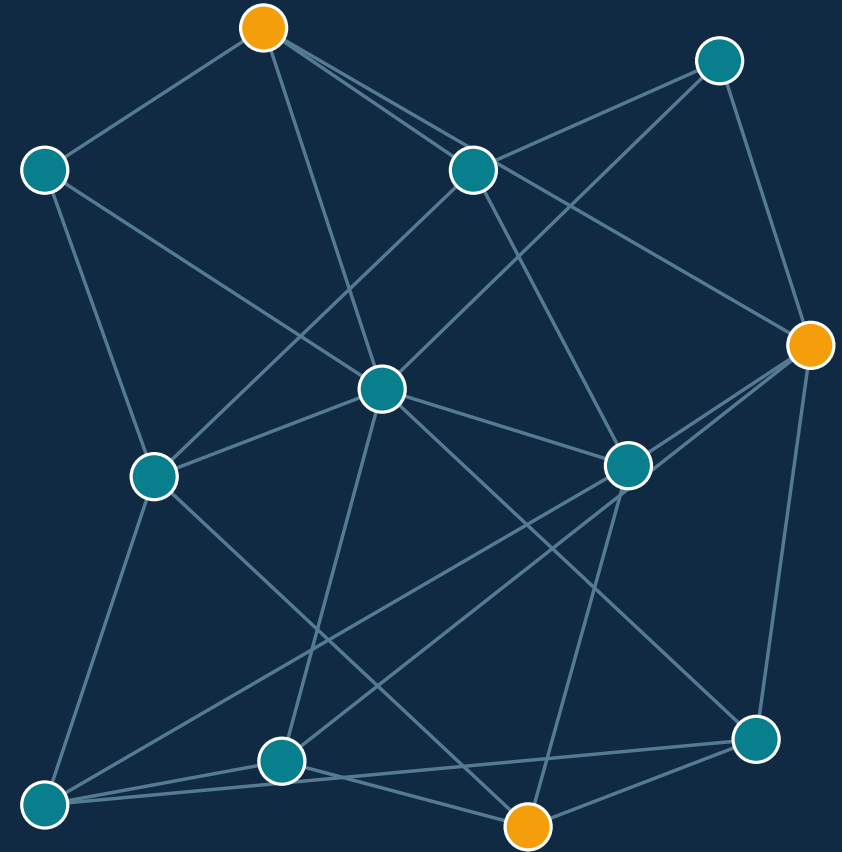


RNG: Flat datacenter networks at scale



Giacomo Bernardi w/ Ratul Mahajan, C. Seshadri, and many others
Amazon

RNG flattens the datacenter network

69%

fewer switches

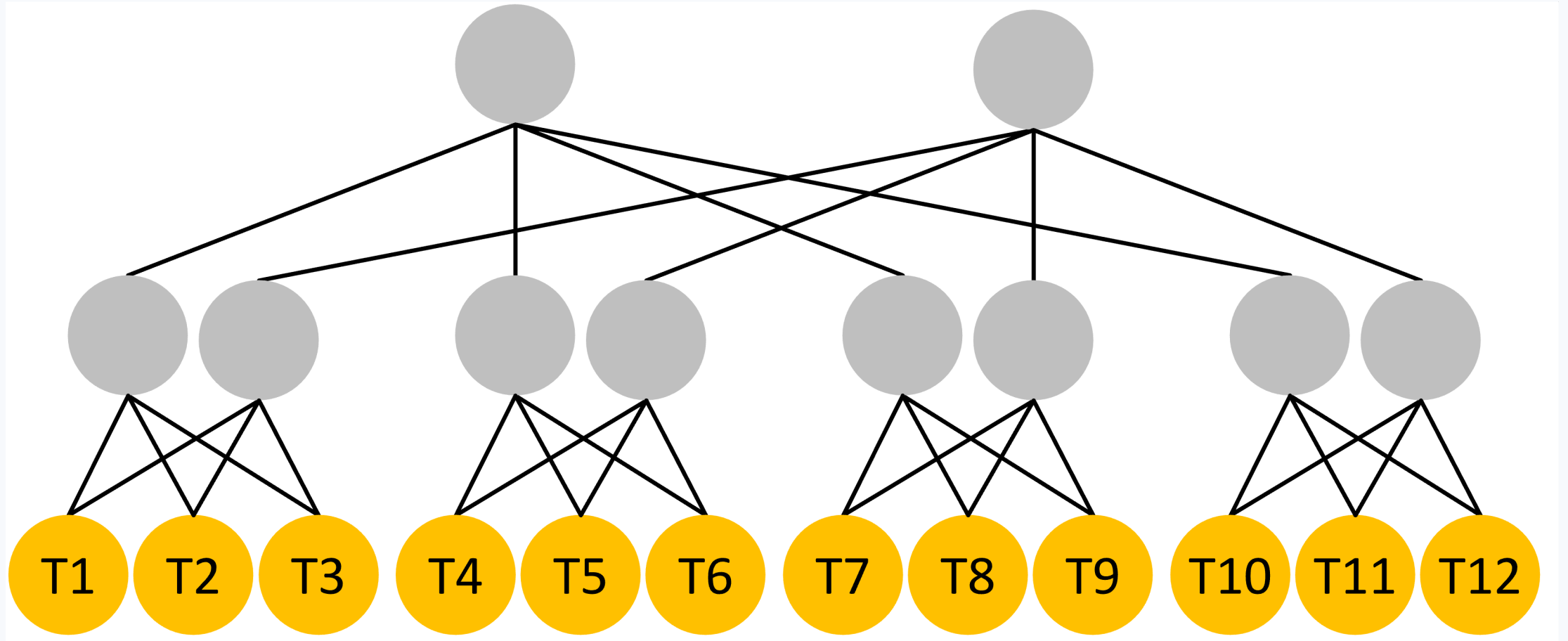
40%

less power

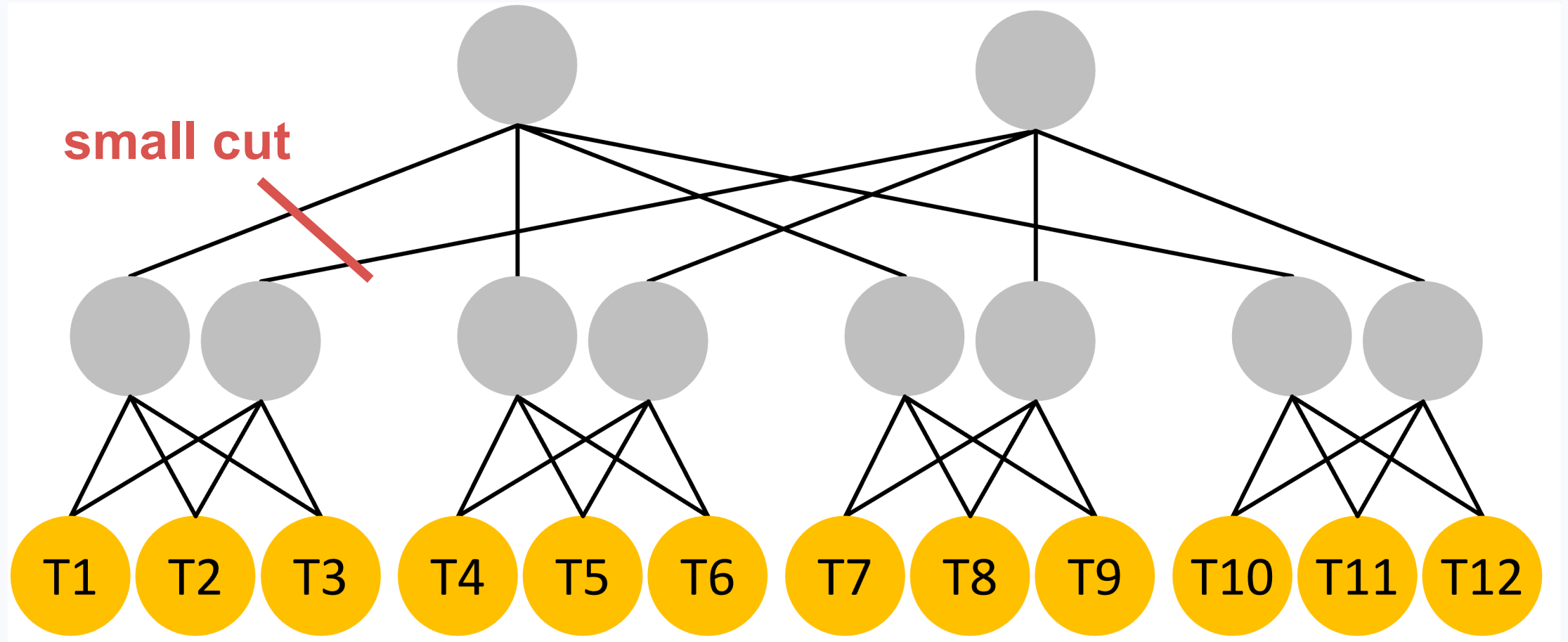
27%

lower cost

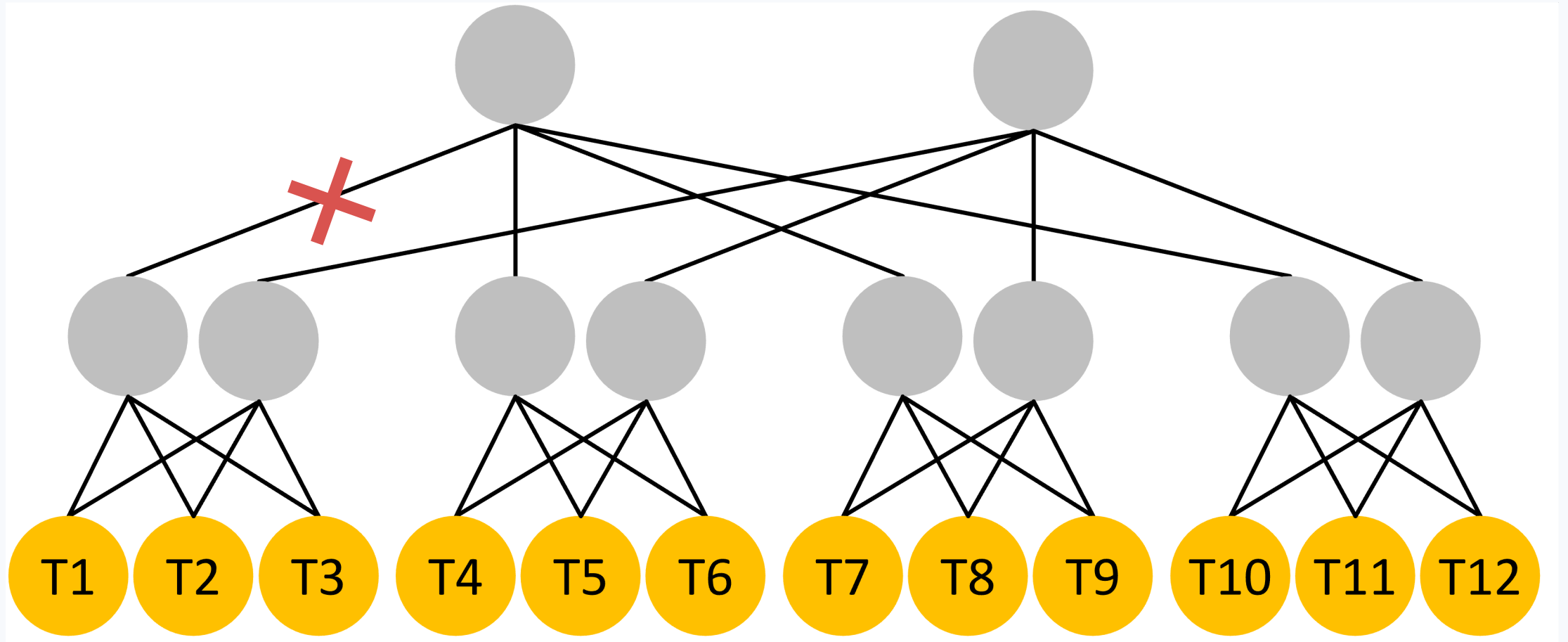
Trees are simple to cable, route, and analyze



But trees strand capacity



Failures have outsized impact in trees



Mitigating the downsides of trees is not easy

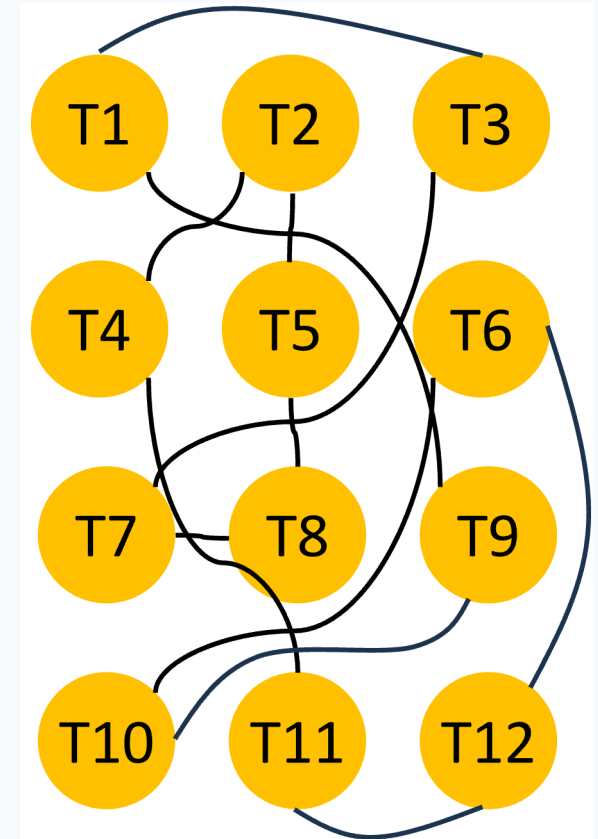
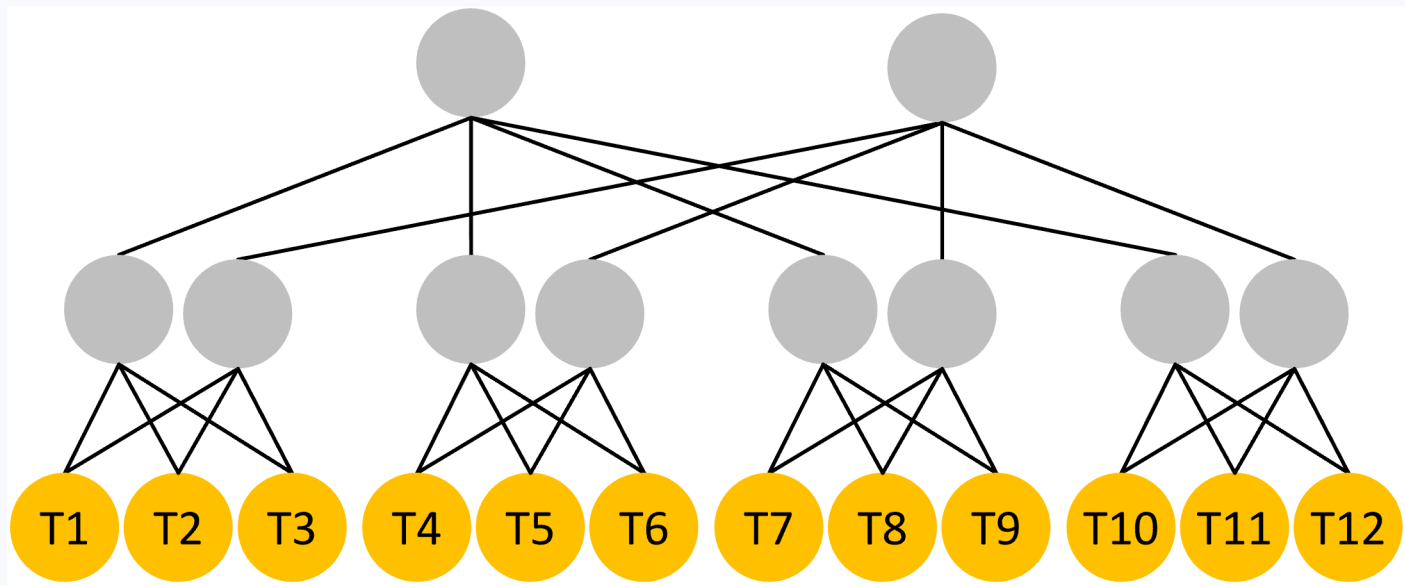


Overbuild



Reconfigure

Expanders make capacity fungible



| But expanders are not easy to build

1 Cabling

2 Routing

3 Predictability

RNG: Resilient network graphs

1 Cabling

SHUFFLEBOX

2 Routing

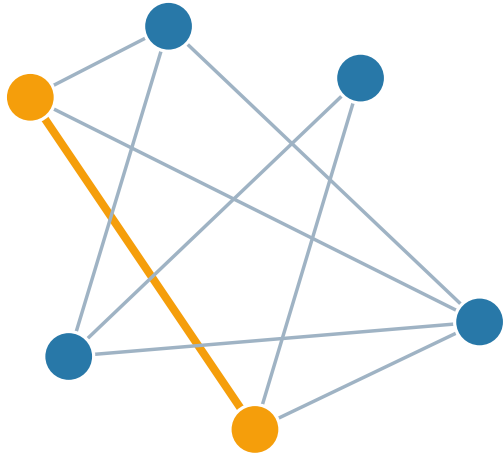
SPRAYPOINT

3 Predictability

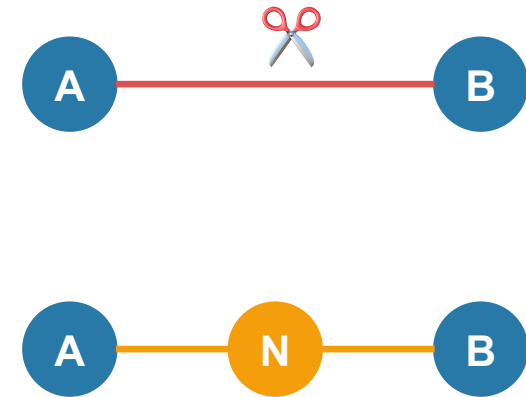
MODELS

Cabling: Physical world resists randomness

Arbitrary neighbors



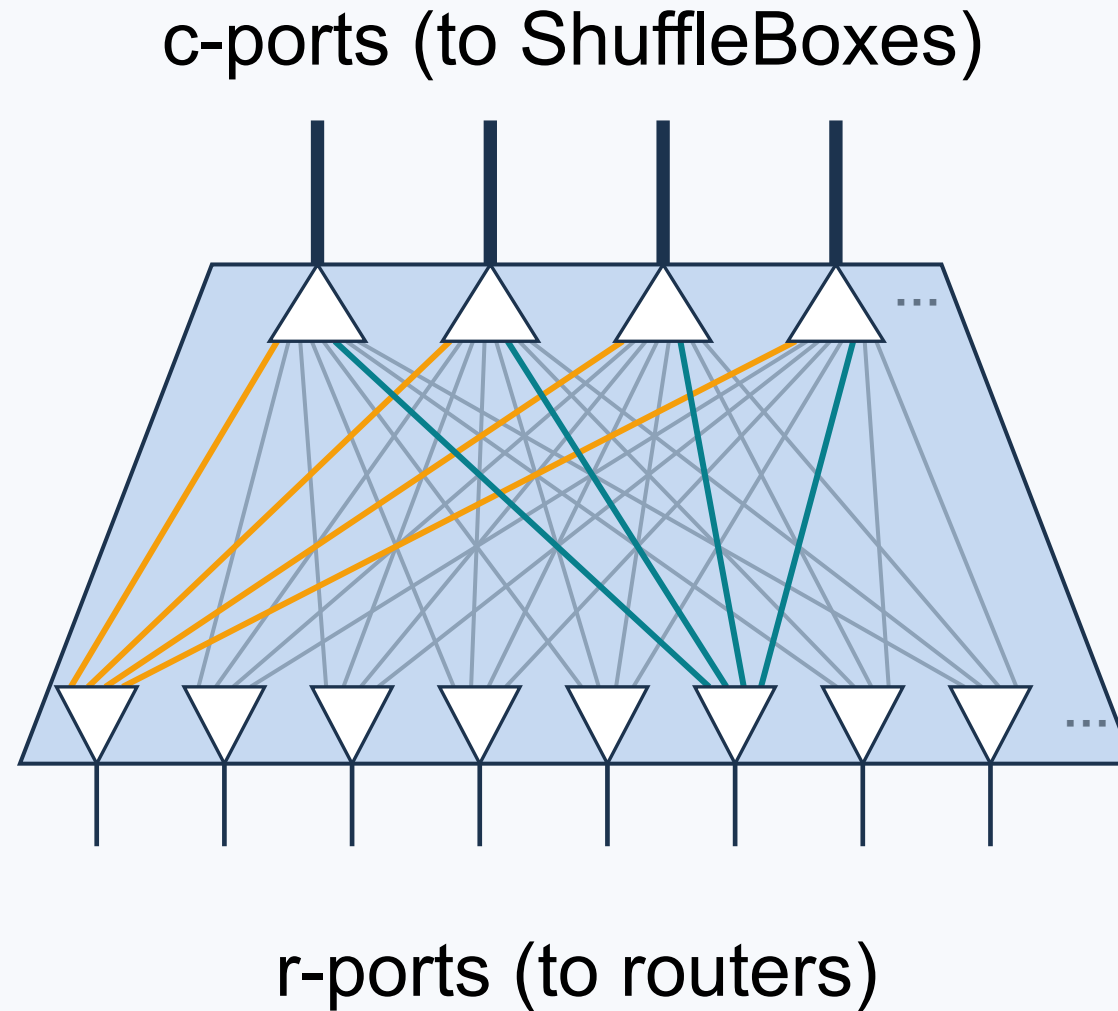
Expansion breaks links



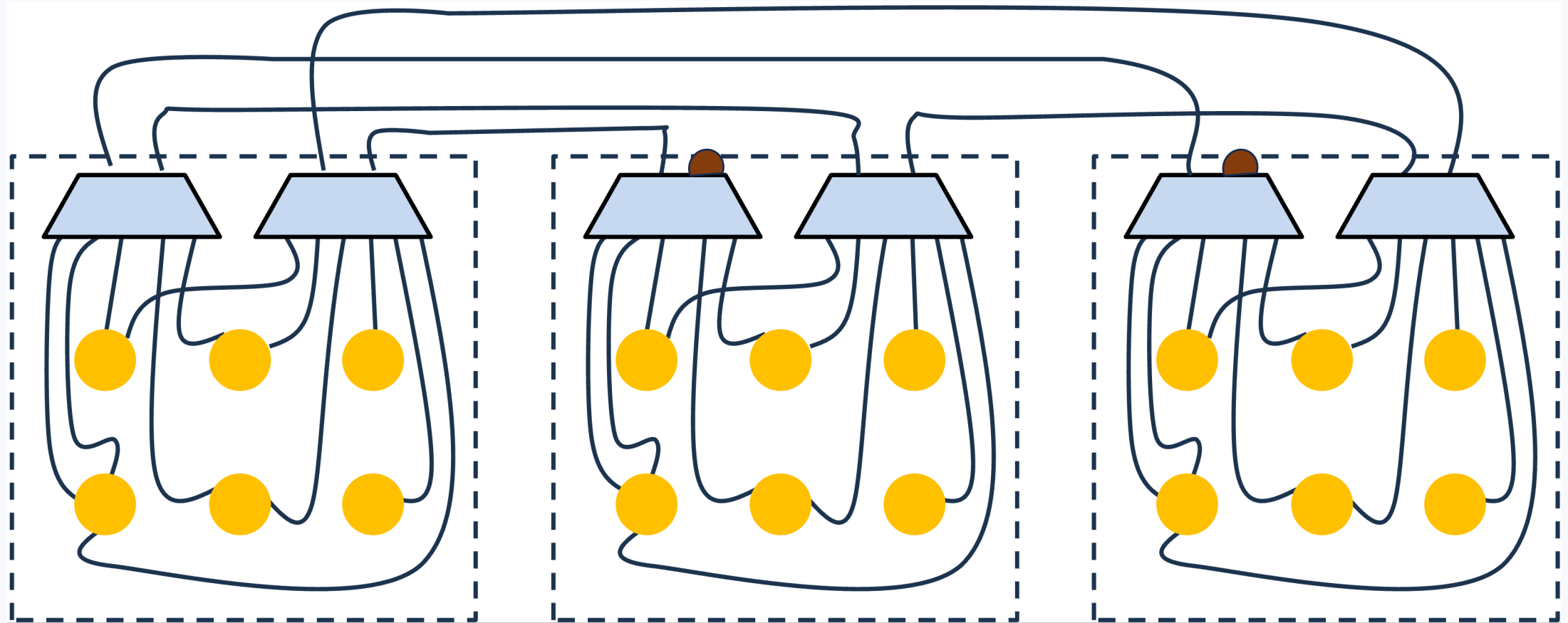
ShuffleBox: A passive optical device



ShuffleBox: A passive optical device



Quasi-random connectivity via structured cabling



ToR

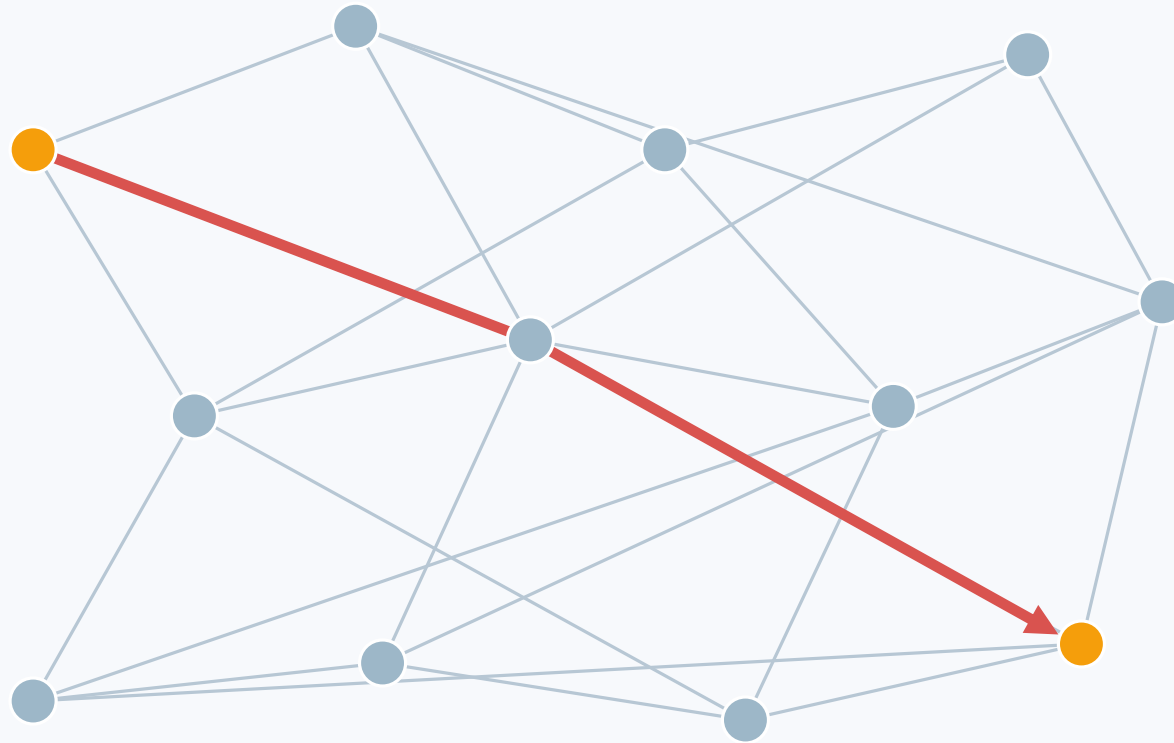


ShuffleBox

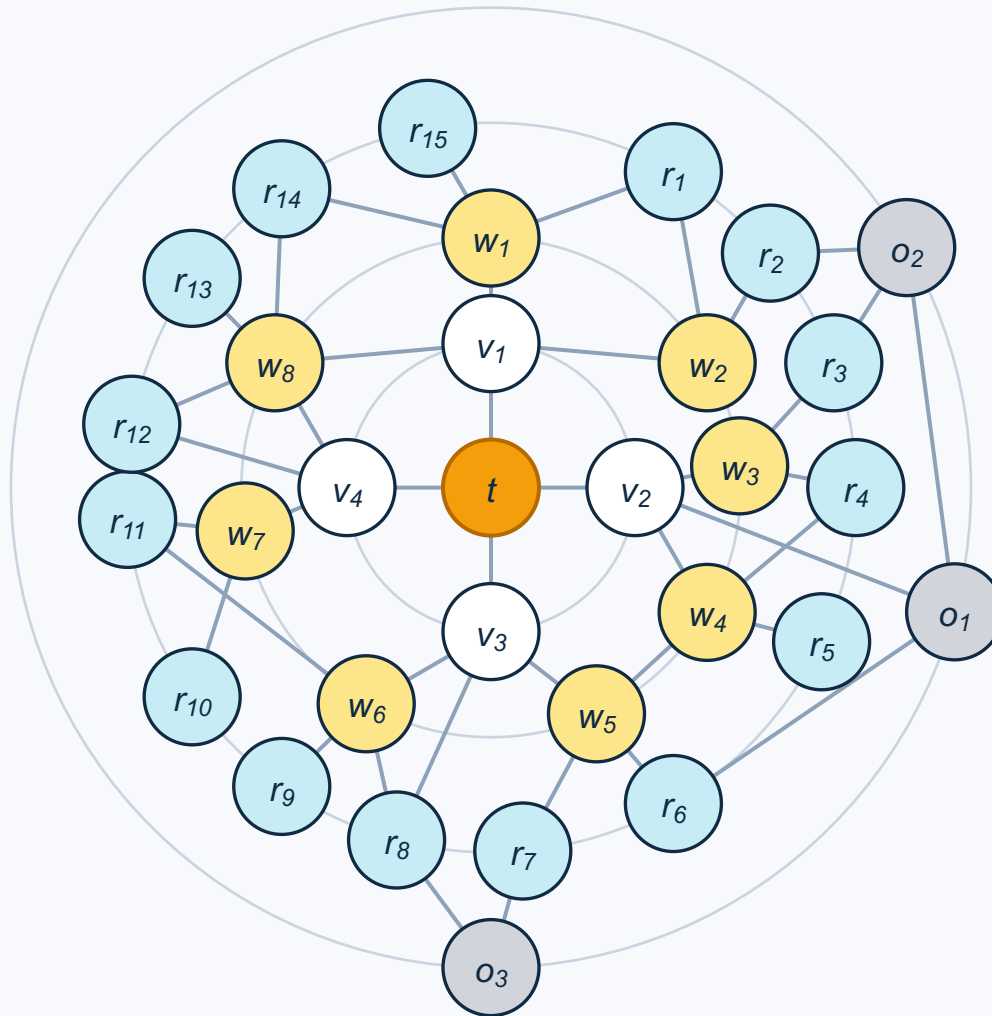


ShuffleBack

Shortest paths cannot exploit expansion

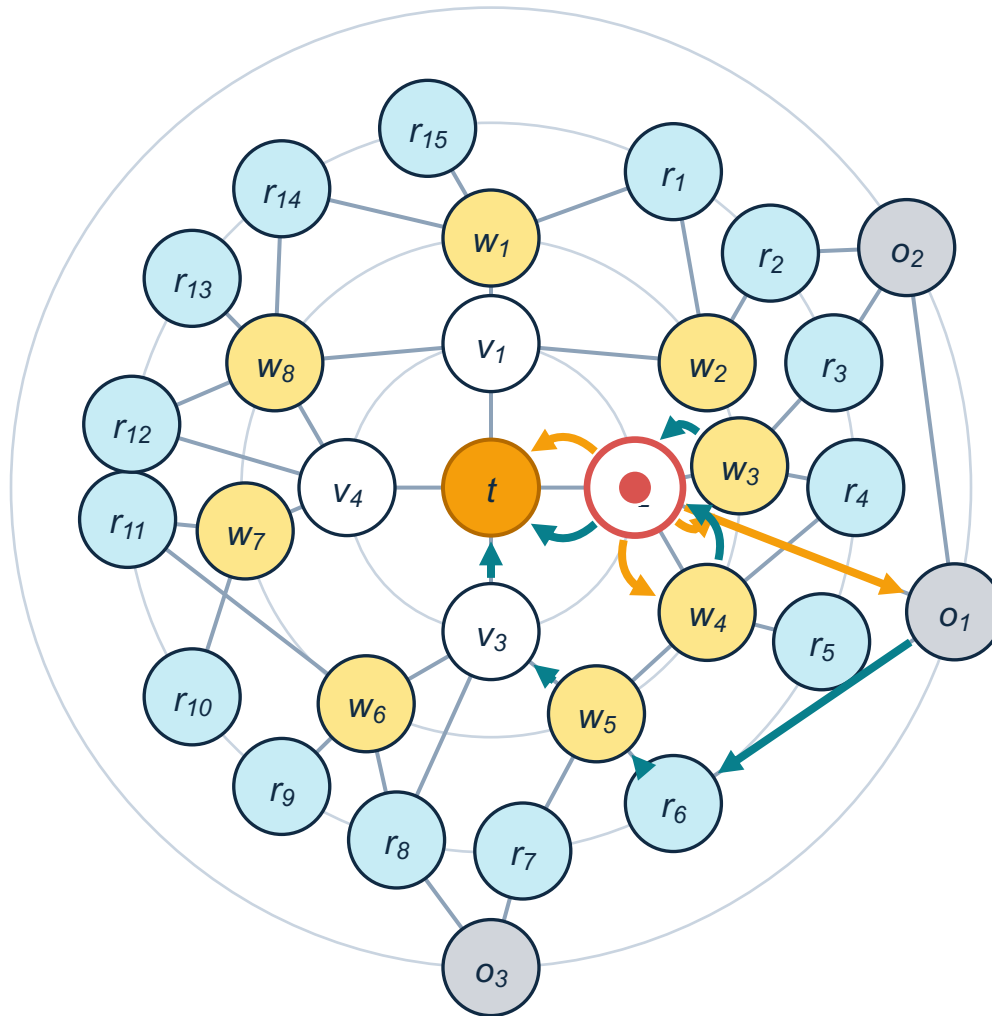


Spraypoint routing



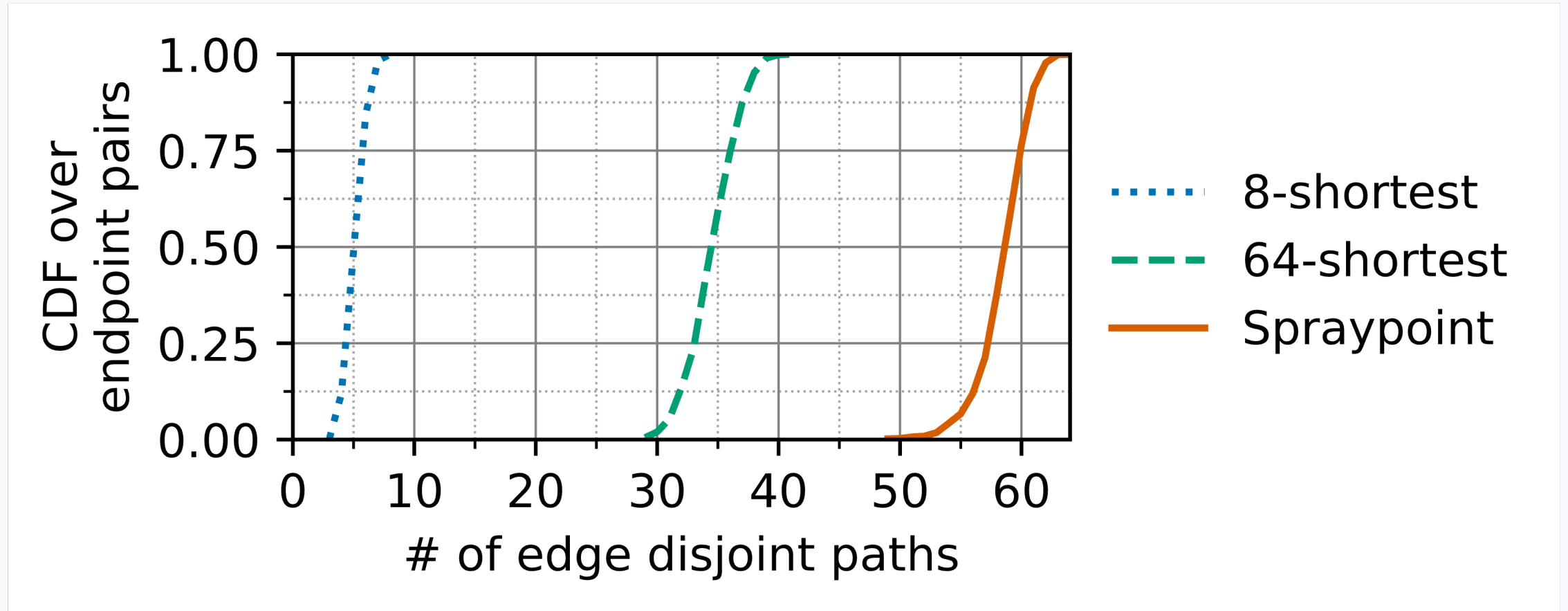
-  **Waypoints at level 0**
-  **Waypoints at level 1**
-  **Inner ring**
-  **Outer ring**

Spraypoint routing

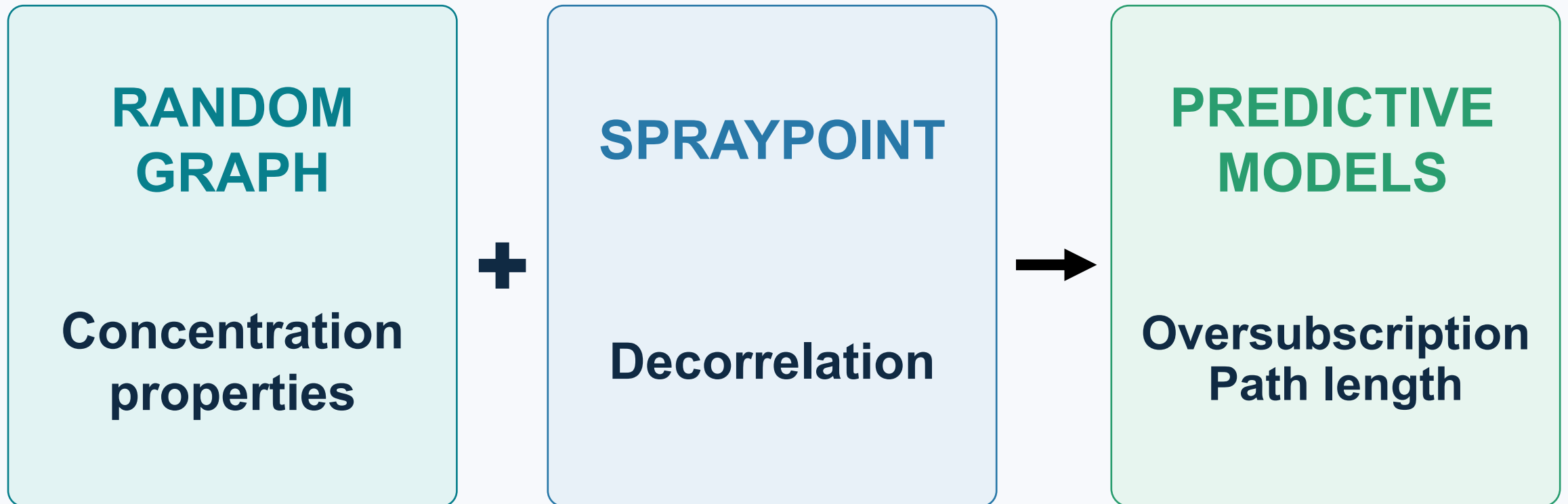


-  **Waypoints at level 0**
-  **Waypoints at level 1**
-  **Inner ring**
-  **Outer ring**

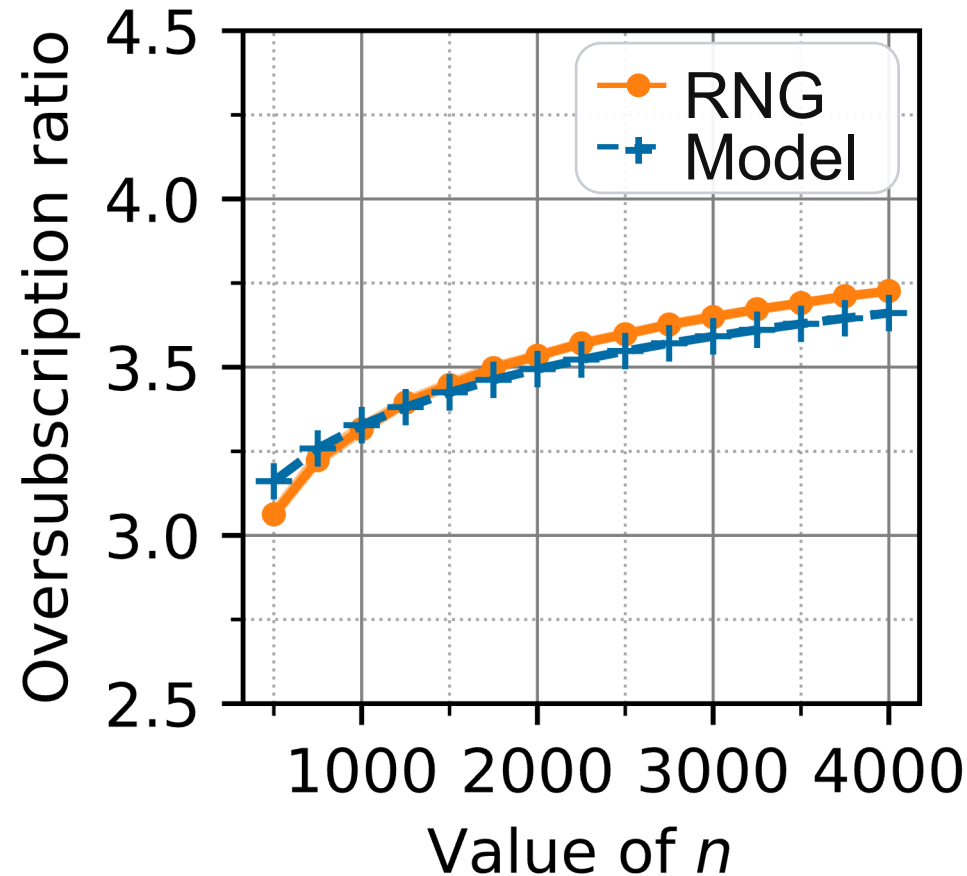
Spraypoint finds almost every available path



Modeling RNG



RNG models enable predictable topology design



**Number of servers,
oversubscription**



**Topology parameters
(n , d , p , h)**

Path to production

Two experimental
fabrics

2024

Tore them
down

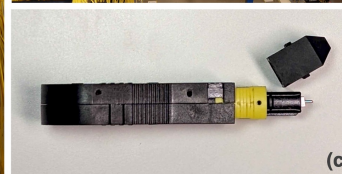
×

Two production
fabrics

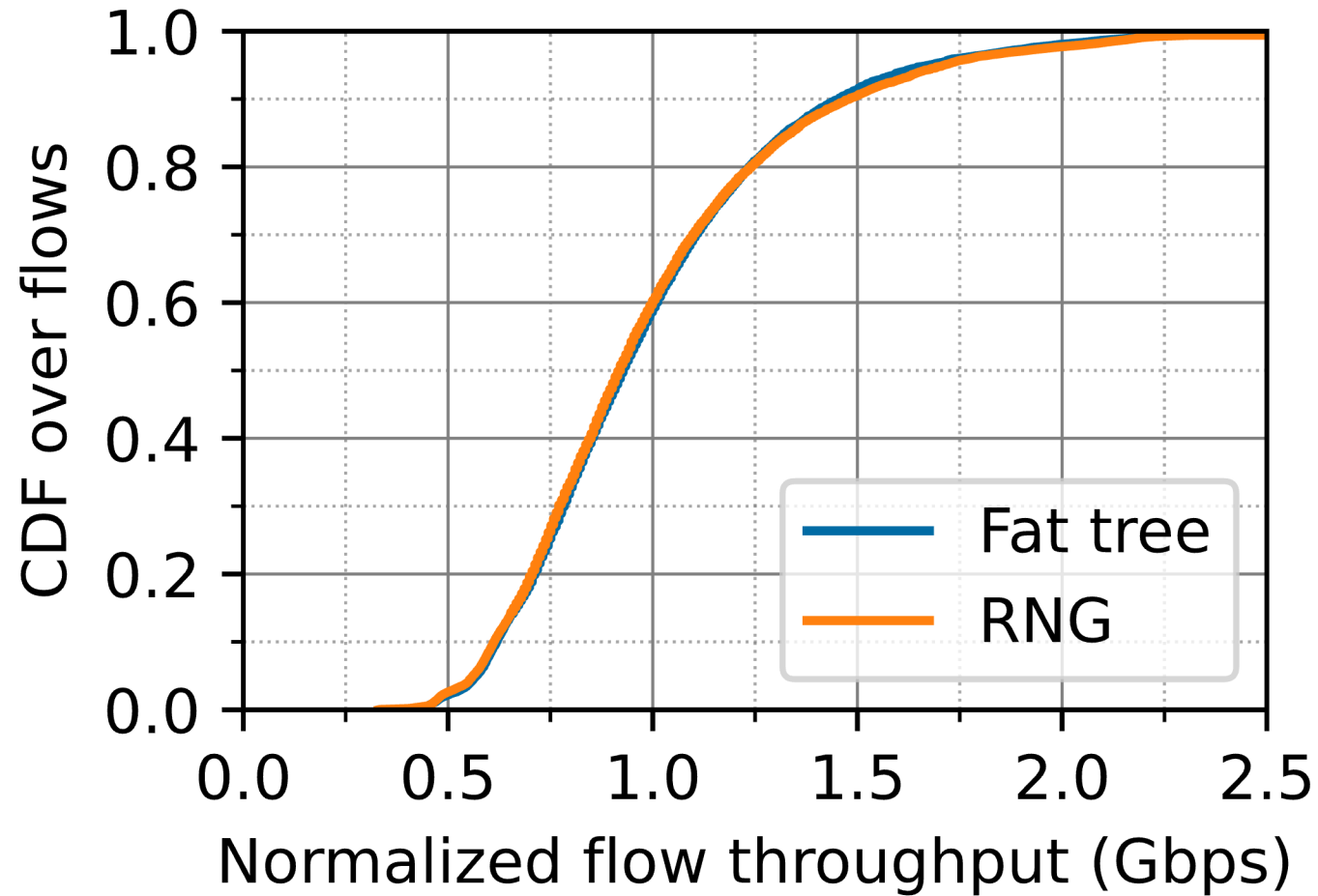
2025

Default for most
workloads

✓

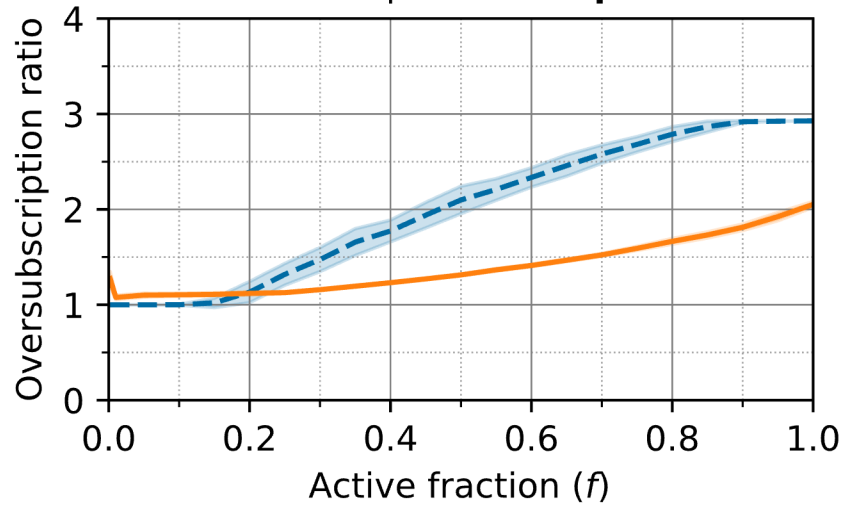


Application flows perform just as well on RNG

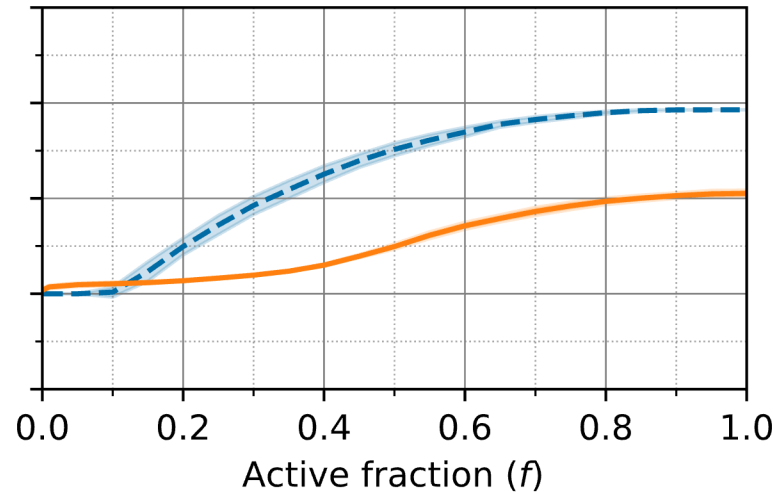


RNG offers generally better throughput

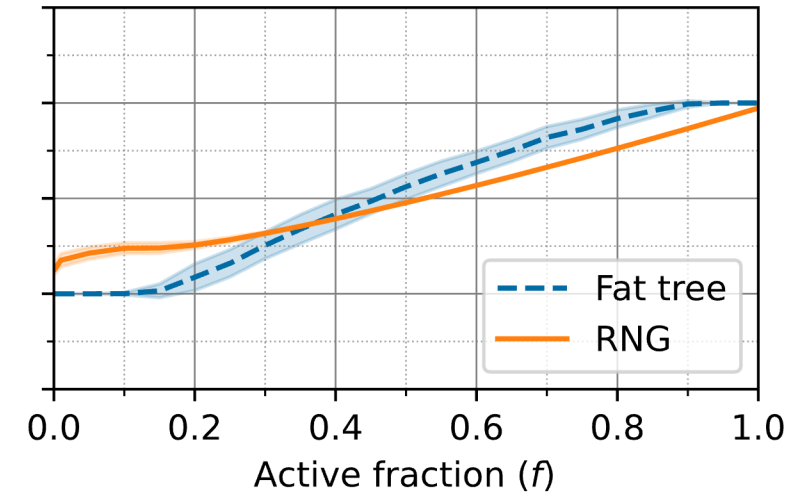
Traffic pattern: **clique**



Traffic pattern: **hubs**

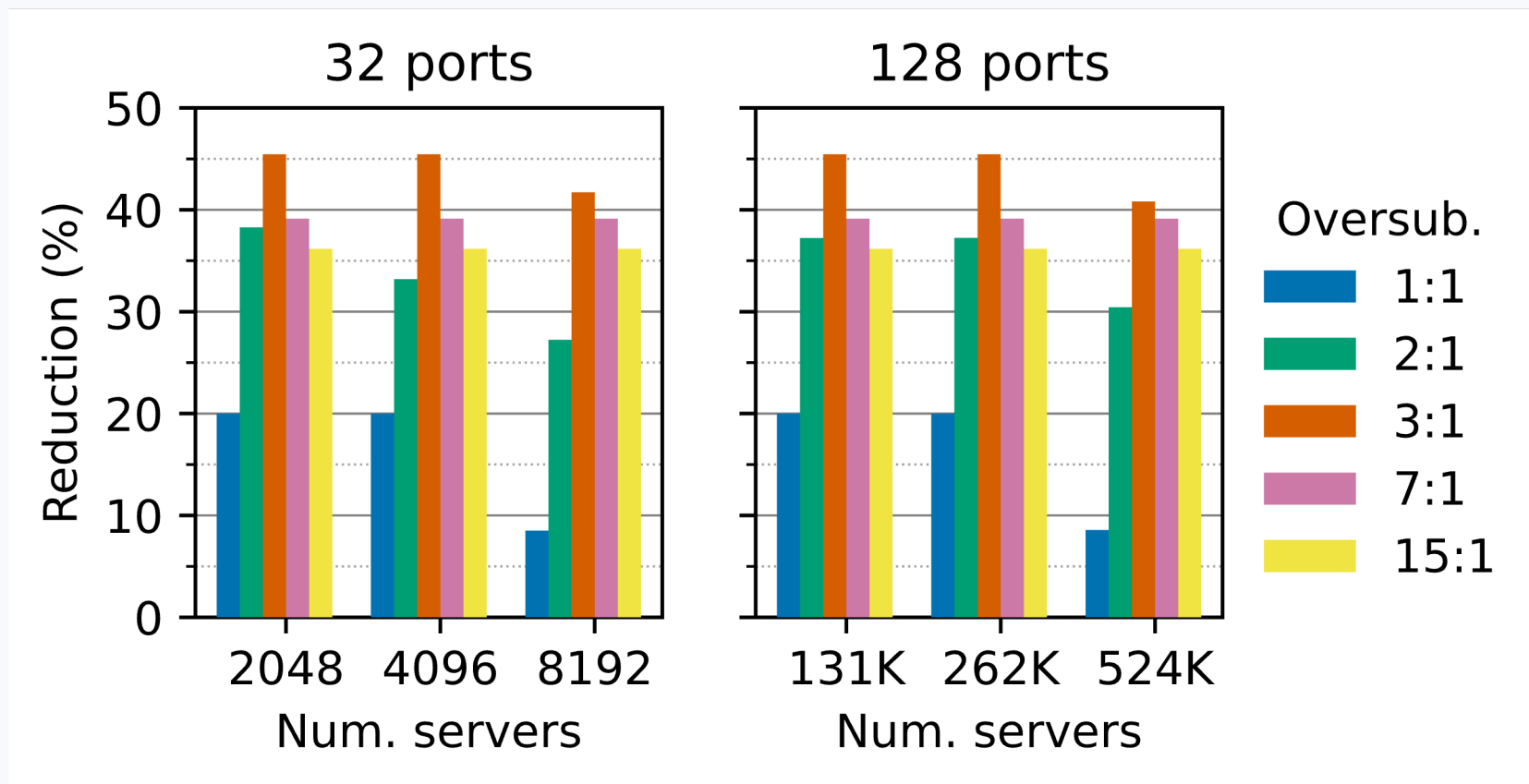


Traffic pattern: **matchings**

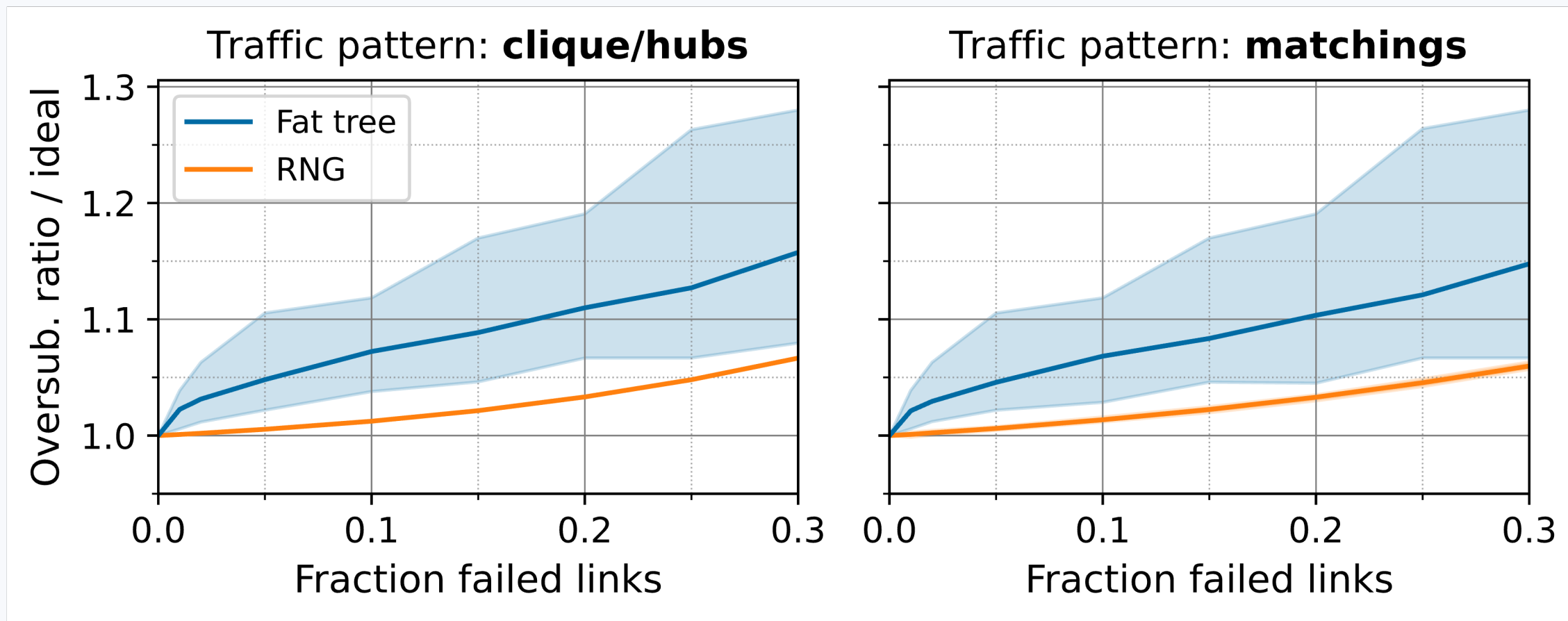


Lower is better

RNG needs 9–45% fewer switches



Failures degrade performance gracefully in RNG



RNG makes flat datacenter networks scale



SHUFFLEBOX

practical cabling



SPRAYPOINT

high-throughput routing



MODELS

predictable design

