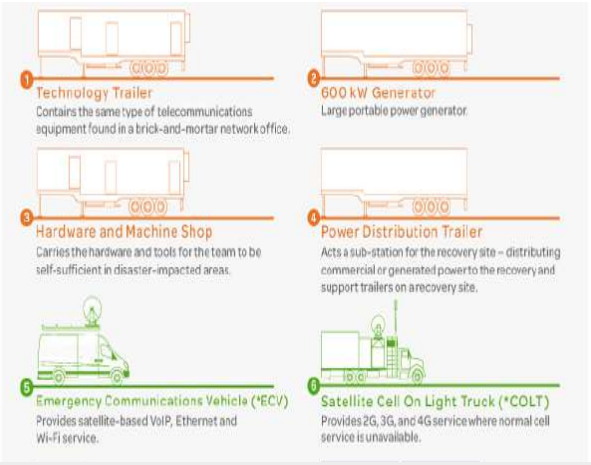
- Post-disaster recovery in metro access is different from that in core networks
  - Too expensive for disaster resiliency
  - *Much less redundant than core*

- After disaster, utmost priority: minimize service downtime (recover network asap)
  - Slice re-provisioning may not be possible with available resources and considering locality of services
  - Control plane managing the slices can also be affected by disasters

Utilize equipment for "temporary relief/service" only in case of disaster instead of preplanning lot of redundant capacity

Rapid network re very units

- In the post-disaste provide both repair and *tempora* ork is going on



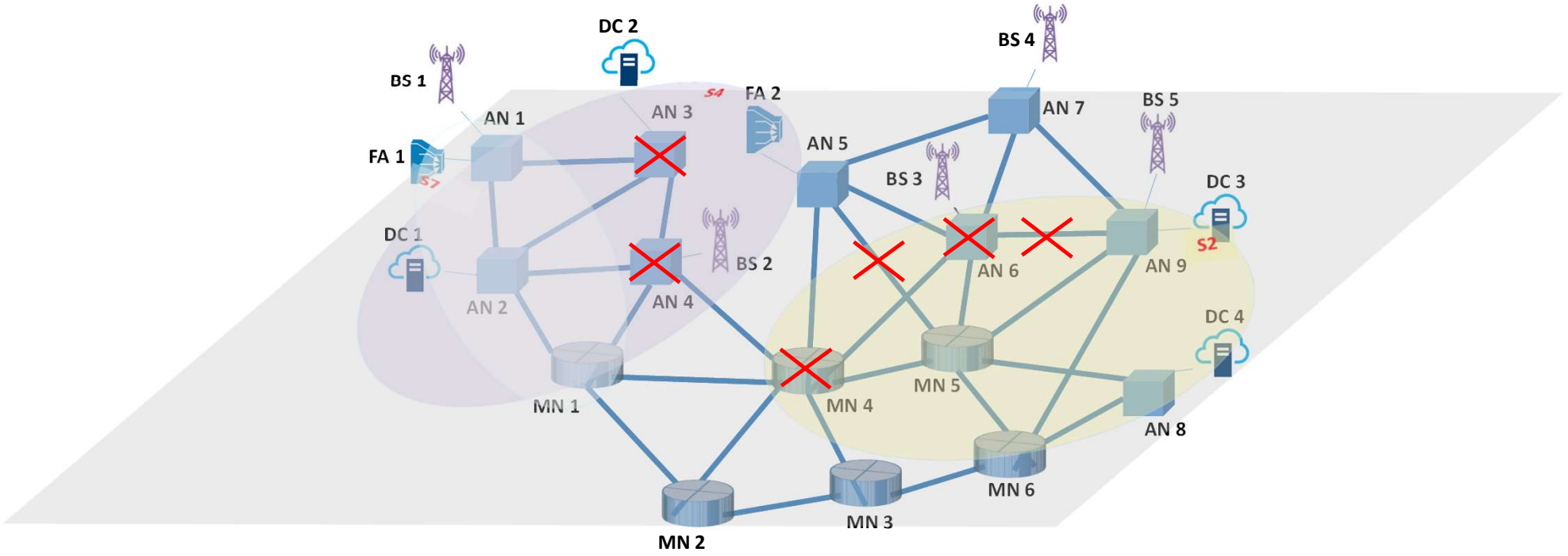
"Slice-aware" routing and deployment strategy to minimize downtime penalty and ensure fast restoration of important slices.

Slice-Aware Service Restoration

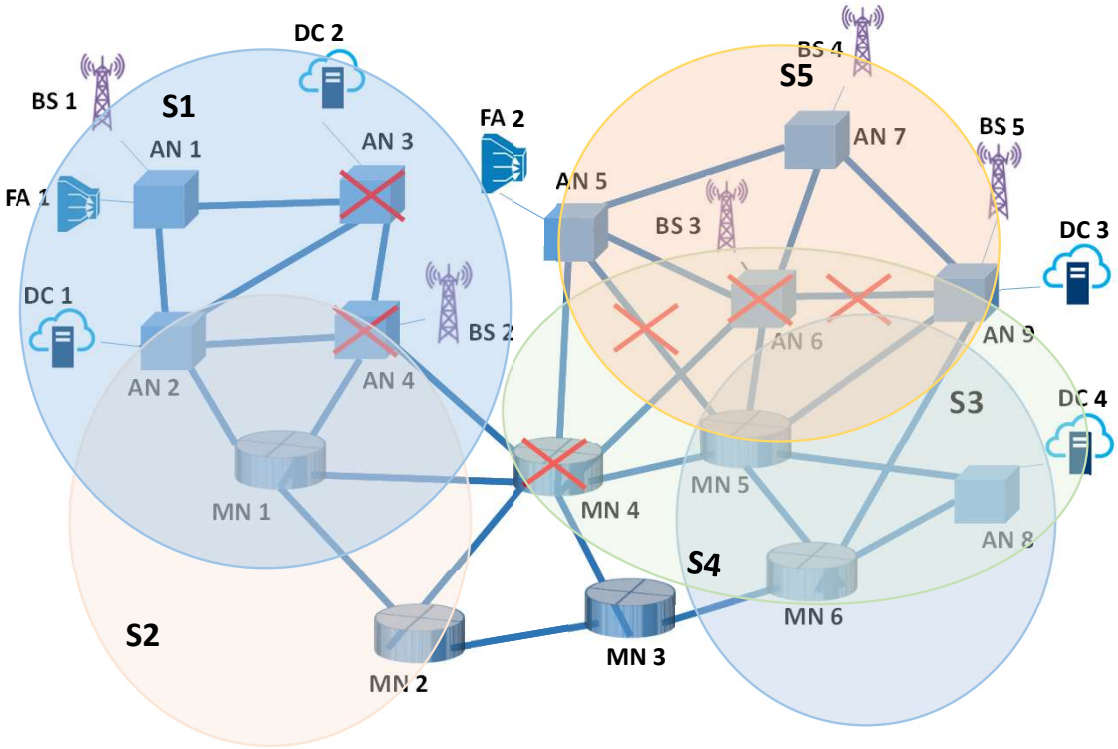
- Model the problem based on classical *vehicle routing problem*
- Recovery trucks provide both repair and *temporary relief/service* while repair work is going on (unlike general network recovery)
- Develop a “slice-aware” routing and deployment strategy for heterogeneous recovery trucks to heterogeneous failure sites

Minimize downtime *penalty* - fast restoration of important slices

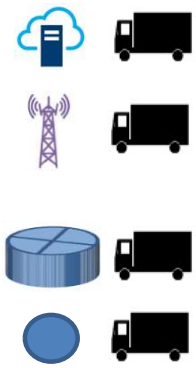
Slice-Aware Service Restoration with Recovery Trucks

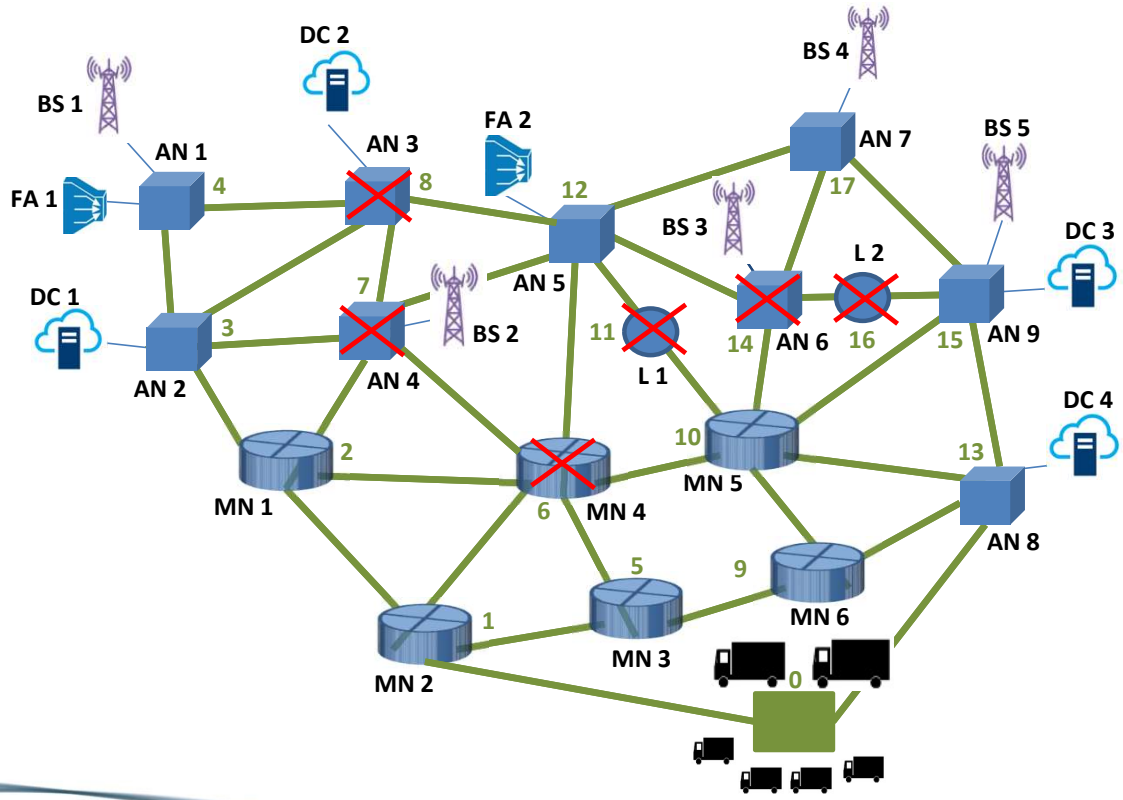


Slice-Aware Service Restoration with Recovery Trucks



Slice-Aware Service Restoration with Recovery Trucks





Vehicle type

Distance – travel time

Recovery time

Slice priority

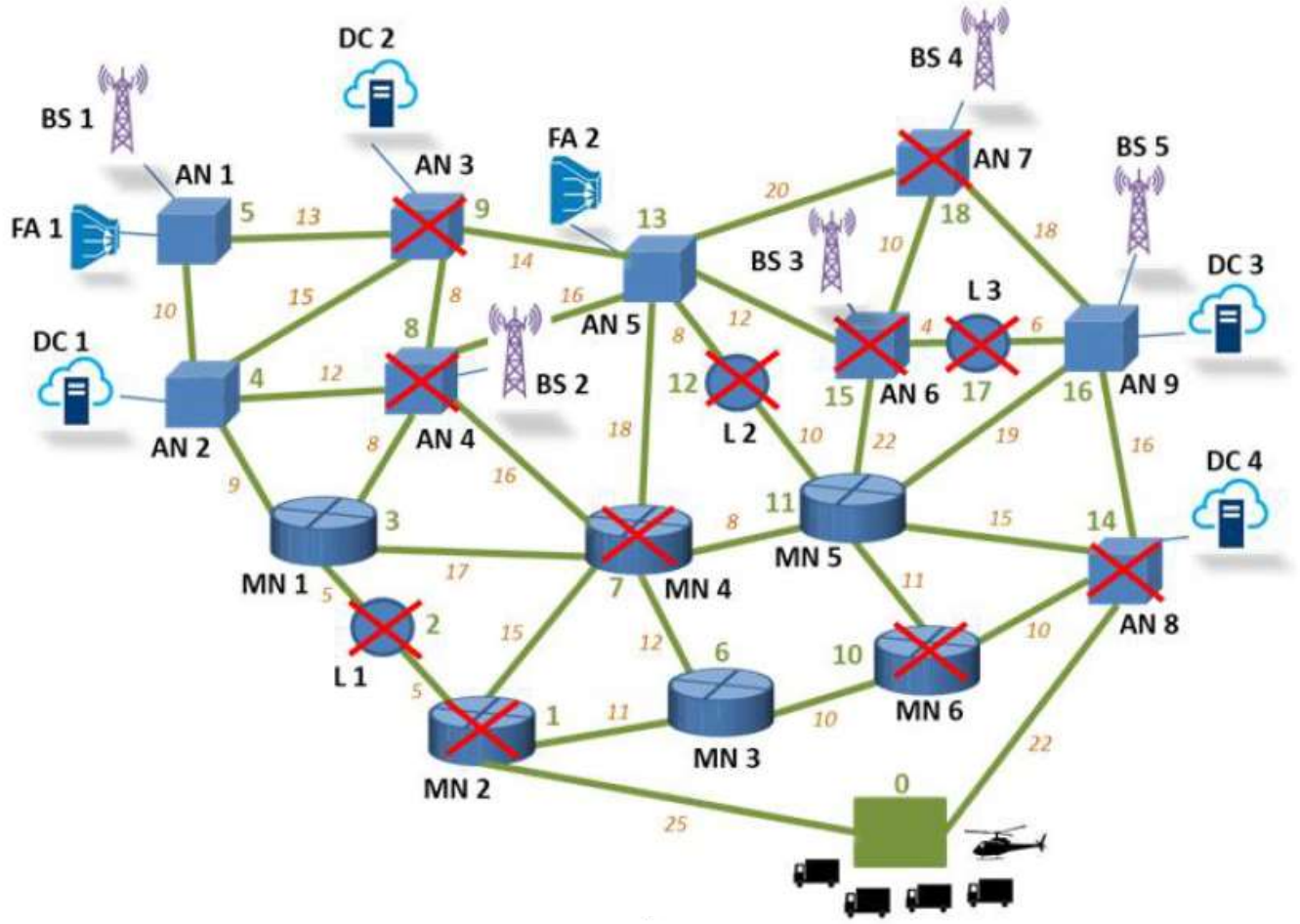
Slice-Aware Service Restoration with Recovery Trucks

- Given: network topology, set of network slices, set of failed nodes, set of heterogeneous trucks
- Output
  - **Routes for recovery trucks**
- Objective: Minimize service disruption penalty of slices
- Solution Approach
  - Mathematical model (MILP)

Compared schemes

- Deployment schemes to be compared
  - Slice-*aware* service restoration *with* temporary service (minimize penalty)
  - Slice-*unaware* service restoration *with* temporary service (minimize travel time)
  - Slice-*aware* service restoration *without* temporary service (repair only)

Simulation Setup



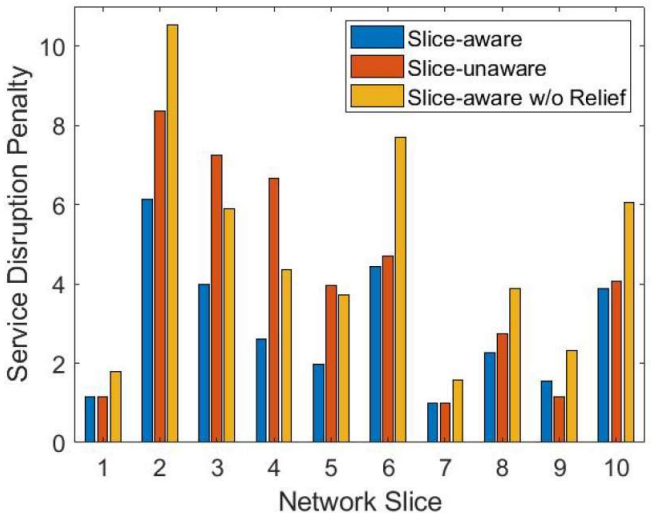
Results

29% savings in penalty

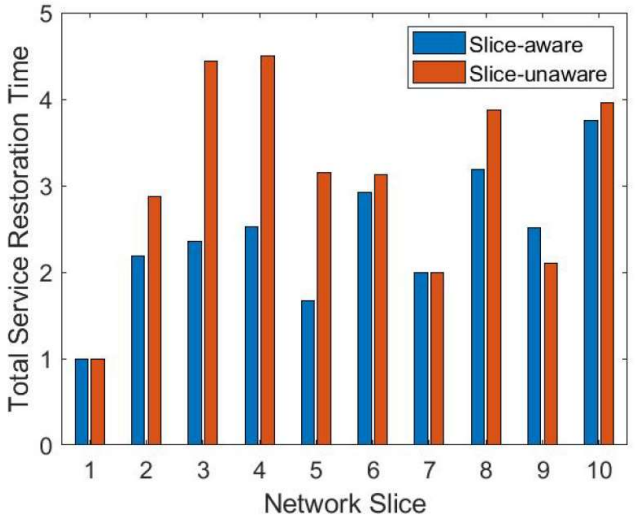
	Slice-aware	Slice-unaware	Slice-aware w/o temp. relief
Cumulative penalty	29.04	41.09	47.88

38% savings in penalty

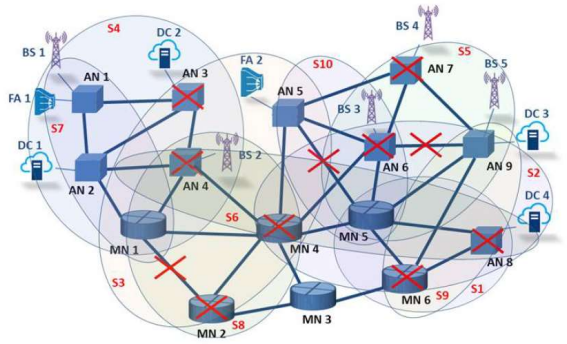
Results



60% reduction in service disruption penalty



46% service-restoration time savings



Conclusion

- Our slice-aware service-restoration approach can achieve significant reduction in service-disruption penalty and savings in service-restoration time in a post-disaster optical metro-access networks