



Peer NAT Proxies for Peer-to-Peer Games

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Motivation

- NAT boxes are ubiquitous
- Major hurdle in establishing connections in p2p games
- Hole punching techniques typically **90%** successful
- NAT proxy servers needed for remaining **10%**
 - Can be costly

Can we use peers as proxies?

Methodology

- Evaluate the feasibility of using client peers as NAT proxies by...
 - Creating a network library implementing both peer and server NAT proxying
 - Comparing it with an existing commercial game library
 - Conducting experiments with actual home users

P2P Abstraction Layer (PAL)

- Our Java network library supporting both UDP and TCP communication primitives
- Implements hole punching based on STUNT (*Guha et al. 2004*) with UPnP support
- Finds peer proxies if direct connections fail and uses a server proxy as a last resort



RakNet

- A popular C++ commercial game library supporting UDP communication primitives
- Originally designed for server-client architectures (i.e. no native p2p support)
- Hole punching and server proxying implemented as plugins

Data Gathering & Evaluation

- **PAL** evaluated using two applet-based games on Facebook
 - Tankie MAX
 - Karkinos
- **RakNet** evaluated using a Windows-based executable test client

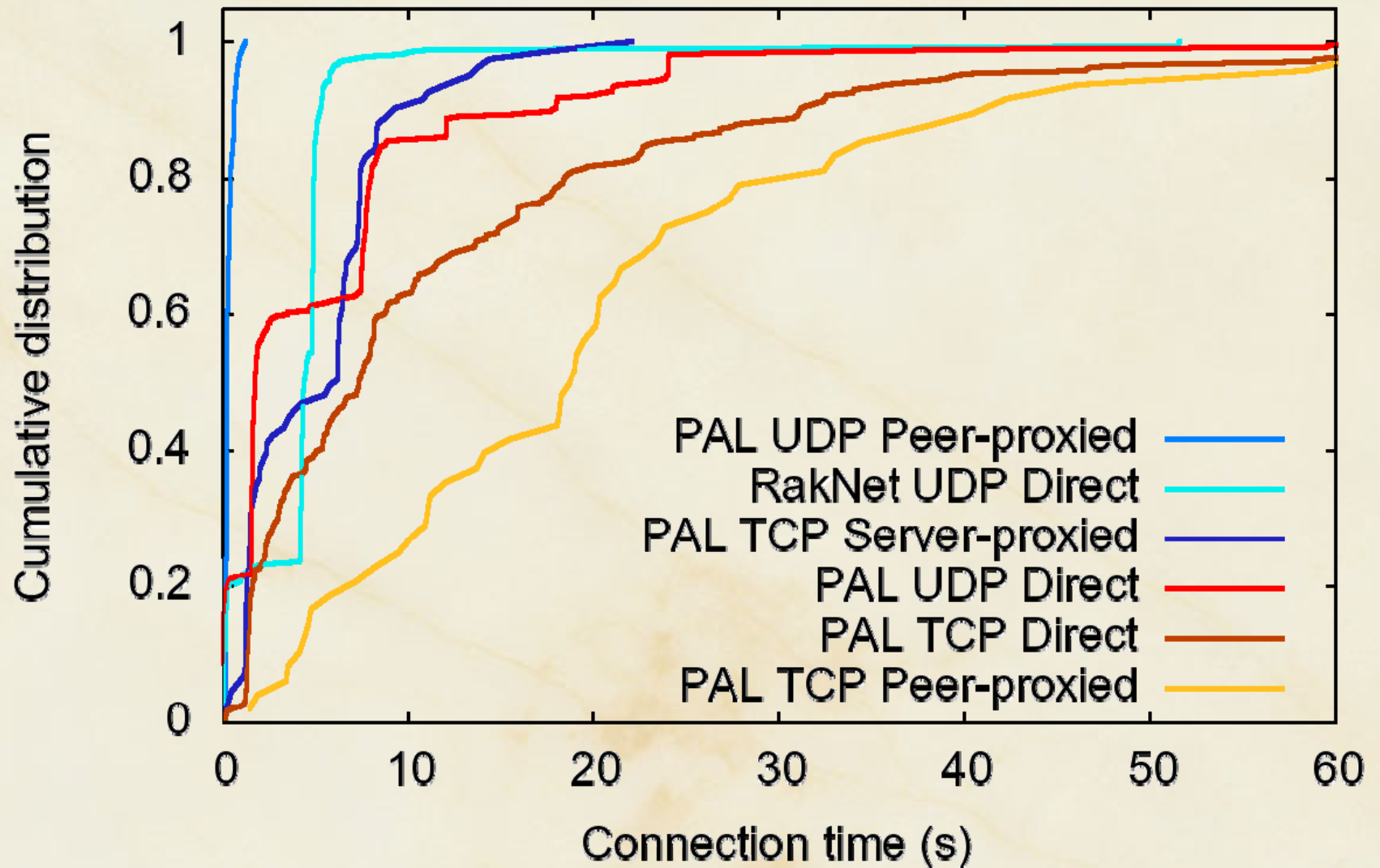
PAL Hole Punching Statistics

Type of Endpoints	UDP		TCP	
	Success	Total	Success	Total
Both NAT w/o UPnP	86.6%	5573	87.7%	1328
Both NAT w/ one UPnP	96.5%	2451	92.3%	426
Both NAT w/ both UPnP	91.2%	431	100%	144
One NAT w/o UPnP	95.6%	856	100%	186
One NAT w/ UPnP	96.6%	207	100%	37
No NAT	100%	50	100%	16
Overall	90.4%	9568	90.8%	2137

RakNet Hole Punching Statistics

Type of Endpoints	UDP	
	Success	Total
Both NAT	91%	391
One NAT	100%	32
No NAT	N/A	0
Overall	91%	313

Time taken to establish various connections

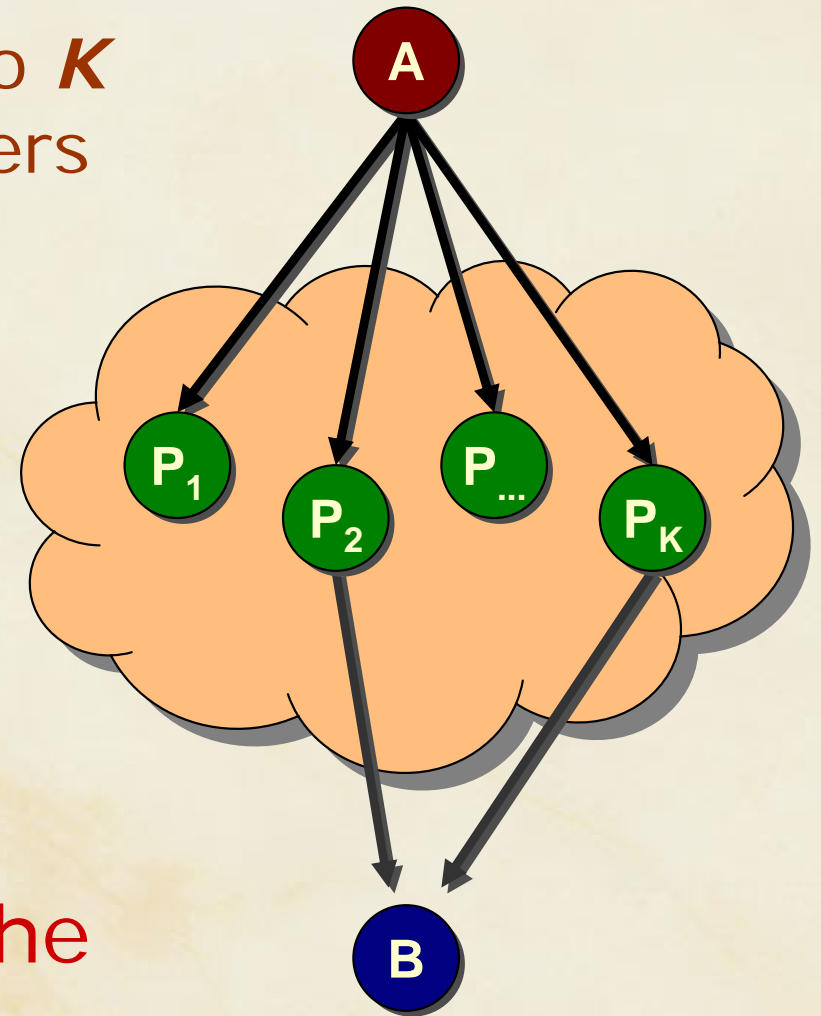


Connection Times

- 10% of direct PAL connections take longer than
 - **15** seconds for **UDP**
 - **30** seconds for **TCP**
- RakNet has a limit of about **10** seconds for direct connection establishment “out of the box”

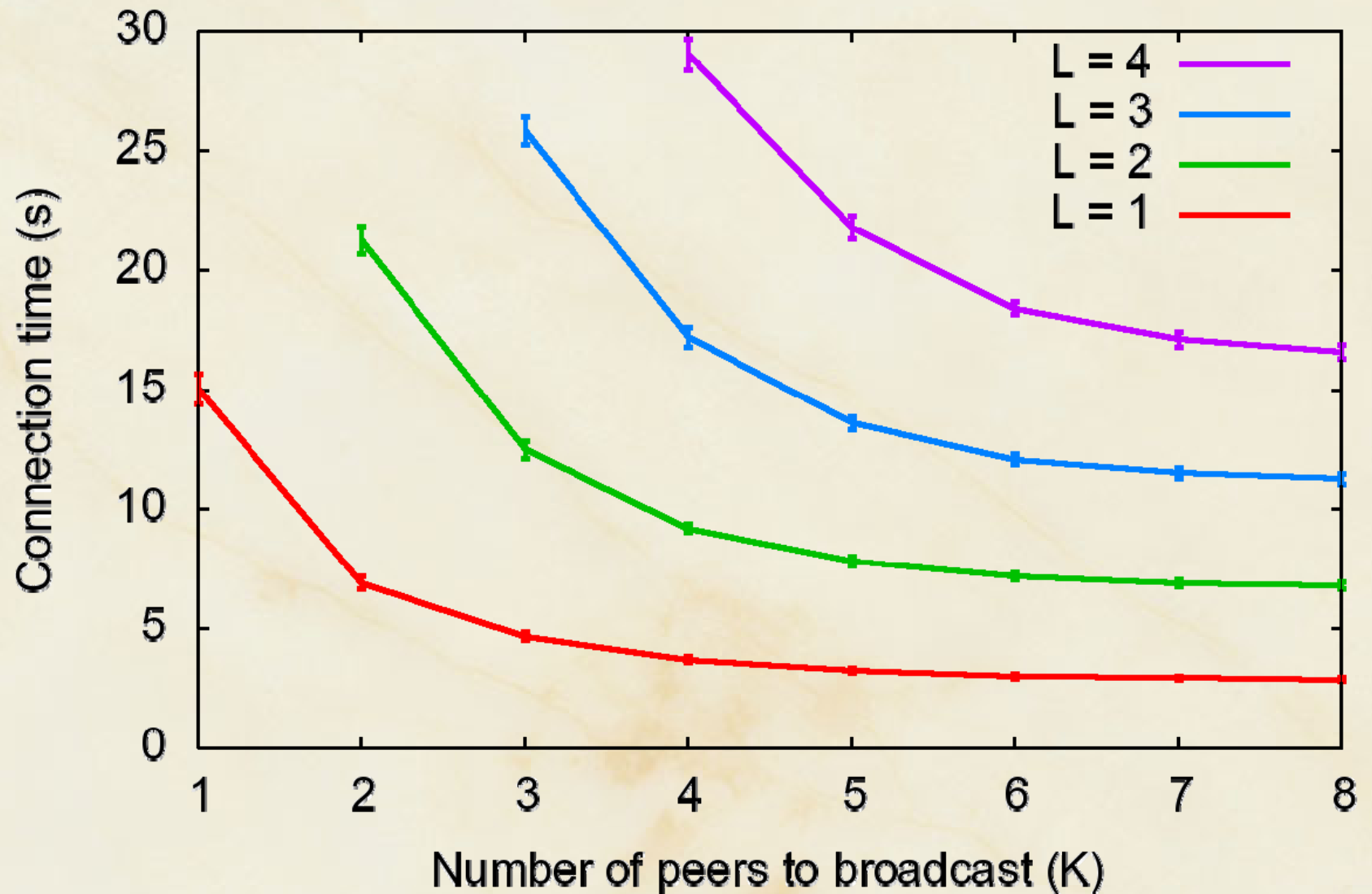
Finding a Peer Proxy

- Broadcast a request to K randomly selected peers
- Pick the best peer out of the first L to respond positively
- Repeat with another K peers if none of them can be a proxy

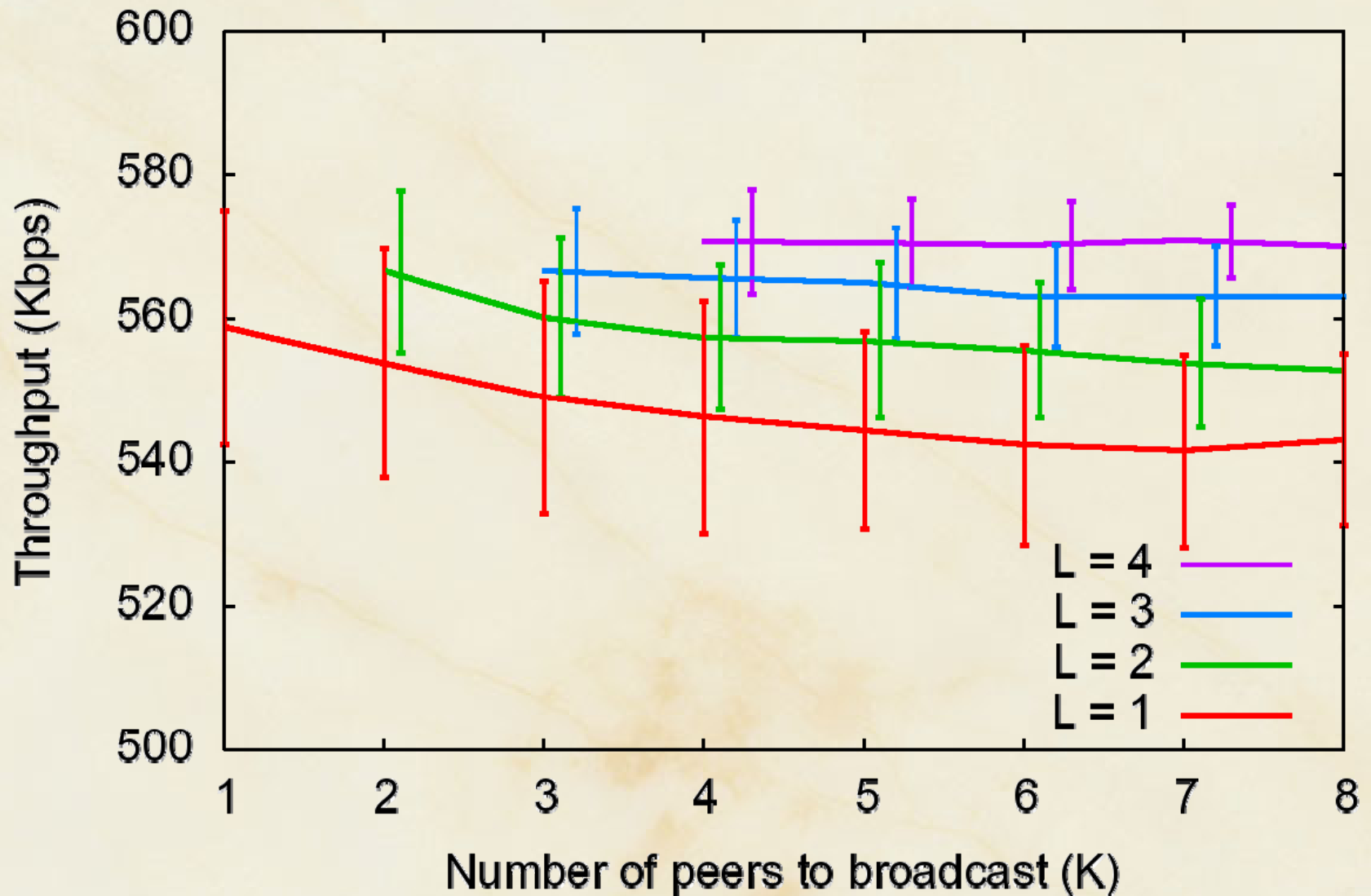


How to decide on the values for K and L ?

Simulated connection times for proxied **UDP** connections



Simulated max. throughput for proxied **UDP** connections



Finding a Peer Proxy

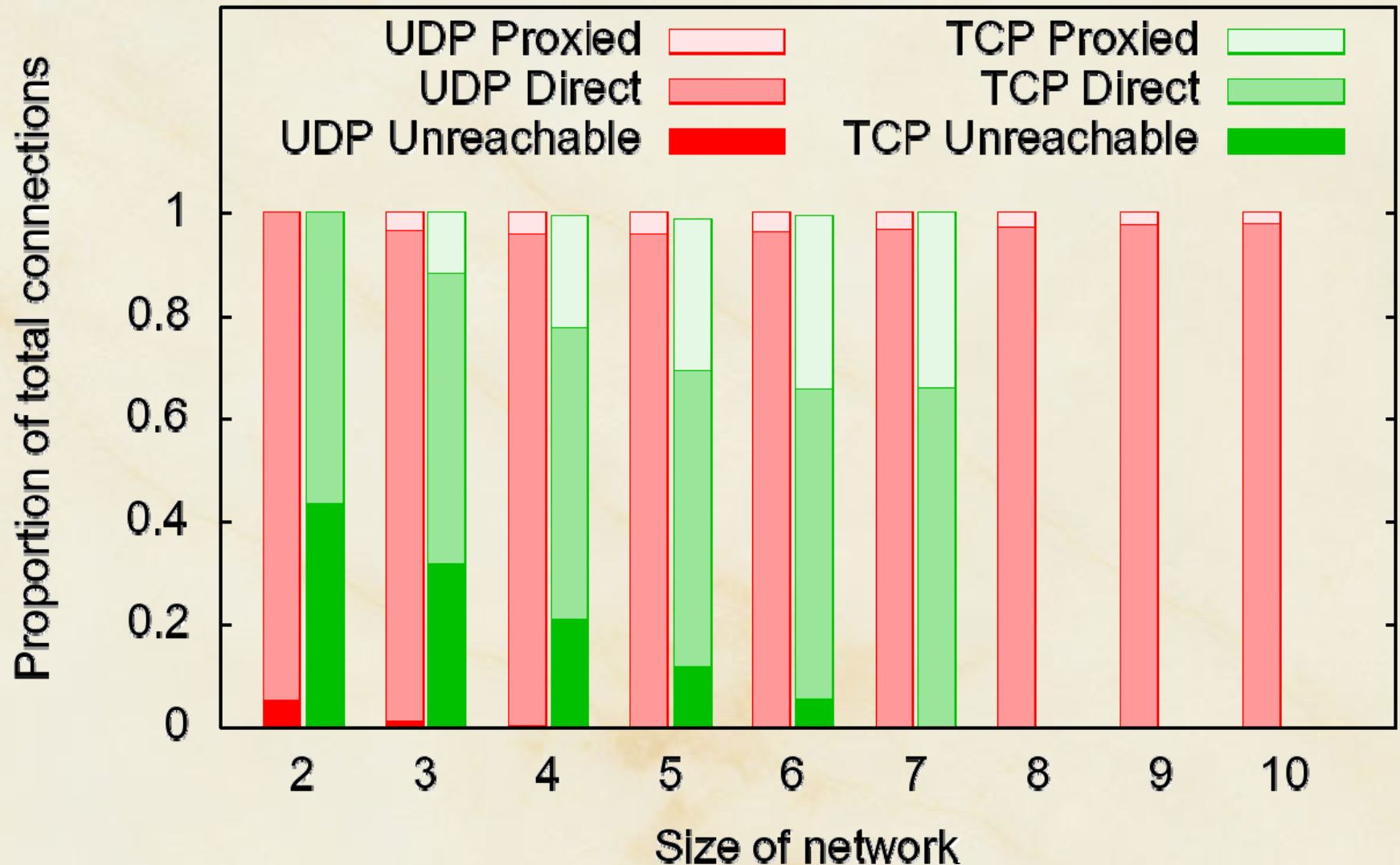
- Broadcasting to **5** peers and waiting for the **first** to respond is sufficient



Evaluating Feasibility

1. Is it easy to find peers that can act as proxies?
2. What is the performance of a peer proxy compared to a server proxy?

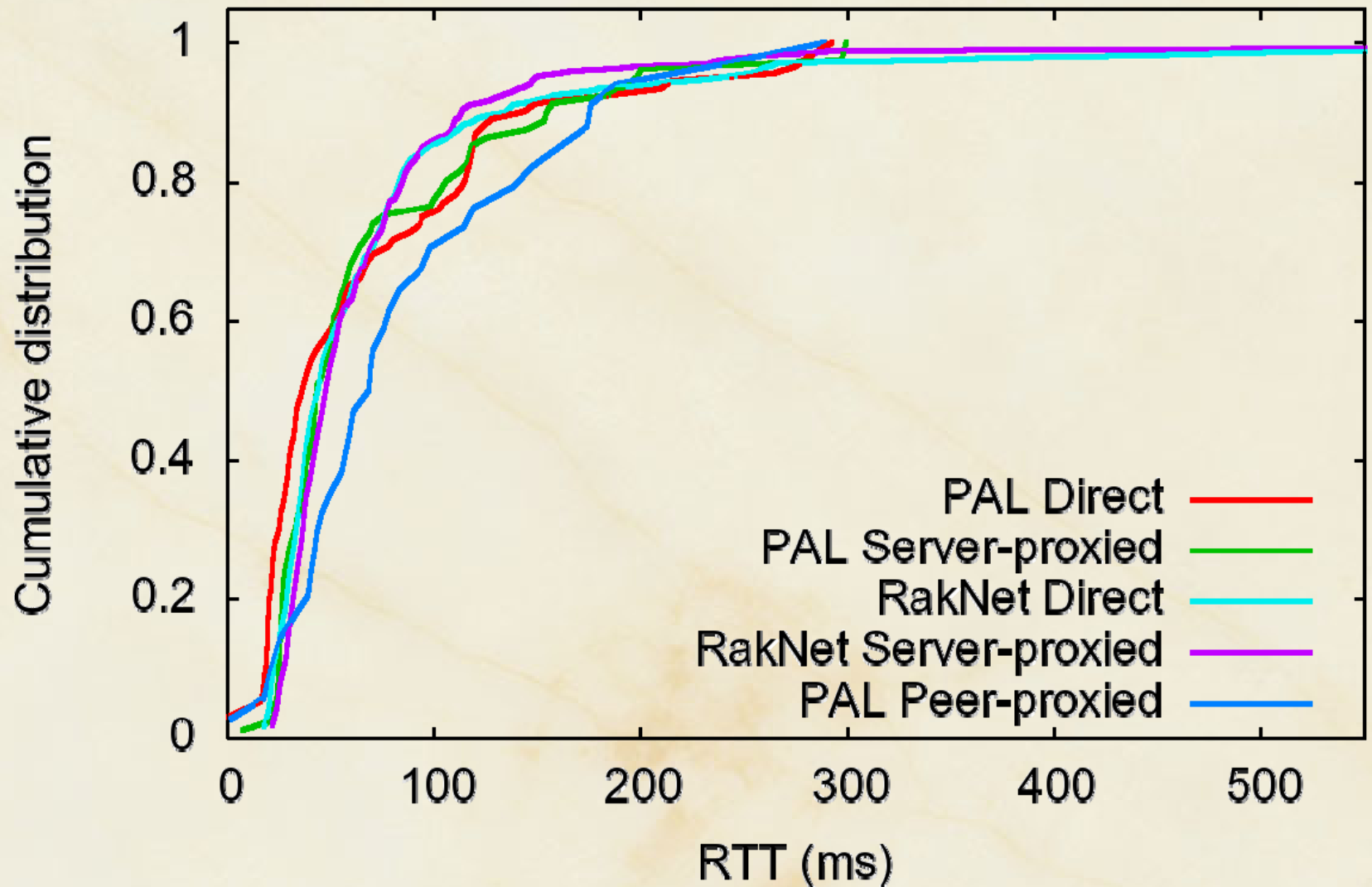
Degree of separation for various network sizes



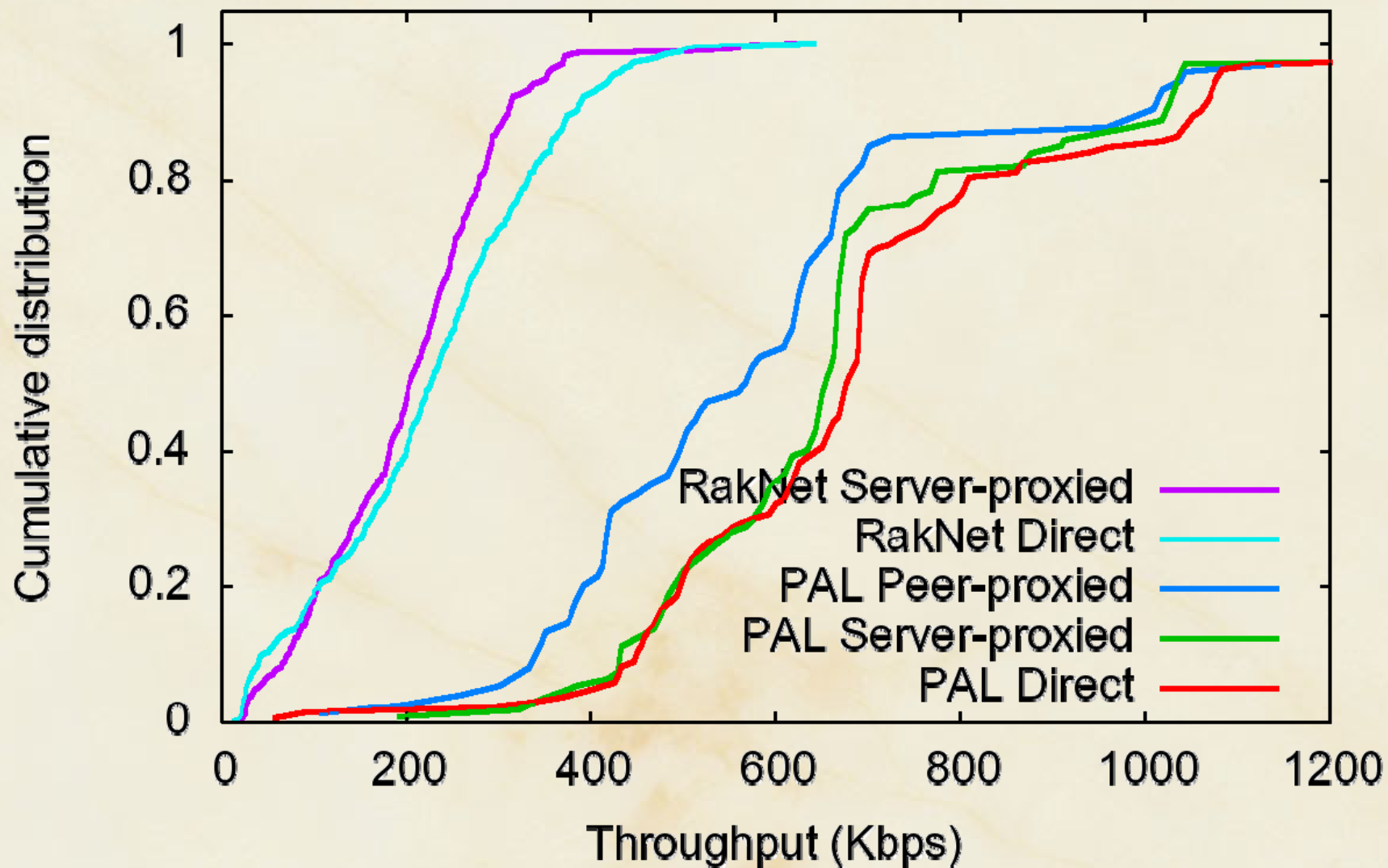
Ease of Finding Peer Proxies

- A proxy is always available for
 - **UDP** if there are at least **4** peers
 - **TCP** if there are at least **7** peers
- **TCP** proxies should be easier to find in practice

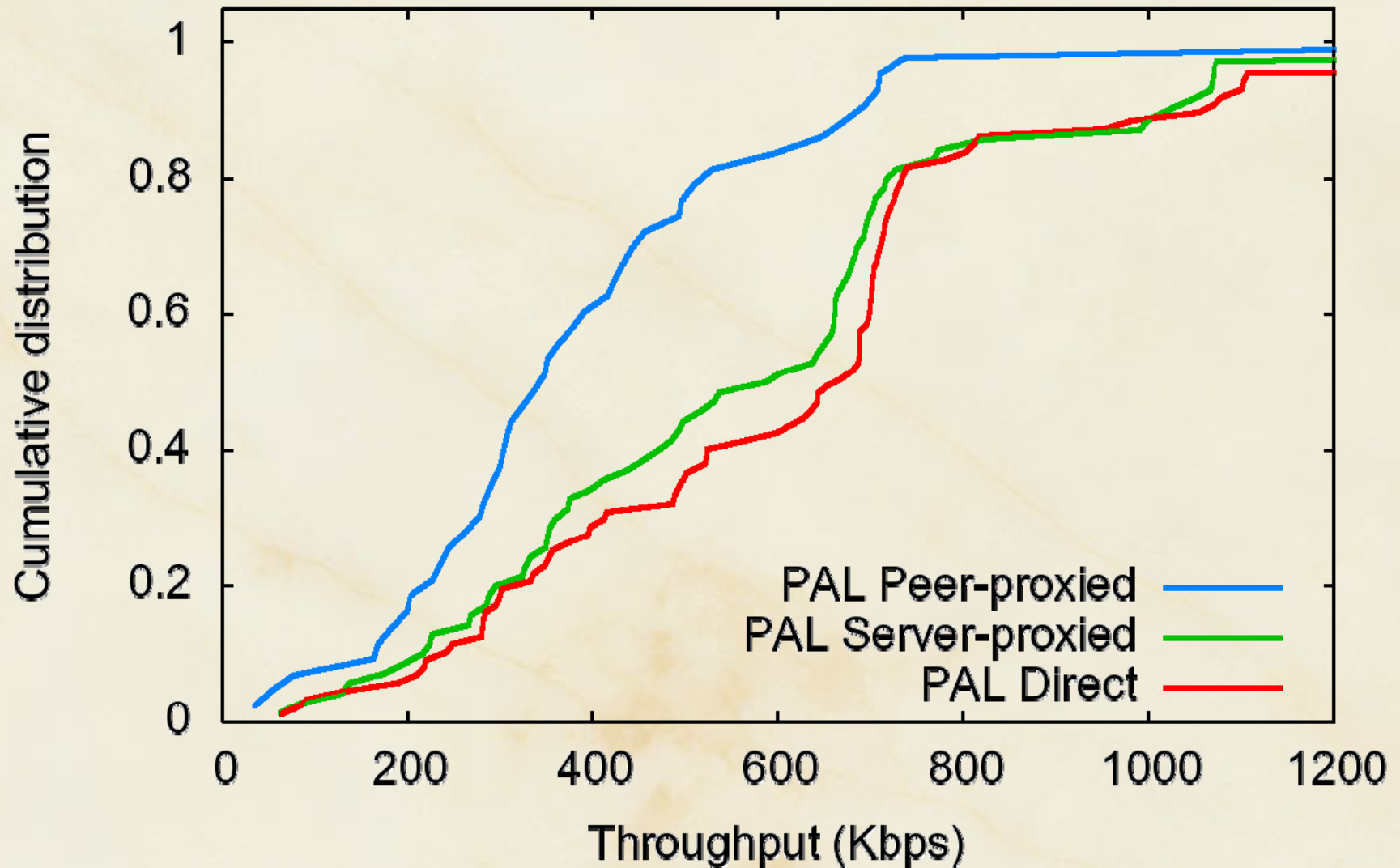
Round-trip latencies for direct and proxied **UDP** connections



Throughput for direct and proxied **UDP** connections



Throughput for direct and proxied TCP connections



Proxy Performance

- Peer proxy latencies 30 ms higher than server proxies
- Peer proxies achieve throughput comparable to server proxies
- Flow control in RakNet results in lower loss rates but significantly lower throughput
 - Other results comparable to PAL

Conclusion

- NAT proxies almost certainly required to support a p2p game
- Feasible to use peers as proxies
 - Easy to find
 - Performance is comparable to server-based proxies
- Our current proxy implementation is still naïve
 - Further optimizations remain as future work

The background of the slide features a close-up of a thin, dark brown branch with several dried, brownish leaves. The leaves are elongated and have a slightly curled appearance. The branch and leaves are set against a light beige, textured background that resembles aged paper or parchment with subtle, wavy patterns.

Thank You

Any Questions?