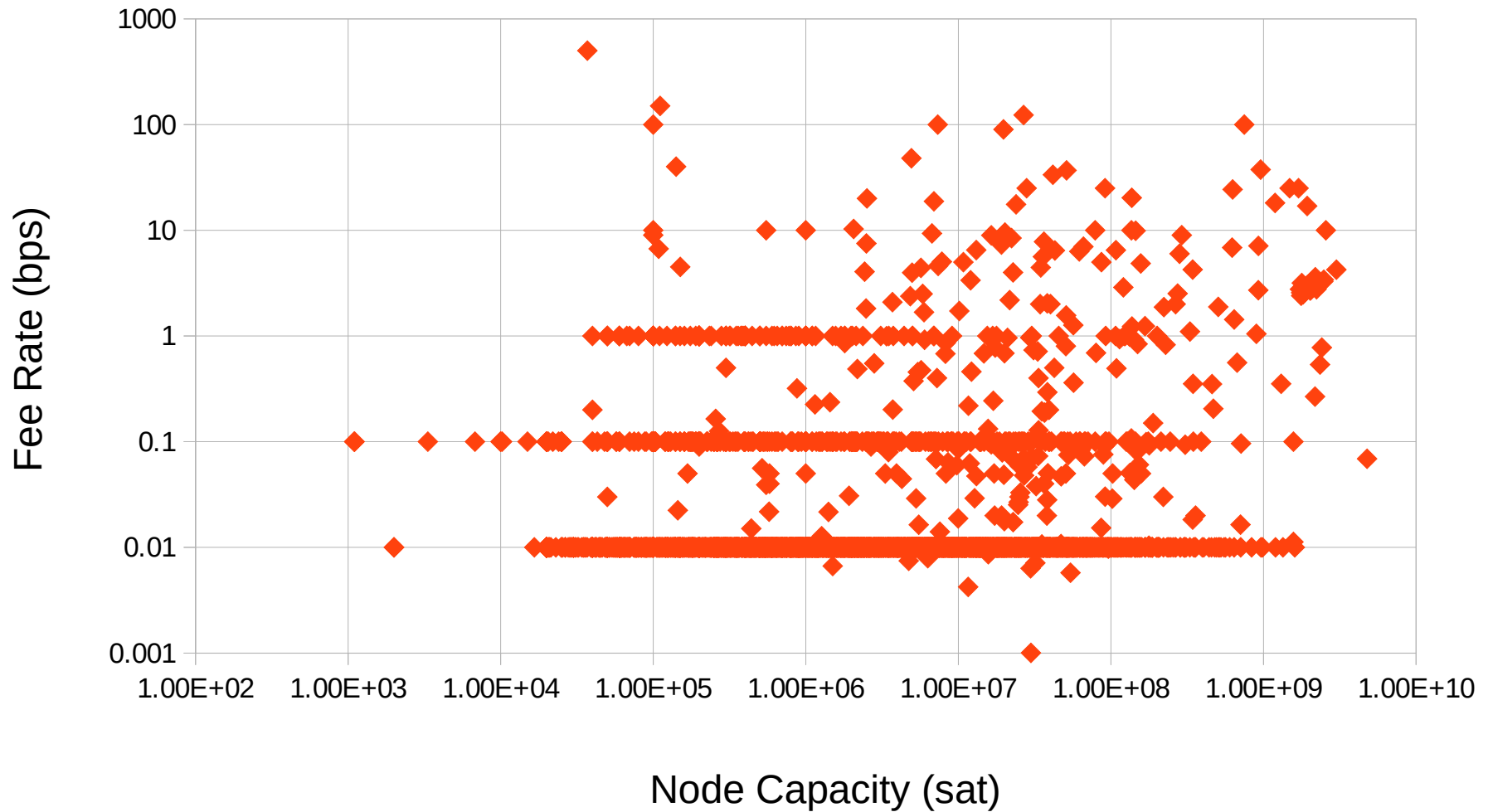


# Analysis of the Lightning Fee Market

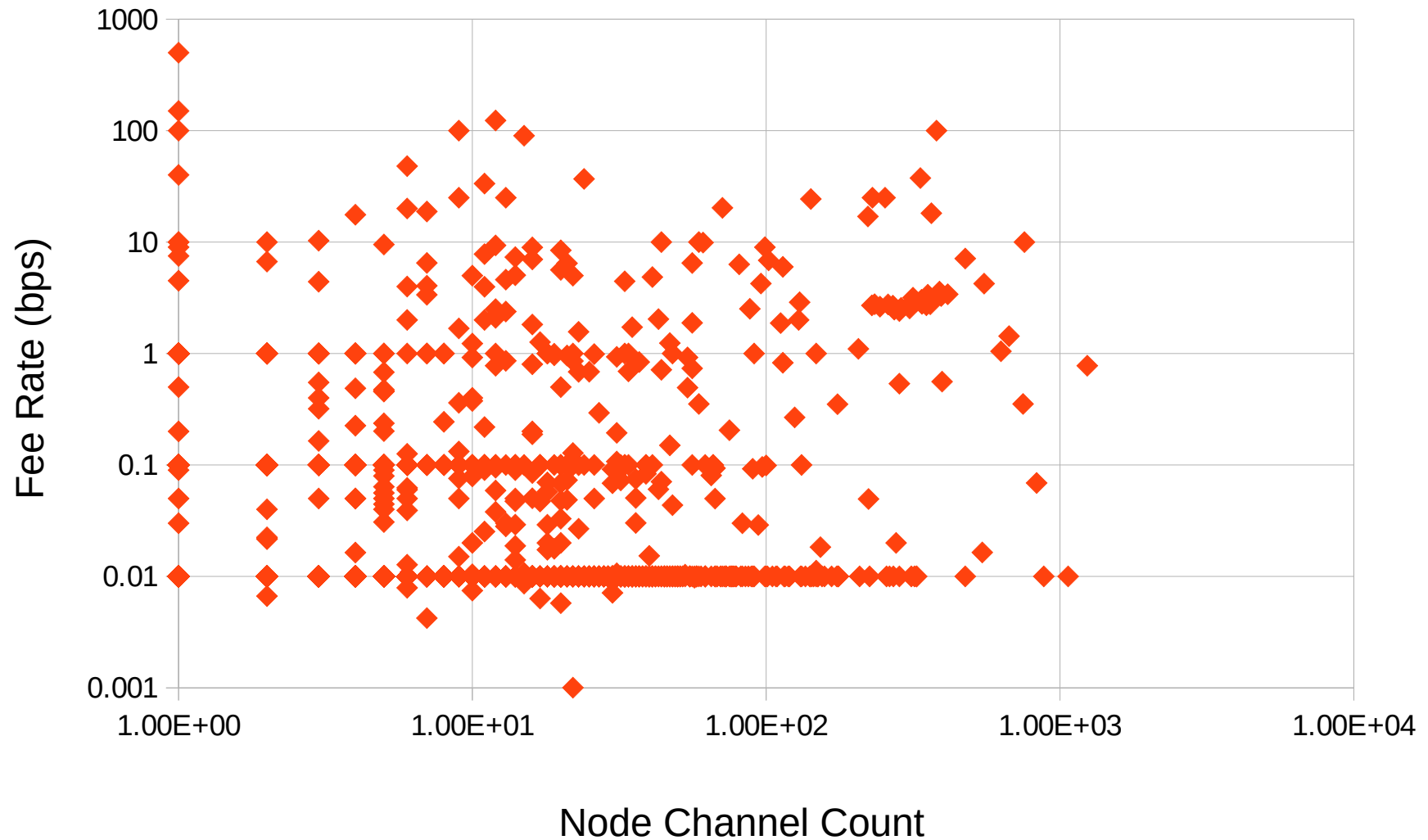
Ken Sedgwick  
Bonsai Software

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](#)

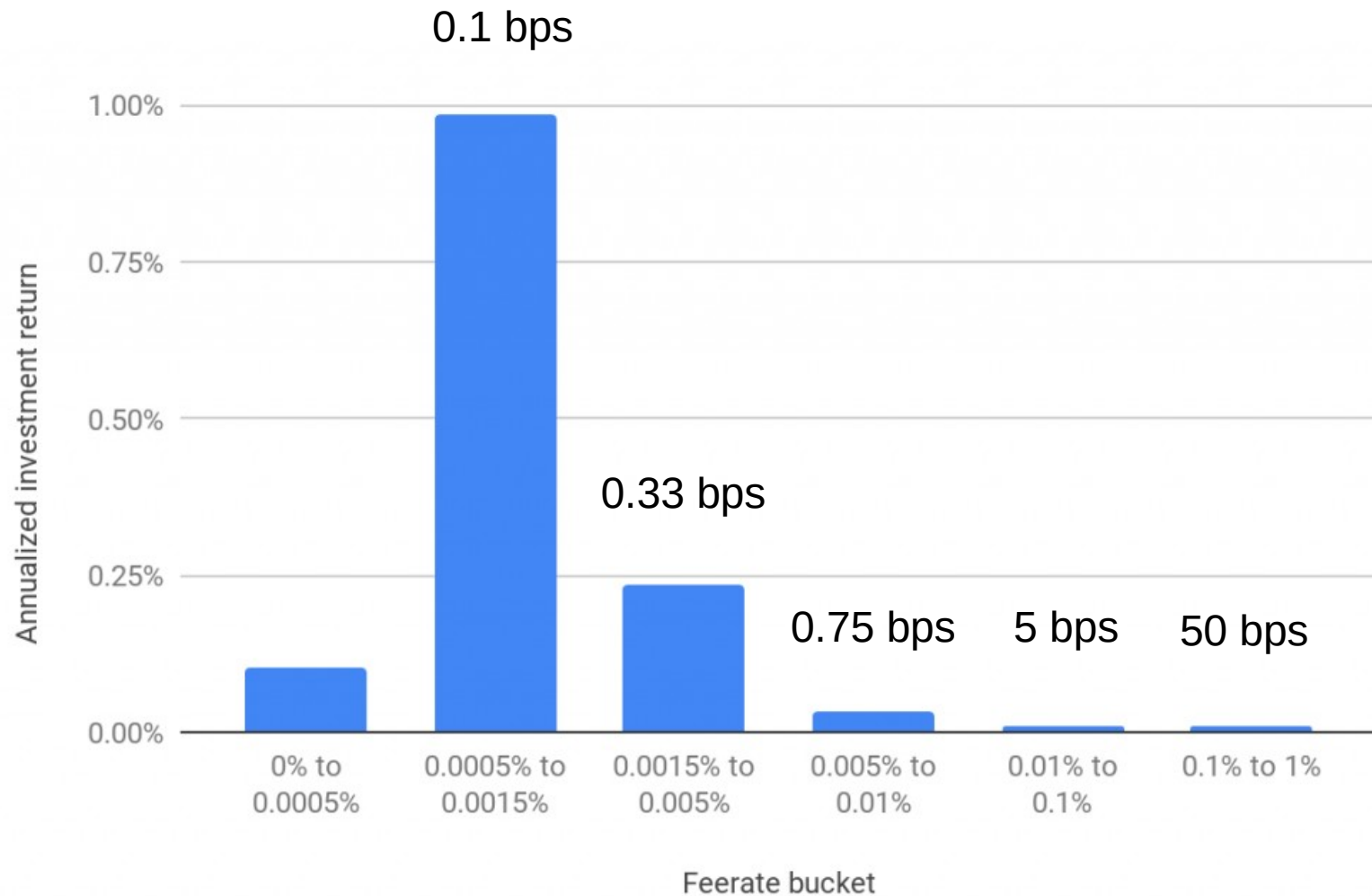
Alias	Capacity	Time Lock Delta	Min HTLC	Base Fee	Fee Rate
<a href="#">LNBIG.com [Ind-07]</a> (Ashburn, VA, United States)	17.50330473 BTC \$145,706.96 ▾ 1,750,330,473 sat	30	1,000	0.080 sat \$0.000006660	0.000800 sat \$0.00000066596

# 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?

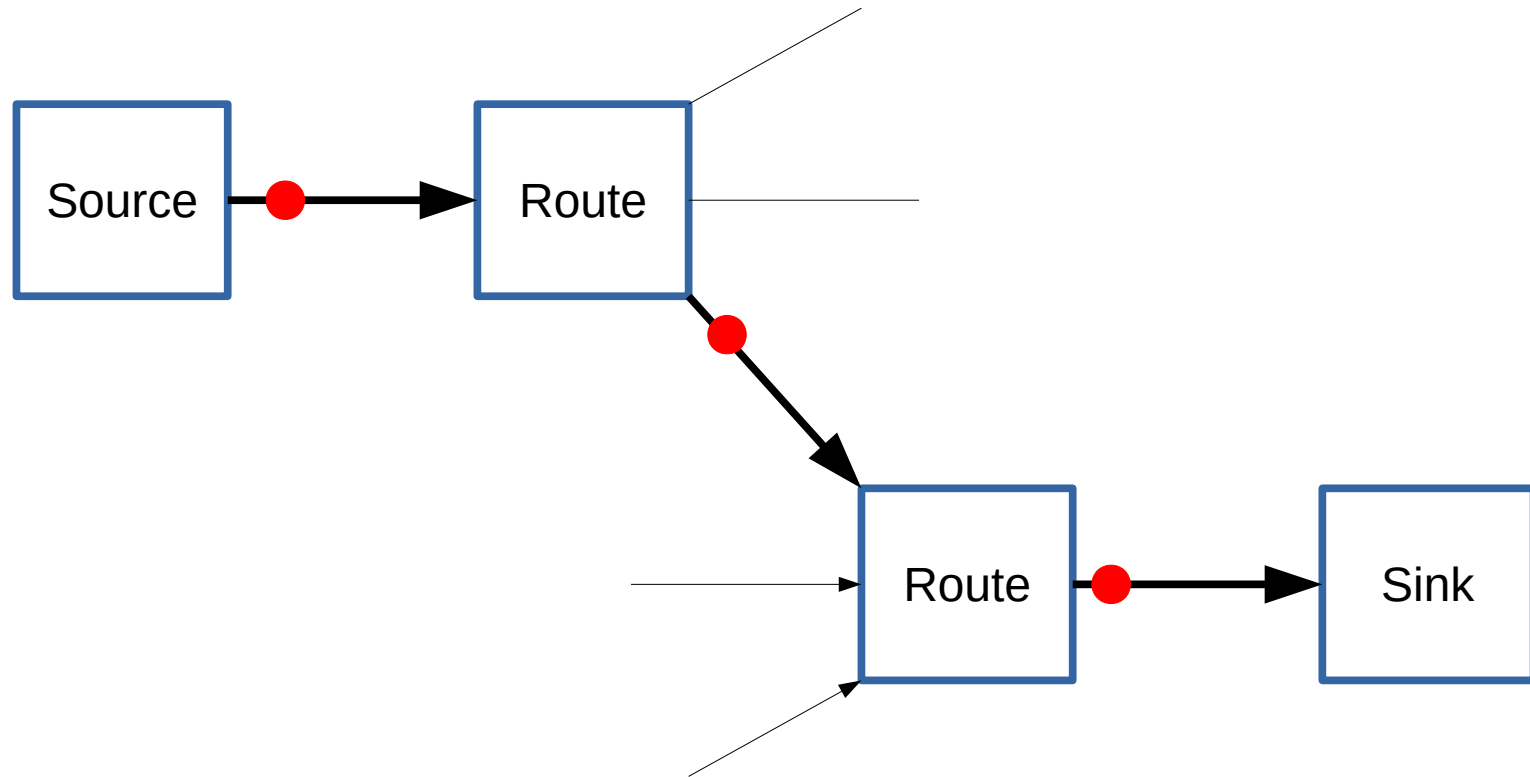
# Profitability vs Lightning Fee Rate



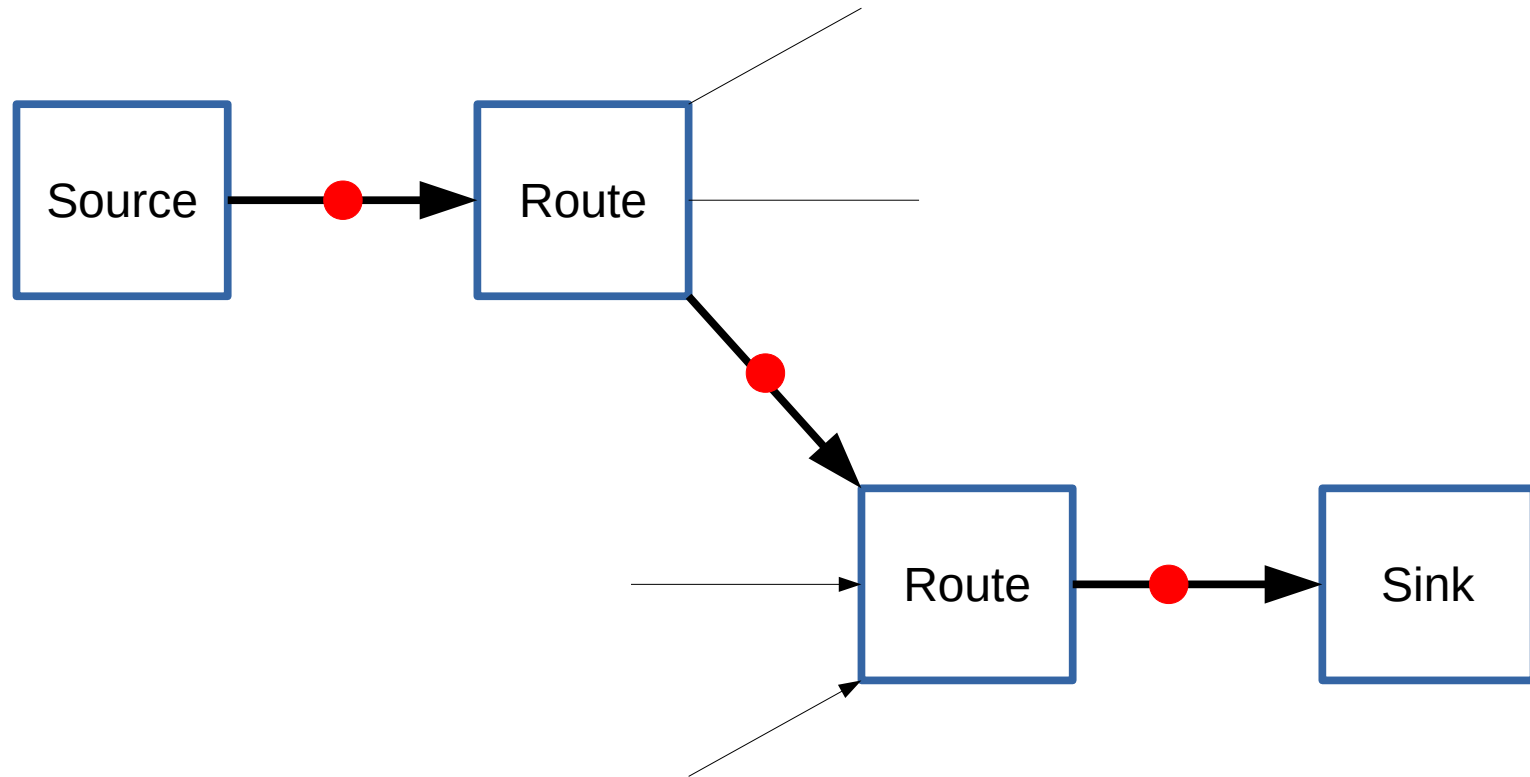
Source: BitMEX Research, [“The Lightning Network \(Part 2\) – Routing Fee Economics”](#)



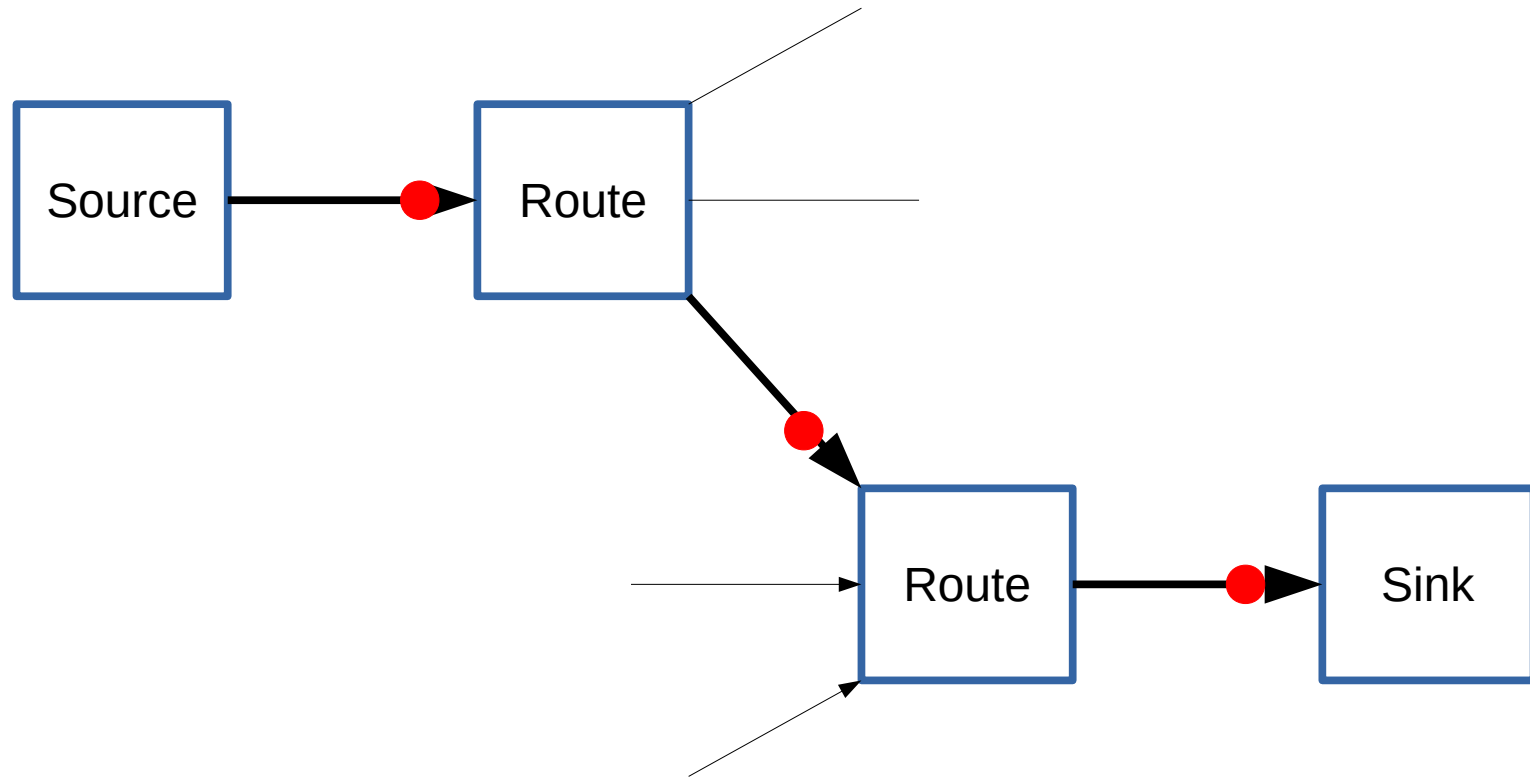
# Linear Payment Flows



# Linear Payment Flows



# Linear Payment Flows



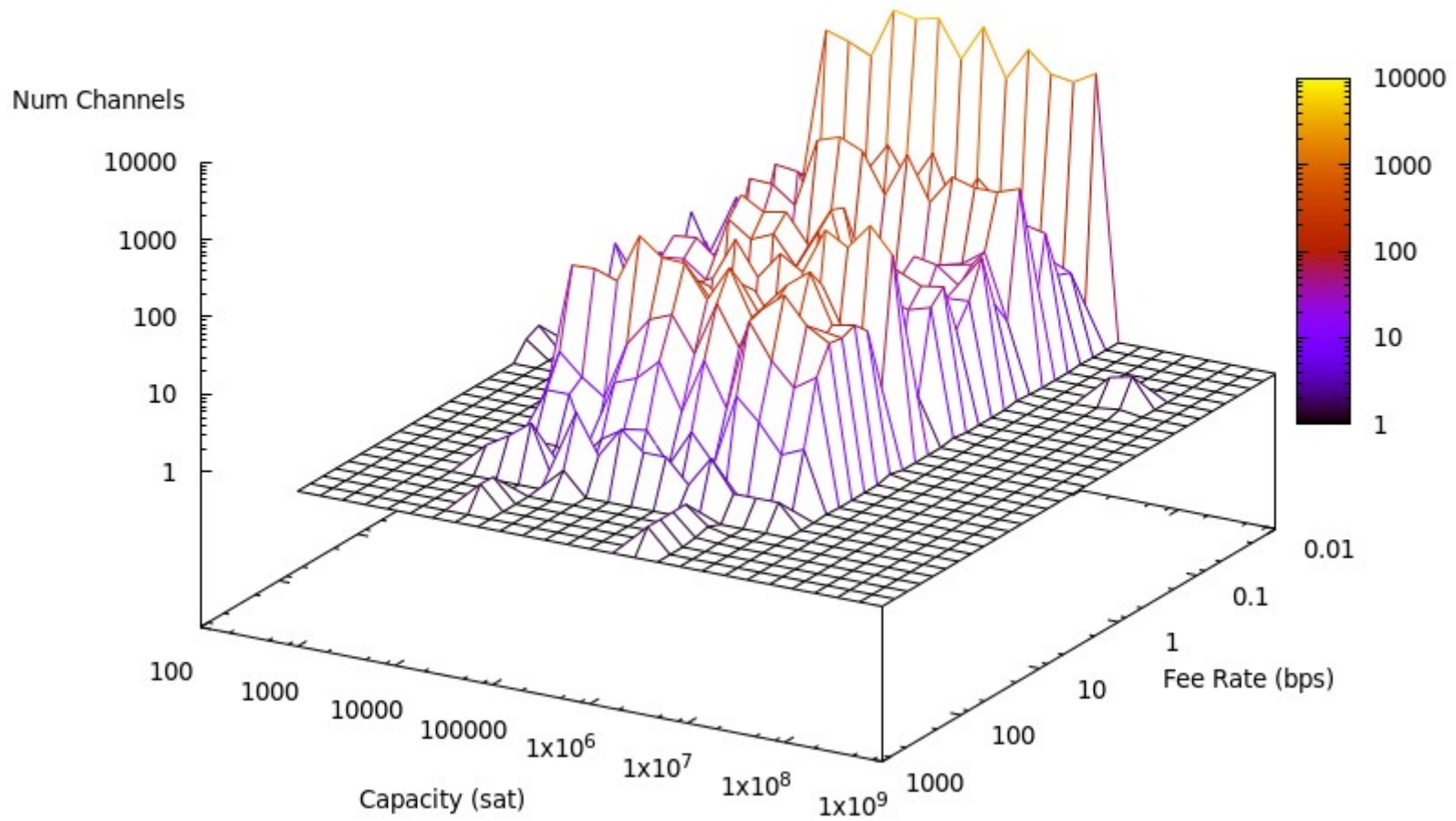
# Methods to Refresh/Replenish Channels

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

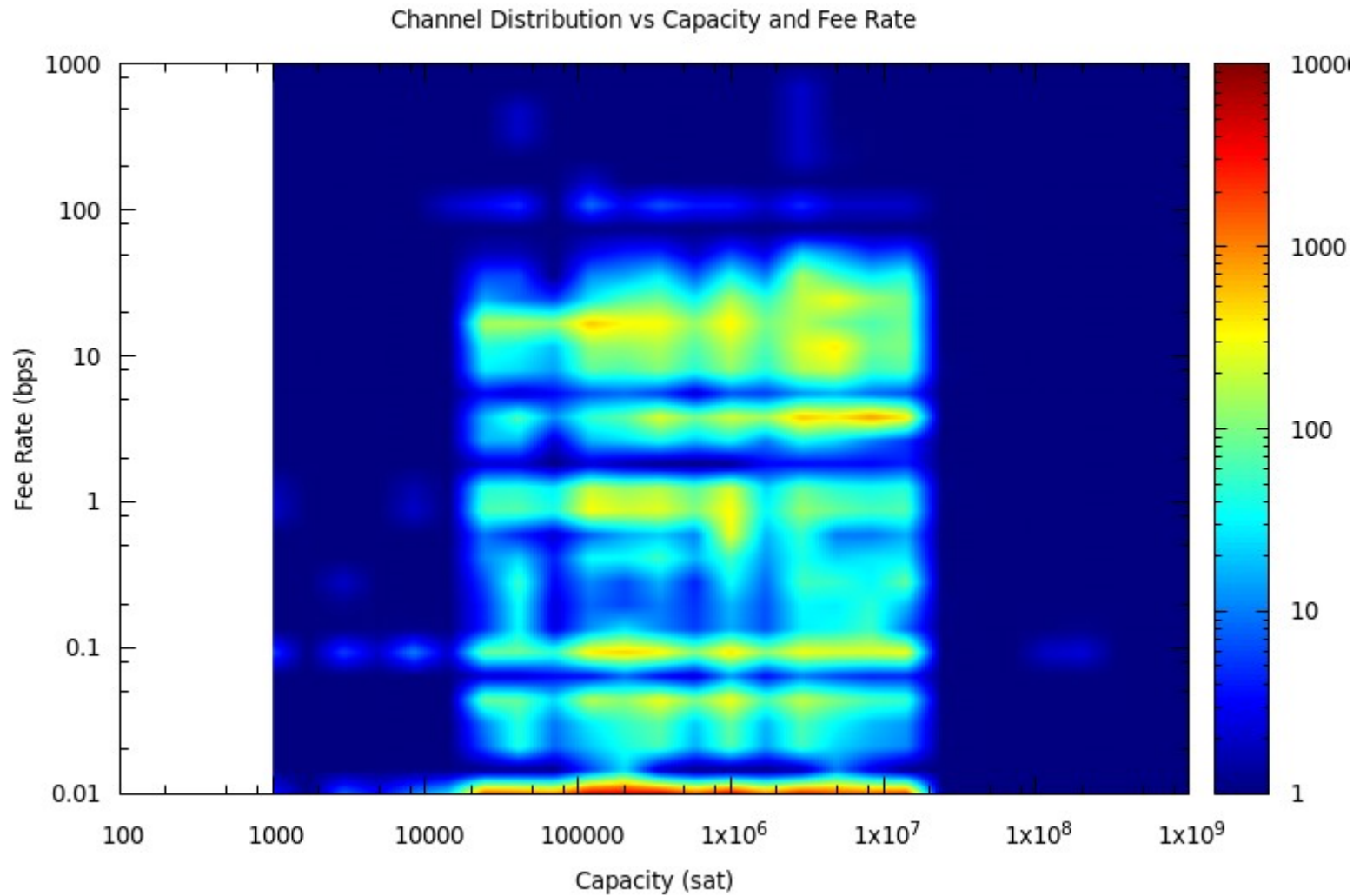
On-chain Mechanisms Work:

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

Channel Distribution vs Capacity and Fee Rate



# Channel Distribution Heatmap



# Break-even Fee Calculation

**VSZ:** Virtual size of funding transaction (150 vbyte)

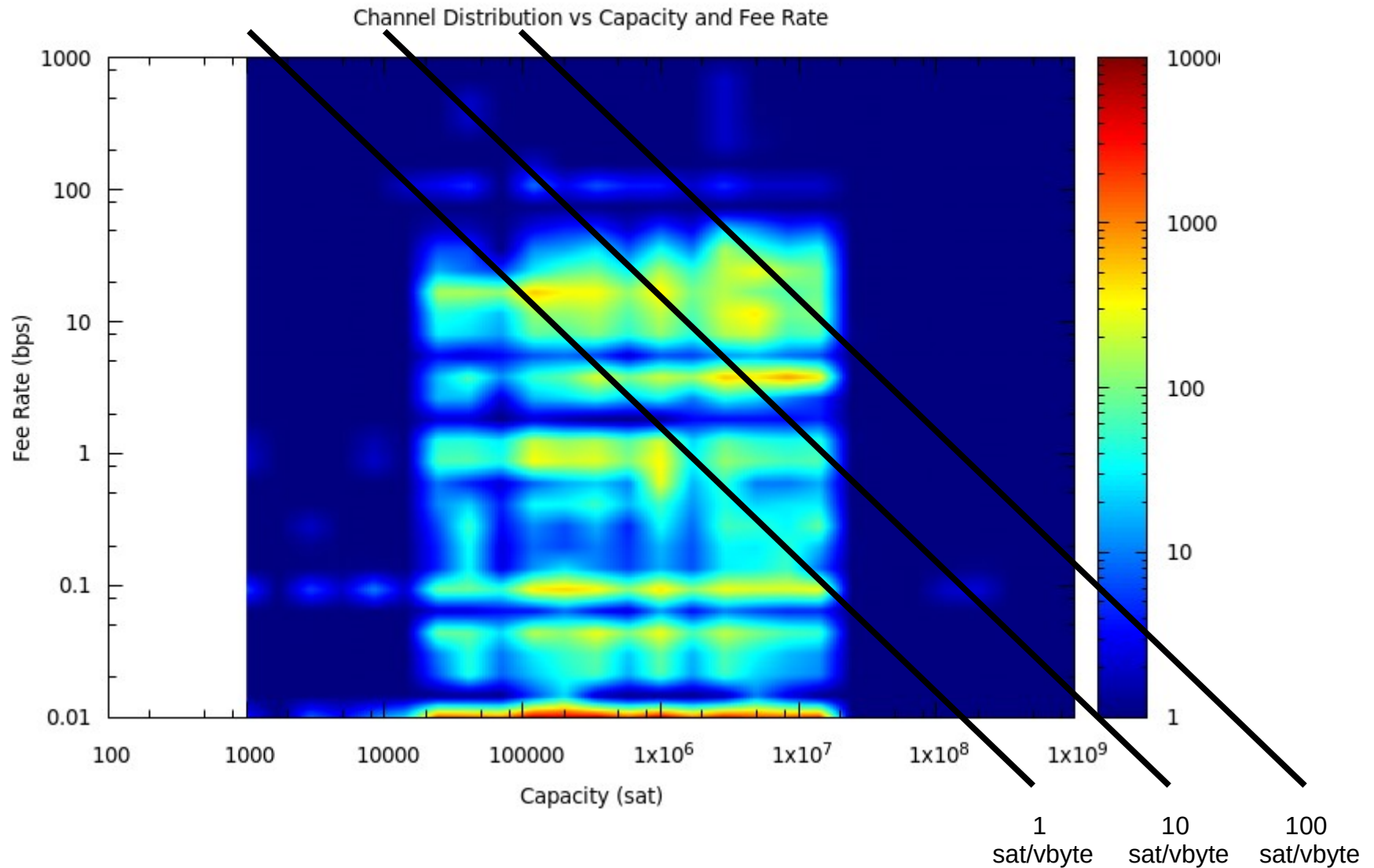
**BFR:** Fee rate of on-chain bitcoin transaction (sats/vbyte)

**CAP:** Size of the created channel (sats)

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

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

# Break-Even Boundaries vs On Chain Fee Rate





# 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.”