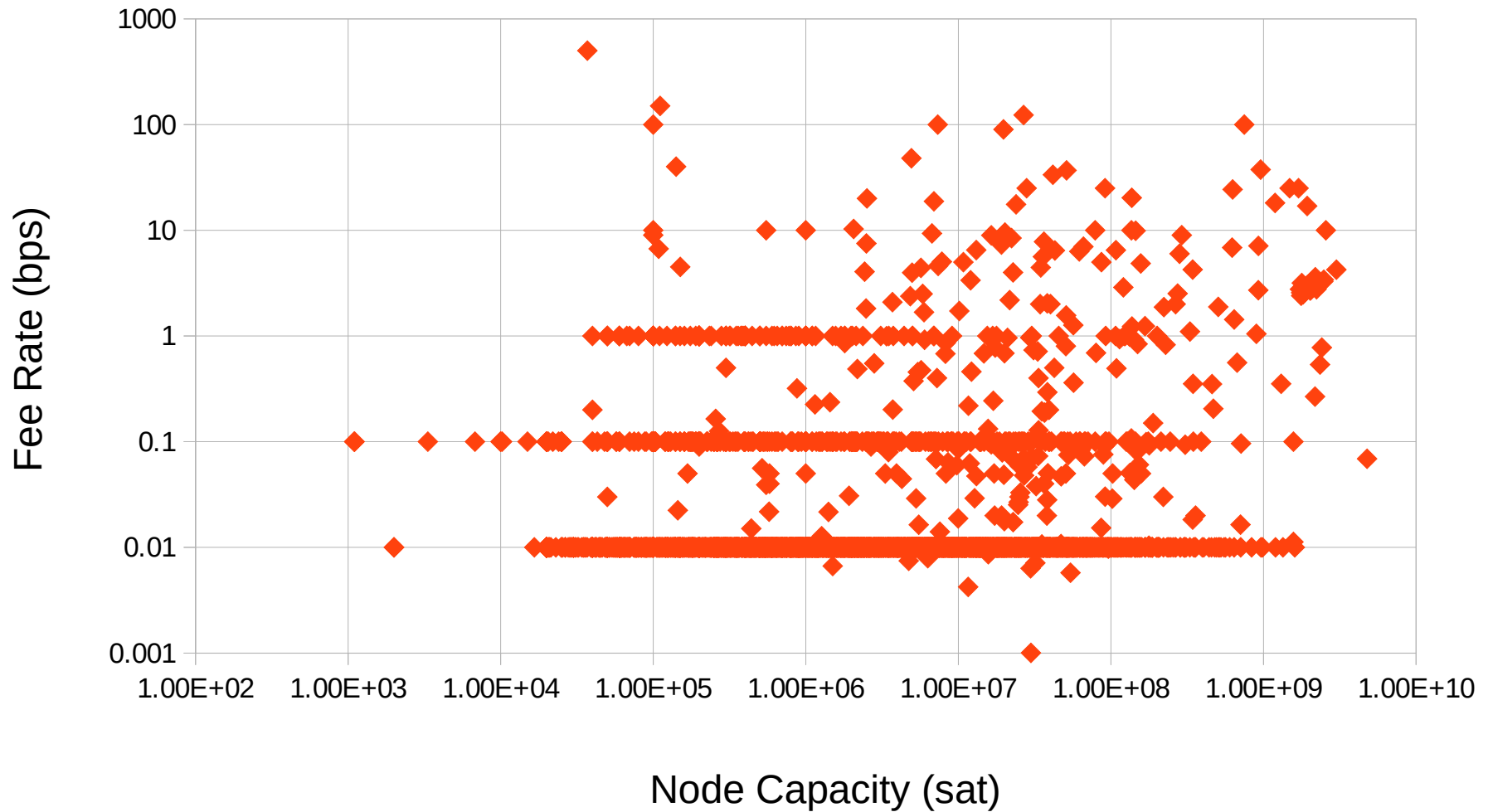


Analysis of the Lightning Fee Market

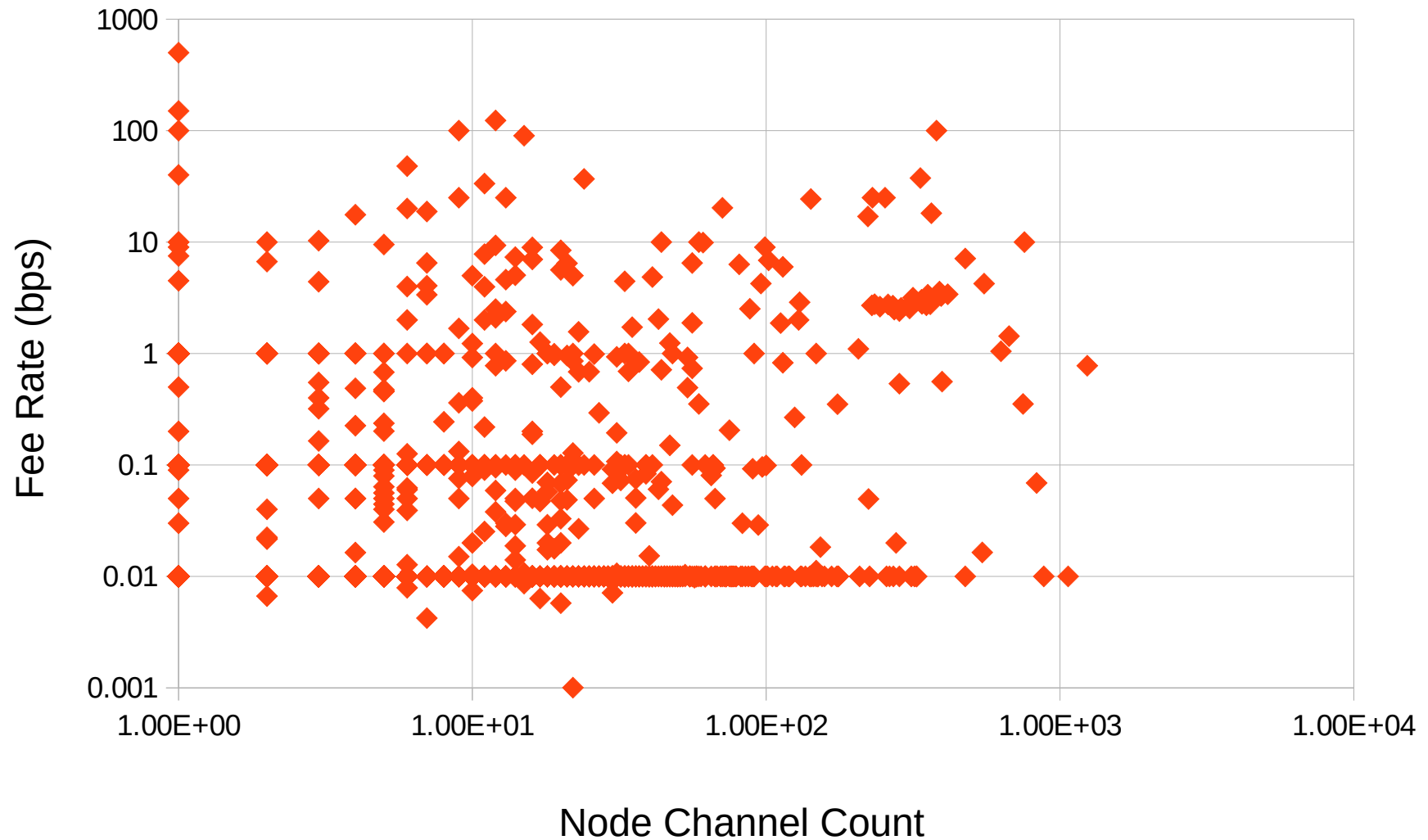
Ken Sedgwick
Bonsai Software

What are Current Lightning
Network Fee Rates?

Node Fee Rate vs Node Capacity



Node Fee Rate vs Node Channel Count



Wow, 100,000%!!

Channel Id: 648176398420738048 Active

Short Channel Id 589513x2985x0
Channel Point e6ceff98e32f4cae7b6eab2b7d40183d2e8e68cb7e503f67293f487bdbdd9b85:0 [\[block explorer\]](#)
Capacity 0.02000000 BTC 2,000,000 sat (0.002451%) \$166.49 ▾
Last Update 19 hours ago **First Seen** Saturday, August 10, 2019 **Age** a month

Node 1 [\[this node\]](#): 0249072e6ab527ed917f826bed335c9511028fea53360d09c177e740f8d0dff0e

Alias	Capacity	Time Lock Delta	Min HTLC	Base Fee	Fee Rate
GoOfAndFyourself[LND]	0.02622793 BTC \$218.34 ▾ 2,622,793 sat	10	1	0.000 sat \$0.000000000	1,000.000000 sat \$0.083245400000

Node 2: 03da1c27ca77872ac5b3e568af30673e599a47a5e4497f85c7b5da42048807b3ed

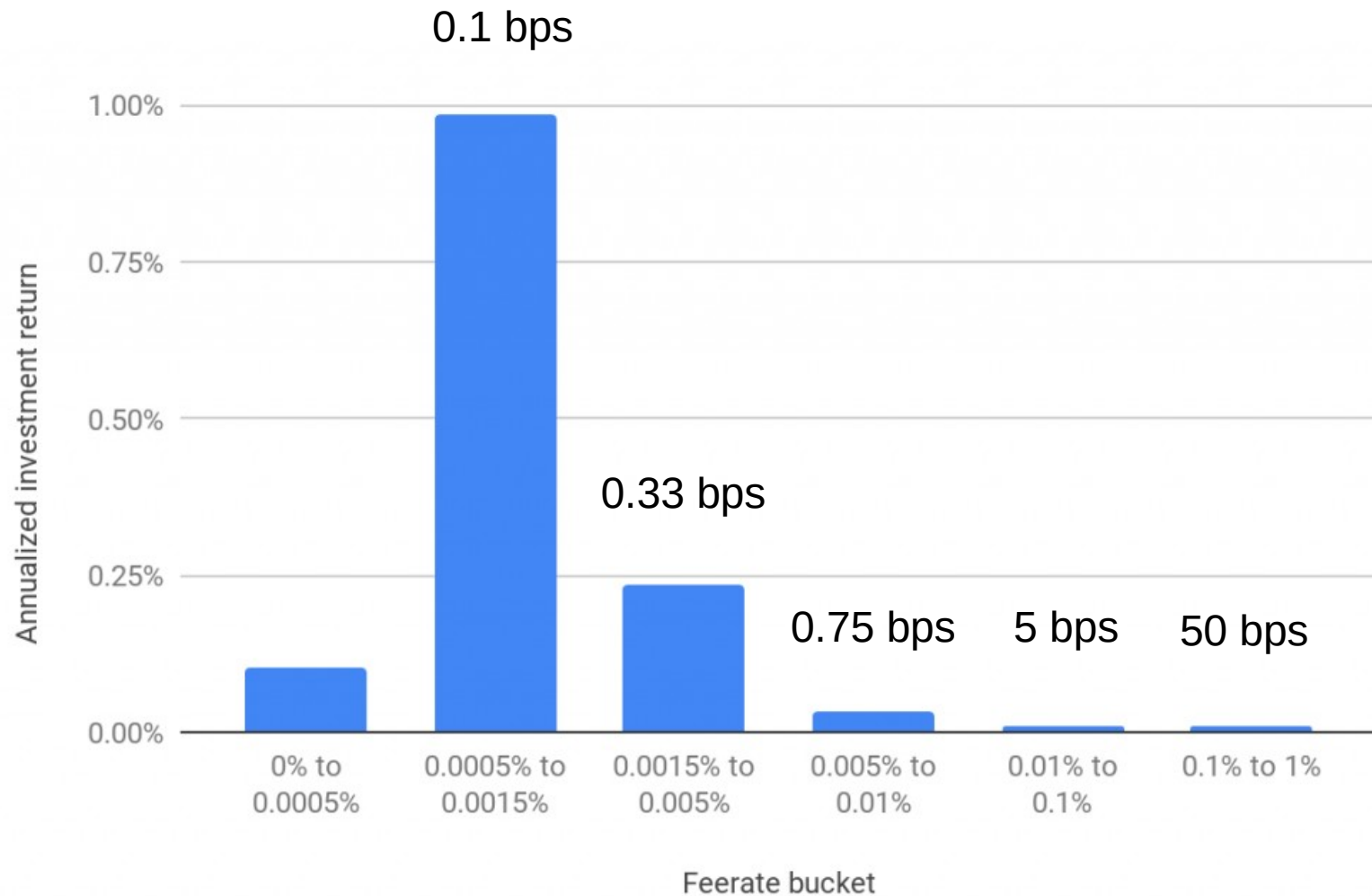
Alias	Capacity	Time Lock Delta	Min HTLC	Base Fee	Fee Rate
LNBIG.com [Ind-07] (Ashburn, VA, United States)	17.50330473 BTC \$145,706.96 ▾ 1,750,330,473 sat	30	1,000	0.080 sat \$0.000006660	0.000800 sat \$0.000000066596

Fee Rates at Some Notable Sites

Alias	Fee (bps)
zigzag.io	100.00
yalls	25.00
OpenNode	18.00
ln1.satoshilabs.com	10.00
LNBIG.com	3.60 – 2.40
BitMEXResearch	1.40
Bitrefill.com	0.50
BTC.COM	0.10
ACINQ	0.03
1.ln.aantonop.com	0.01

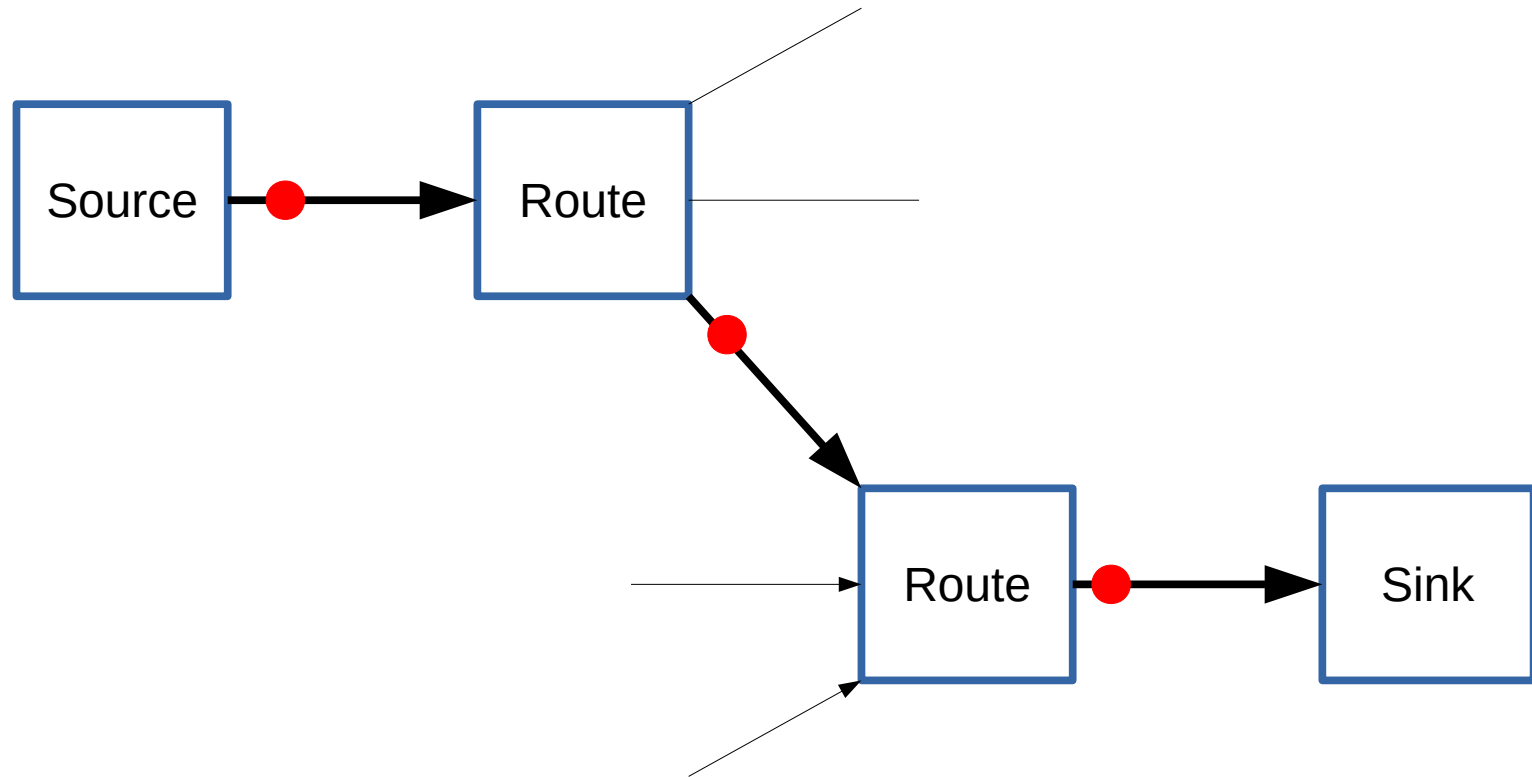
What are the Market
Forces on Fee Rates?

Profitability vs Lightning Fee Rate

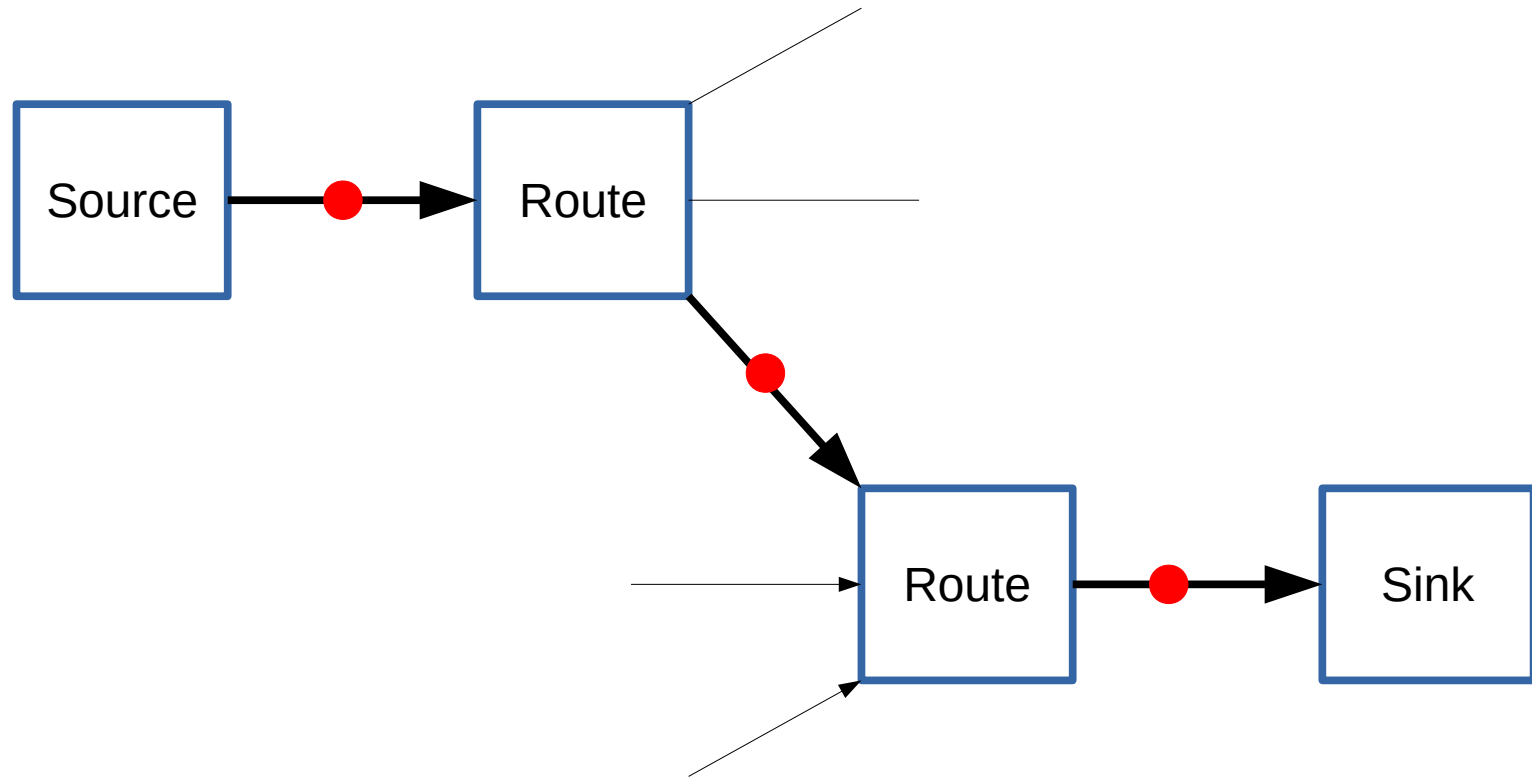


Source: BitMEX Research, [“The Lightning Network \(Part 2\) – Routing Fee Economics”](#)

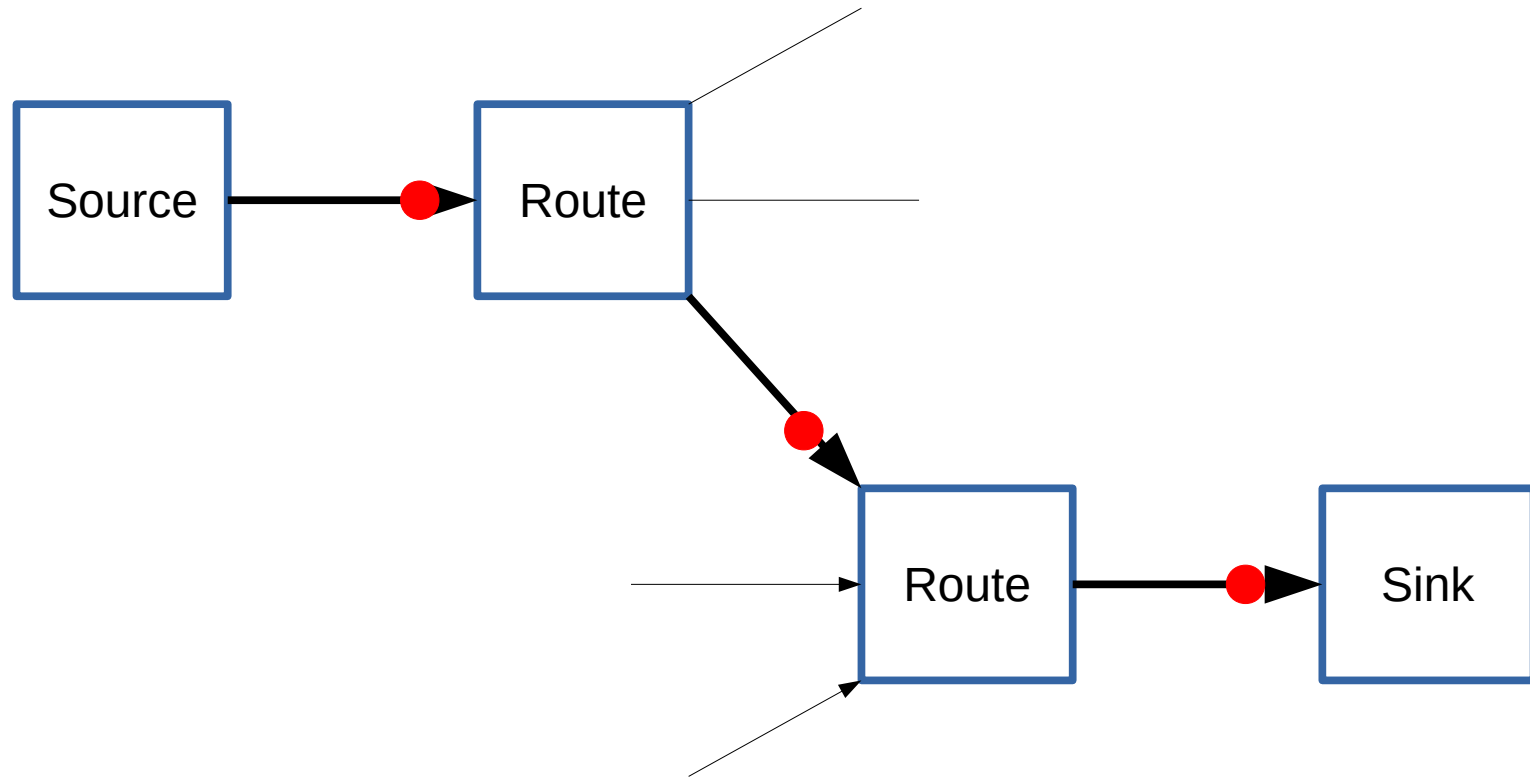
Linear Payment Flows



Linear Payment Flows



Linear Payment Flows



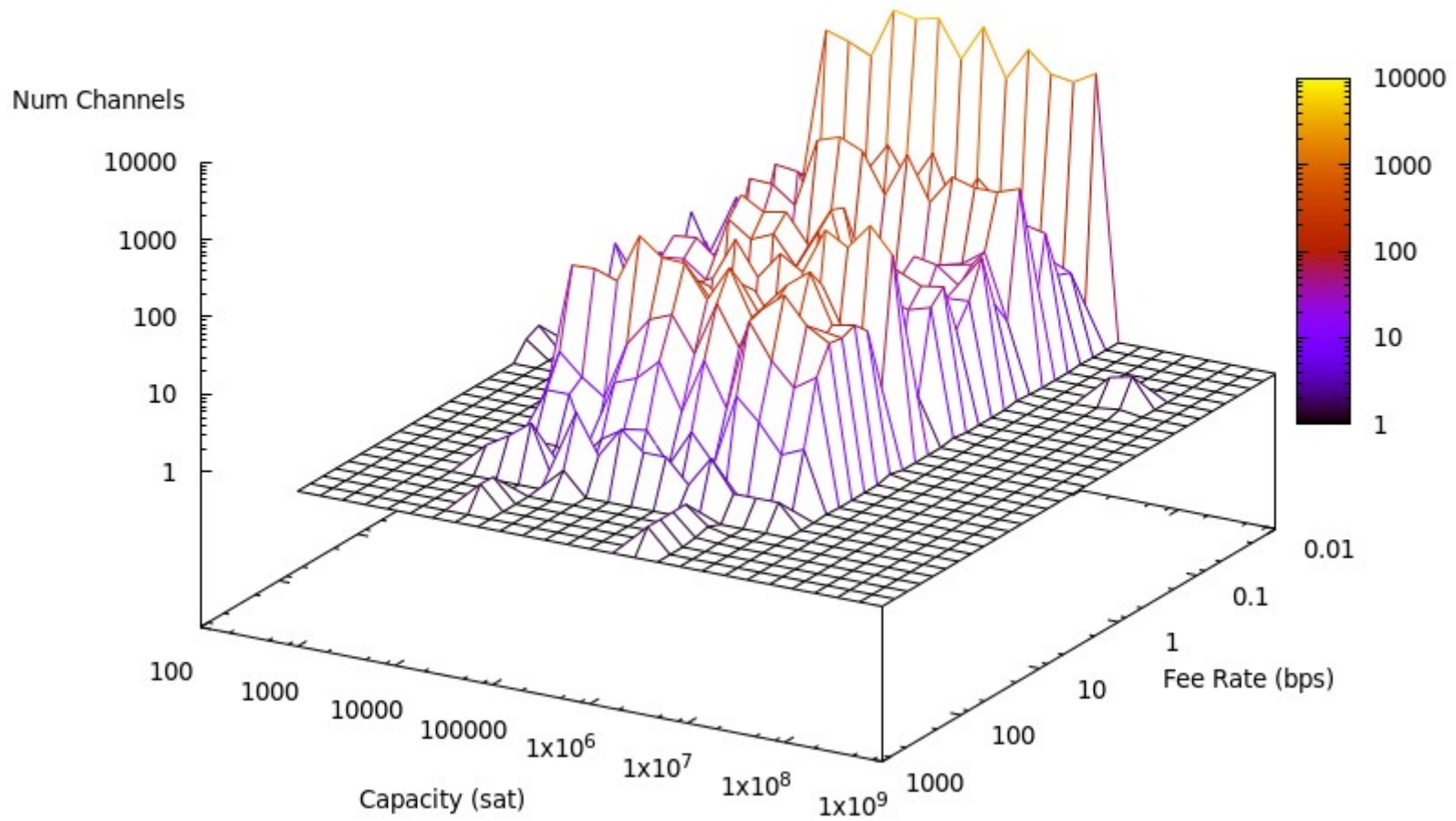
Methods to Refresh/Replenish Channels

Off-chain “looping” is likely to unbalance neighbors, no net “network” gain.

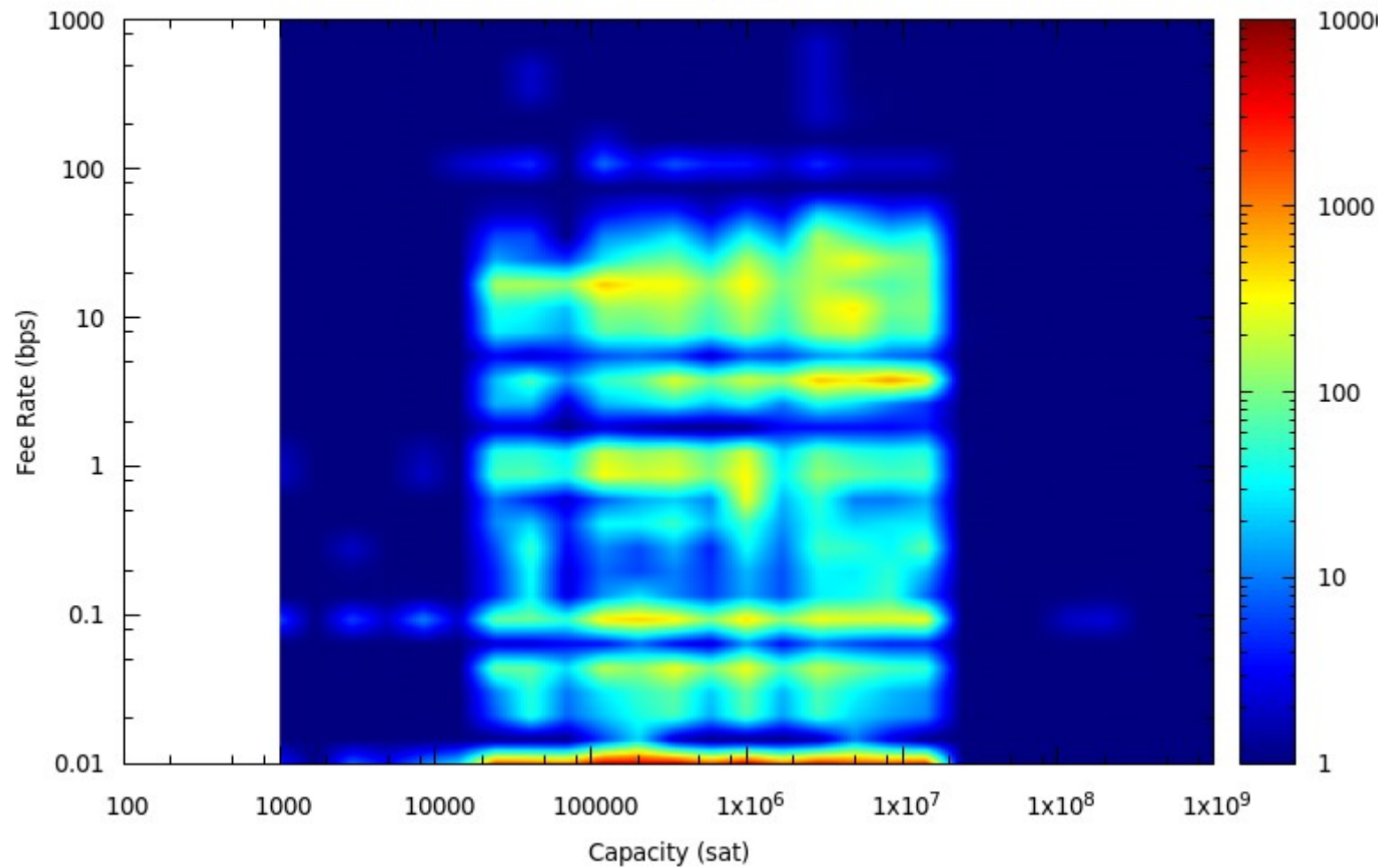
On-chain Mechanisms Work:

- Close spent channel and open fresh channel
- Loop-in and loop-out
- Splicing

Channel Distribution vs Capacity and Fee Rate



Channel Distribution vs Capacity and Fee Rate



Break-even Fee Calculation

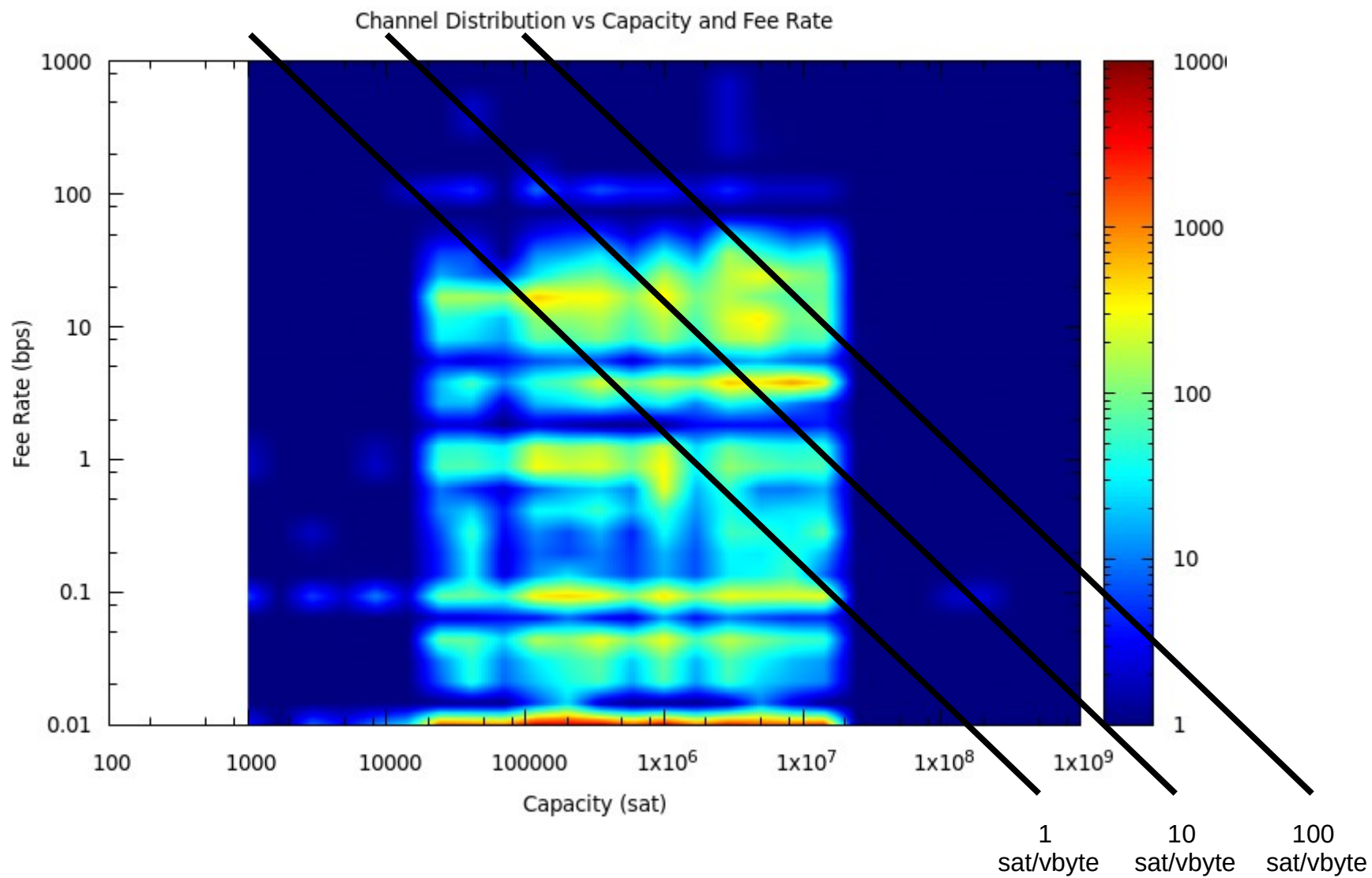
VSZ: Virtual size of funding transaction (150 vbyte)

BFR: Fee rate of on-chain bitcoin transaction (sats/vbyte)

CAP: Size of the created channel (sats)

LFR: Resulting break-even lightning fee rate (bps)

$$\text{LFR} = 10000 * \text{BFR} * \text{VSZ} / \text{CAP}$$



Observations

- Larger channel sizes help
- Fee rates of a few bps work

How does this compare to credit cards?

Square charges 275 bps (2.75%) of each swiped transaction

5 hops at 10 bps each is only 50 bps!

What Happens in the
Future?

Things Get Better

- As the network scales, more endpoints can both send and receive off-chain. Less dominated by “sources” and “sinks”.
- Off-chain looping becomes viable; channels can be replenished without unbalancing neighbors.

Lightning Fee Rates Should Decrease

Conclusions

- Many current lightning channels are not charging enough fees to cover on-chain replacement.
- Lightning fee rates of a few basis points are achievable and sustainable.
- As the network becomes larger loops will become more prevalent and fee rates can fall further.

Thanks!

What does Steady State Look Like?

[“Modeling a Steady-State Lightning Network Economy”](#) - Gregorio Guidi

“In particular, we have seen how the condition for having balanced income and expenses implies that the demand imbalance on the channels of the network flows around in “circuits”, and that letting the system evolve towards equilibrium (breaking the circuits) causes a spanning tree to emerge from the topology of the network.”