

Survivor: an Enhanced Controller Placement Strategy for Improving SDN Survivability

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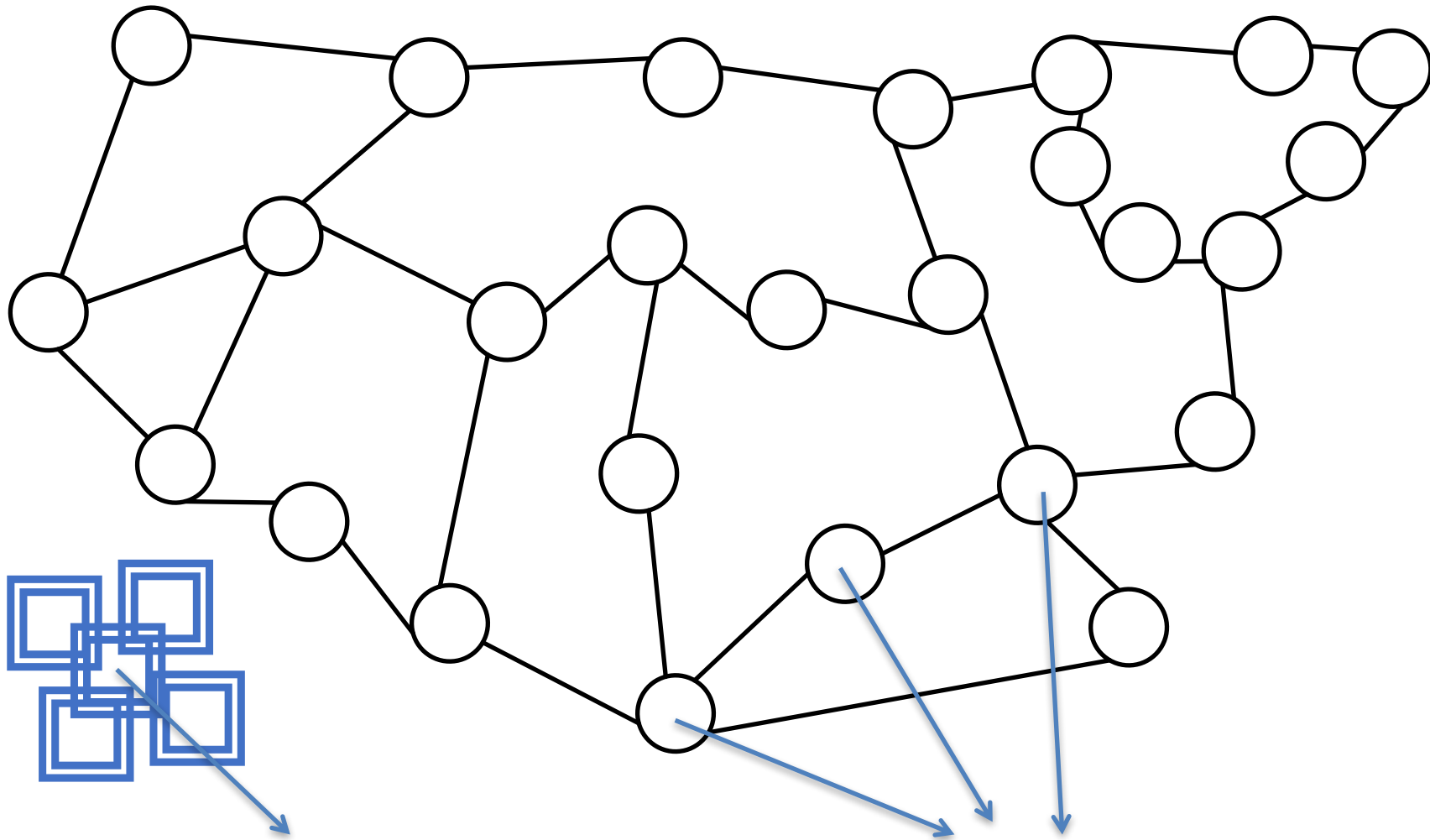
Software-Defined Networking Design

- Changing the way networks are designed and managed
- Separates the control plane from the data plane
- Moves the control logic to an external entity (Controller)
- Controller provides resources and abstractions to facilitate programming

... Despite its benefits, SDN created an inherent dependency relationship between forwarding devices and the controller.

Software-Defined Networking Design

Controller Placement Problem

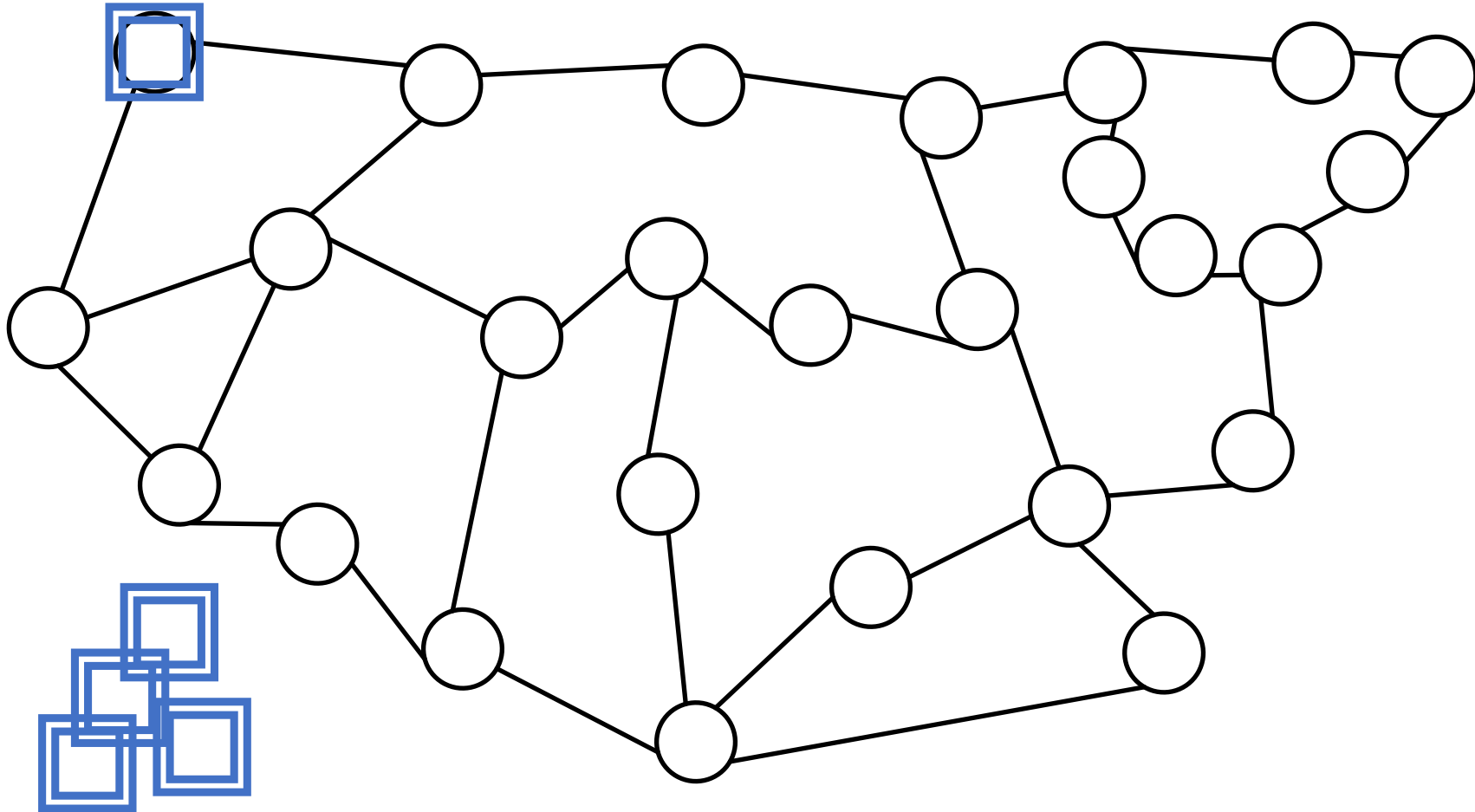


Set of SDN Controllers

Forwarding devices

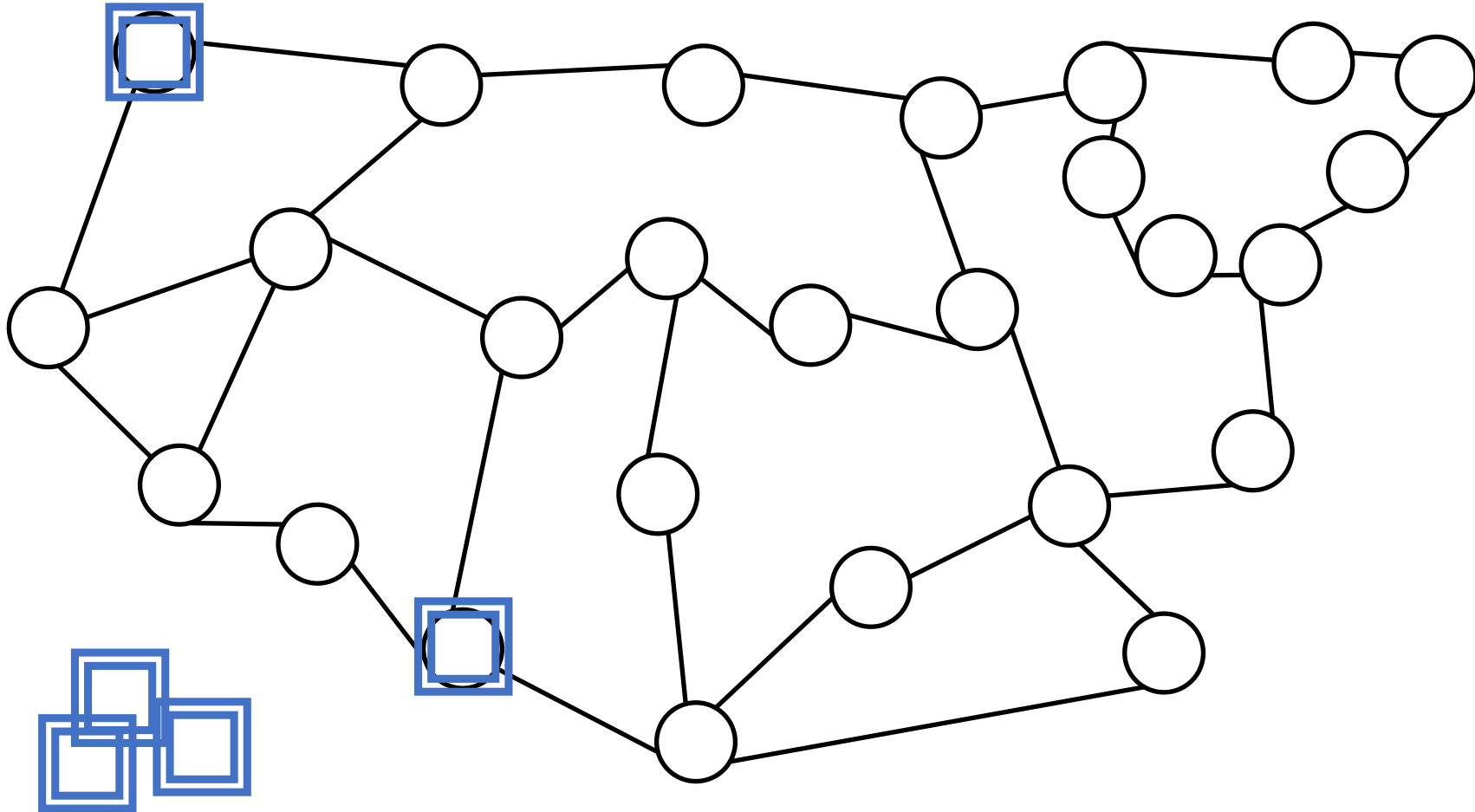
Software-Defined Networking Design

Controller Placement Problem



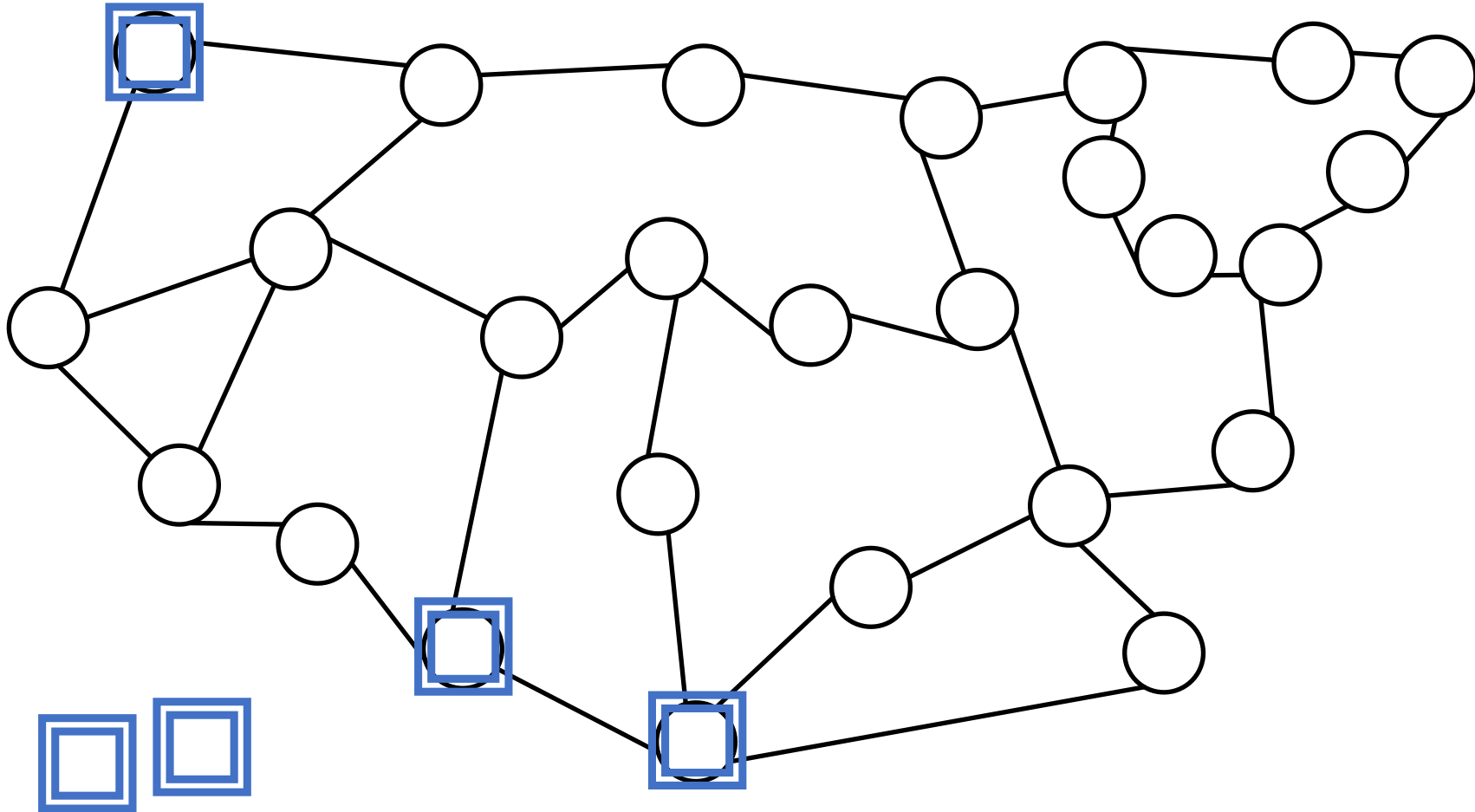
Software-Defined Networking Design

Controller Placement Problem



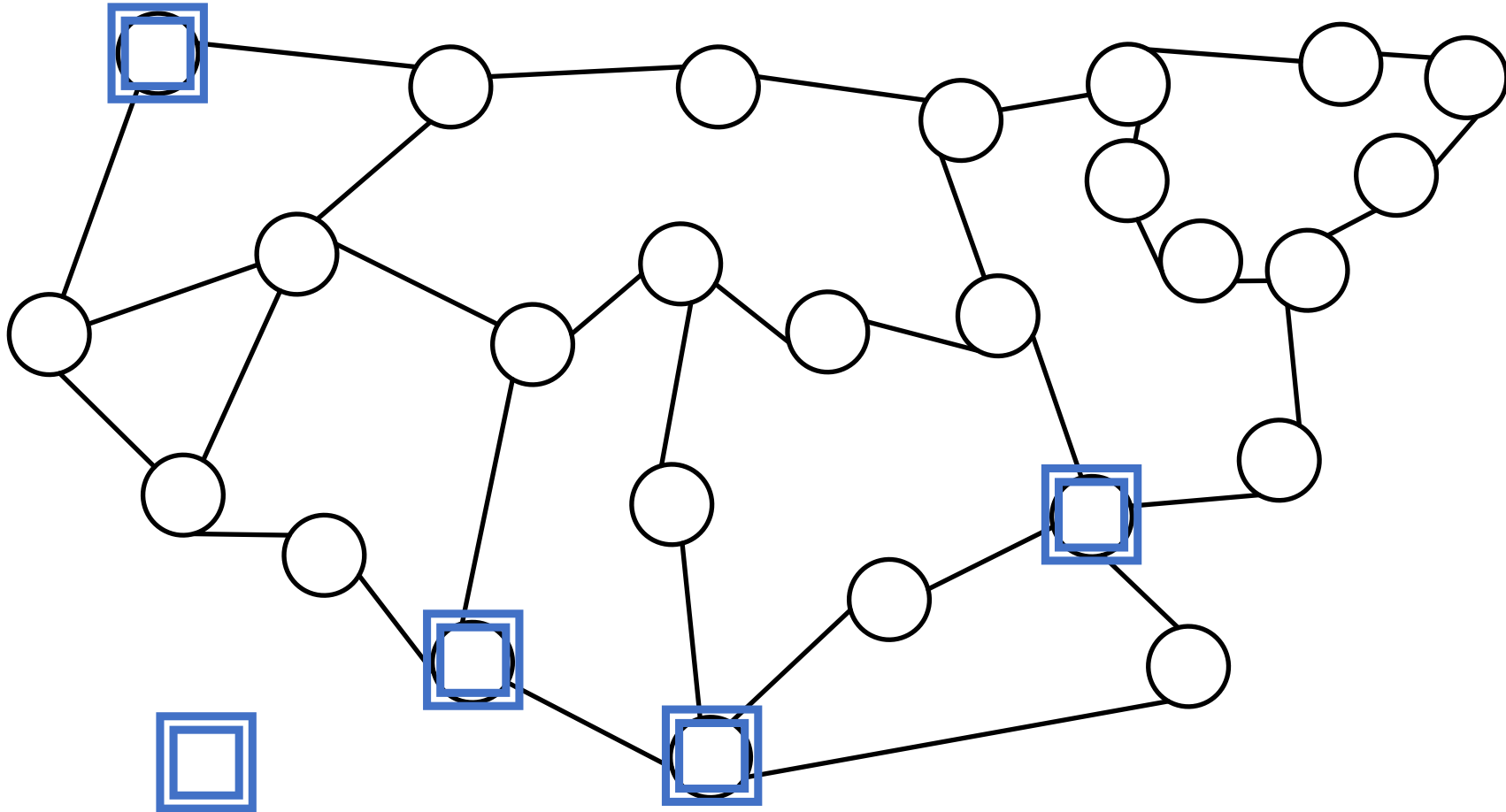
Software-Defined Networking Design

Controller Placement Problem



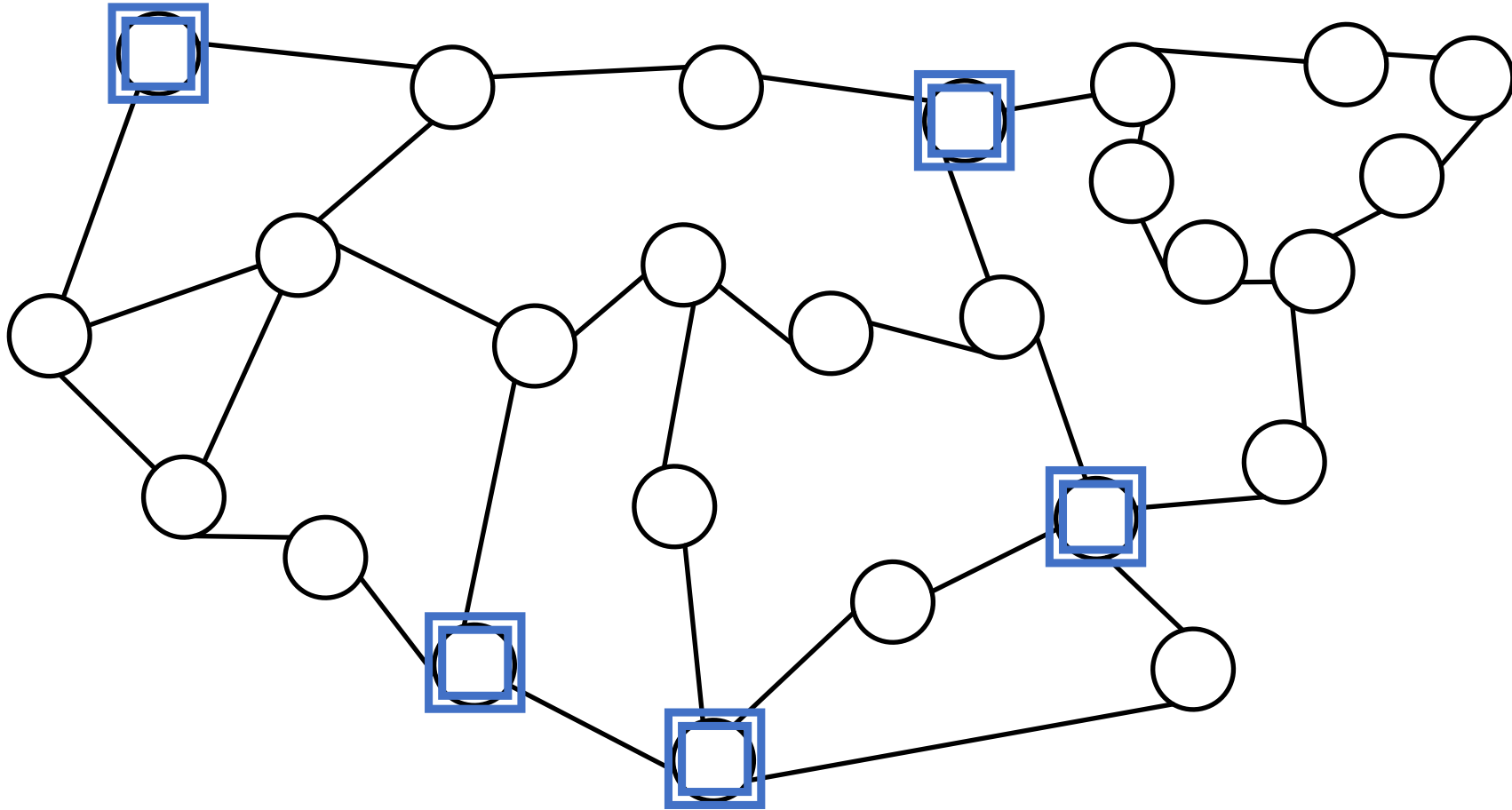
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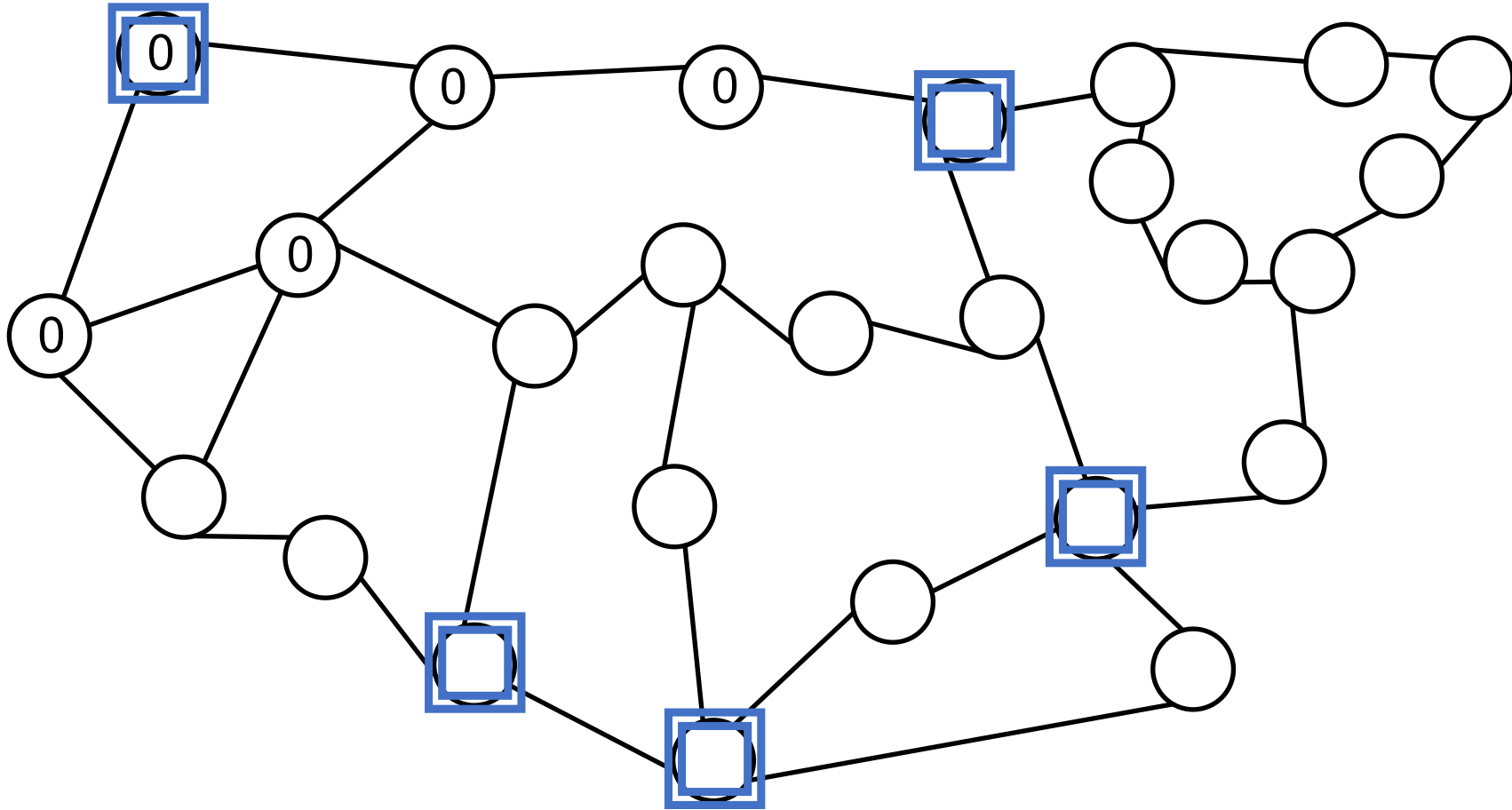
Software-Defined Networking Design

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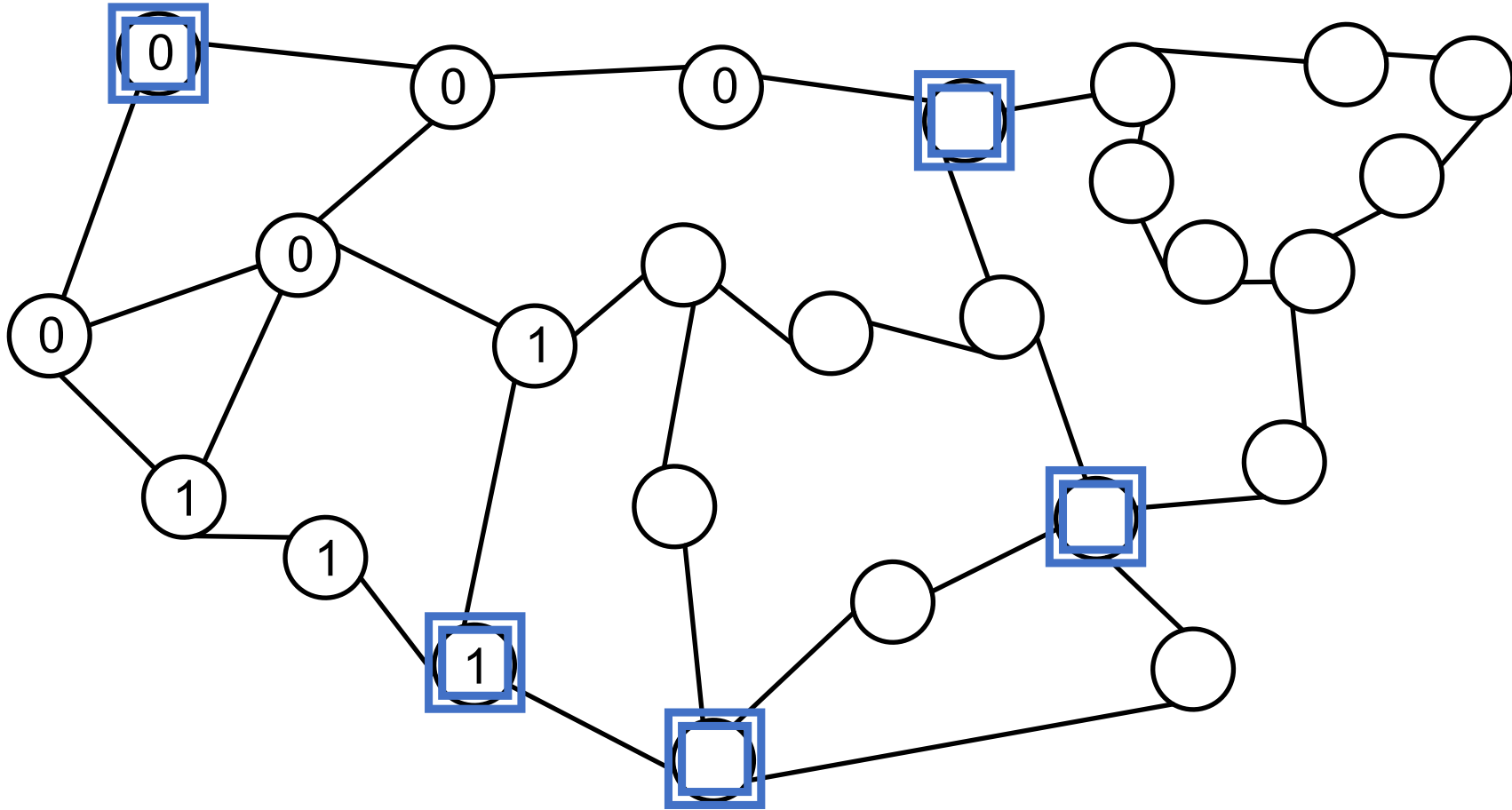
Software-Defined Networking Design

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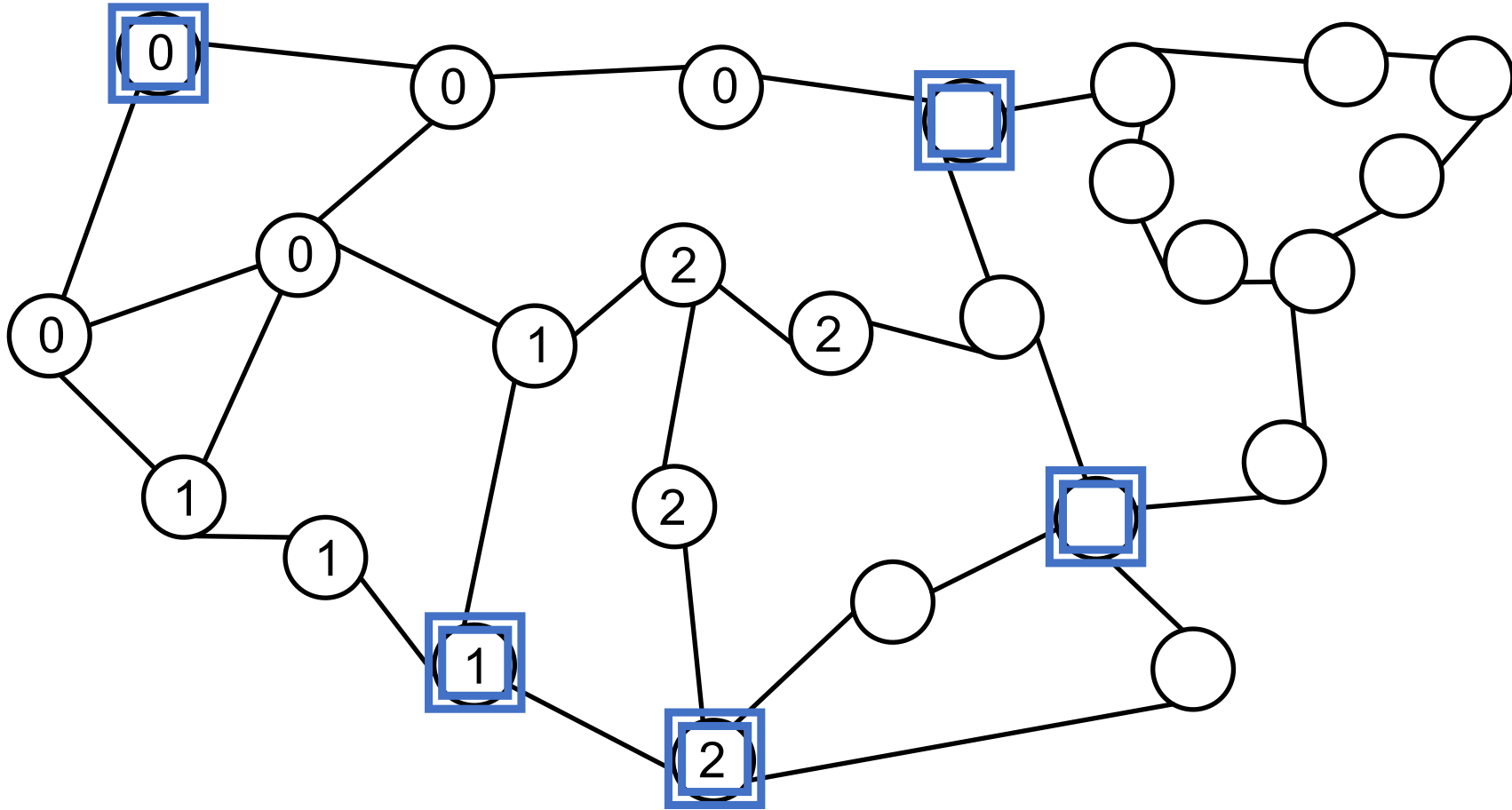
Software-Defined Networking Design

Controller Placement Problem



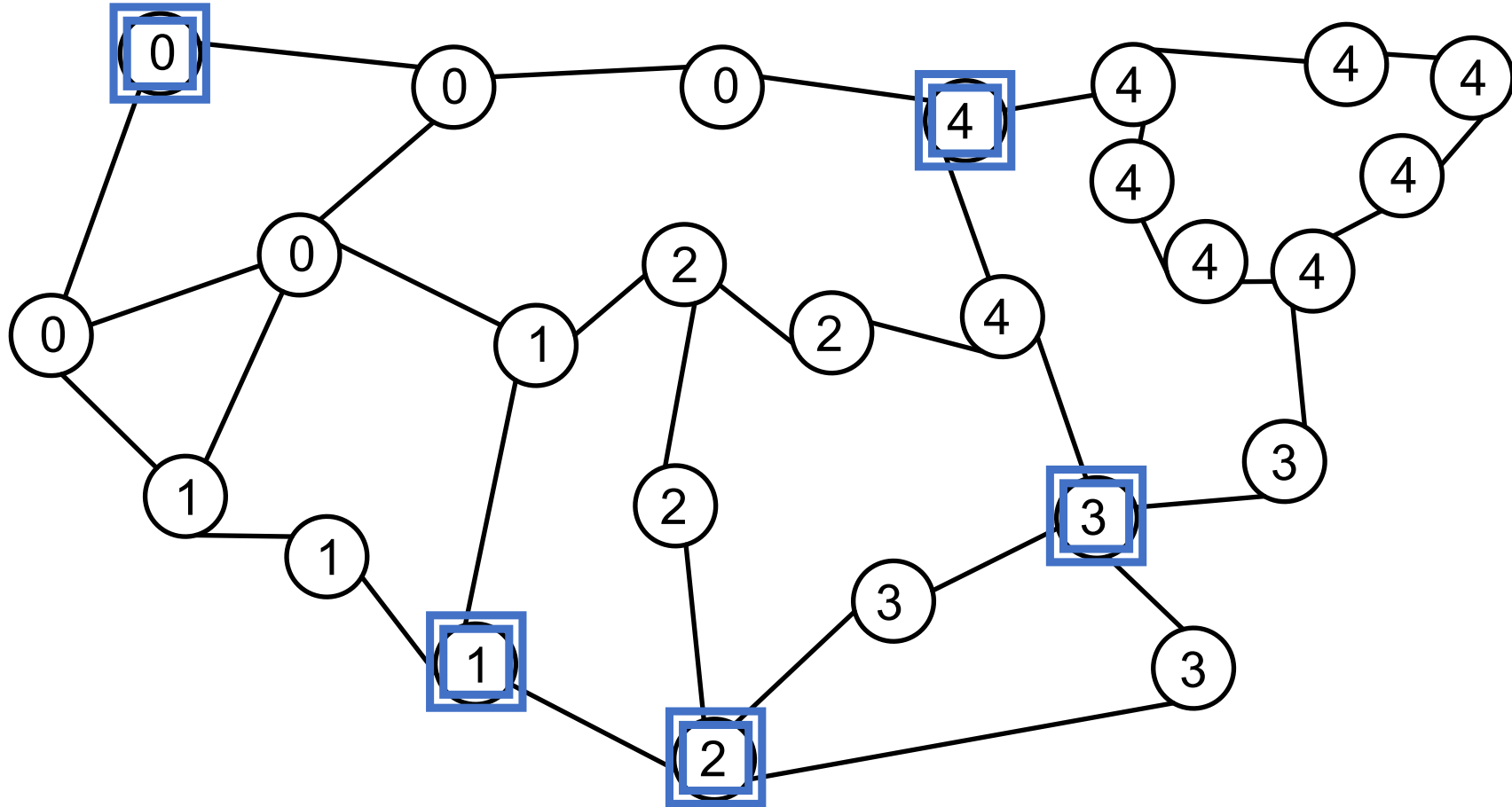
Software-Defined Networking Design

Controller Placement Problem



Software-Defined Networking Design

Controller Placement Problem



Ok, the control plane design is ready.

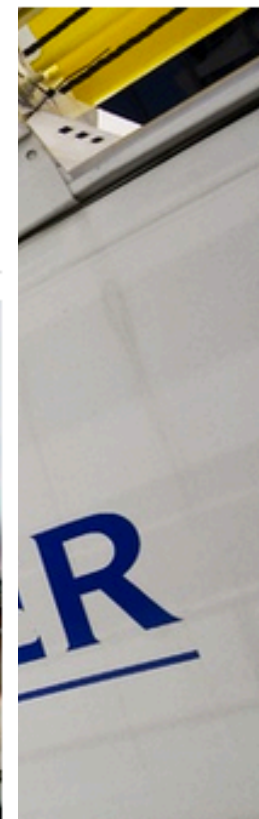
“The network is down.”

AUG 27, 2014 7:08AM ET

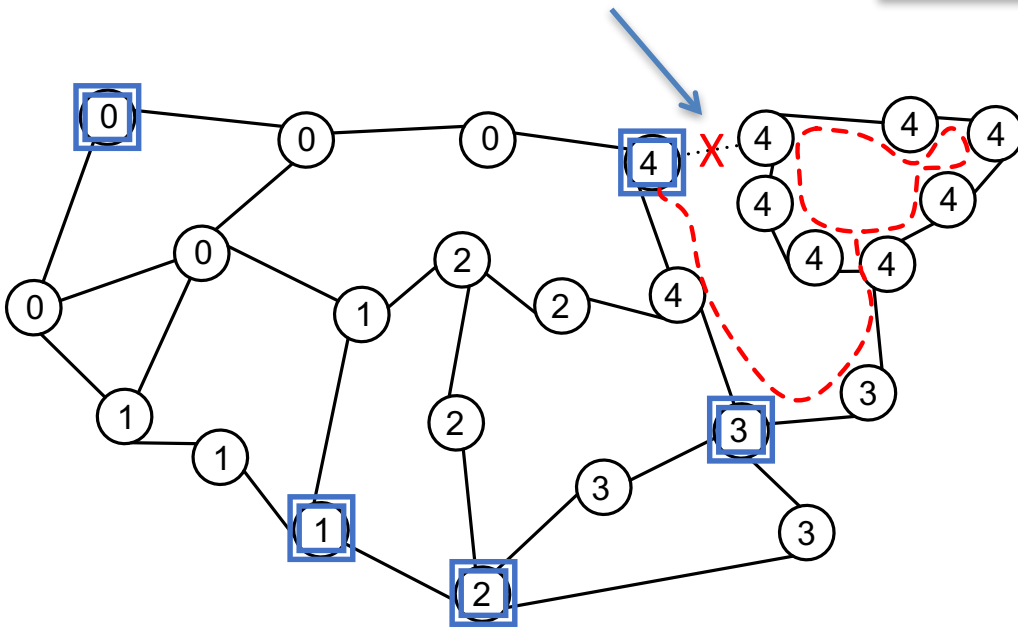
AT&T Says U-Verse Service Being Restored, But Customers Remain Frustrated By Outage

The Huffington Post | By Gerry Smith

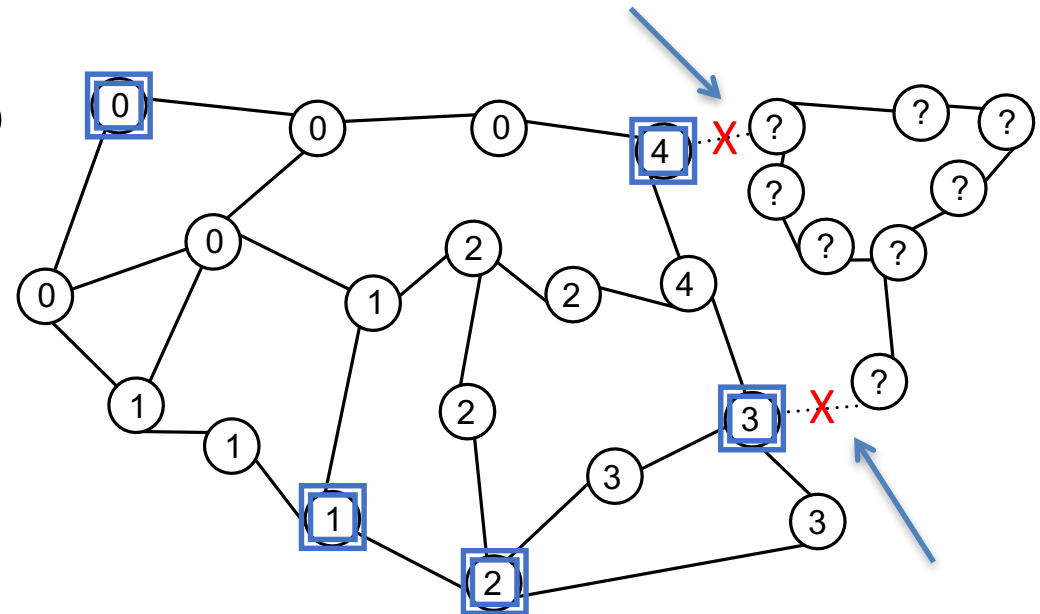
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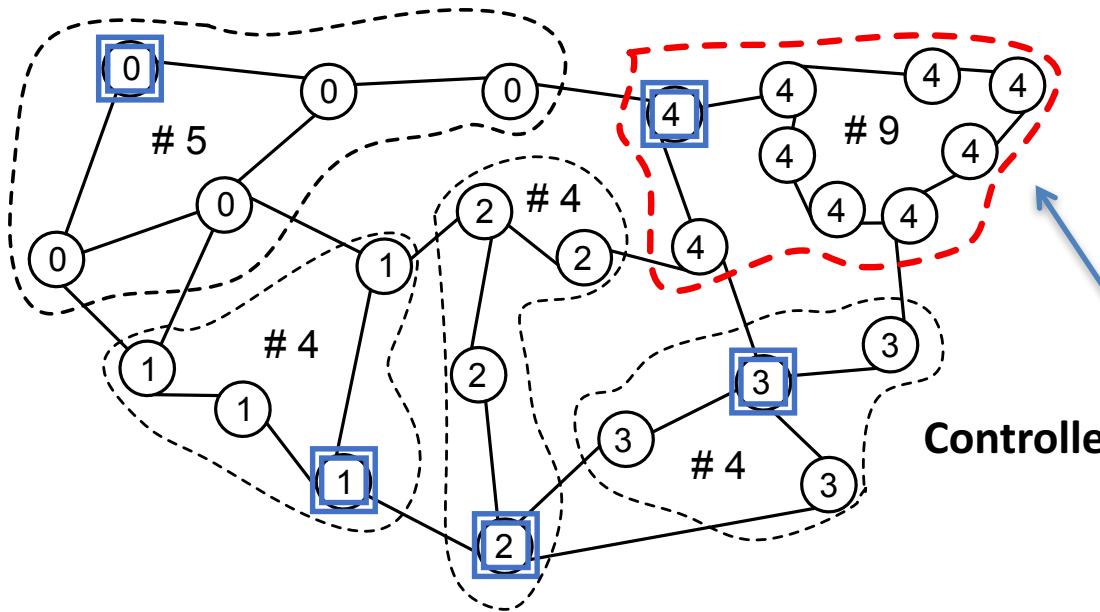
Software-Defined Networking Design



Single link failures



Multiple connectivity failures



Controller overload

Controller Placement Strategy for Improving SDN Survivability

Goal: novel controller placement strategy that deals with control plane survivability in large scale SDN networks.

Provide and **maintain** network services in face of operational challenges

React and **attempt to recover** from harmful events

Outline

- **Introduction:** context and motivation
- **Proposed Approach:** strategy and modeling
- **Results:** resilience and overload
- **Conclusion**

Proposed Approach

Goals

- **Connectivity**

Increase path diversity between device-controller

- **Capacity**

Avoid controller overload

- **Recovery**

Define a methodology for composing smarter failover mechanisms

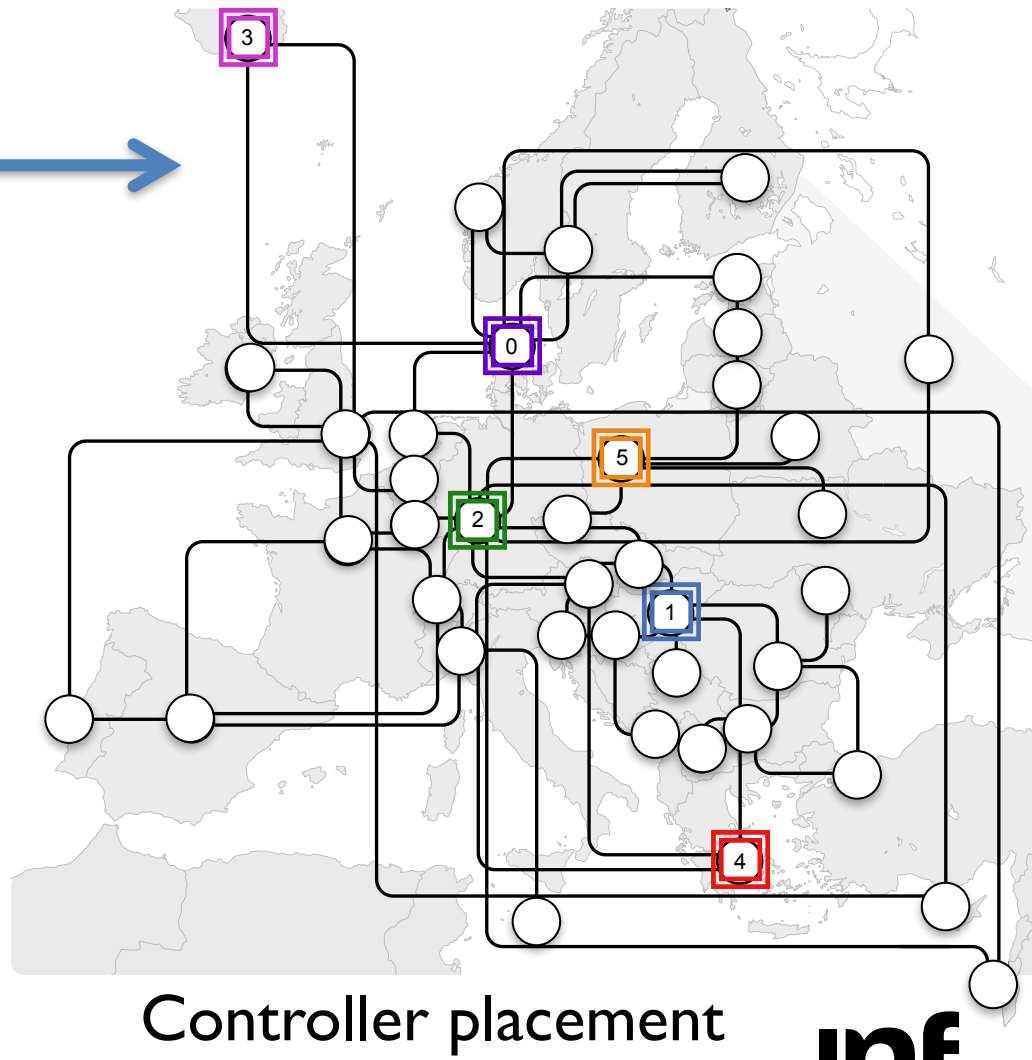
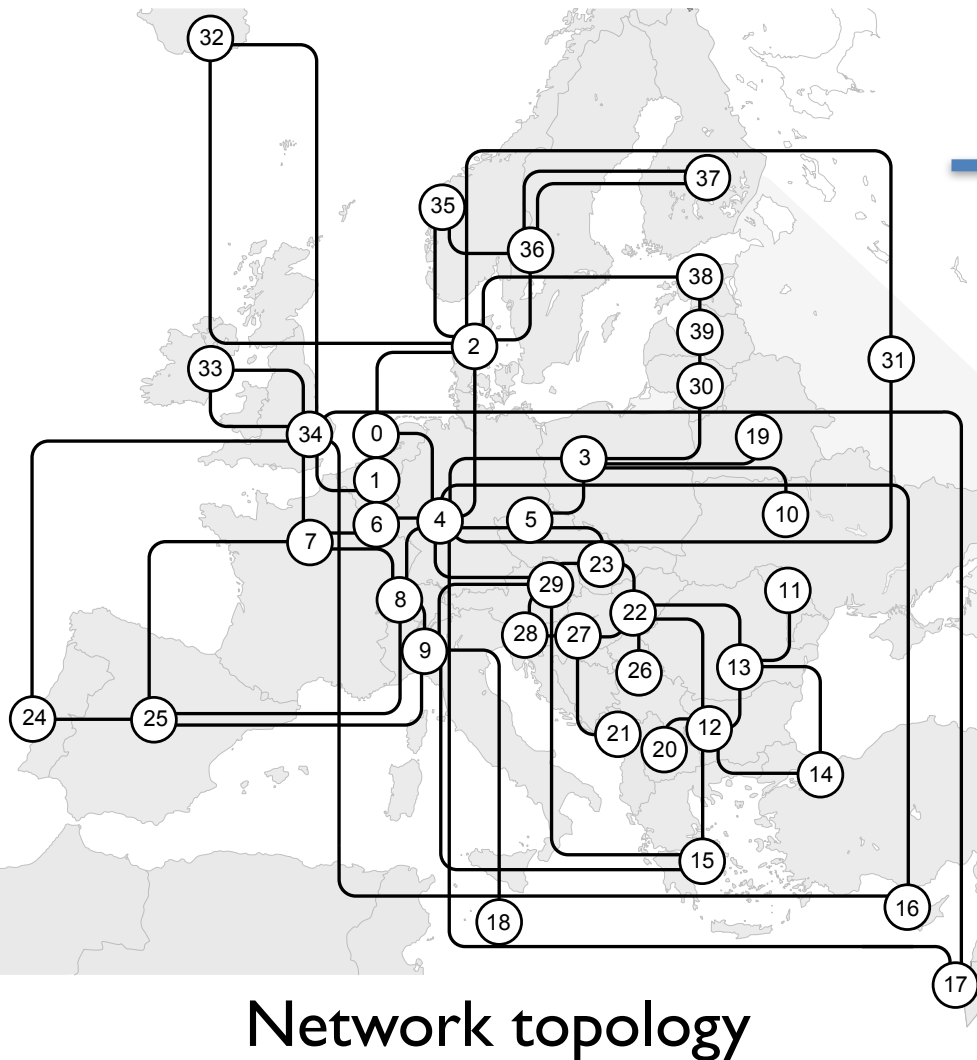
Proposed Approach: Overview

Divided in two complementary parts

- Defines the placement of controllers instances
- Compose the list of backup controllers for each device in the network

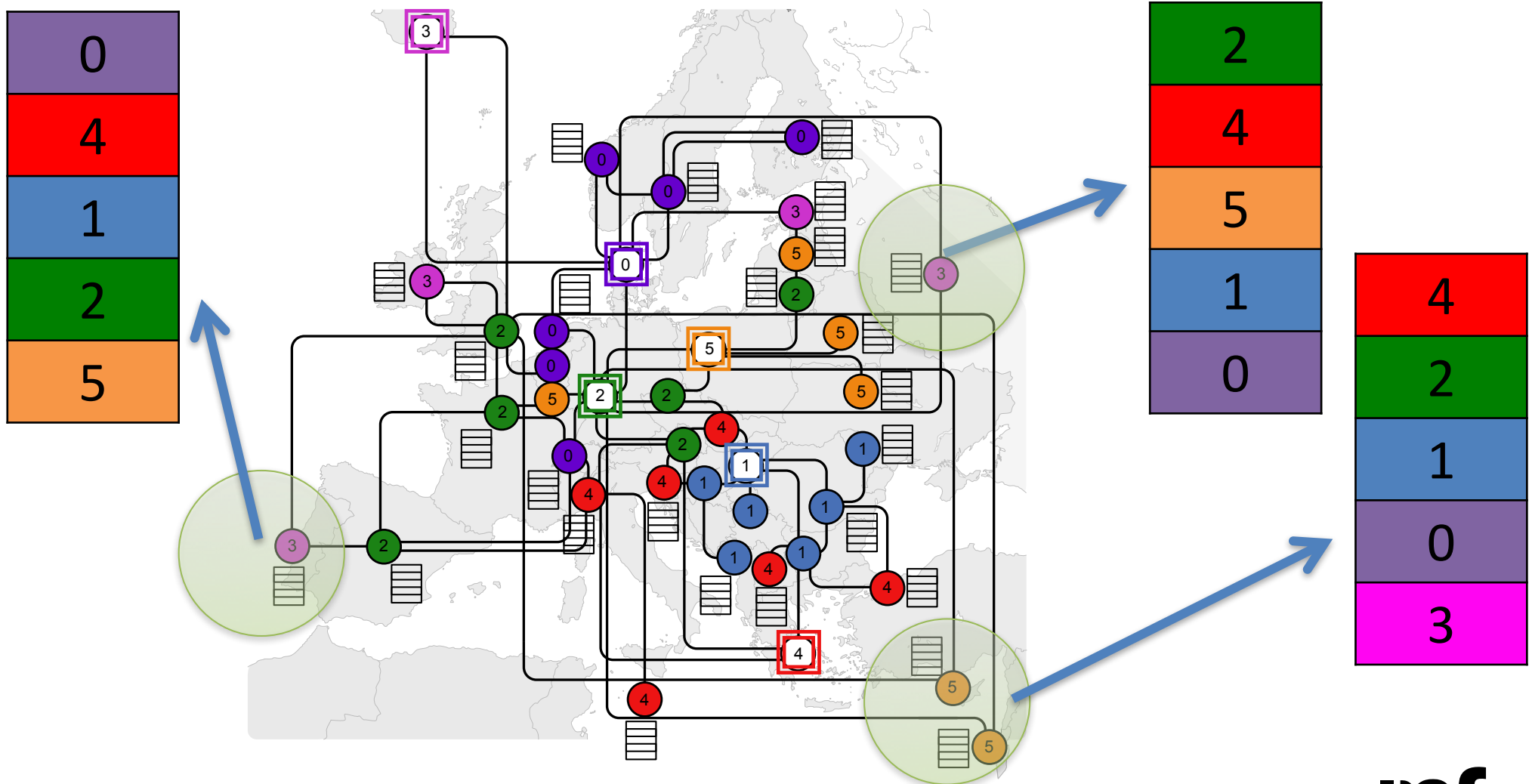
Proposed Approach: two complementary parts

- Defines placement for controller instances



Proposed Approach: two complementary parts

- Specifies backup controllers for each device in the network



Proposed Approach: modeling

Optimal Linear Model for Controller Placement

- Strategy modeled as optimization problem
- Achieve the optimal solution
- Survivor strategy: Integer Linear Program,
1 objective (maximize connectivity between device-controller)

Heuristics for Defining Lists of Backup Controllers

- Compose the lists of backup controllers
- Eliminating the need to manually determine the list
- Proximity and Residual capacity-based heuristics
- Proposed generic framework for designing heuristics

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Methodology

Configuration

- Three different WAN topologies: Internet2 (10 nodes, 15 links), RNP (27 nodes, 33 links) and GÉANT (40 nodes, 61 links)
- Controllers capacity: 1800 kilorequests/s
- Forwarding devices requests: 200 kilorequests/s
- Percentage of controller backup resources: 30%

Comparison method

- Resilient placement strategy Zhang et al., denoted by MCC

[CUNHA et al., 2009; KNIGHT et al., 2011; TOOTOONCHIAN et al., 2012; ZHANG et al., 2011]

Methodology

Four metrics

– Resilience

- Resilience equation used by Zhang et al., 2011
- Cardinal of edge-connectivity

– Overload

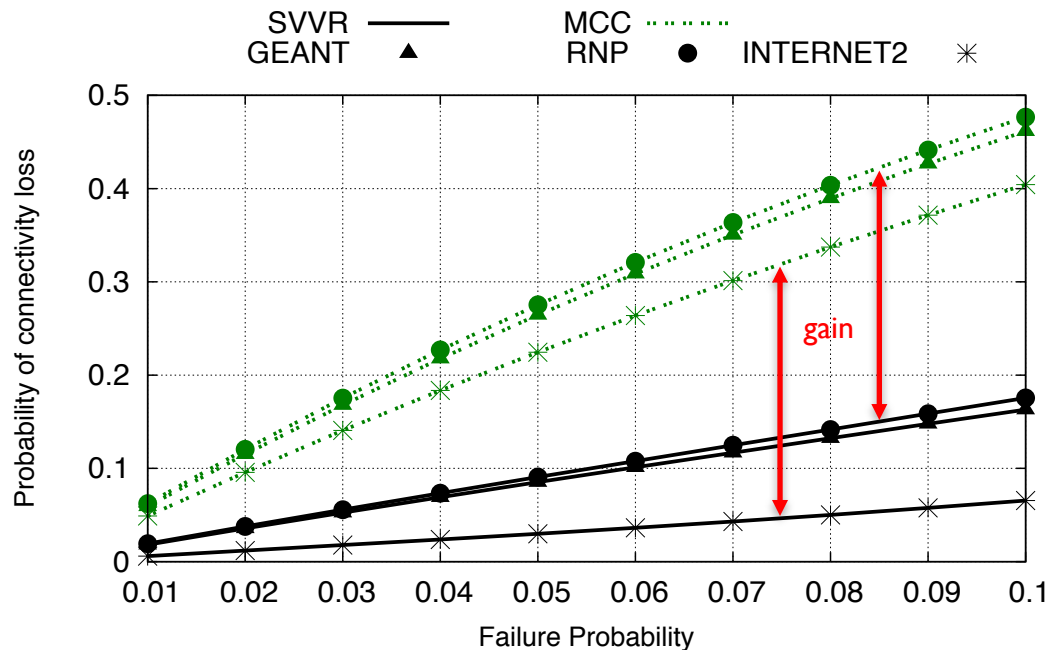
- Number of overloaded controllers
- Load distribution for each of the controller instances

[CUNHA et al., 2009; KNIGHT et al., 2011; TOOTOONCHIAN et al., 2012; ZHANG et al., 2011]

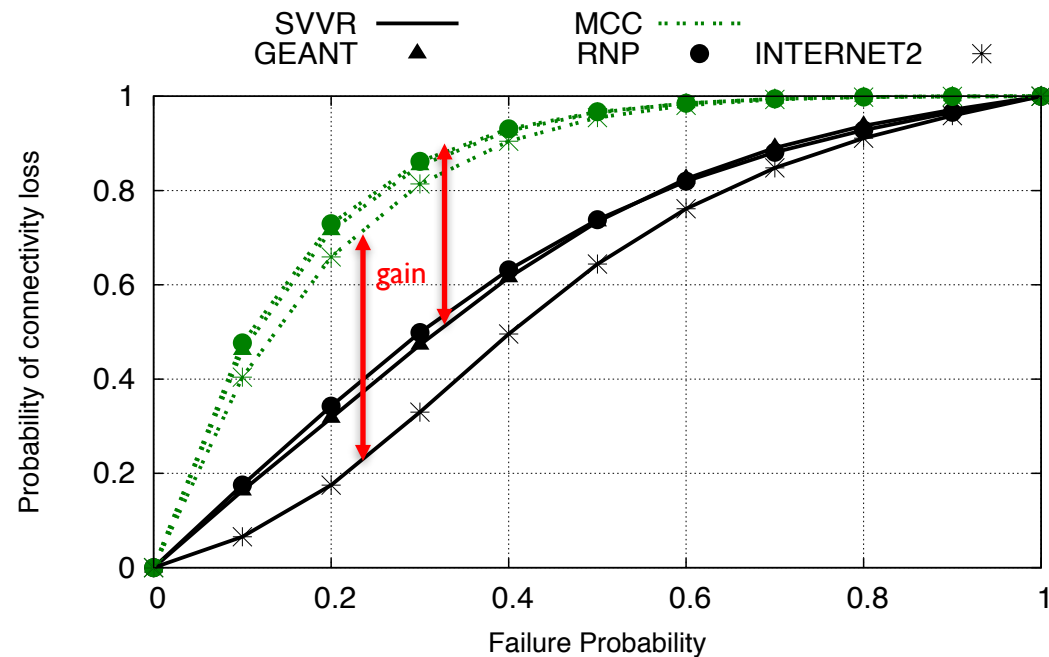
Results: resilience

Probability of connectivity loss

(Resilience equation, Zhang et. al)



(a) 1% a 10%

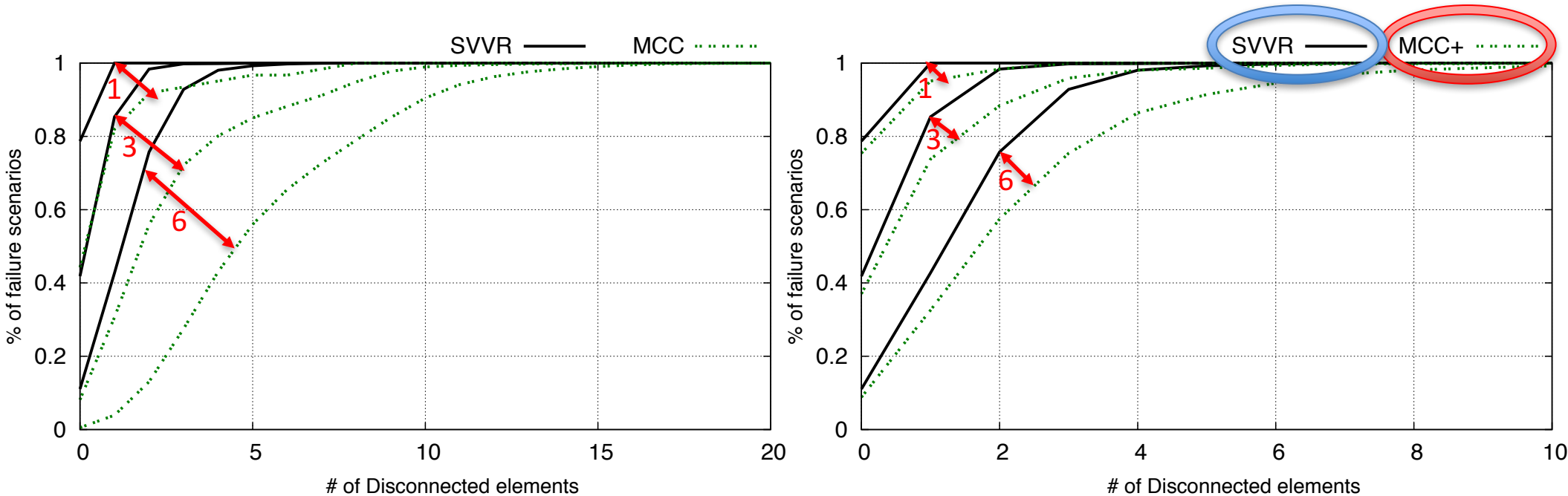


(b) 0% a 100%

Survivor reduces the probability of connectivity loss.

Results: resilience

Effect of exploring path diversity (Cardinal of edge-connectivity)

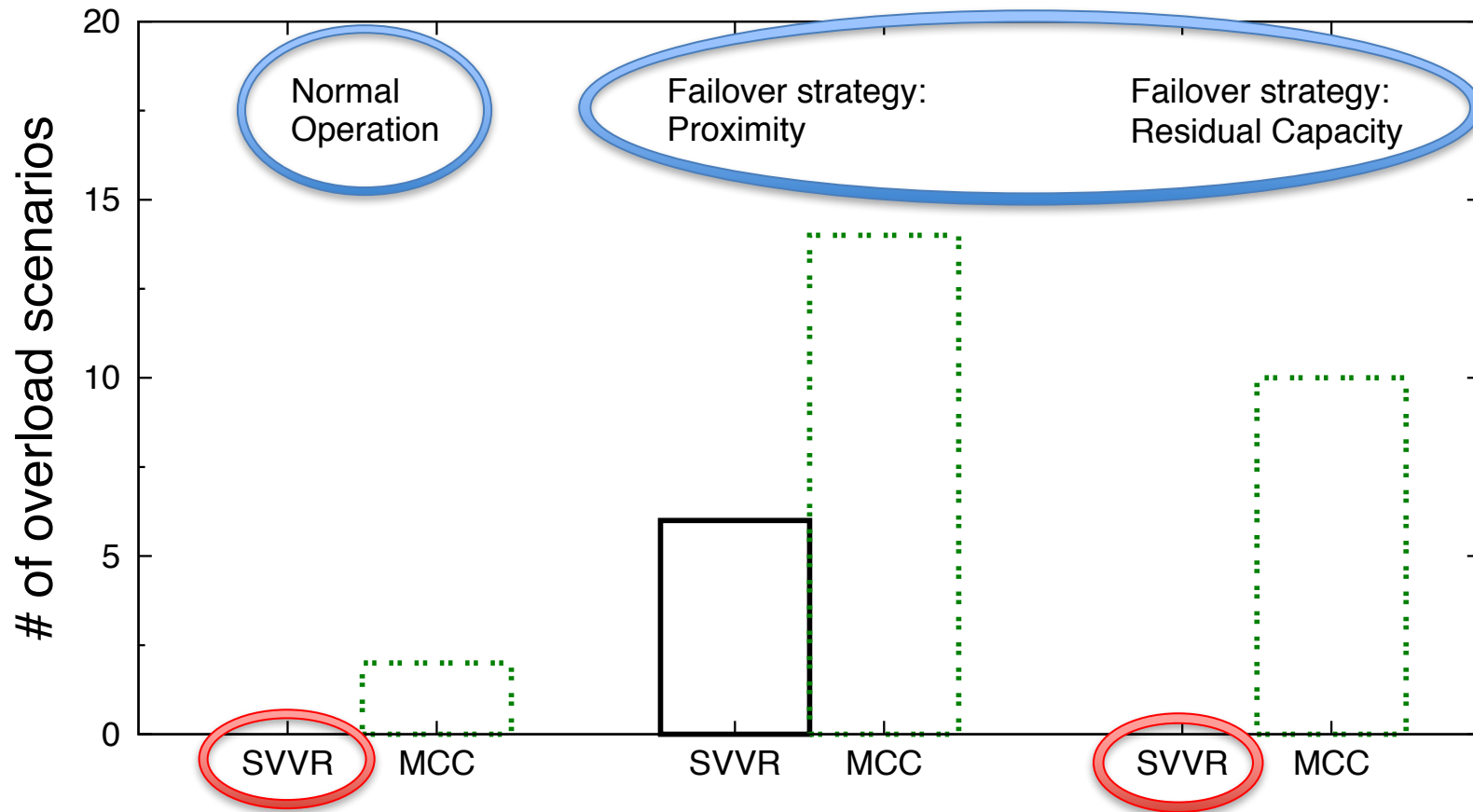


CDFs of disconnected devices for all possible cases of 1, 3 and 6 link disruptions

Path diversity increases the network survivability, and it requires explicit consideration to be fully explored.

Results: overload

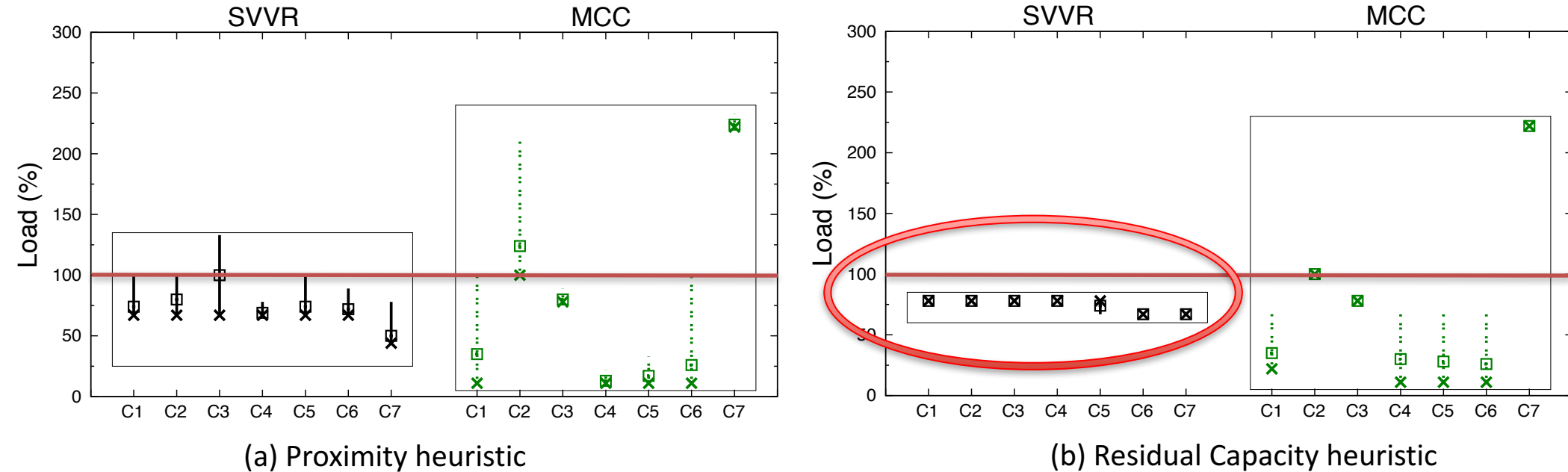
Number of overload scenarios



Network convergence after disruptions is highly sensible to predefined information in failover mechanisms.

Results: overload

Network state after convergence (Load distribution)



Controller overload can be handled proactively by adding capacity-awareness and setting backup resources.

Outline

- **Introduction:** context and motivation
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Final Remarks

Contributions

- Significant reduction on connectivity loss
- More realistic controller placement strategy
- Smarter recovery mechanisms
- Optimization model in order to generate optimal results

Ongoing work

- Studying meta-heuristics
- Extend evaluation

Thank You!

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