A Sybil-proof DHT using a social network

Socialnets workshop

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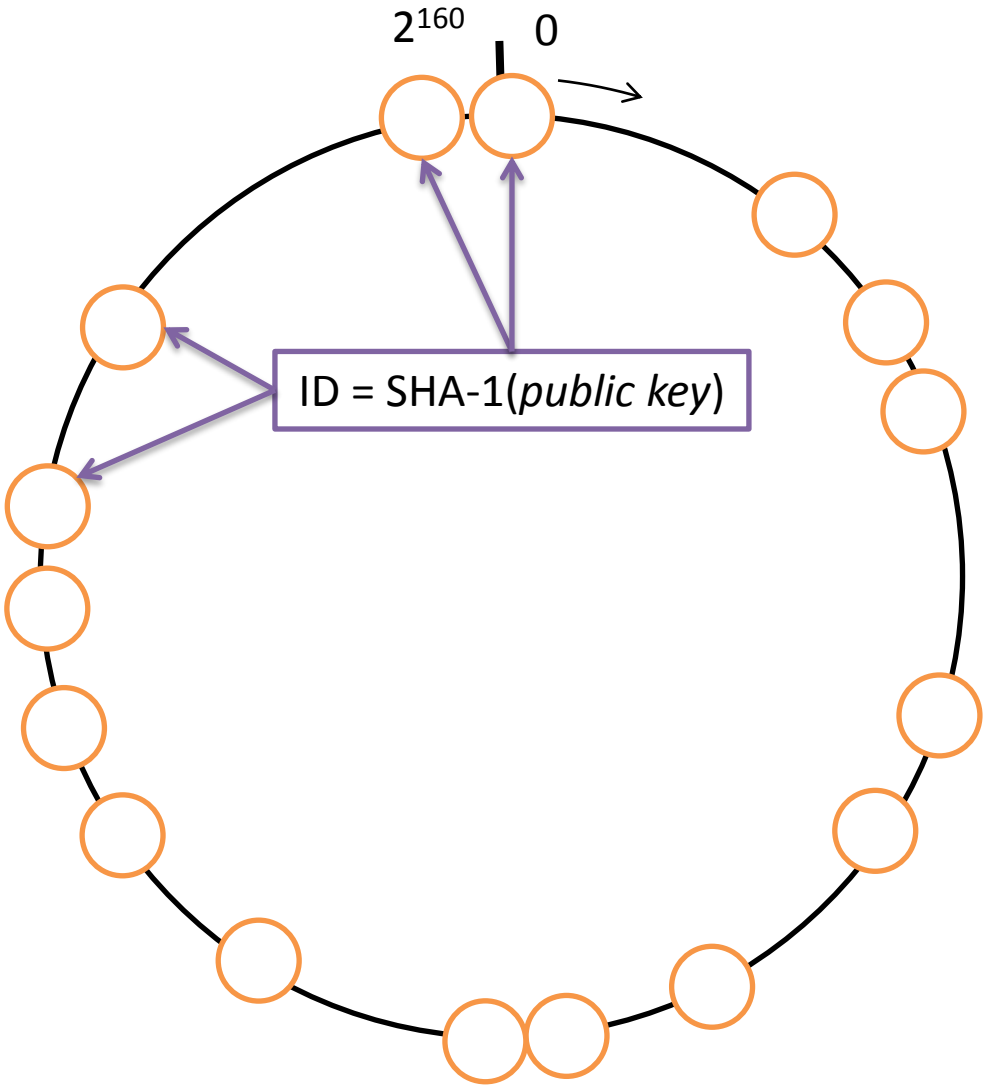
Overview

- Distributed Hash Tables
- The Sybil attack
- Model (network, adversary)
- Tool: random sampling from a social network
- Sybil-proof DHT protocols

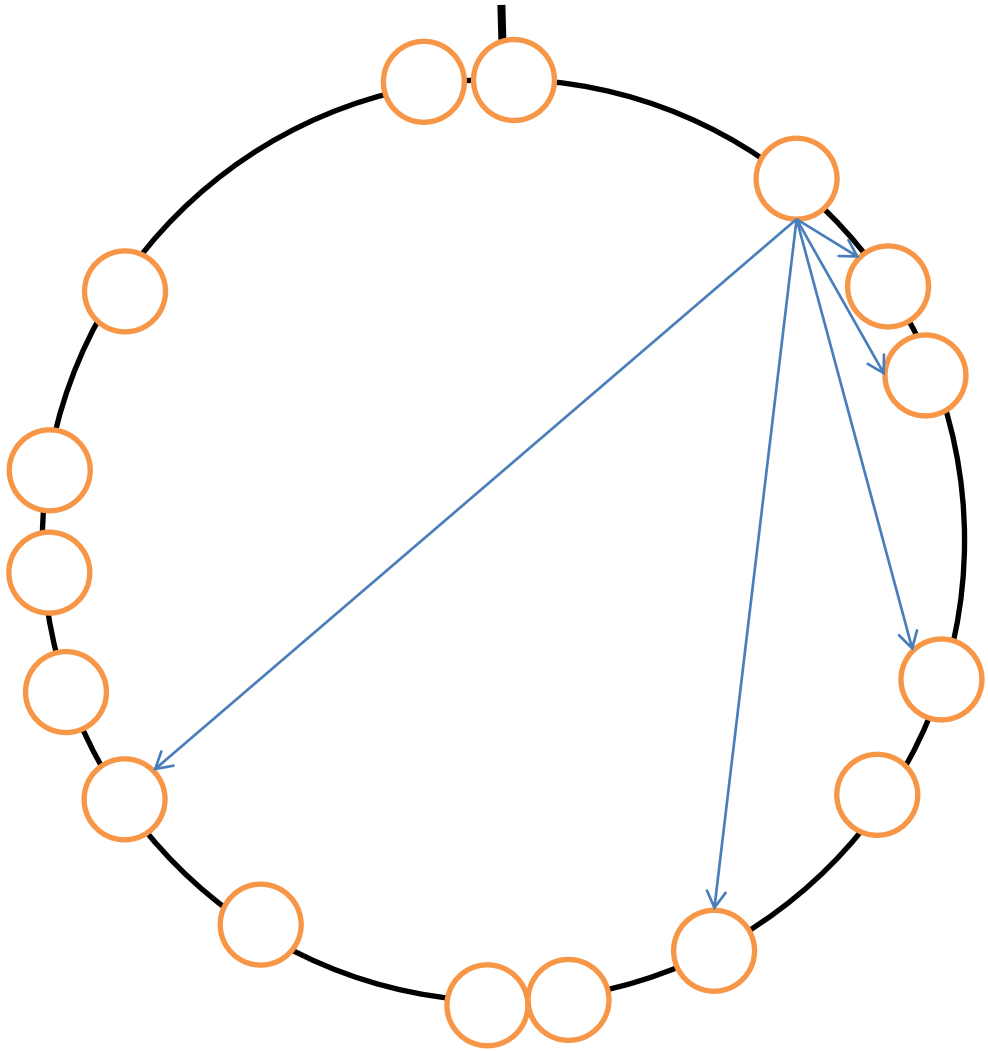
DHT routing in three slides

- Structured DHT: a layer in many P2P systems
- Used by requesting node to find another node by ID
  - IDs typically hash of public key: *self-certifying*
  - DHT maps ID to IP address



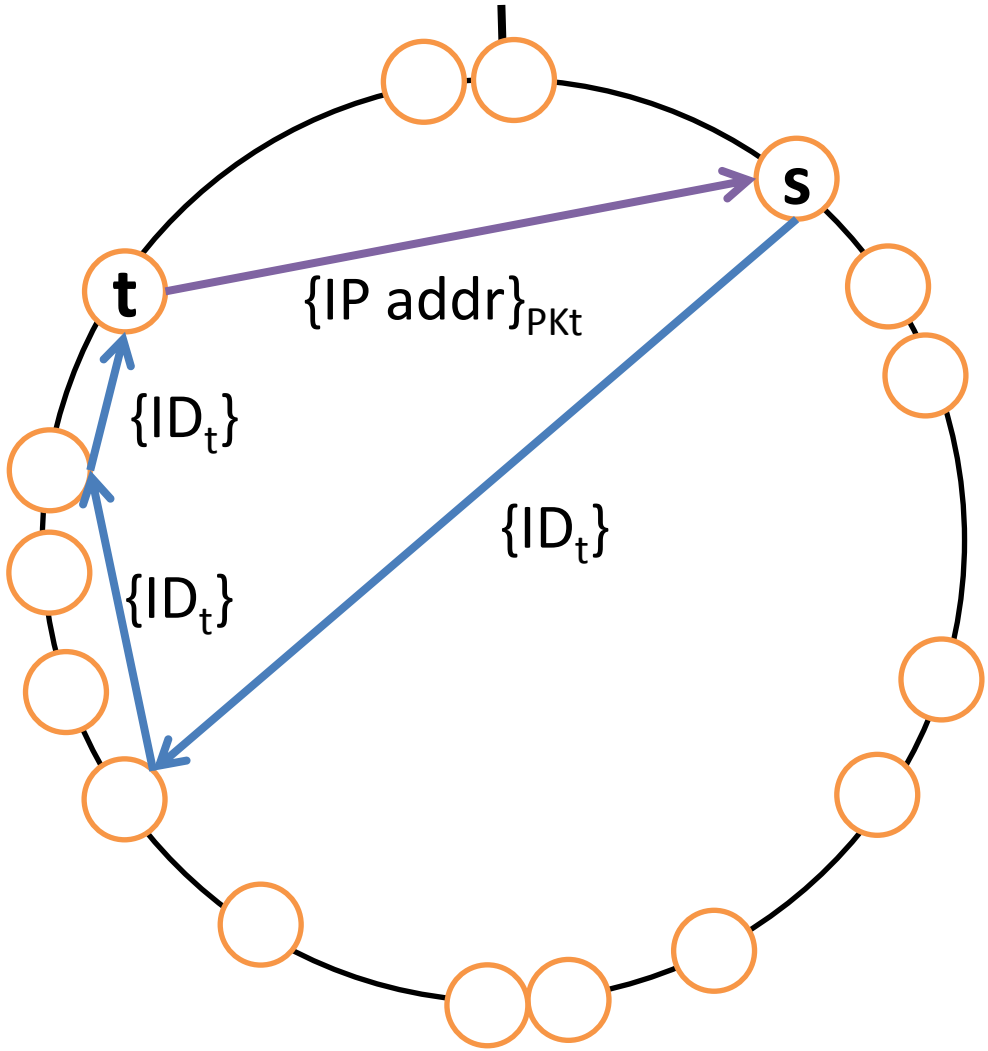
DHT routing in three slides

- Sub-linear table size
  - Nodes need not keep track of all other nodes
  - Reduces bandwidth usage
  - Enables scaling



DHT routing in three slides

- Routing via intermediate hops
- Result is authenticated
- Trade off table size versus routing hops



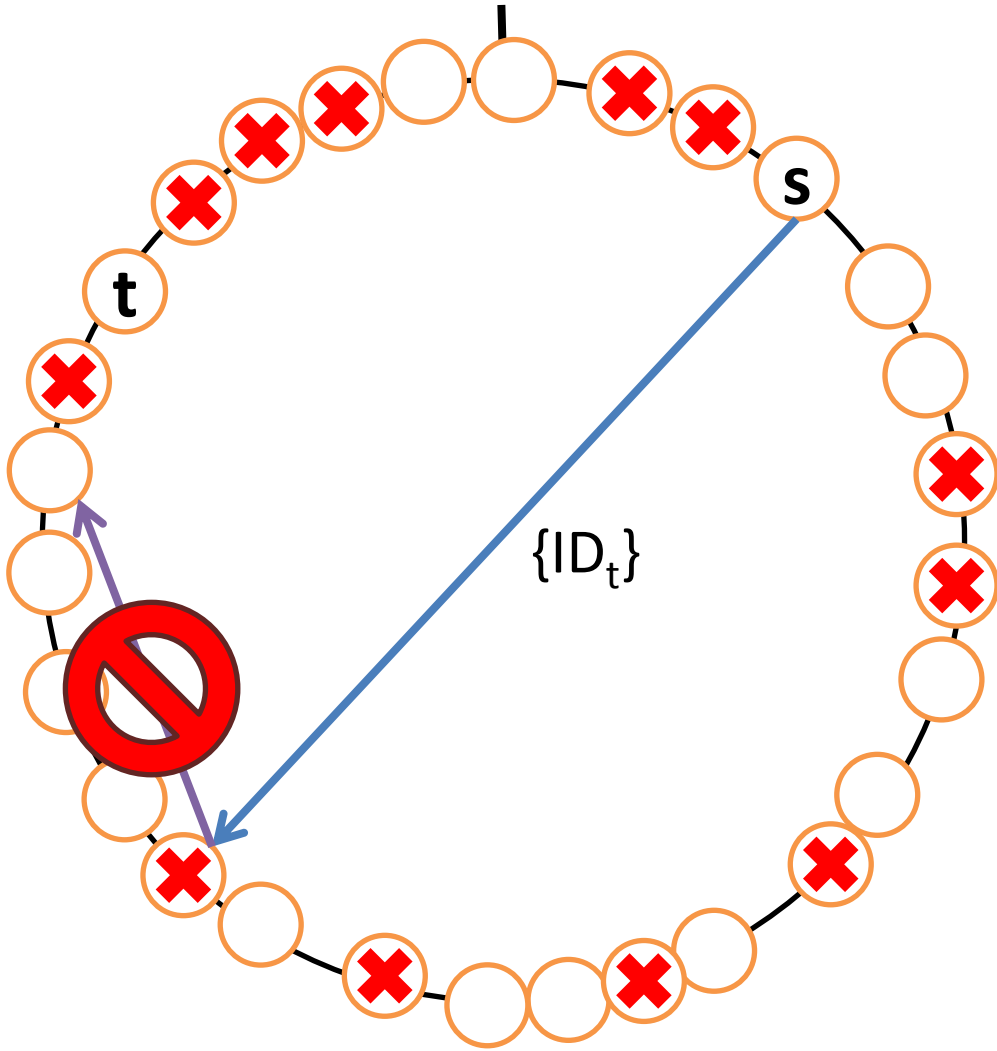
The Sybil Attack

"One can have, some claim, as many electronic personas as one has time and energy to create."

Judith S. Donath

DHTs are subject to the Sybil attack

- Attacker creates many pseudonyms
- Disrupts routing or stabilization
- Douceur, 2002: "without a logically centralized authority, Sybil attacks are always possible"

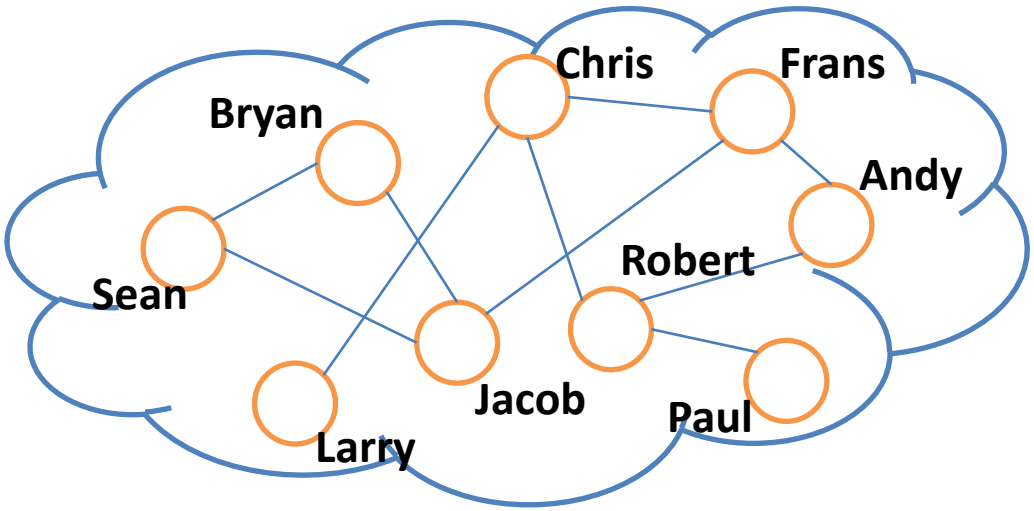


Methods to limit the Sybil attack

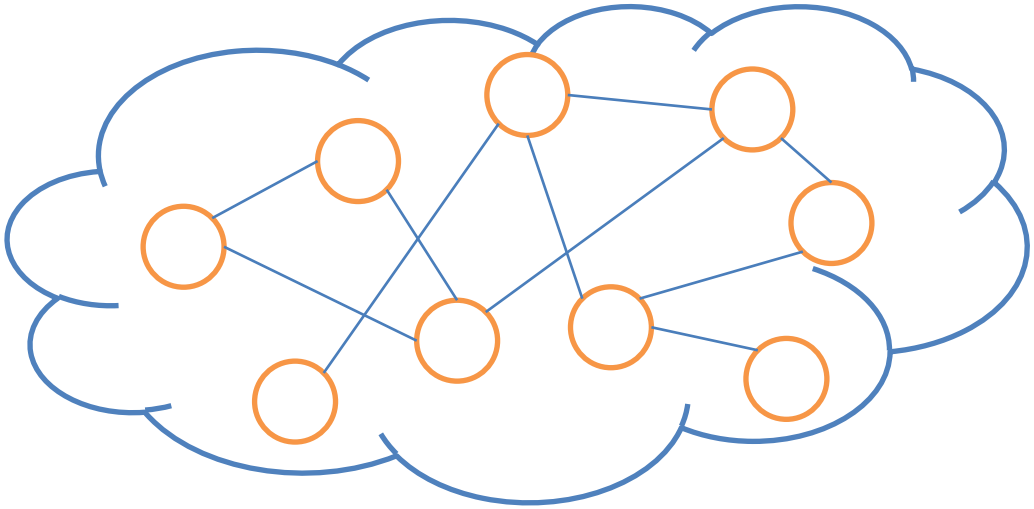
- Limit IDs per IP address
- Central CA issues IDs
  - Strong PKI
  - CAPTCHA
  - Cryptographic puzzles
- All methods have drawbacks
  - cost, compatibility, barriers to entry
- Adversary may have more resources

Social network can help

- Nodes have social links to other nodes
  - social links established outside of the DHT
  - provides additional information usable by DHT

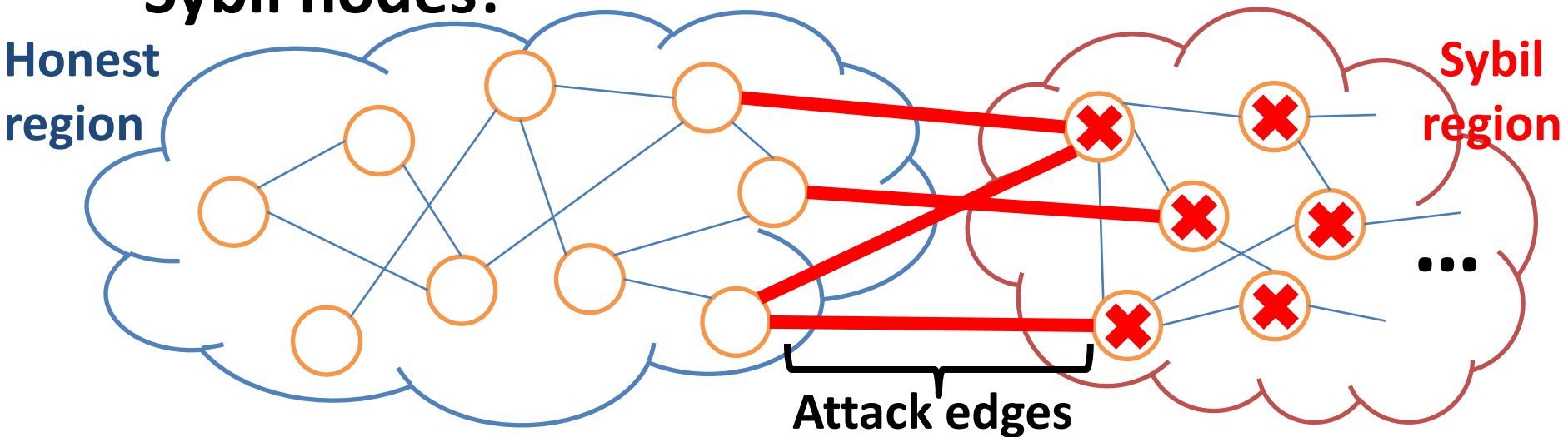


Social network model



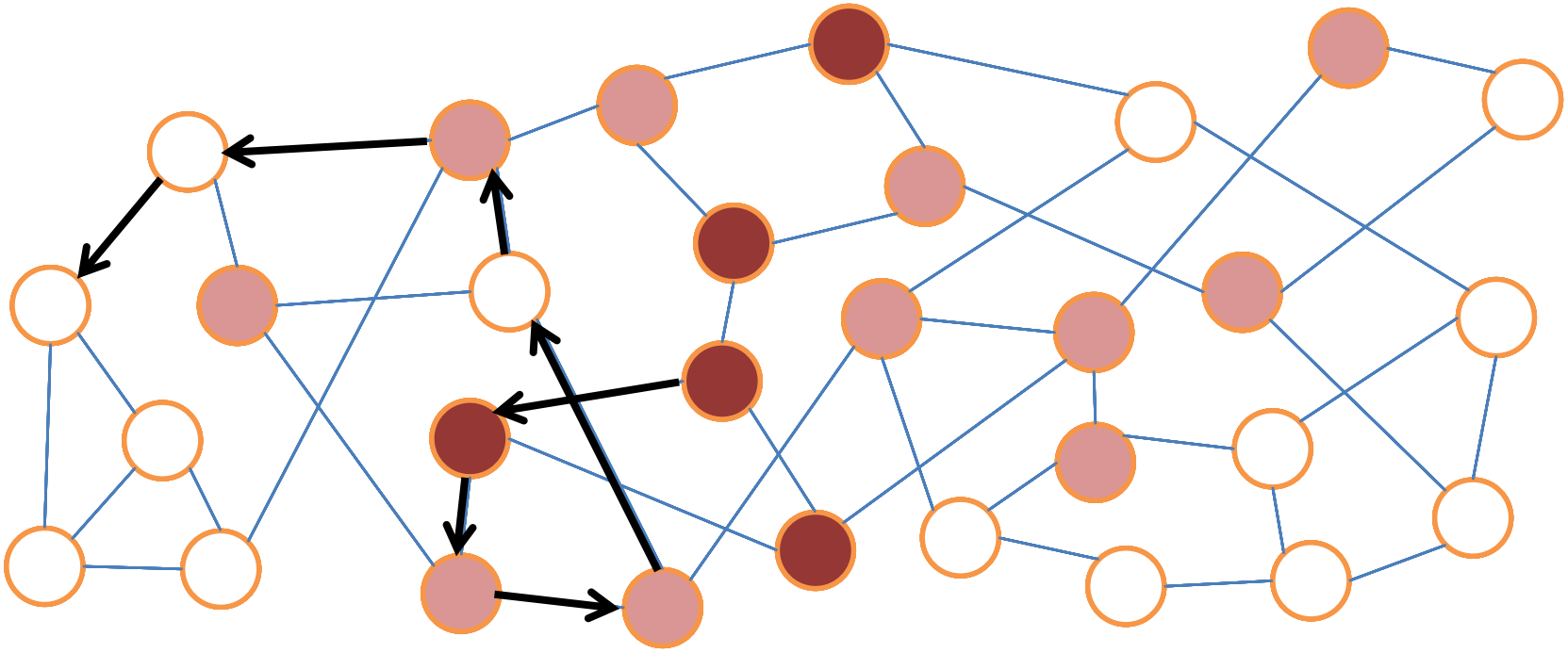
Social network model

- n = number of **honest nodes**
  - *for this talk only,* all nodes have ~same degree
- *g* = number of **attack edges**
  - *g* = o(n/log n) tolerable by protocol
- **Correctness is independent of number of Sybil nodes!**



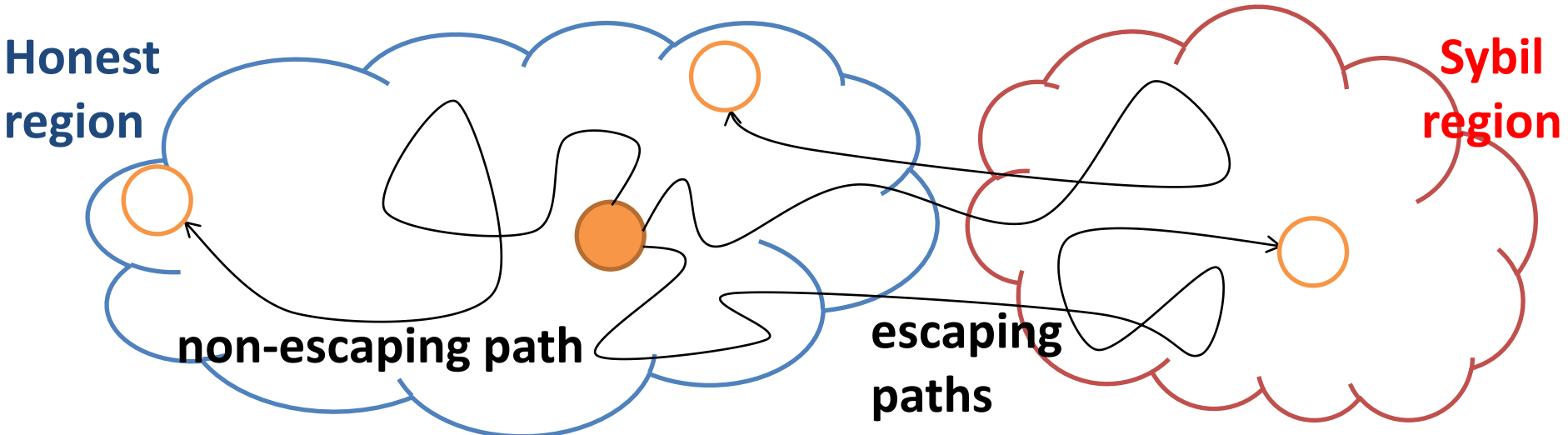
Mixing time

- Random walk: choose each hop randomly
- Mixing time: #hops until uniform probability
- **Fast mixing** network: mixing time = O(log n)



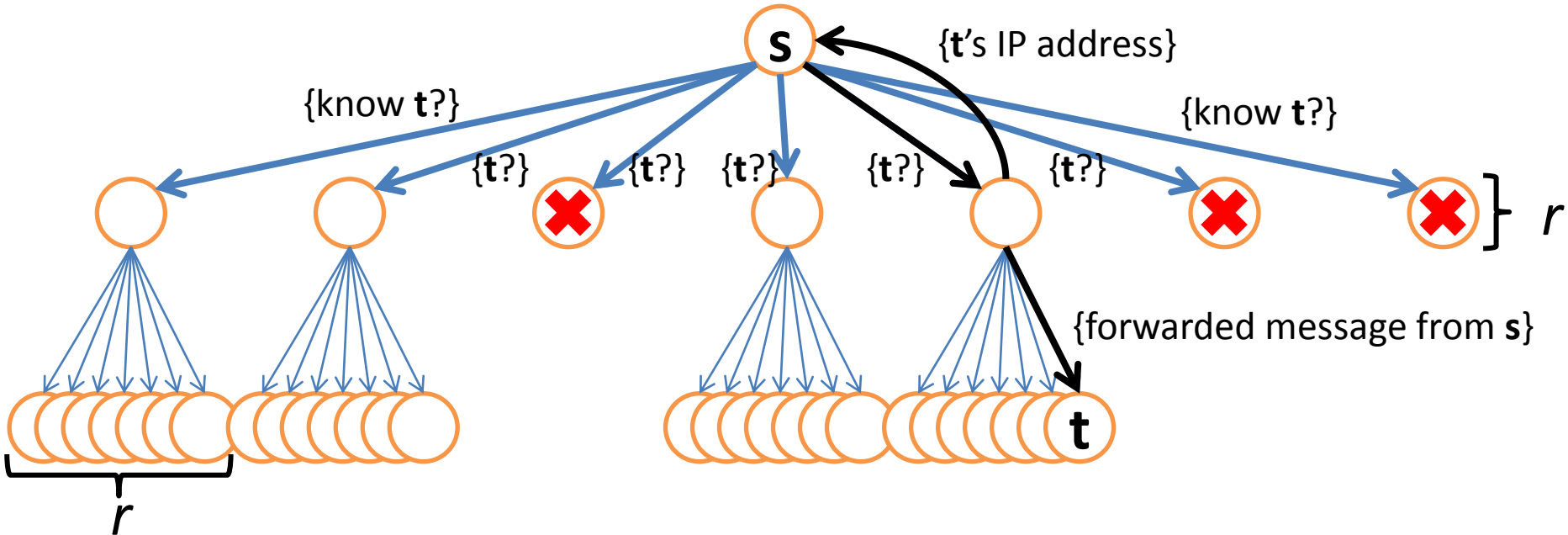
Sampling by random walks

- A random walk has o(1) chance of escaping*
  - True when *g* bounded by o(n/log n)
  - Of *r* walks, (1-o(1))*r* = $\Omega(r)$ end nodes are good!
  - Can't distinguish good from bad nodes in set



Basic one-hop DHT design

- Construct finger table by *r* random walks
- Route to *t* by asking all fingers about *t*
  - If $r = \Omega(\sqrt{n} \log n)$, some finger knows *t* WHP
- Adversary cannot interfere with routing

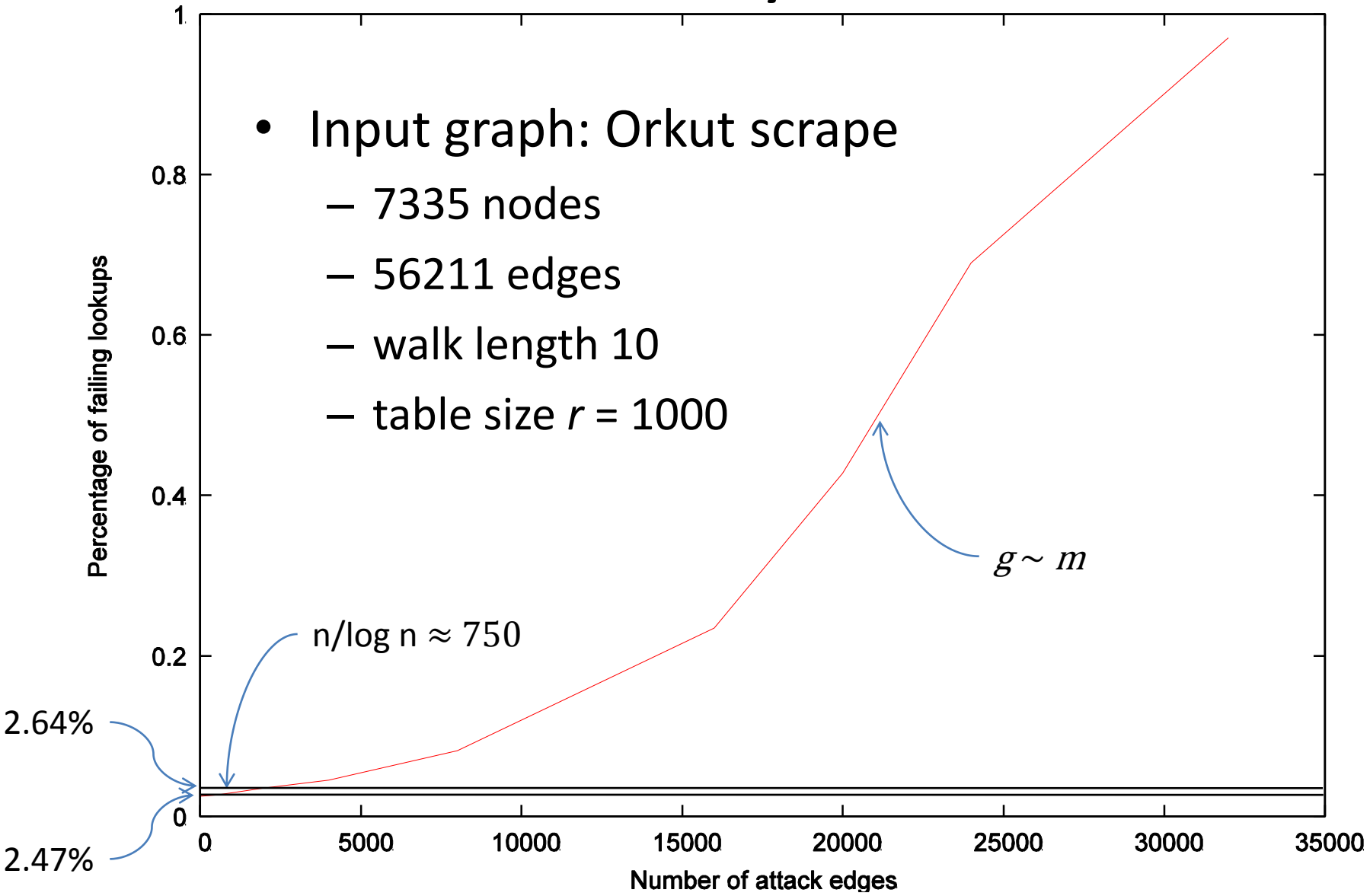


Properties of this solution

- Finger table size: $r = O(\sqrt{n \log n})$
- Bandwidth to construct: O(r log n) bits
- Bandwidth to query: O(r) messages
- Probability of failure: 1/poly(n)

Preliminary results

- Input graph: Orkut scrape
  - 7335 nodes
  - 56211 edges
  - walk length 10
  - table size r = 1000



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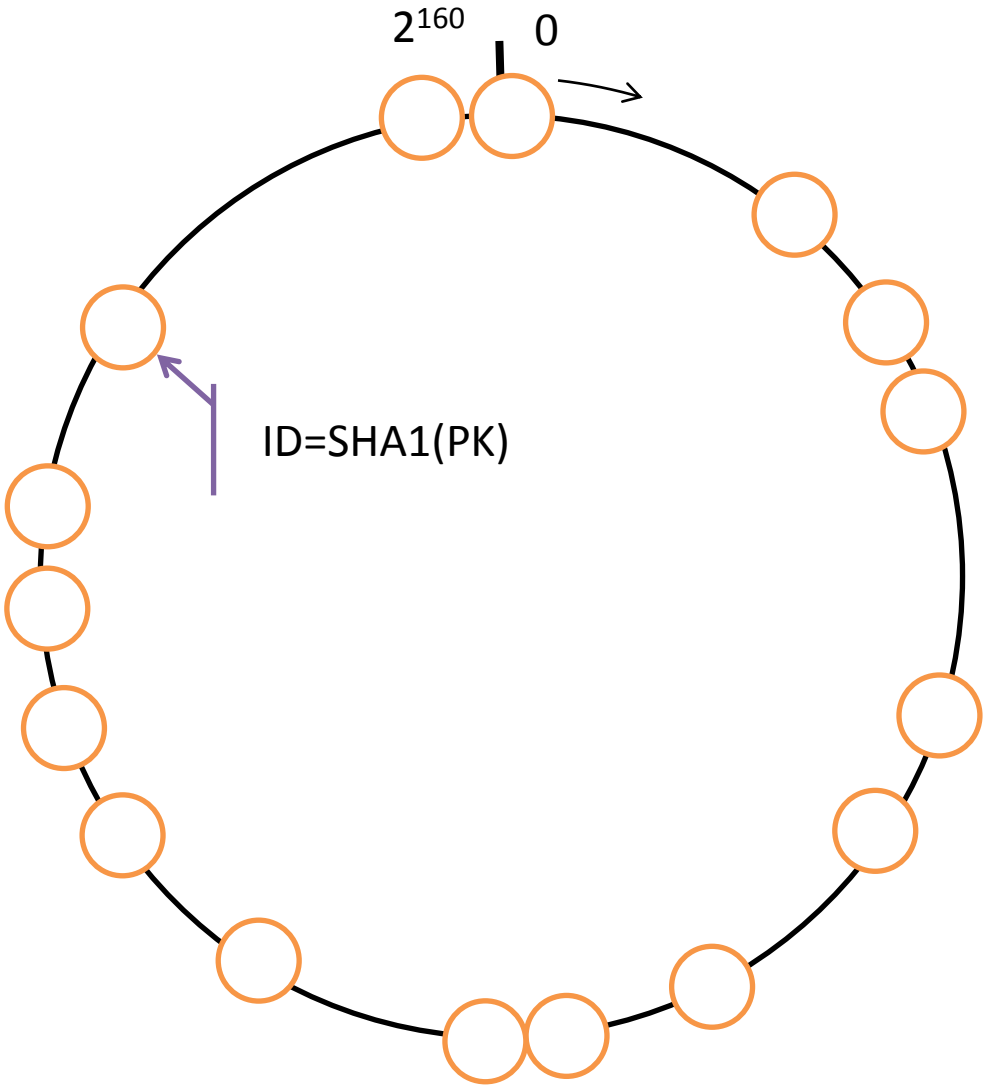
Structured one-hop DHT

- Goal: reduce bandwidth used by routing lookup
- Method: add Chord-like structure to DHT
- Assign hash IDs on ring



Structured one-hop DHT

- Goal: reduce bandwidth used by routing lookup
- Method: add Chord-like structure to DHT
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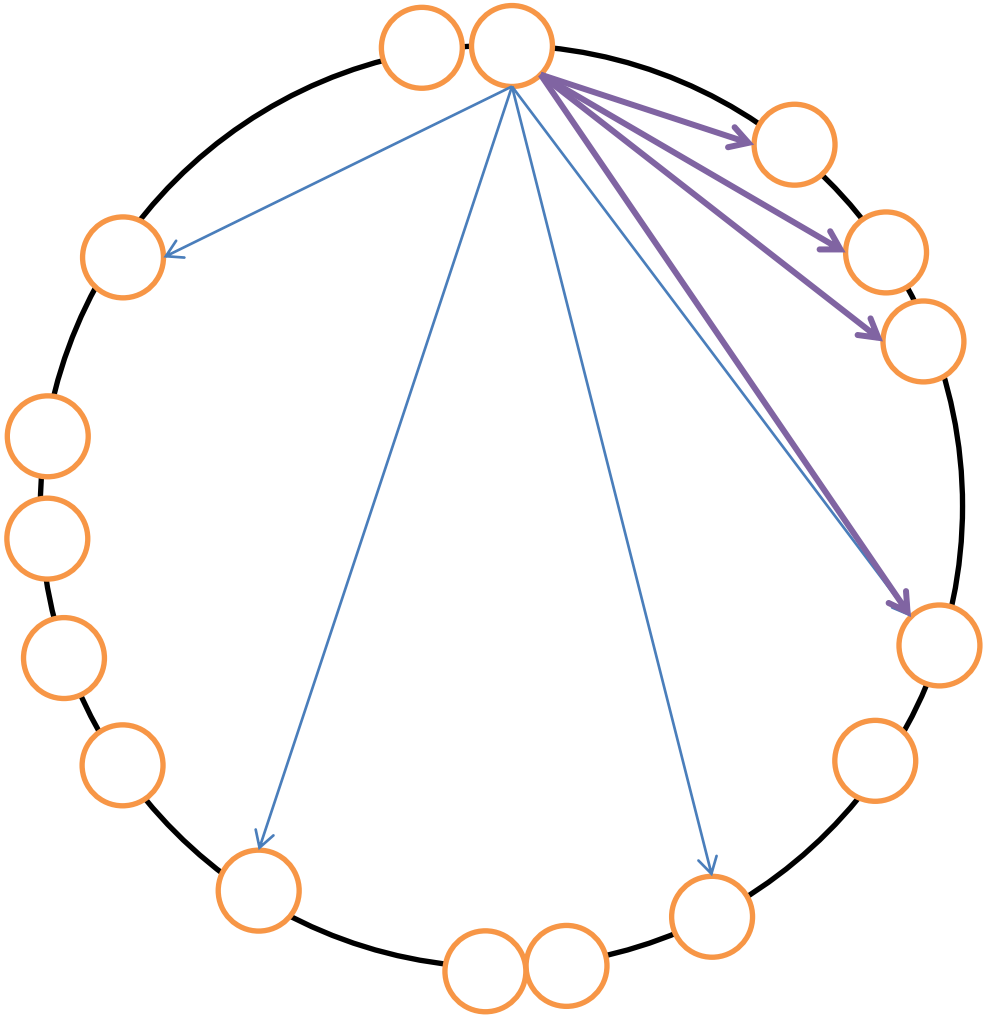
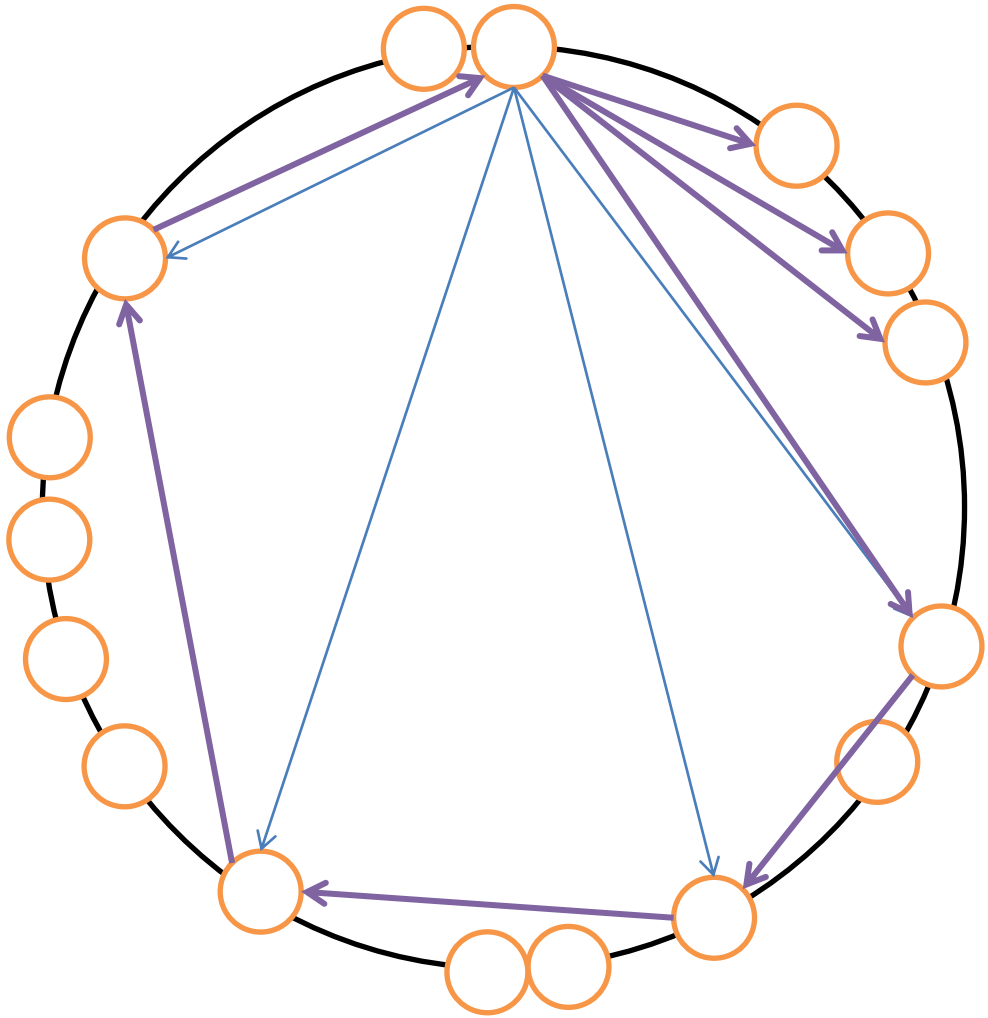
- Already have finger tables
- Need successor tables



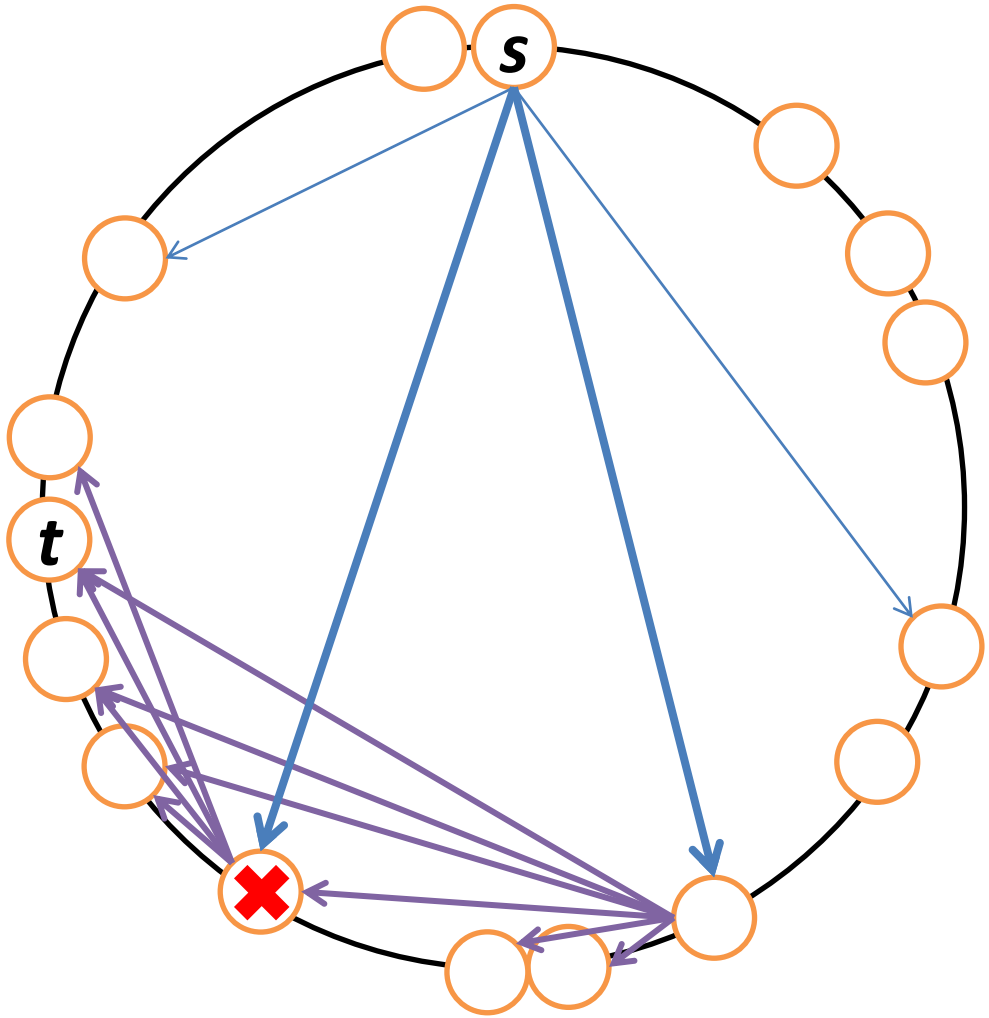
Constructing successor tables

- Construct finger tables
- Sort finger table by ID
- Tell each finger about its successors in your finger table
  - costs extra messages
  - send O(log n) successors
- Each node learns its *r* successors WHP



Using successor tables

- To route, query closest finger to target
  - finger's successor table should contain target
- If failed, finger may be evil or simply unlucky
- Try next closest finger
  - Expect O(1) tries



Hard to extend to O(log n) hops

- Would like to have smaller routing tables
  - this requires more hops per lookup
- First finger table (from random walks) has o(1) fraction of bad fingers
- Successive refinements (closer successors in ID space) using Chord stabilization: fraction of bad nodes grows at each step
- Tricky? Yes. Impossible? Unclear.

Summary

- DHTs are subject to the Sybil attack
- Social networks provide useful information
- Created a Sybil-resistant one-hop DHT
  - Resistant to g = o(n/log n) attack edges
  - Table sizes and routing BW $O(\sqrt{n} \log n)$
  - Uses O(1) messages to route
- This is important: enables fully decentralized and secure peer-to-peer systems

The “Tom” attack

Tom has 230357403 friends.

The “Tom” attack

From: Flickr Mail <mail@flickr.com>
Subject: [Flickr] You are aameesh's newest contact!
Date: 29 Mar 2008 08:00:19 +0000
To: ctl-flickr@mit.edu

Hi Chris Lesniewski,

You are aameesh's newest contact! If you don't know aameesh, aameesh is probably a fan of your photos or wants a bookmark so they can find you again. There is no obligation for you to reciprocate, unless you want to. :)

About aameesh / amish patel

← Photos | Send FlickrMail | Buy aameesh a Pro Account

i am 38 year old upcoming self made artist from india i hve upload my paintings to show others artists
i want to sale if anyone want to purchase
anyone can pass comments on my work i want to know remarks of other artists

i have even anothor page of my well clicked photographs
www.flickr.com/photos/aameesh

my paintings
www.flickr.com/photos/aameesh3

my graphics work
www.flickr.com/photos/aameesh2
i have won 'canon camera power shot420' @ femina holiday contest
another i have won 'canon camera power shot 430' from india today travel plus contest
'olympus camera i have won from 'smart photography' magazine but in my cousin brother name
amish patel
jamnagar
india
aameeshhpatel@yahoo.com

I'm **Male** and **Taken**.

www.flickr.com/photos/aameesh2
jamnagar, India

aameesh's contacts (2,172)

aameesh counts you as a **friend**. See aameesh's other friends here.






Add aameesh as a contact

Testimonials

Write a testimonial about aameesh

aameesh doesn't have any testimonials yet.

Block this person