

Talking to Strangers

- routing in the face of
Disorder, Greed and Malice

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The Internet Is Changing

Increasingly, users are owning their own **content, servers, even networks.**

What does this mean to us*, and how can we facilitate this trend?

* Networking Researchers

A world full of strangers

"Many children are taught never to talk to strangers,
an extreme precaution with minimal security benefit."

- *Bruce Schneier*

Open Access Points

Myriad Wireless Devices

Shared Media

Internet ASs

Disaster Help Agencies

Blogs

Peer-to-Peer Networks

Multi-Hop Wireless Community Networks

Coming Up...

New Roles for Today's User

Content Creator Publisher
Network Owner

Our Work

Scalable, Self-Organizing Routing
Enforceable Bandwidth Allocation
Sabotage Resistant Routing

User as Content Creator

Wikipedia Blogs Photo sites IMDB
Personal web sites Webcams Skype

Increasingly bi-directional flow of information

Large amounts of user generated data -
relevant to almost nobody

The end of asynchrony?

User as Publisher

Gnutella eDonkey Kazaa Bittorrent
Home Servers Skype Webcams

Large increases in upstream bandwidth usage

Caching and Akamai-style predistribution useless

The end of the uncongested core?

User as Network Owner

**Open Access Points Connection Sharing
Community Mesh Networks**

Multi-homing, peering and
failover between users - no admins

Networks highly susceptible to sabotage

Edge links same capacity as core links

The end of BGP? ;-)

Coming Up...

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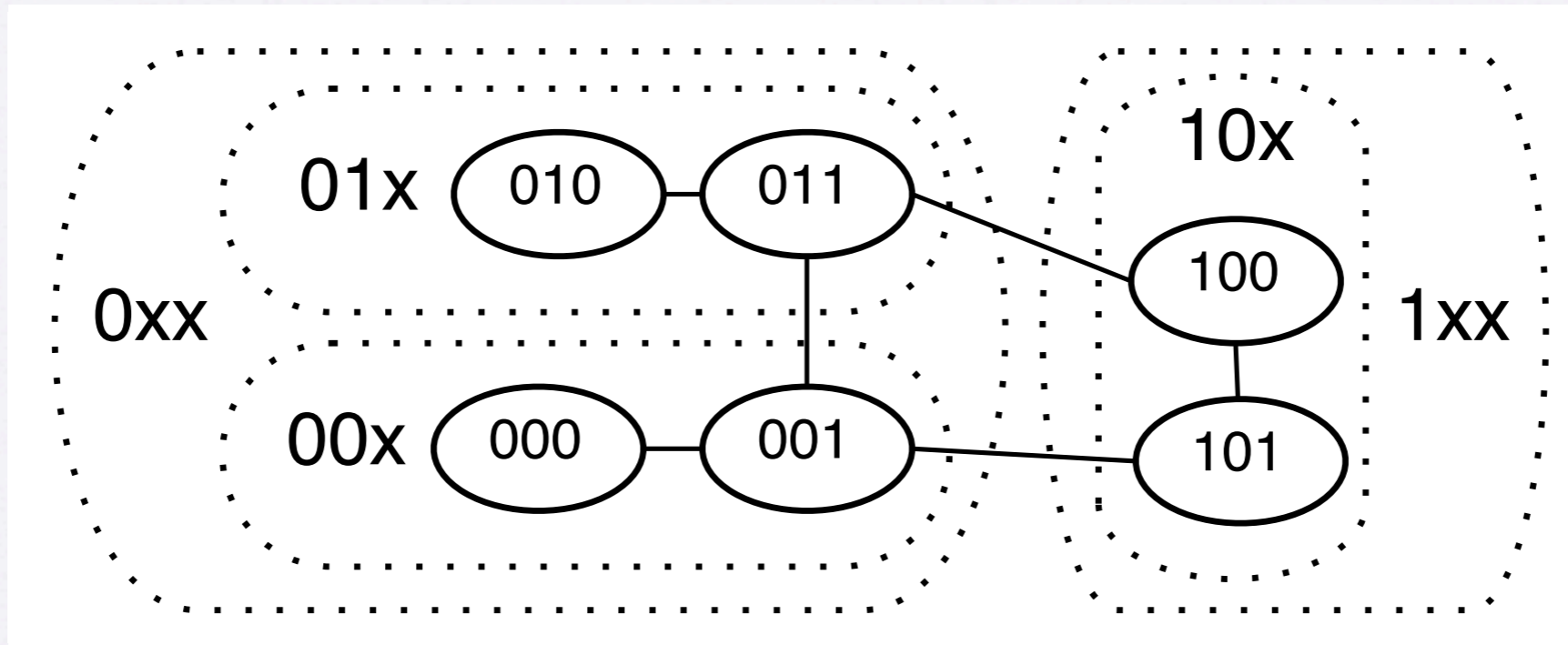
Our Work

Scalable, Self-Organizing Routing
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Challenge: Scalable, Self-Organizing Routing

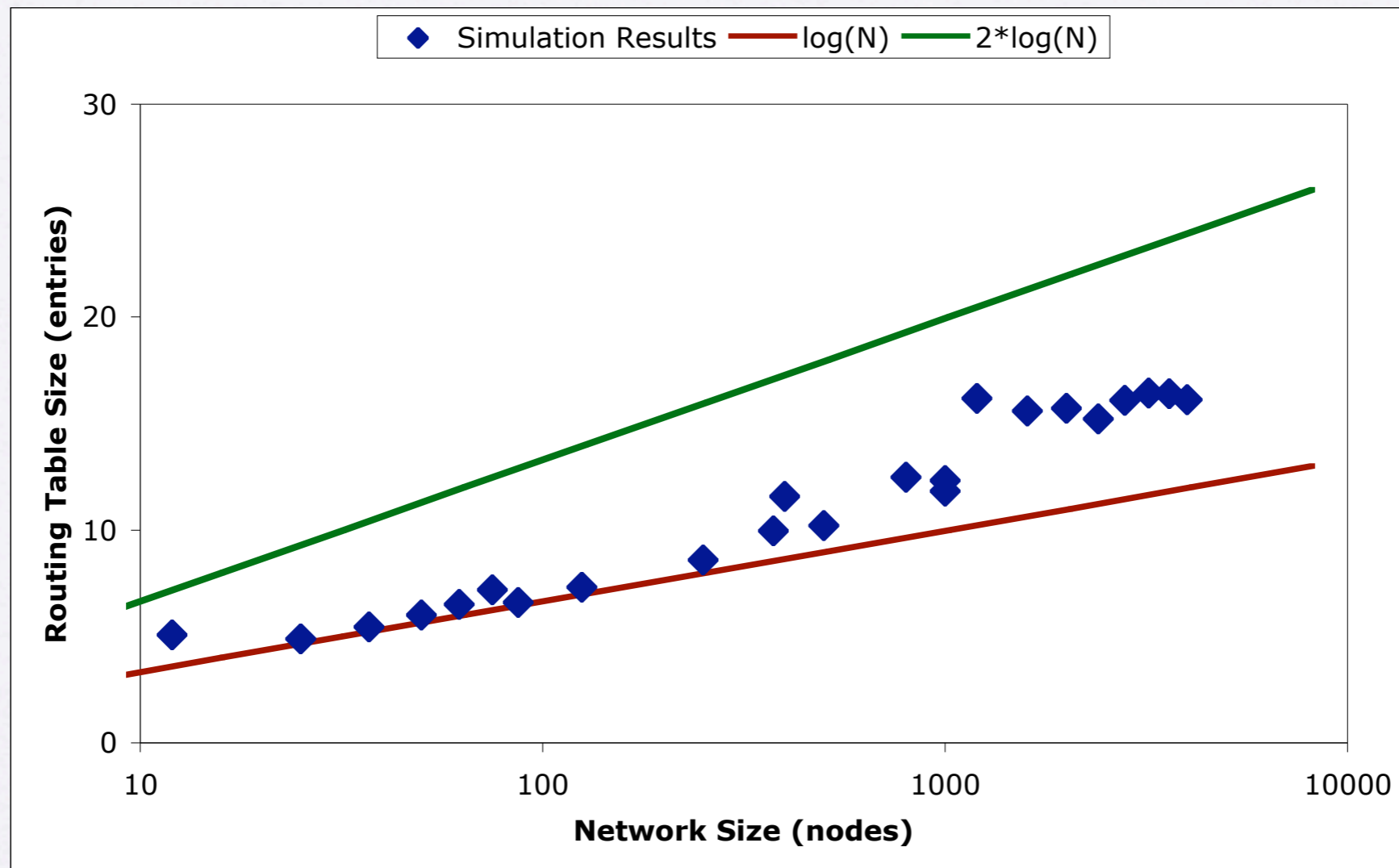
- Network of any size
- With wired, wireless, directional or omni connectivity
- With mobility or without
- No central ownership / administration

Idea: Dynamic Address Allocation



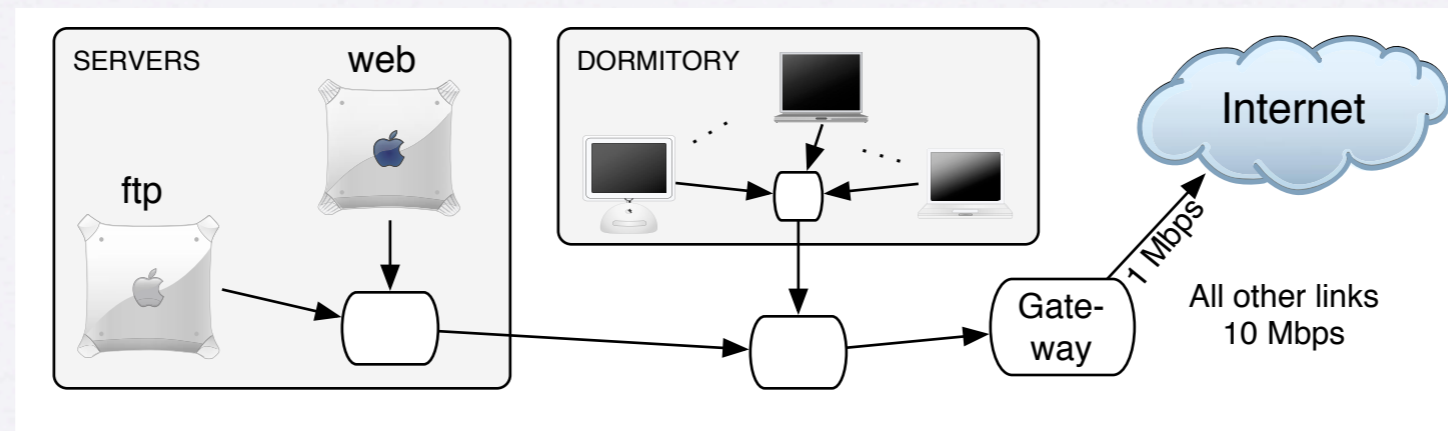
- Address describes location in topology
- Routing becomes easy and scalable

Routing Table Size



- Average routing table size $< 2 \cdot \log N$
- About 15 entries for 4000 nodes

Challenge: Enforceable Bandwidth Allocation

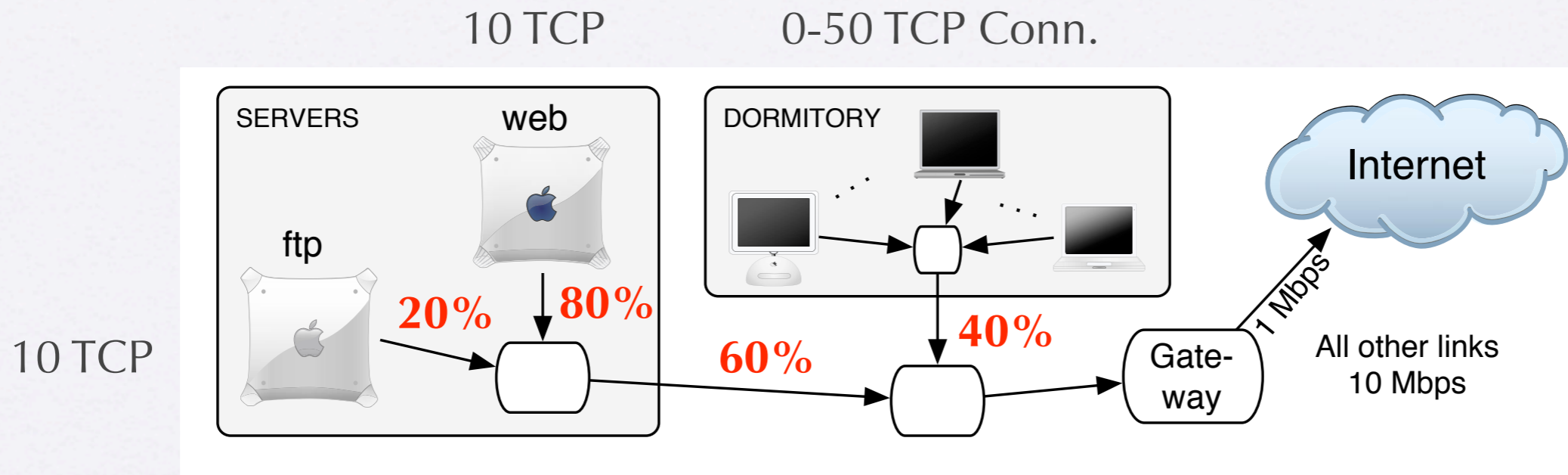


- CAMPUS ADMIN: “Servers should get 60% of the bottleneck link”
- SERVER ADMIN: “Web should get 80% of the capacity allocated to servers”
- DORM ADMIN: “All students should share equally, regardless of application, protocol, or hacks!”

Idea: Weighted, Per-Source Allocation

- **Enforceable:** Protect well-behaved users against greedy or malicious peers
- **Flexible:** Give administrators more control over bandwidth allocation
- **Robust:** Not rely on end-points for network stability
- **Distributed:** No centralized control of weights

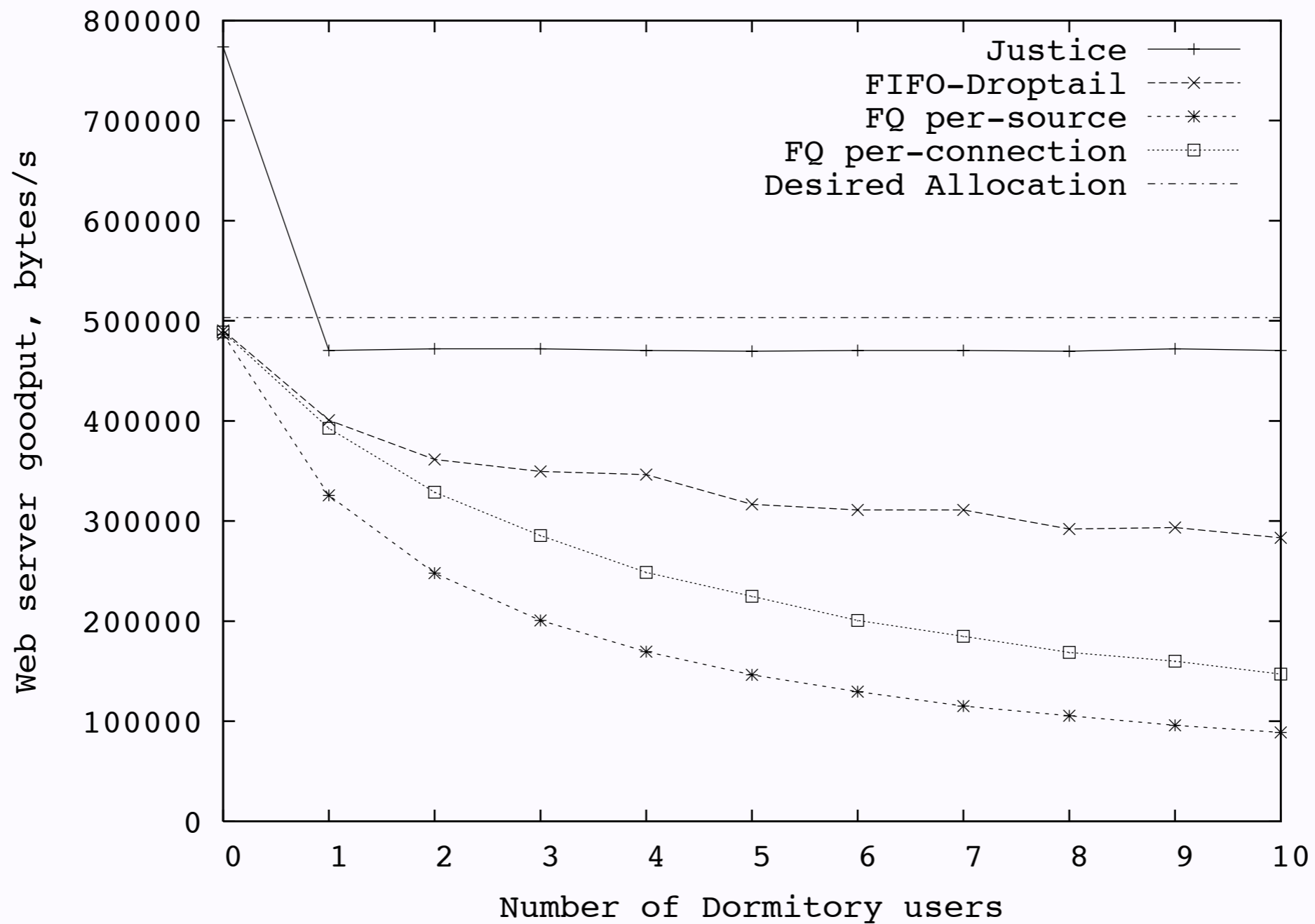
Example Scenario



- Bandwidth allocation per source
- Source weight carried in packet, updated along way
- Weighted per-source fair queuing on bottleneck links
- **Minimum** web-server share to Internet: **0.48 Mbps**

Justice is Enforcable

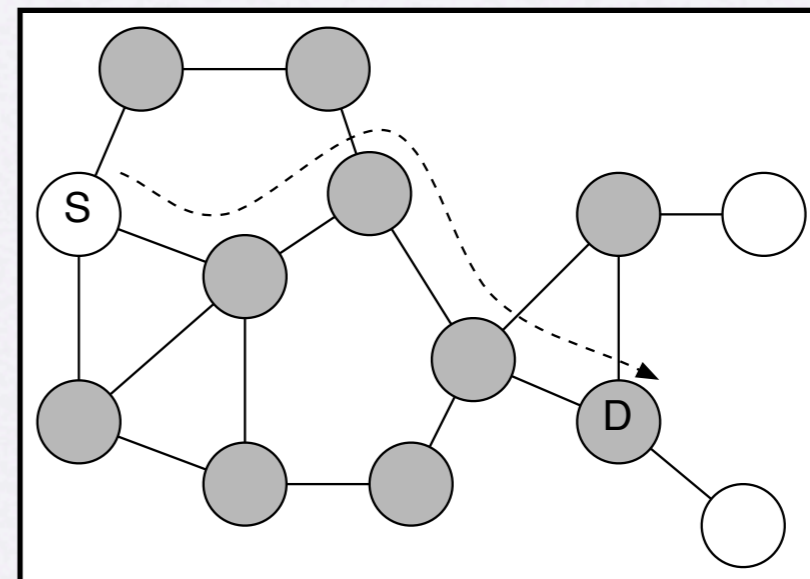
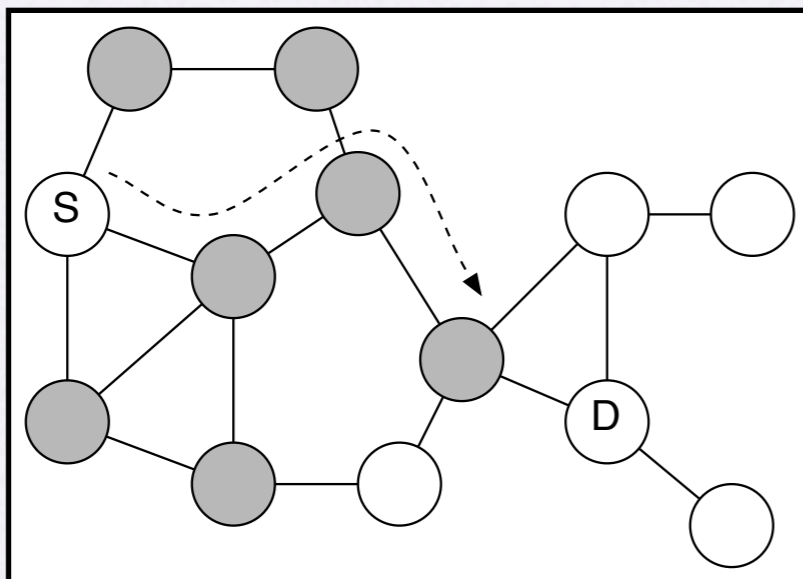
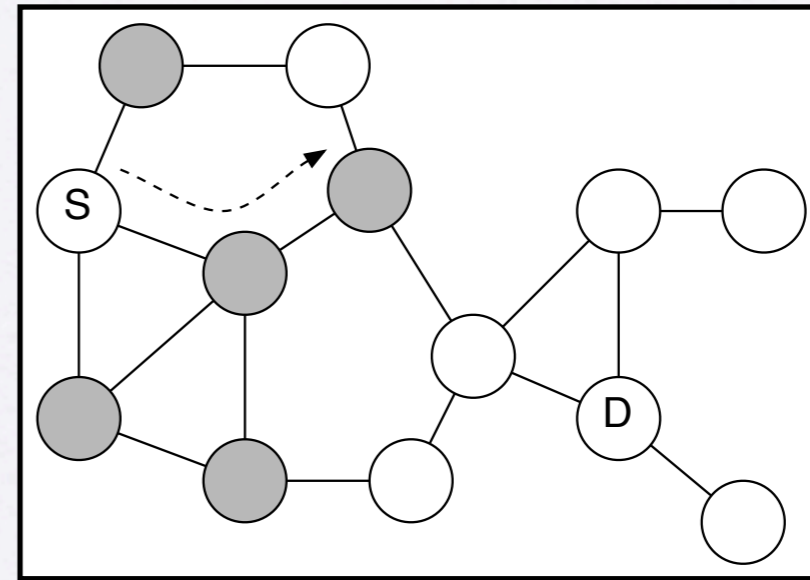
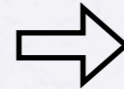
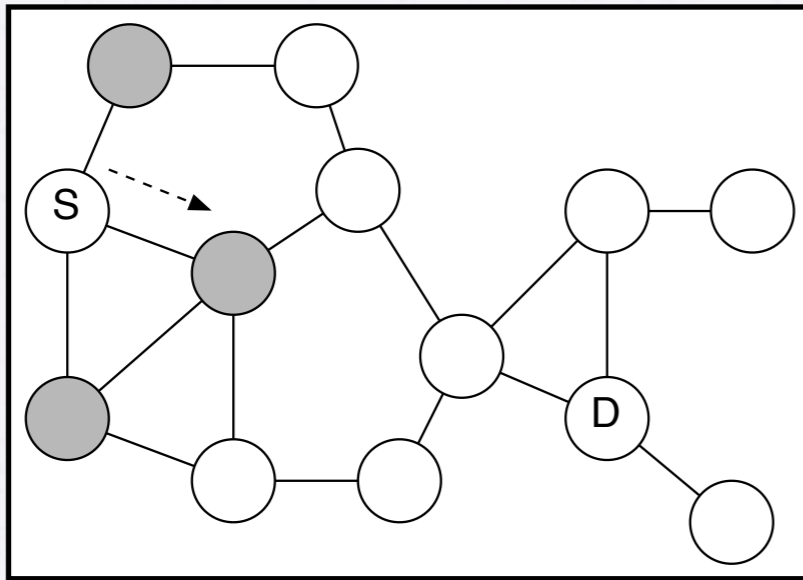
Web Server Goodput



Challenge: Sabotage Resistant Routing

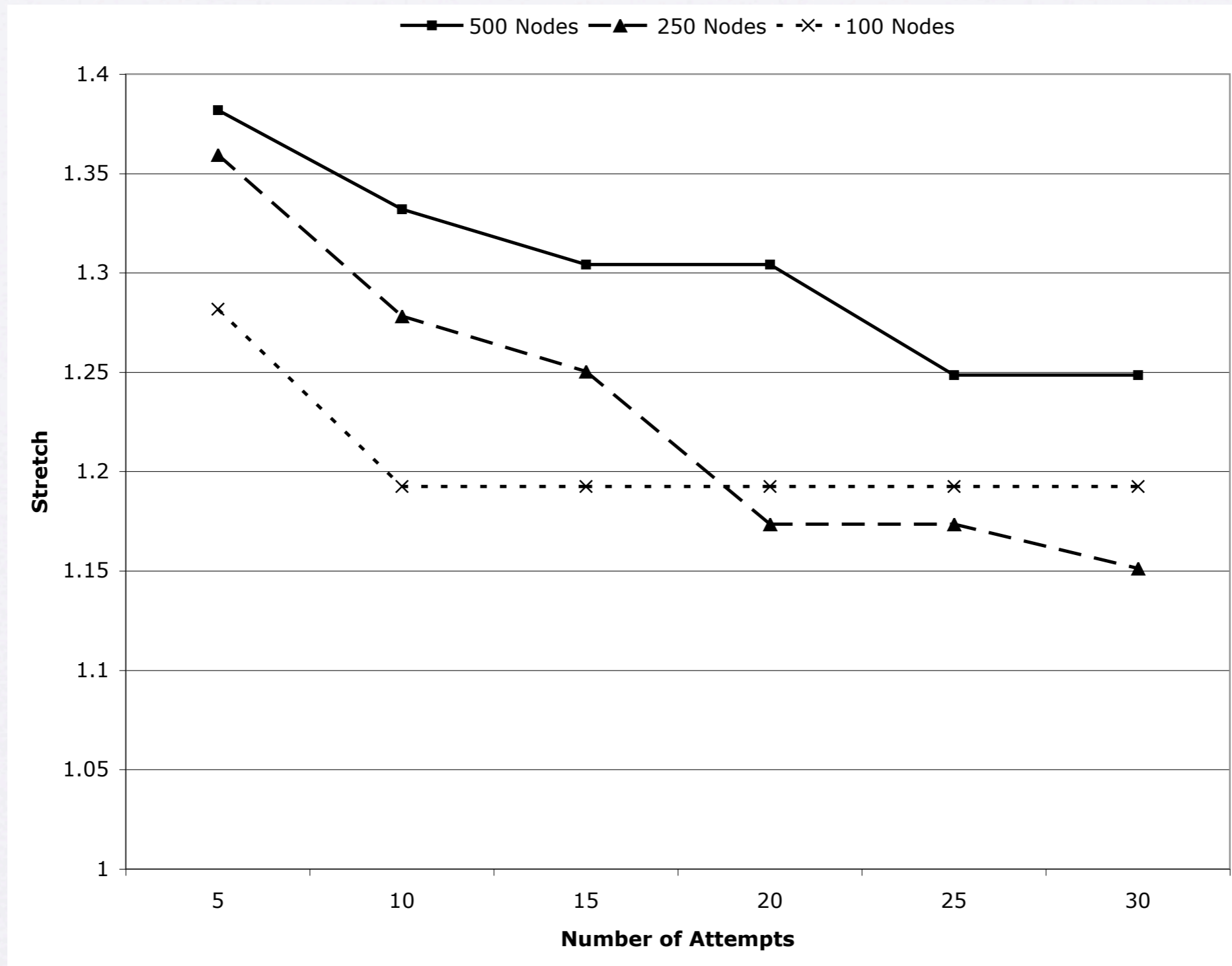
- Open networks are extremely susceptible to routing sabotage
- Most secure routing work not applicable to open networks
- Extreme scenario: many colluding attackers, with out-of-band connectivity

Idea: Random Path Generation

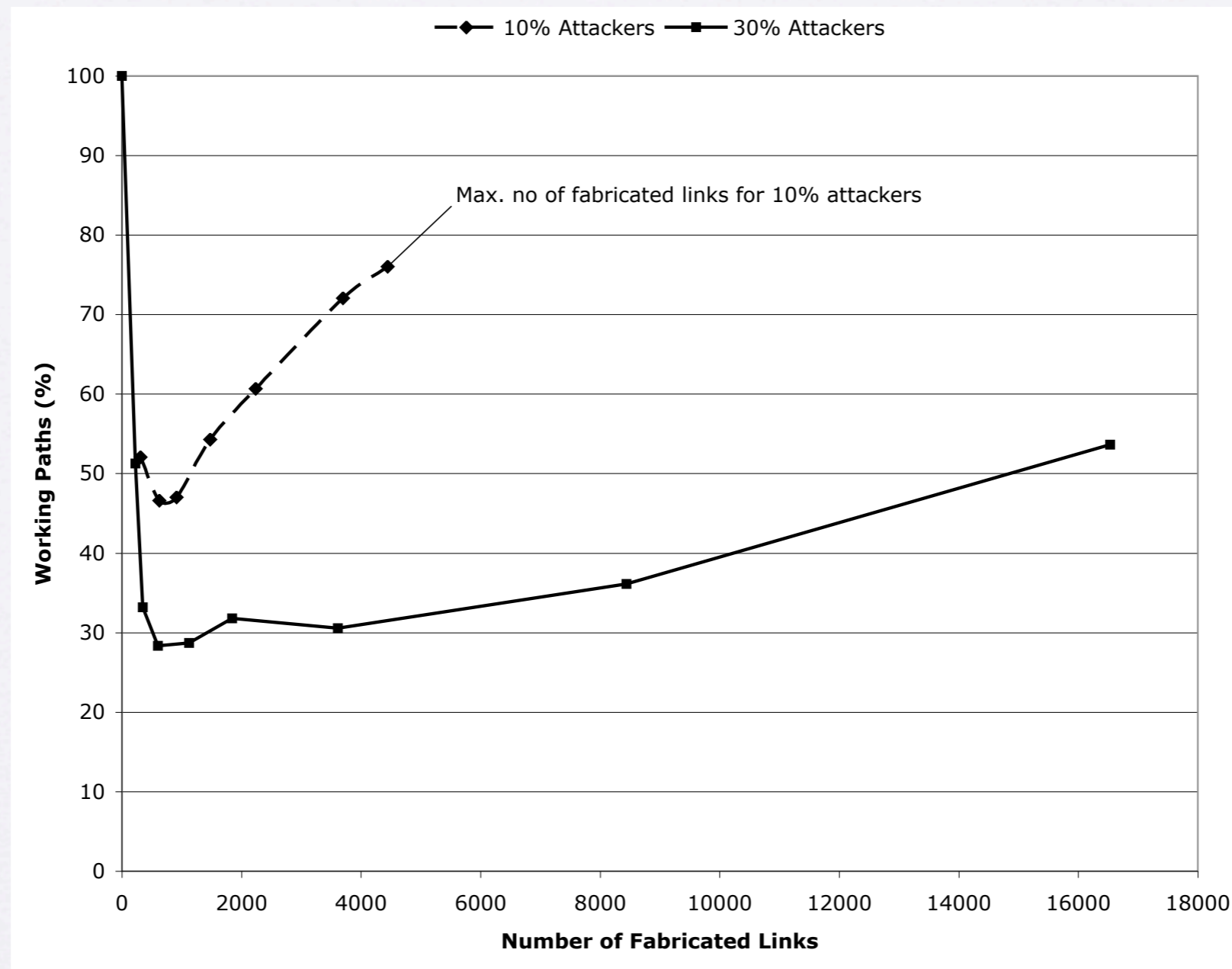


[under submission]

Path Stretch - No Attackers



Finding paths in polluted graphs



200 nodes - 10% and 30% attackers

Conclusion

- The Internet is Changing - new challenges and opportunities lay ahead
- Distributed ownership of: content, servers, and networks
- Close look at fundamentals necessary