The effects of disruption and topology on the computer network packet delivery

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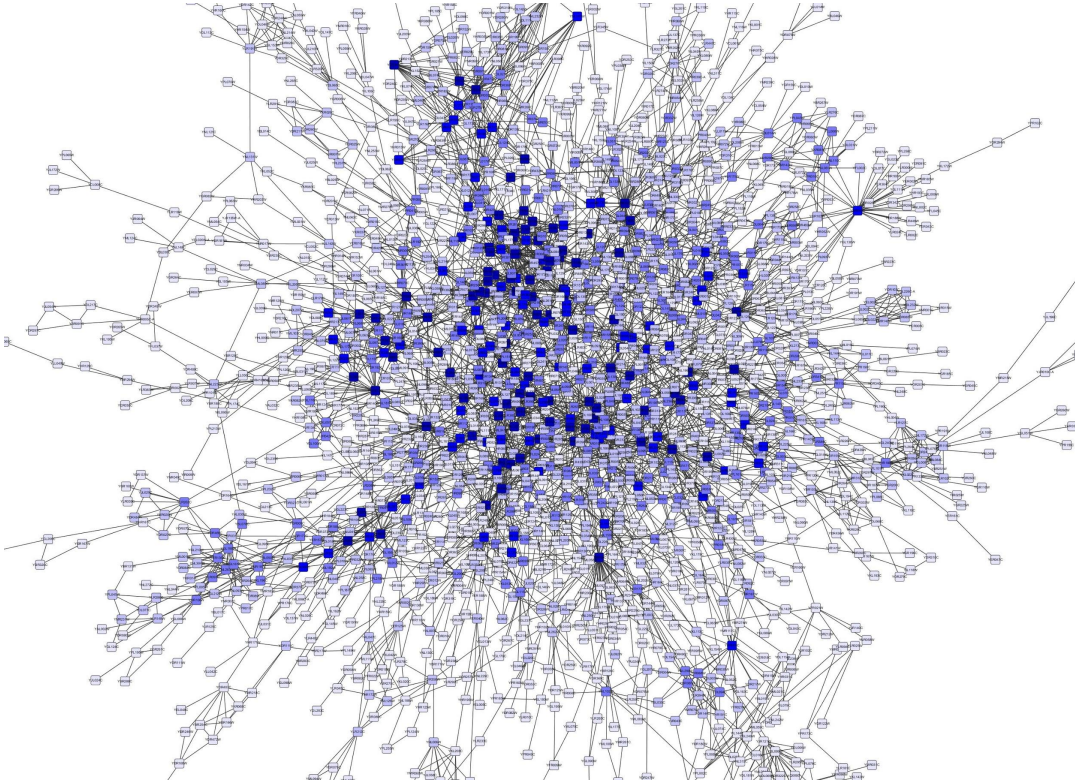
Networks

Active field of research.

Finding the dependencies between :

- Network “noise”
- Topology
- Transport efficiency

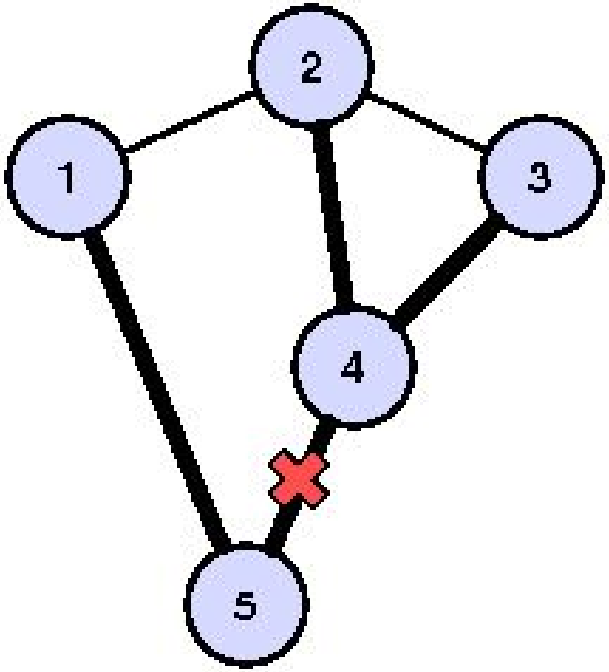


0.6-1.4%

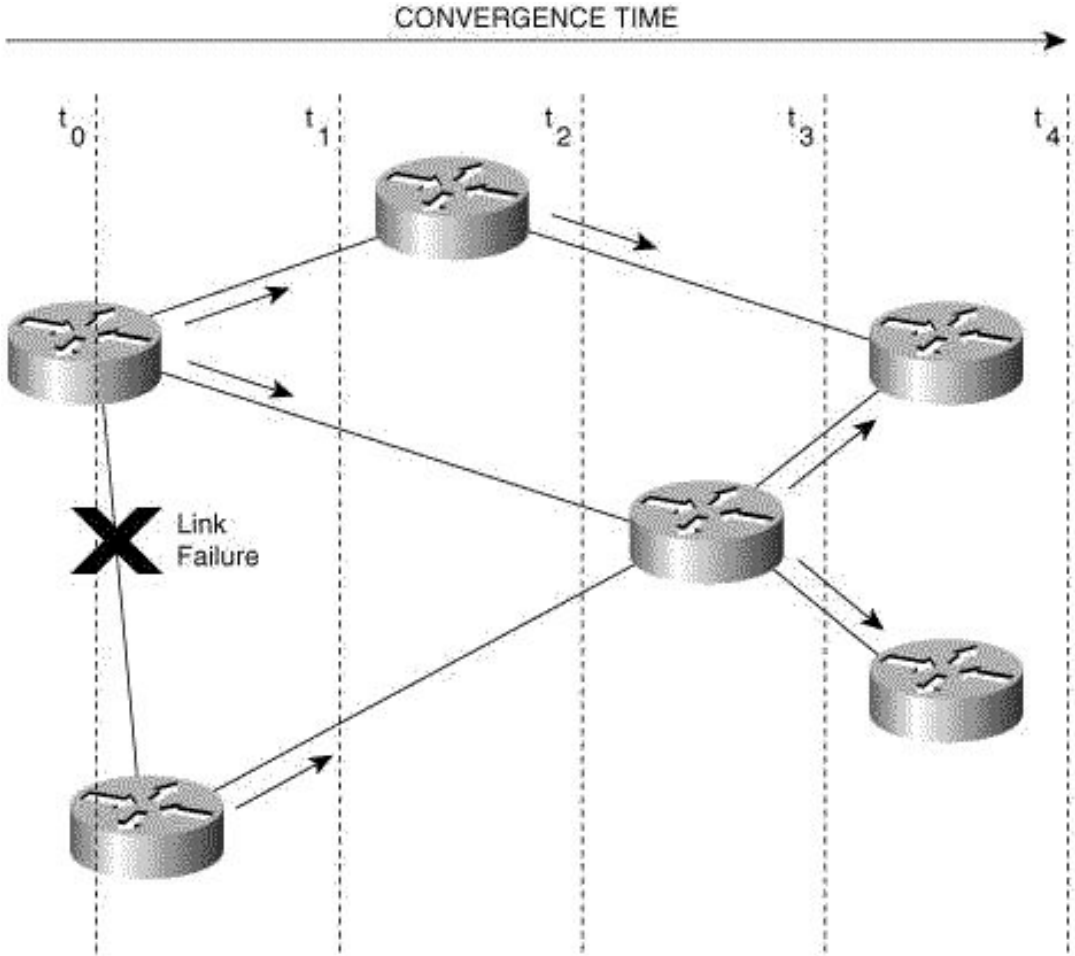
Nygren, Erik, Ramesh K. Sitaraman, and Jennifer Sun. "The Akamai network: a platform for high-performance internet applications." ACM SIGOPS Operating Systems Review 44.3 (2010): 2-19.

Network disruption

- Detect
- Inform others



Convergence takes time...



100ms-15min

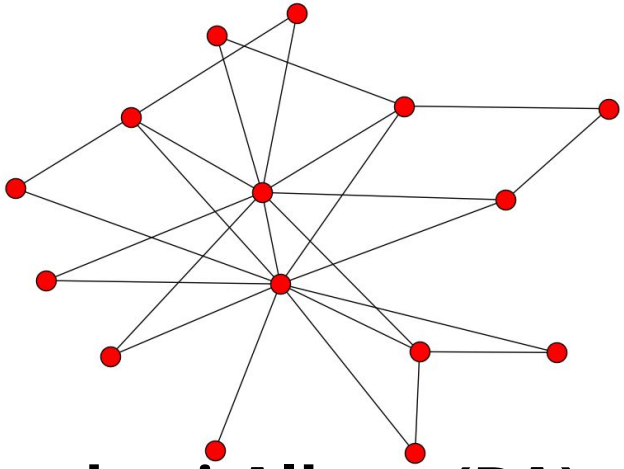
Yan, Hong, et al. "Tesseract: A 4D Network Control Plane." NSDI. Vol. 7. 2007.

Labovitz, Craig et al. "The impact of Internet policy and topology on delayed routing convergence." *INFOCOM 2001. Twentieth Annual Joint Conference of the IEEE Computer and Communications Societies. Proceedings. IEEE* 2001: 537-546.

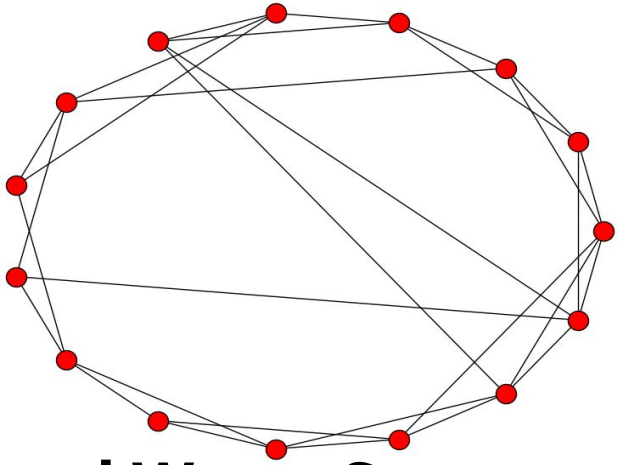
Research questions

How the network resiliency during network reconvergence is affected by :

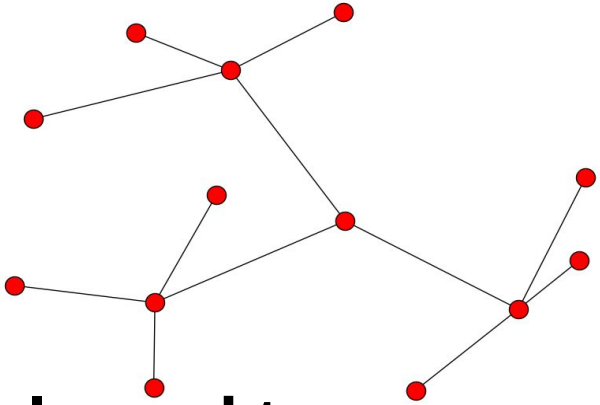
- topology **type** and **size**
- topology **partitioning**
- link state change **probability**



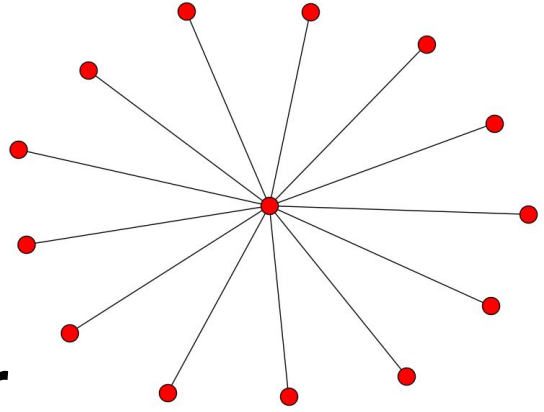
Barabasi-Albert (BA)



Connected Watts-Strogatz (WS)



Balanced tree



Star

Topology sizes

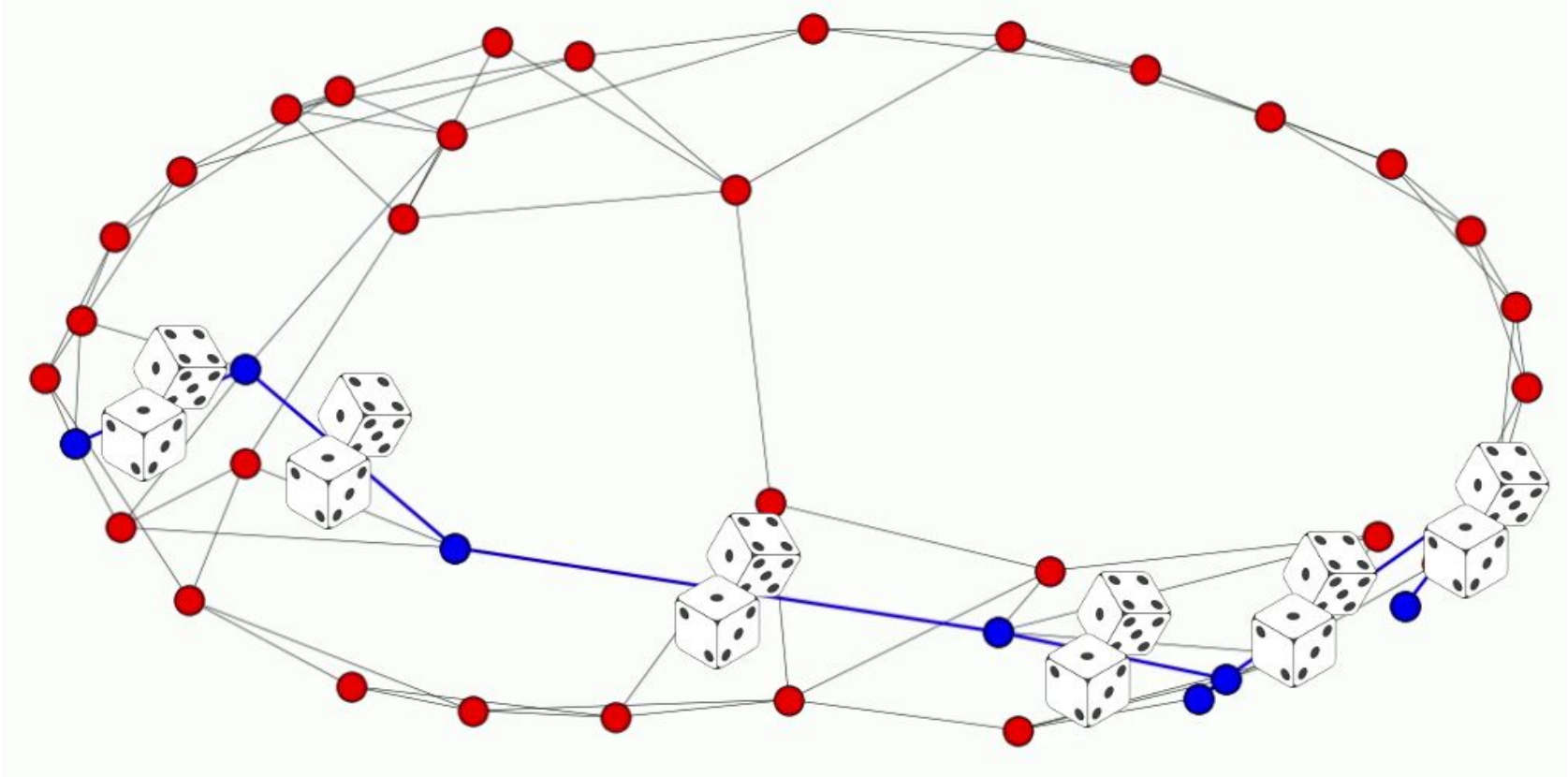
- Small (40)
- Medium (121)
- Large (364)

… and partitioning

- 2
- 4
- 8

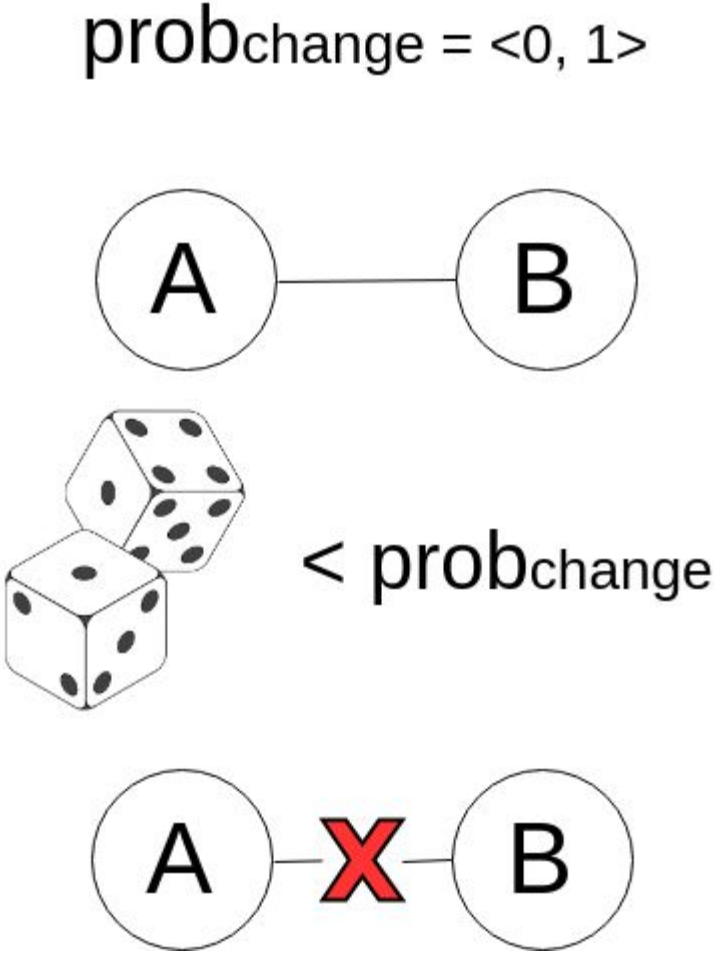
- BA
- WS

Introducing failures



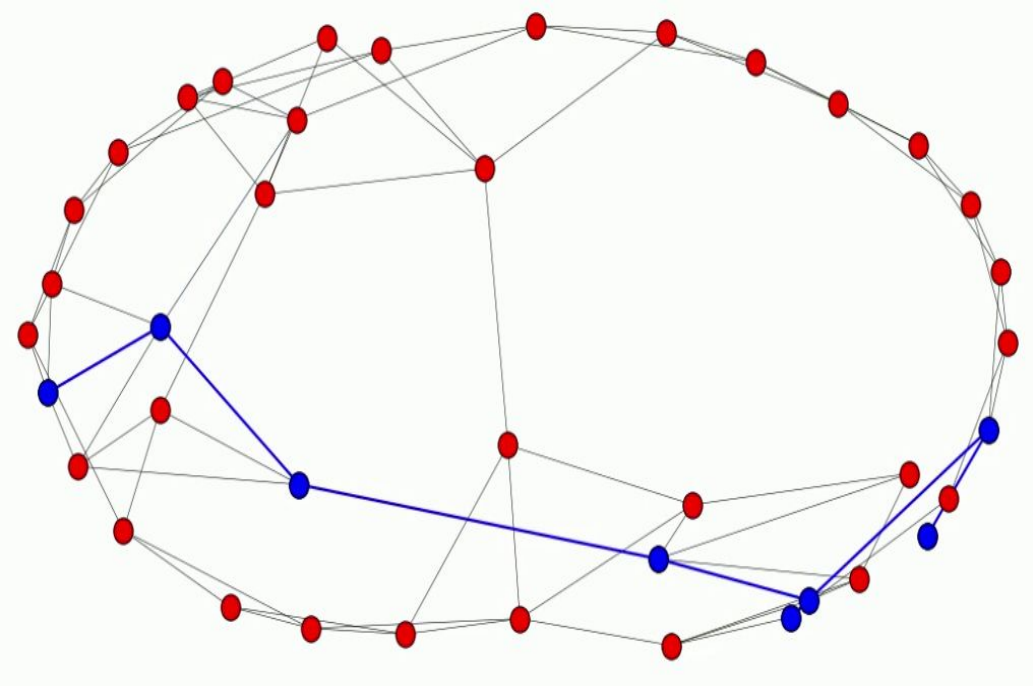
Probability of link state change

- Experiments conducted for 10 logarithmically spaced values of probability



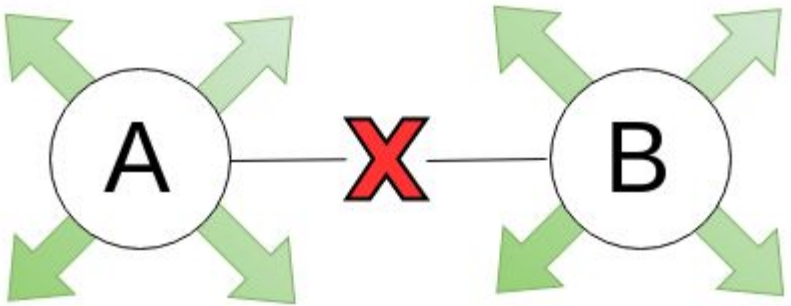
In-simulator link-state protocol

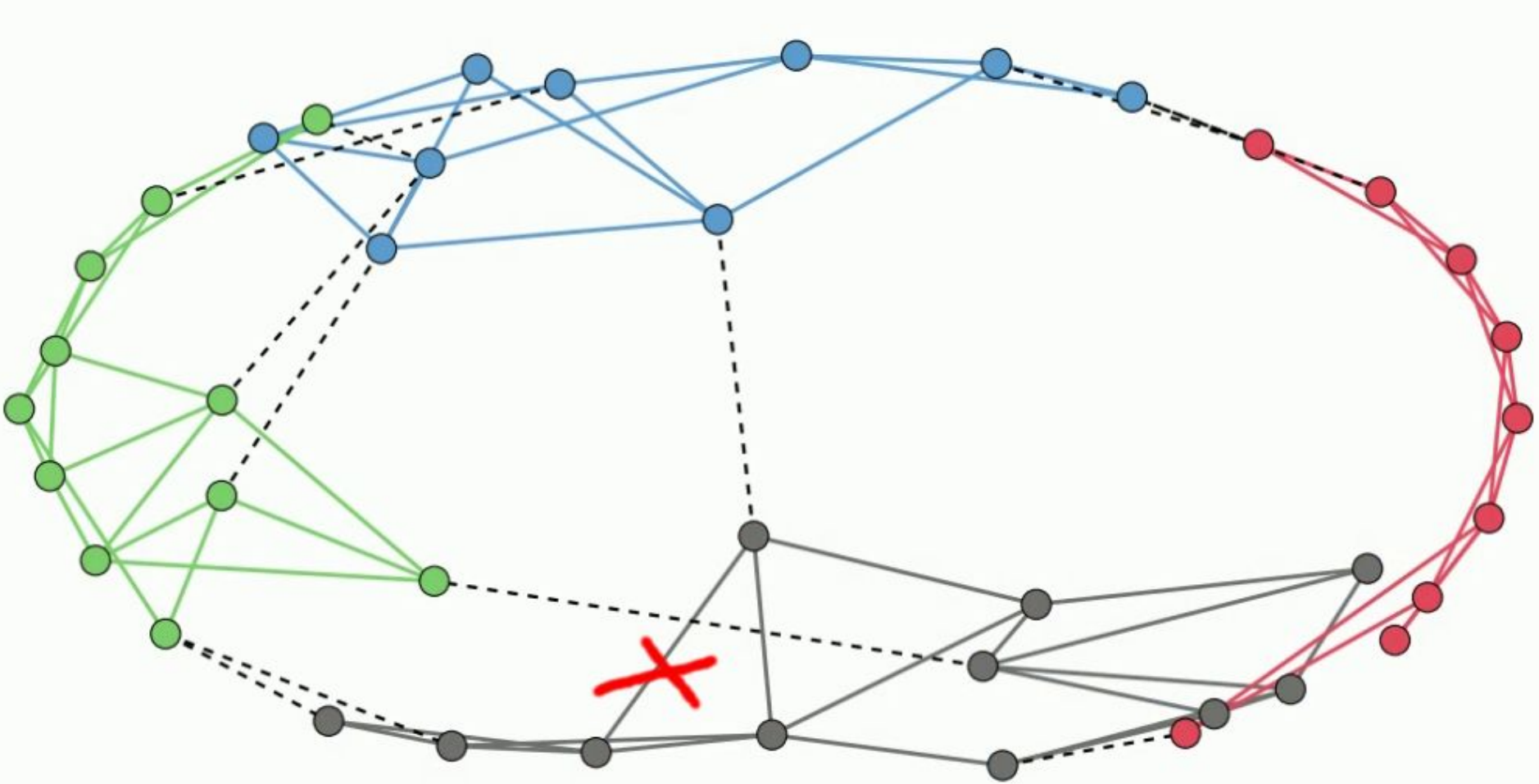
- Every node has knowledge about the **complete** topology
- Runs link-state shortest path routing algorithm

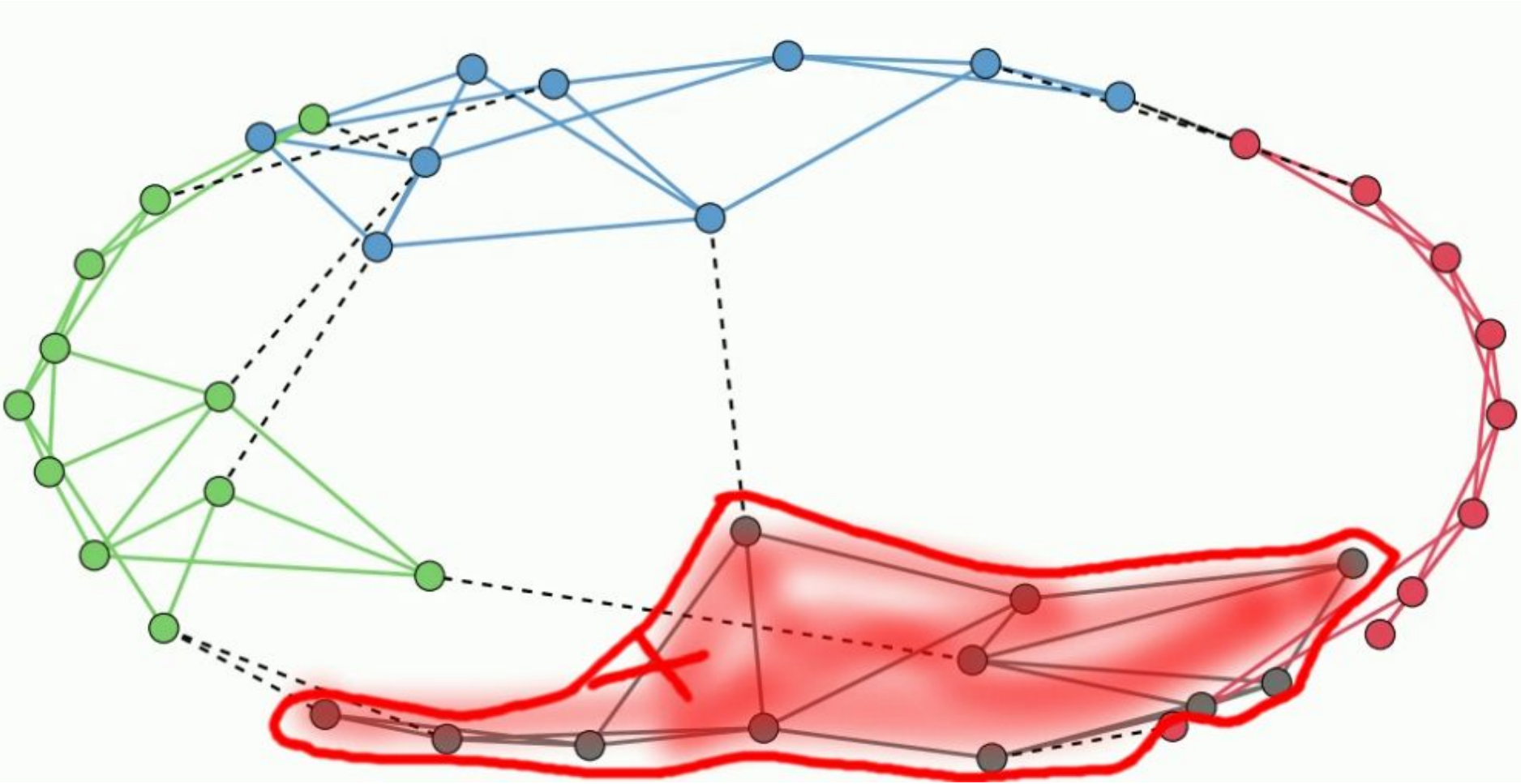


In-simulator link-state protocol

- On the link change event “state” packet sent to the neighbours







Metrics

Delivery ratio

$$\frac{packets\ received}{packets\ transmitted} \times 100\,[\%]$$

Mean path length

$$\frac{\sum_{i=0}^{N} path\ length(i)}{N}$$

$$N = received\ packet\ count$$

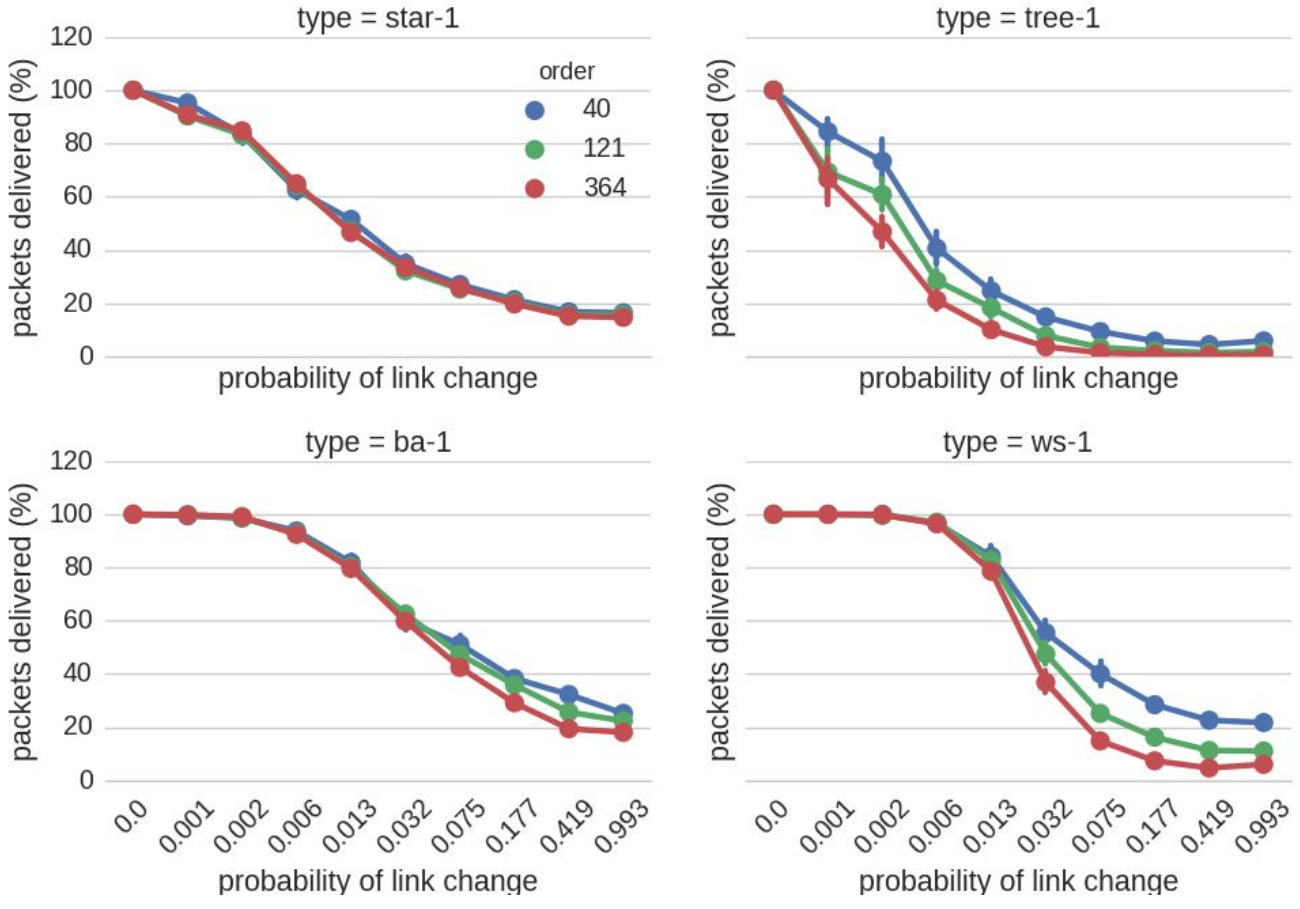
“TTL exceeded” ratio

$$\frac{TTL\ dropped\ packets}{packets\ transmitted} \times 100\,[\%]$$

“NO ROUTE” ratio

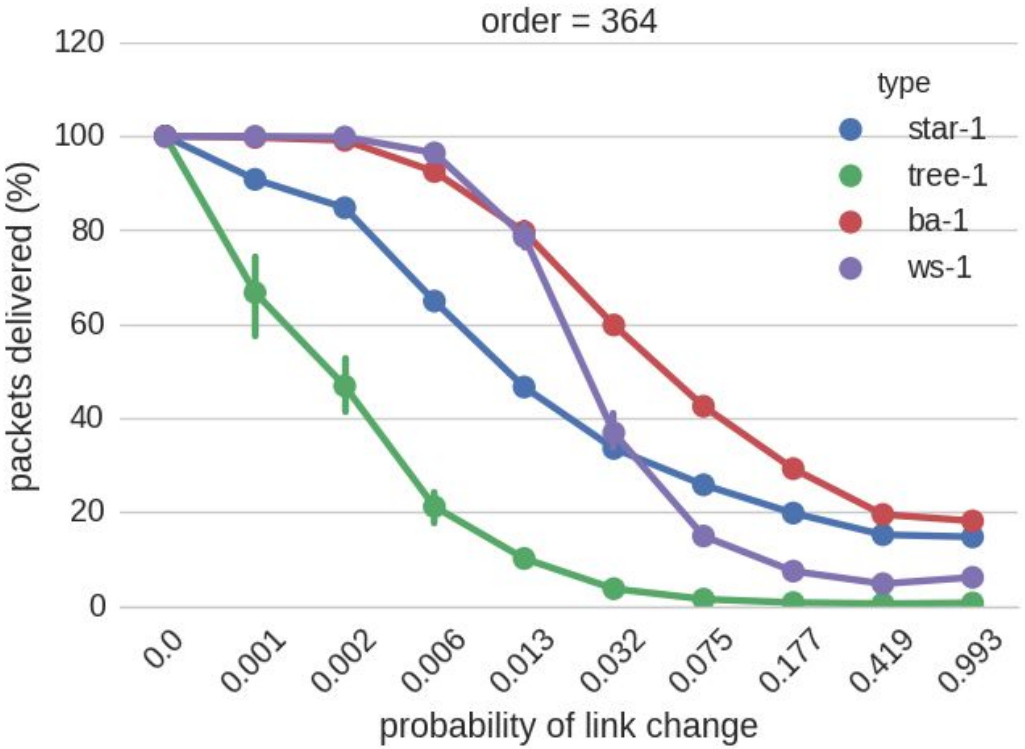
$$\frac{NO\ ROUTE\ dropped\ packets}{packets\ transmitted} \times 100\,[\%]$$

Size effect


type = star-1
type = tree-1
type = ba-1
type = ws-1
packets delivered (%)
probability of link change
order
40
121
364
0
20
40
60
80
100
120
0.0
0.001
0.002
0.006
0.013
0.032
0.075
0.177
0.419
0.993

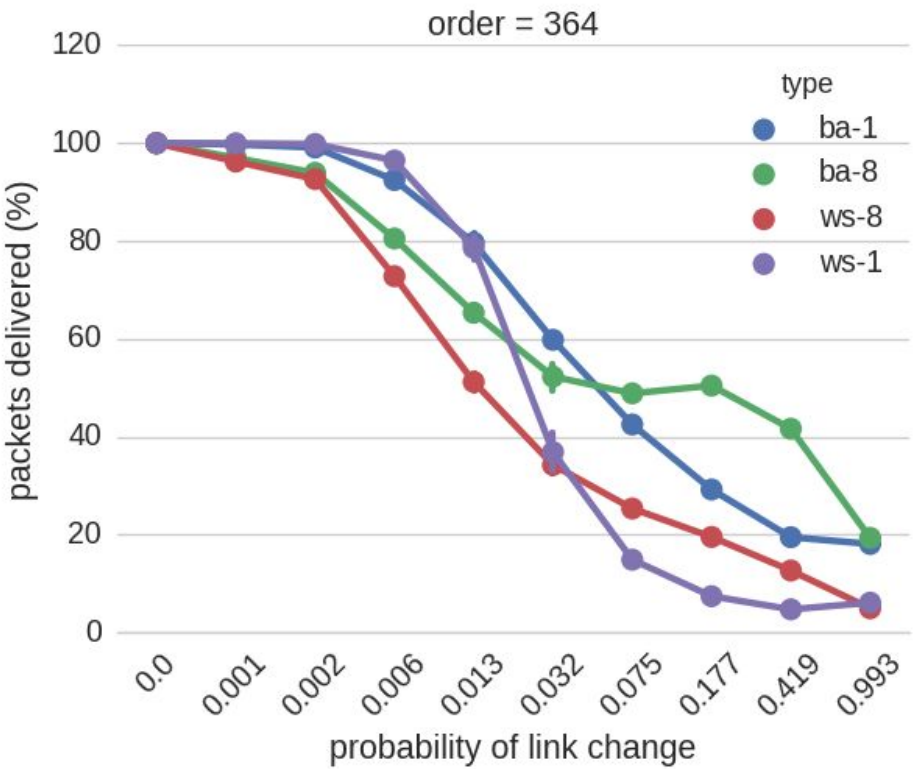
Topology **type** effect

- BA does significantly better for p>0.013



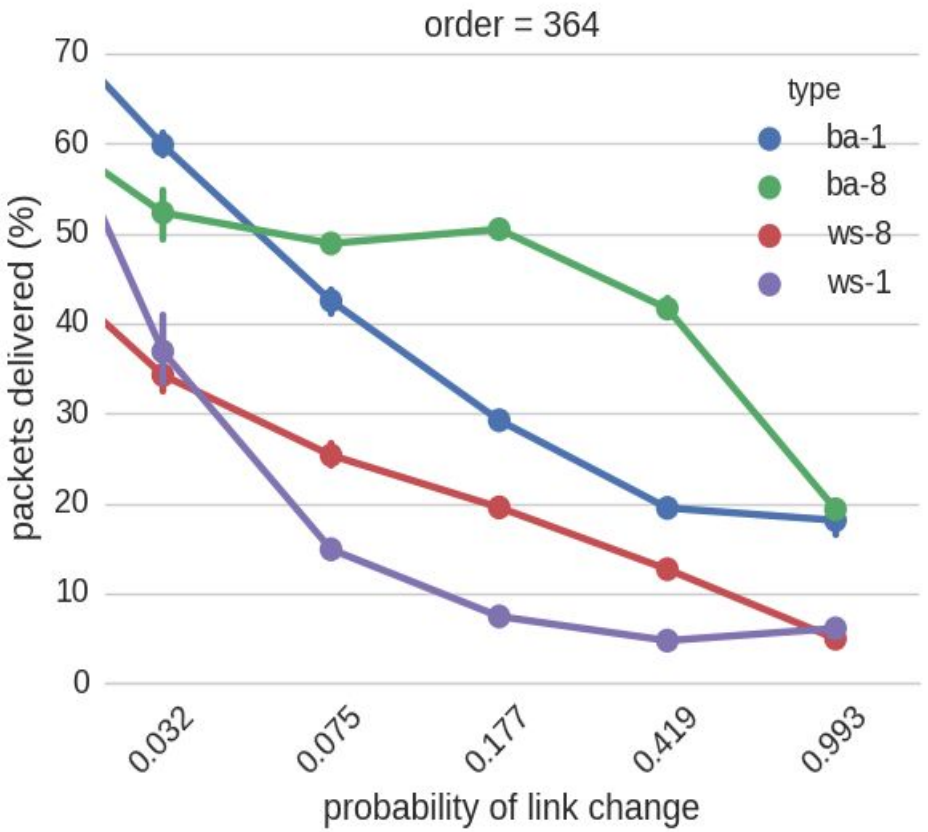
Partitioning effect

- For low link state change prob. (p<0.75) it decreased the performance
- But, when the links started to become lossy...



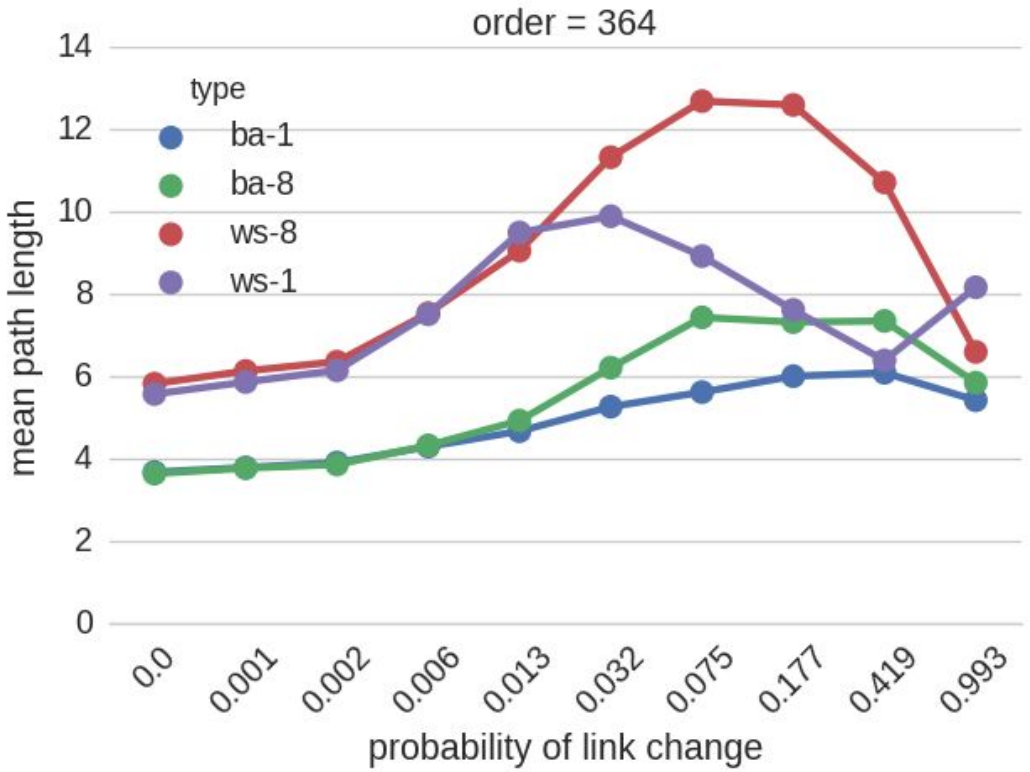
Partitioning effect (prob. >= 0.075)

- It improved data delivery for both WS and BA (p>=0.075)



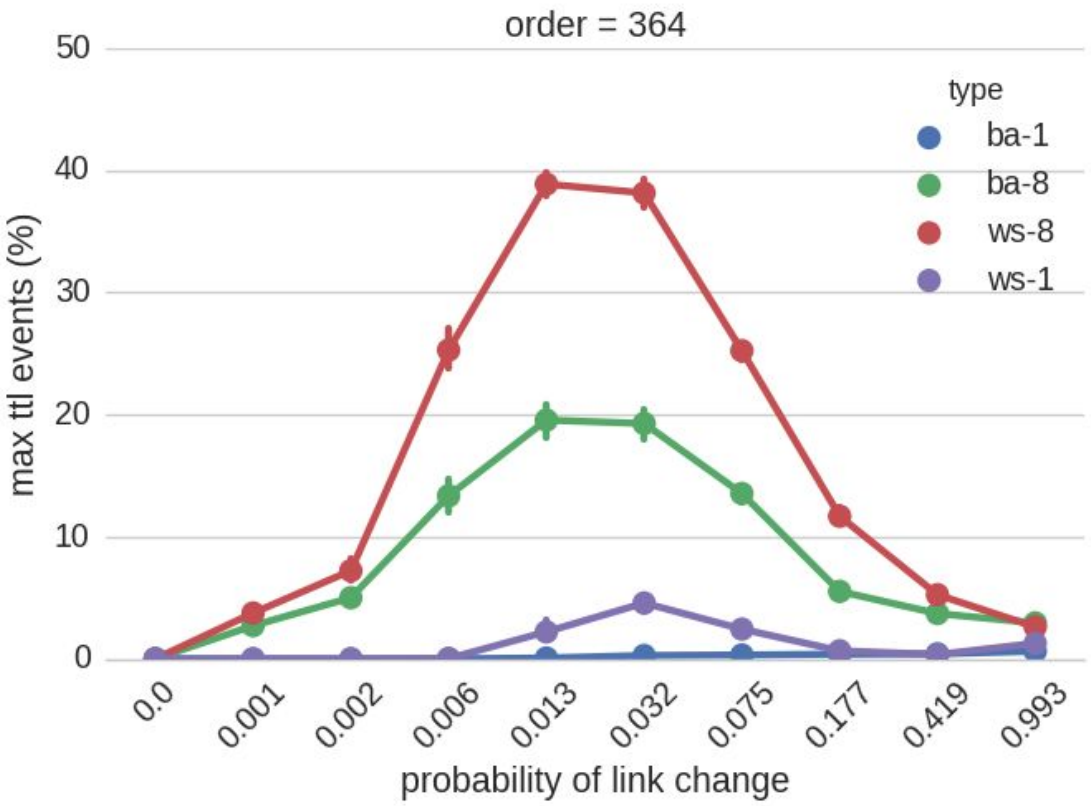
Partitioning effect

- Partitioning extended path length, p>0.013



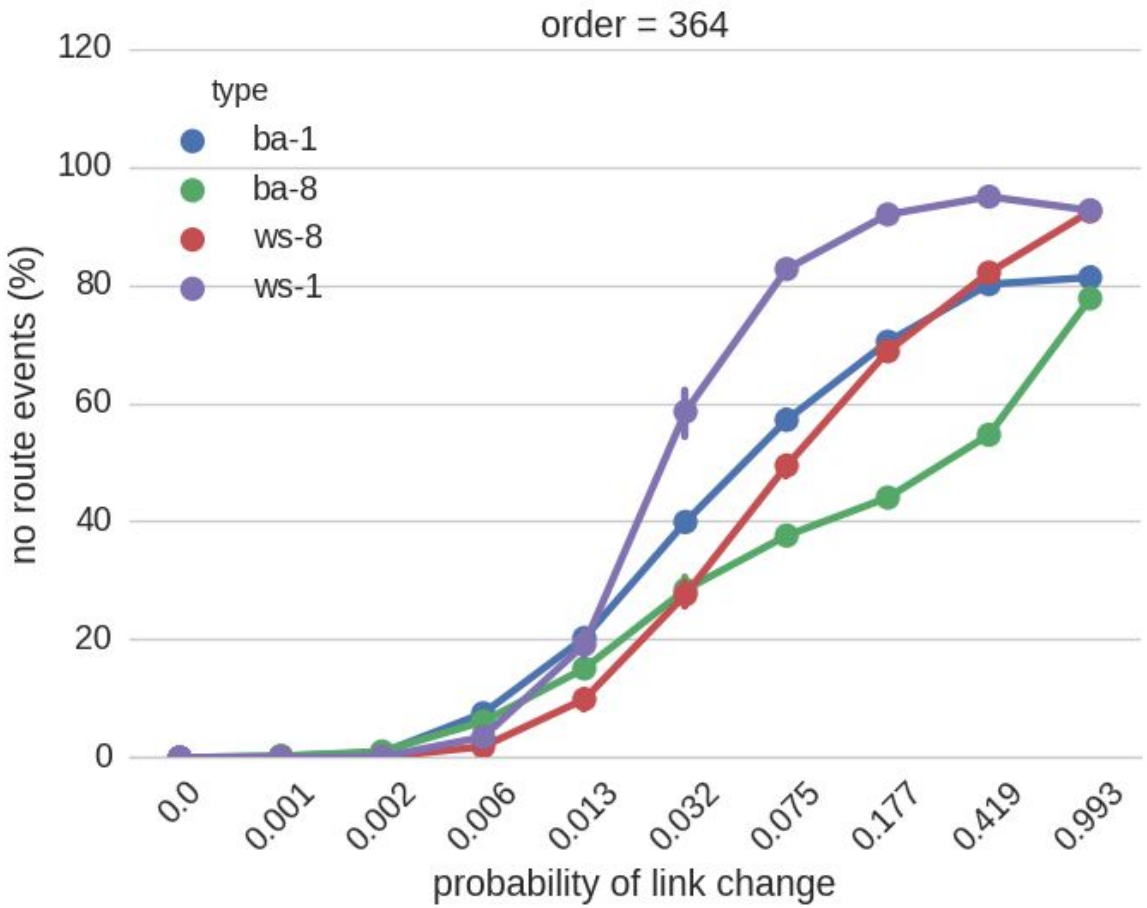
“TTL exceeded” events

- Partitioning amplified loop occurrence
- Peak looping occurs near p=0.013, 0.032



“NO ROUTE” events

- Less missing routes for partitioned nets



Conclusions

- **Size** increase caused lower packet delivery (more links, more failures)
- BA model **type** appears to be the most resilient (high number of edges, low diameter)
- Topology **partitioning** increased data delivery for “noisy” networks ($p>0.075$)