Improving the Reliability of Internet Paths with One-hop Source Routing

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Motivation

- Increasing interest on Internet reliability
  – Way bellow the 99.999% ("five 9s") expected in the public-switched telephone network
- Previous approaches
  – Server replication (through clustering or CDNs) – expensive and commonly limited to high-end web sites
  – Multihoming (multiple ISP links) – only protection against single-link failures
  – Overlay networks – most previous approaches (RON) required non-scalable background monitoring

Key issues explored

- Failure characteristics of Internet paths and implication about effectiveness of overlay routing as a solution
  – Explored through a 7-days, large-scale measurement using PlanetLab as vantage point
- Can this be done in a more scalable manner?
  – One-hop source routing with random selection of intermediary node
- What benefits would end-users see?
  – Build and evaluated a prototype with a simple web-browsing workload

Path failures

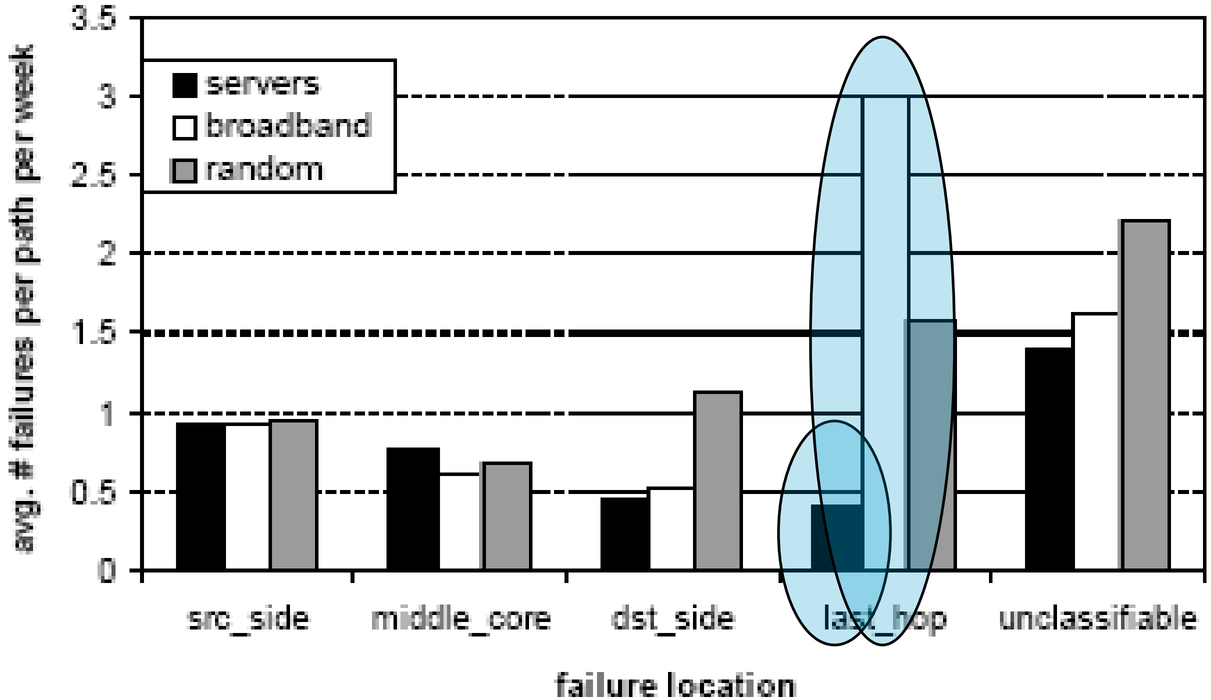
- Week long measurement study
  - Probed 3,153 destinations from 67 Planetlab sites
  - Each destination is probed from exactly one node
- Goal is to answer
  - How often do paths fail? Where do failures occur? How long do failures last?
- Use 3153 destinations:
  - 378 popular web servers
  - 1,139 broadband hosts
  - 1,636 randomly selected IPs
- Probing approach
  - TCP ACKs at different frequencies, customized traceroute
  - Failure: 3 probes lost & failed traceroute

How often do paths fail

- Failures do happen, but not frequently
  - On average each path sees 6 failures/week
  - Server paths see 4 failures/week
  - Broadband paths see 7 failures/week
- Most paths see at least one failure in a week
  - 85% of all paths
  - 78% of server paths
  - 88% of broadband paths

Where do they fail

- For popular servers, few last-hop failures – good for SOSR
- For broadband nodes, last-hop failures dominate



Path downtime and failure duration

- Failure durations are highly skewed
  - Majority of failures are short
  - Median, significantly better than average, failure duration: 1-2 min for all paths
  - Median path availability: 99.9% for all paths
- A significant fraction of paths see long failures
  - Tend to occur on last-hop
  - Mean path availability: 99.6% for servers and 94.4% for broadband
- Failure duration
  - ~11’ on paths to servers
  - 84’ on paths to broadband hosts

Implications about overlay-based fix

- Failures happen often enough that they are worth fixing
- But, they are rare enough that recovery schemes should be inexpensive under normal conditions
- Failures near the end-nodes limit the performance of indirection routing
  - good news: servers see very few failures near end hosts
  - bad news: broadband hosts see many last_hop failures

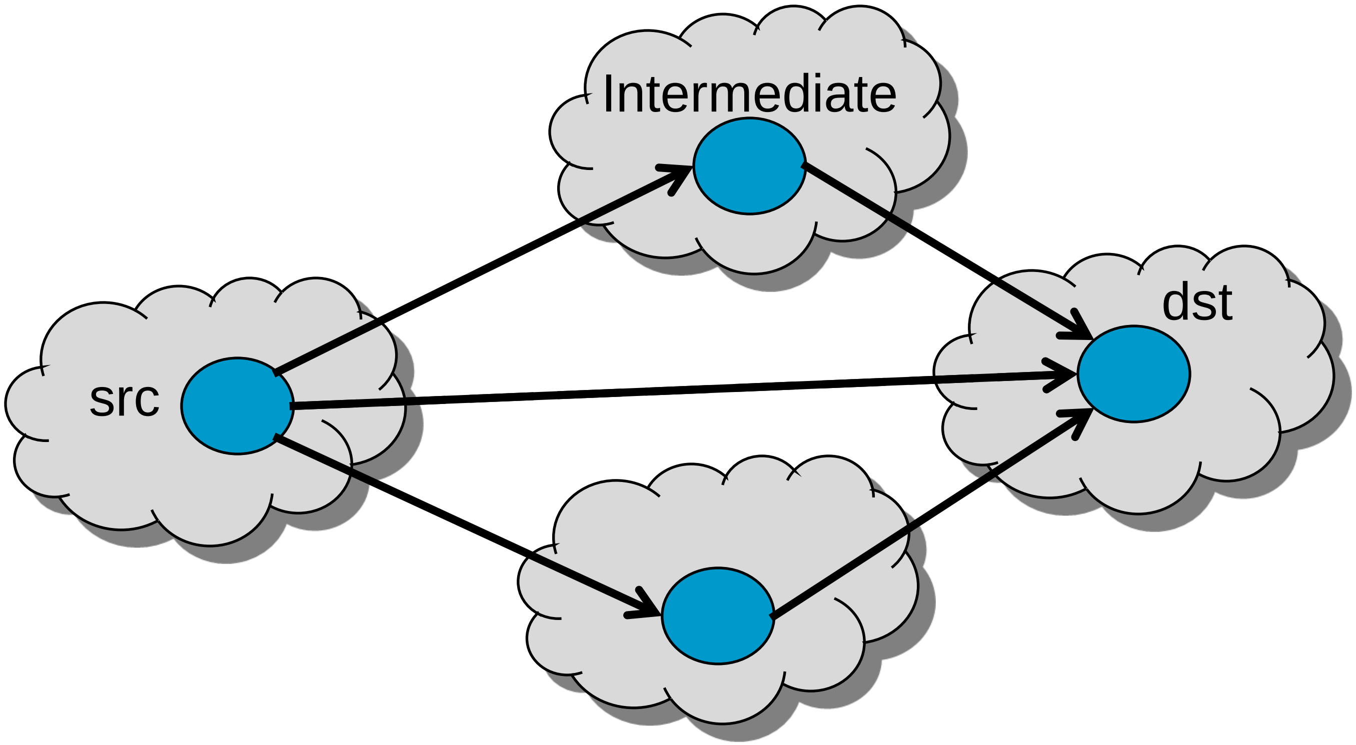
Potential of SOSR

- Source routing can help recover from 66% of all failures on paths to servers
- Problem, again, is last hop
- Highly effective for core failures

percent of failures that are recoverable		
	servers	broadband
src_side	54%	55%
core	92%	90%
dst_side	79%	66%
last_hop	41%	12%
all	66%	39%

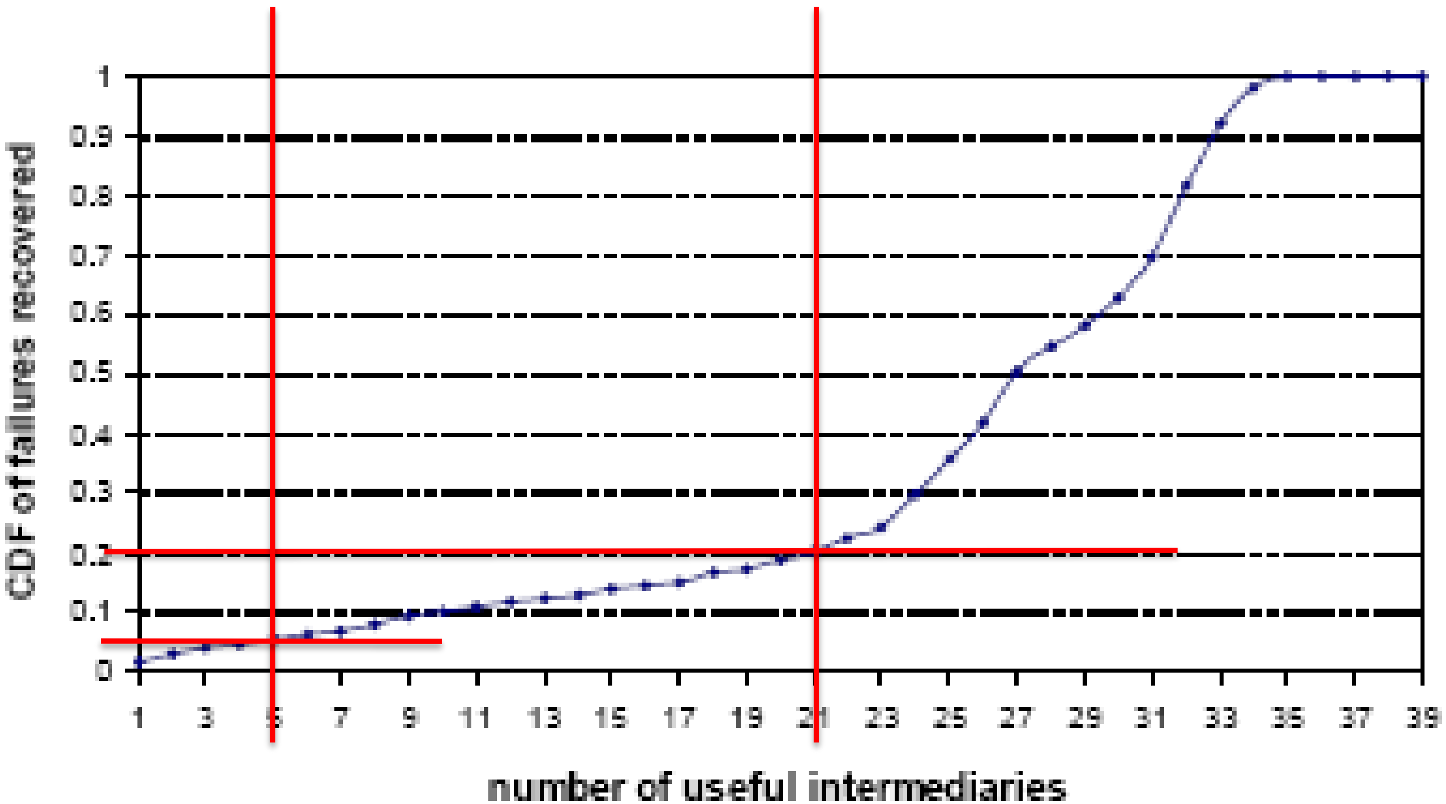
One-hope source routing

- Use default path under normal conditions
- When default path fails, source attempts to recover by routing through an intermediary
- You may need more than one attempt



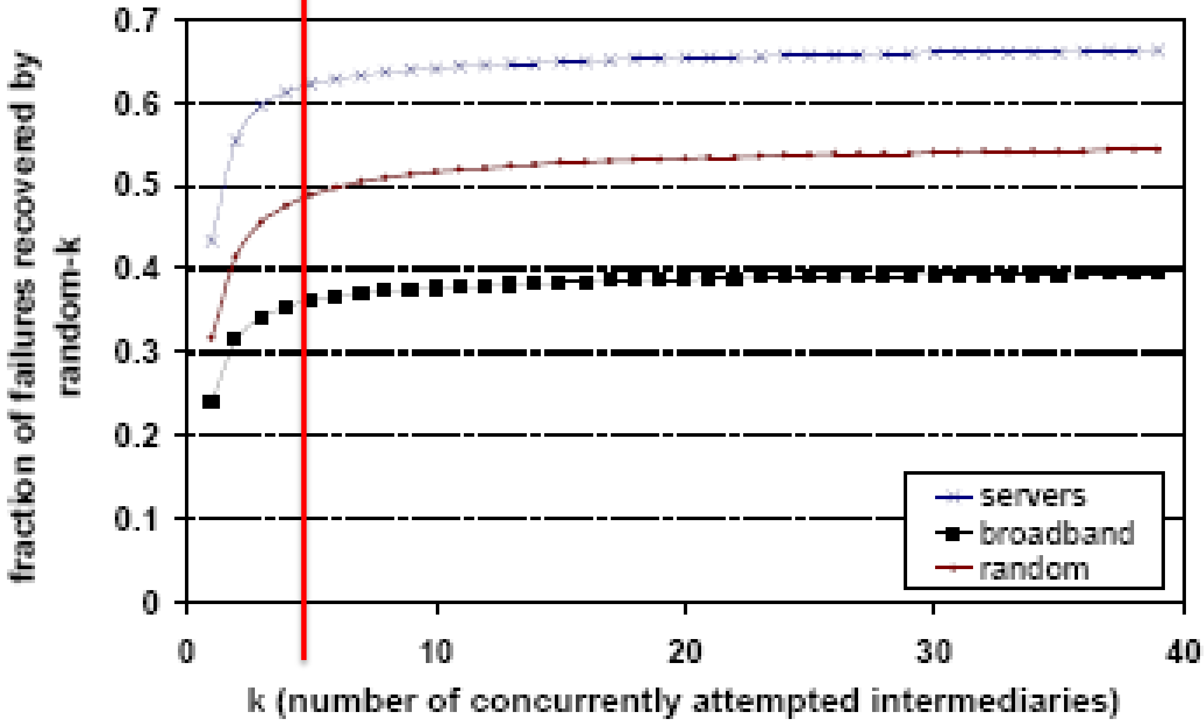
Number of useful intermediaries

- 81% of the recoverable failures could be recovered through at least 21/39 intermediaries
- Still, ~6% could only be recovered through 1-5 nodes



Effectiveness of Random-k

- Random-k: Pick K intermediaries at random, try them all, choose the first one to get through
- Random-4 delivers near-optimal success rate
  - 61% of all failure, 92% of all recoverable failures
  - Requires no a priori probing or state



User perceived benefits

- SOSR recovers from 56% of network failures
- But, can't recover from application failures
- 62% of wget + SOSR failures are application related

	network level failures	application level failures			HTTP error codes
		TCP refused	HTTP refused	HTTP timeout	
wget	328	40	78	35	44
wget SOSR	145	41	101	96	37

Conclusions

- Failures happen, but they are short and infrequent and many occur on last-hop for broadband paths
- Recovery must be cheap in the common case
- A simple schemes can work, Random-4, no probing, realizes the potential of any scheme
- Web users see only 20% fewer failures

Question 3

- *Could SOSR solve performance faults?*