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# ***Analysis of link failures in an IP backbone network***

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# Motivation

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- Today's Service Level Agreements:
  - Performance in terms of delay and packet loss
  - Availability in terms of “port availability”
- Need to introduce a “service availability” metric:
  - Would permit to compare VoIP/VPN services to standard telephone networks

Question:

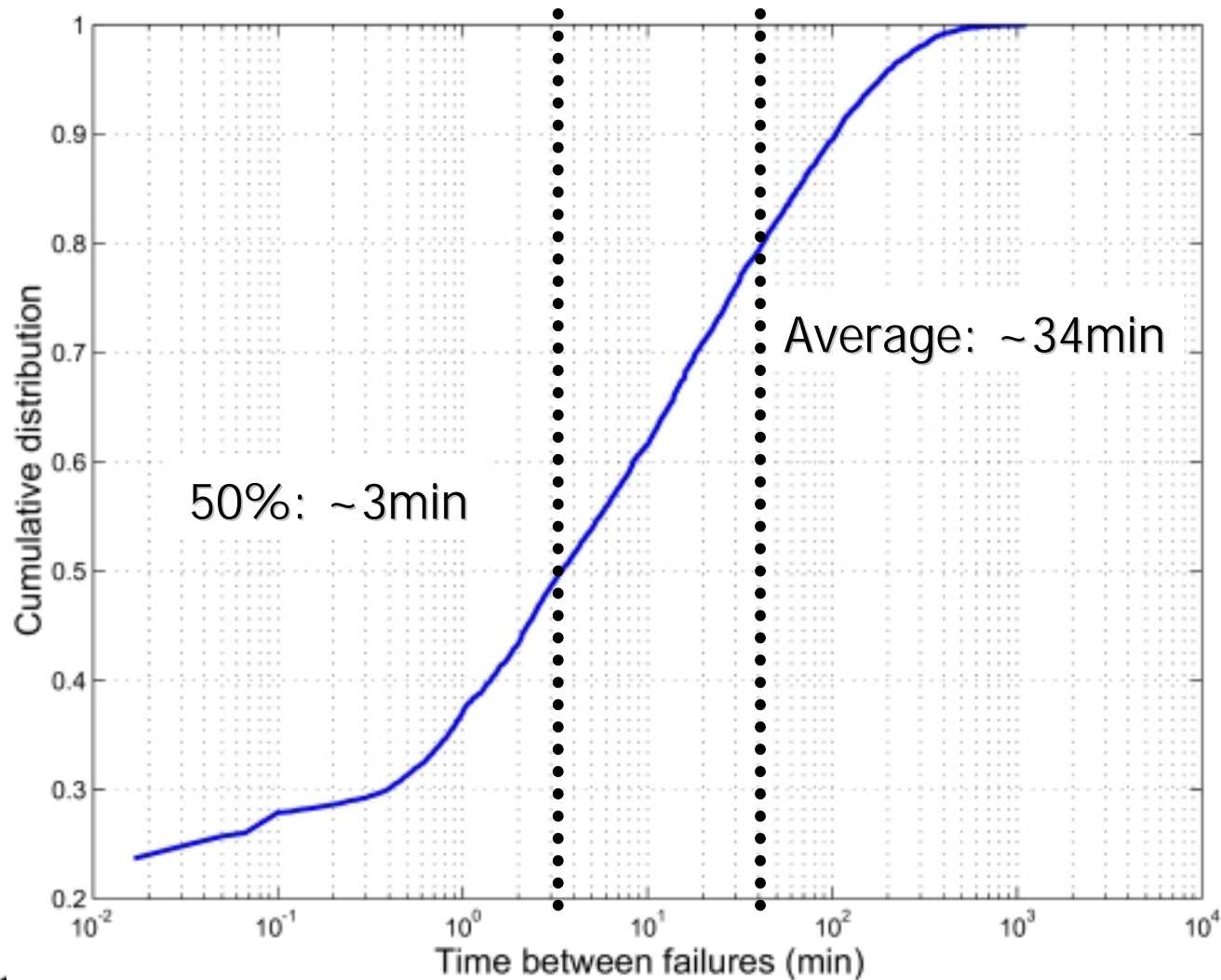
“How often does a router have no forwarding information for any given destination prefix?”

# Methodology

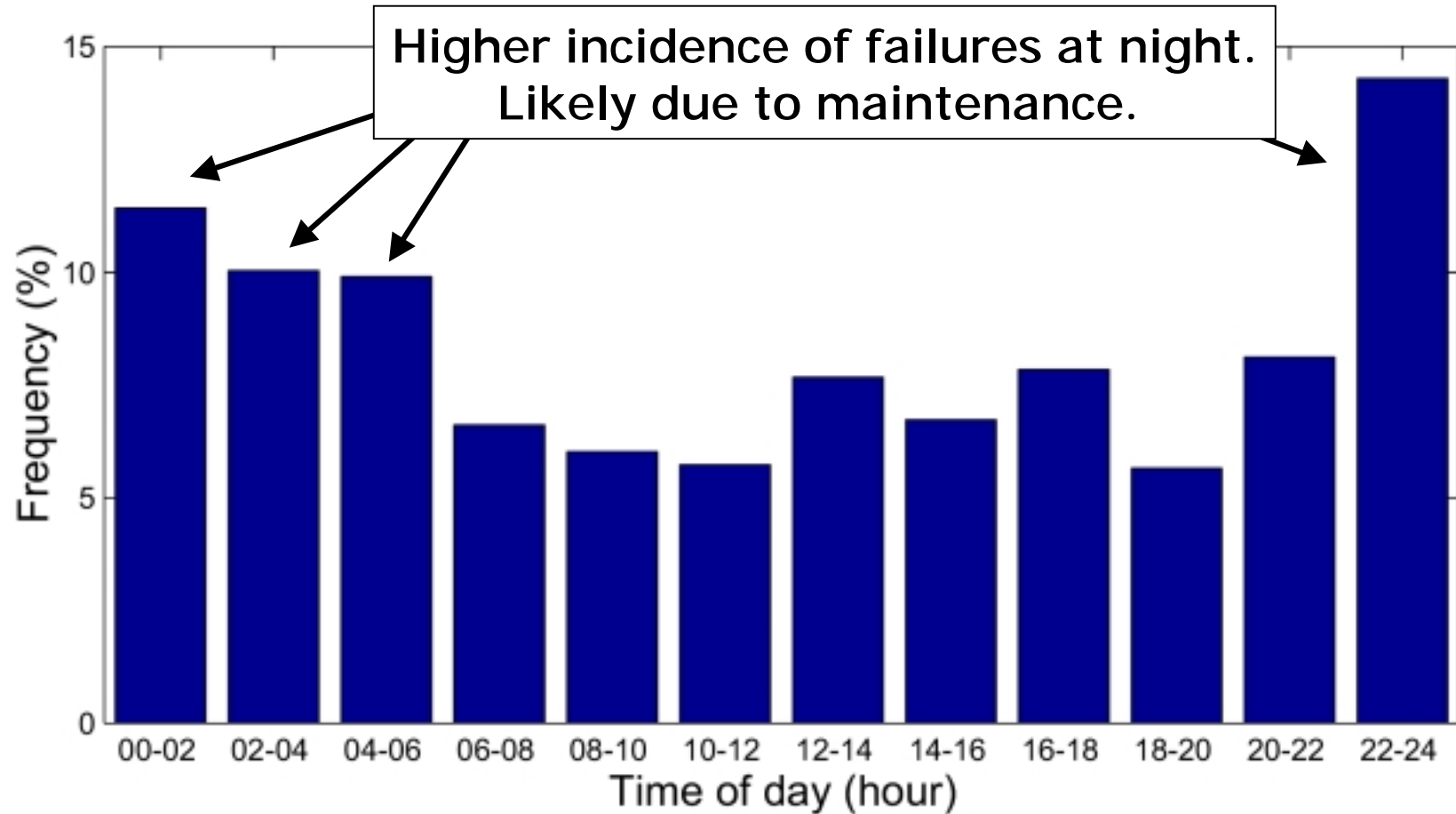
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- Frequency and duration of link failures
  - Recorded IS-IS routing updates
  - Python Rout(e)ing Toolkit to listen to failures
  - 4 months of data (Dec 2001 – Mar 2002)
  - U.S. inter-PoP links
  - Failures less than 24hrs long

# Network-wide Time Between Failures



# Breakdown by time of the day (EDT)

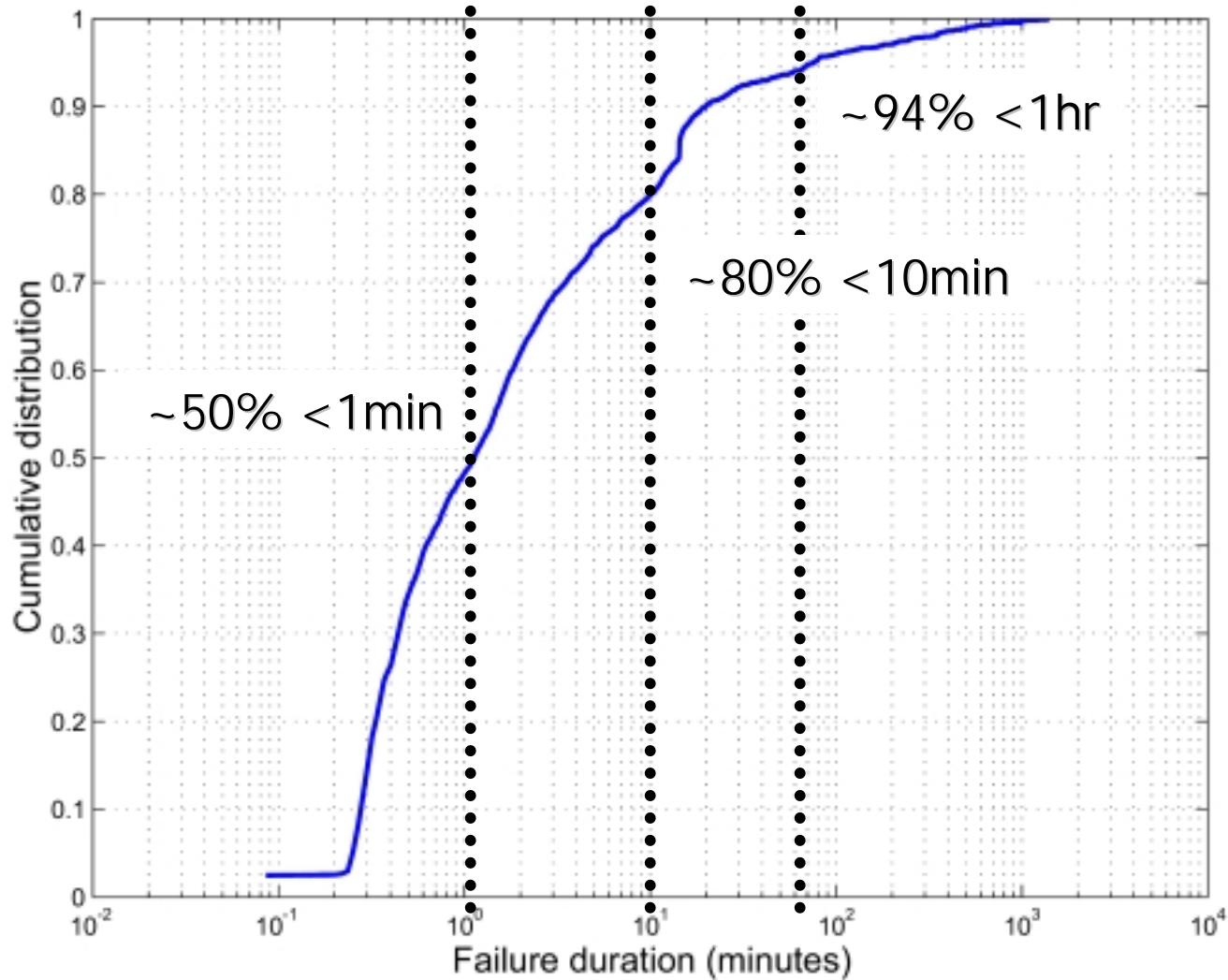


# *Causes of failures*

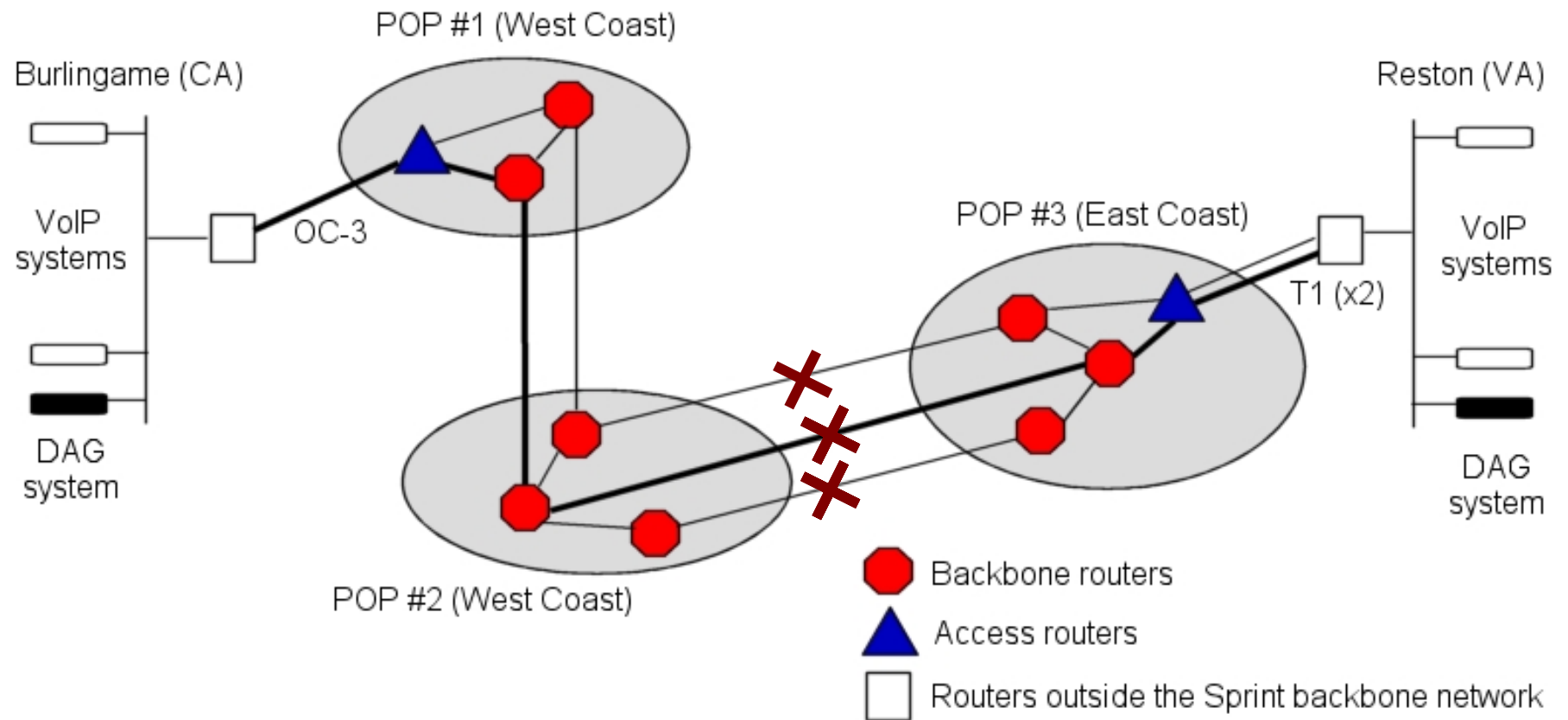
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- Duration may give a hint
- Some speculations:
  - Long (>1hour): fiber cuts, severe failures
  - Medium (>10min): router/line card failures
  - Short (>1min): line card resets
  - Very Short (<1min): optical equipment

# Does the duration give any hint?



# Controlled failure experiment





## *Impact of a failure: 7 steps to re-route traffic*

1. Detect link down <100ms
2. Wait to filter out transient flaps 2s
3. Wait before sending update out 50ms
4. Processing & flooding the update ~10ms/hop
5. Wait before computing SPF 5.5s
6. Compute shortest paths 100-400 ms  
→ **exp. protocol convergence: 5.1s / 5.9s**
7. Update the routing tables ~20 pfx/ms  
→ **exp. service convergence: 1.5s / 2.1s**  
→ **exp. total disruption: 6.6s / 8.0s**

# Conclusion

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- Link failures are part of everyday operations
- Majority of failures are short-lived
- Disruption in packet forwarding depends on
  - routing protocol dynamics and implementation
  - router architecture
  - too many timers and interactions among different components
- Need to develop link failure model:
  - define IP service availability
  - need more points (4 months are not enough)