# Analysis of the Lightning Fee Market

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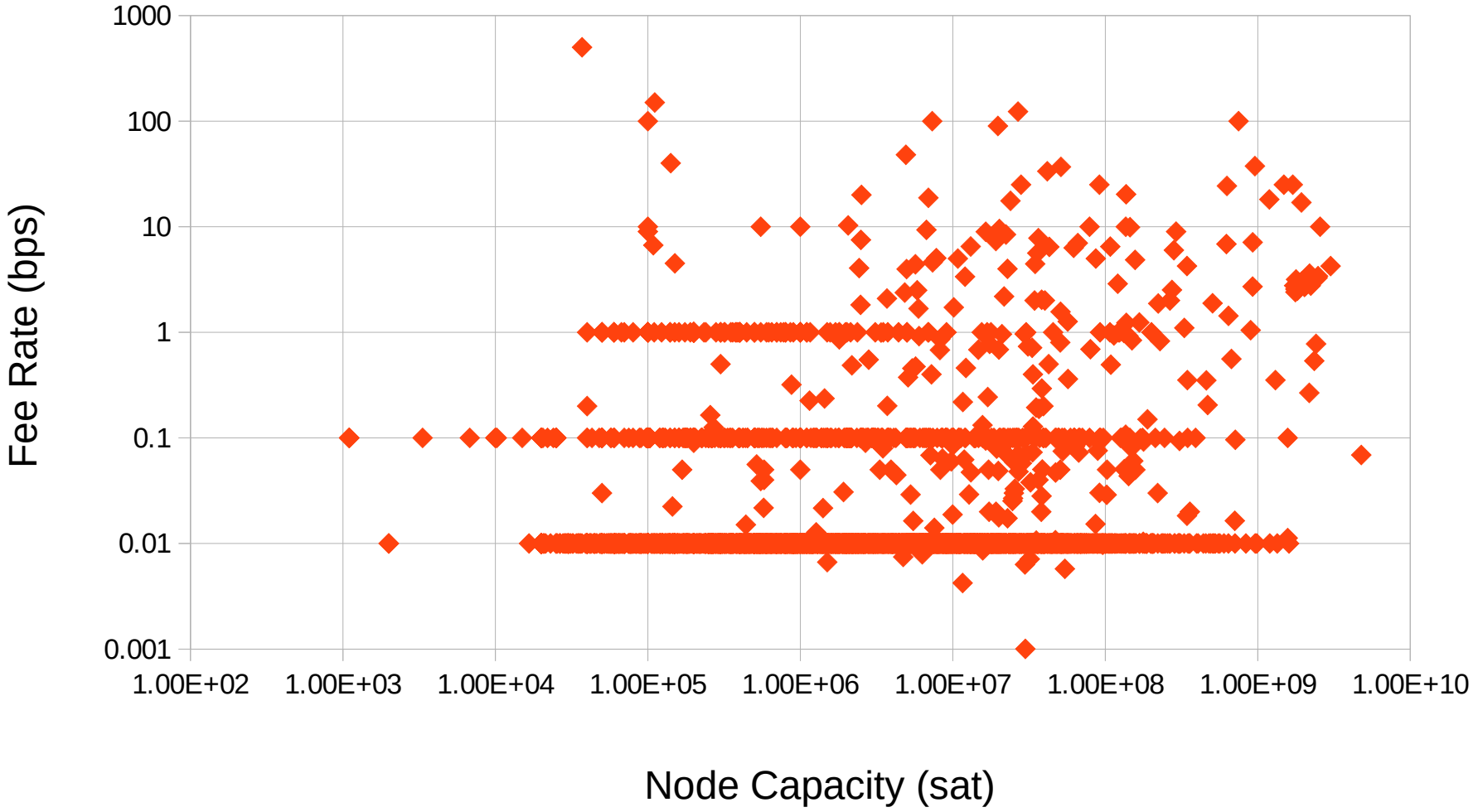
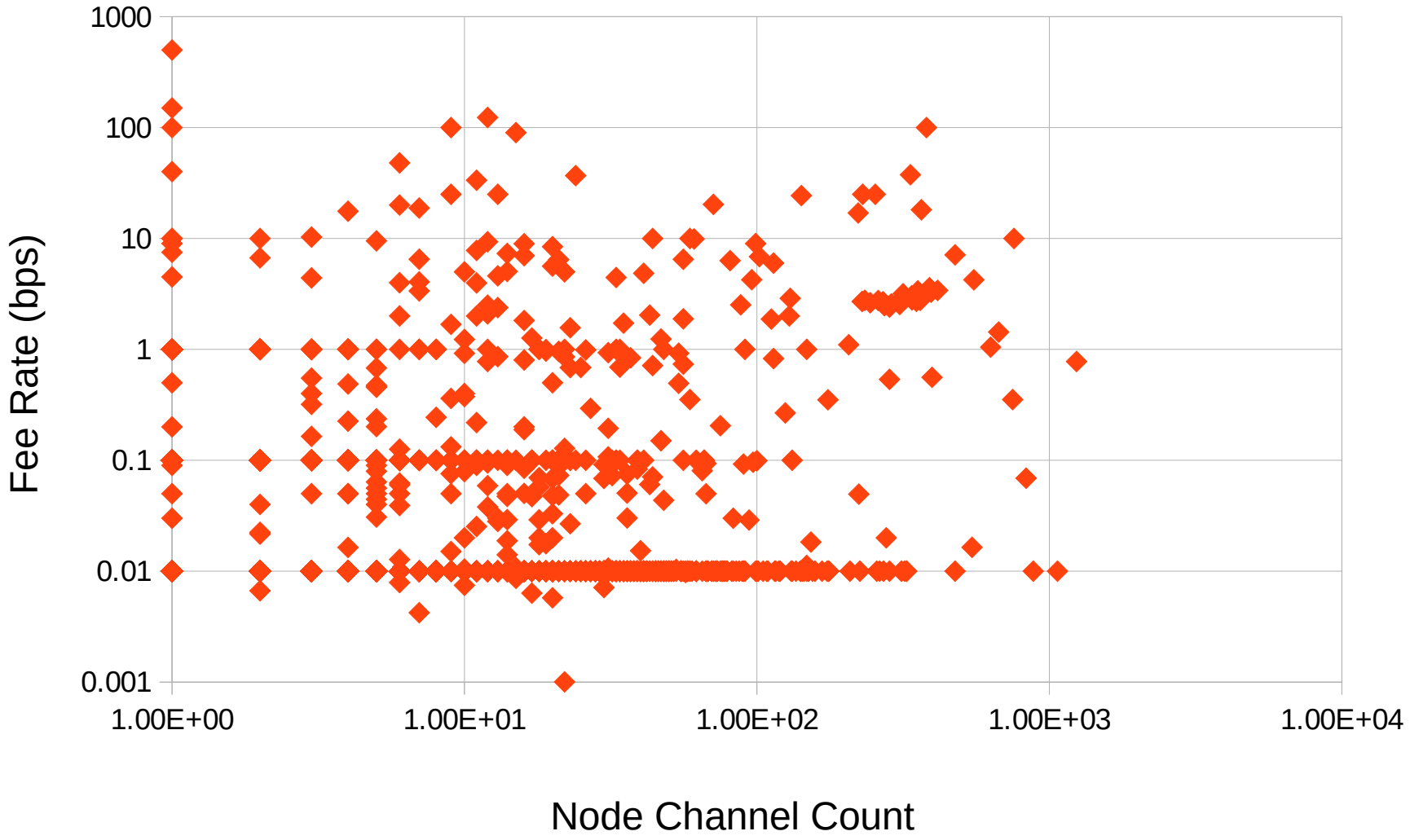
# What are Current Lightning Network Fee Rates?

# 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]: 0249072e6ab527ed917f826bed335c9511028fea53360d09c177e740f8d0dffc0e**

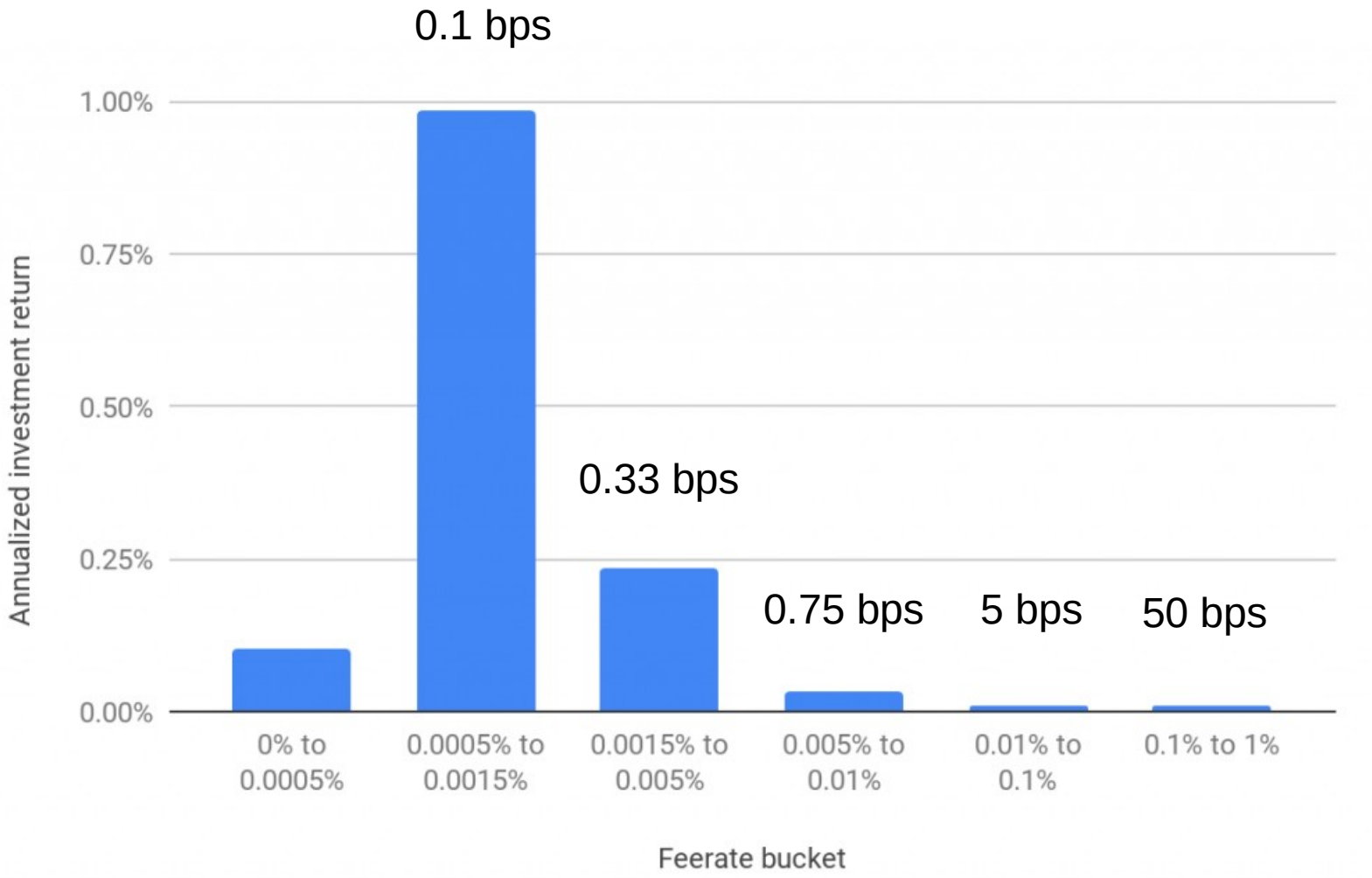
| Alias | Capacity | Time Lock Delta | Min HTLC | Base Fee | Fee Rate |
|---|---|---|---|---|---|
| GoOfAndFyourself[LND] | 0.02622793 BTC $218.34<br>2,622,793 sat | 10 | 1 | 0.000 sa<br>$0.00000000 | 1,000.000000 sat<br>$0.083245400000 |

**Node 2: 03da1c27ca77872ac5b3e568af30673e599a47a5e4497f85c7b5da42048807b3ed**

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

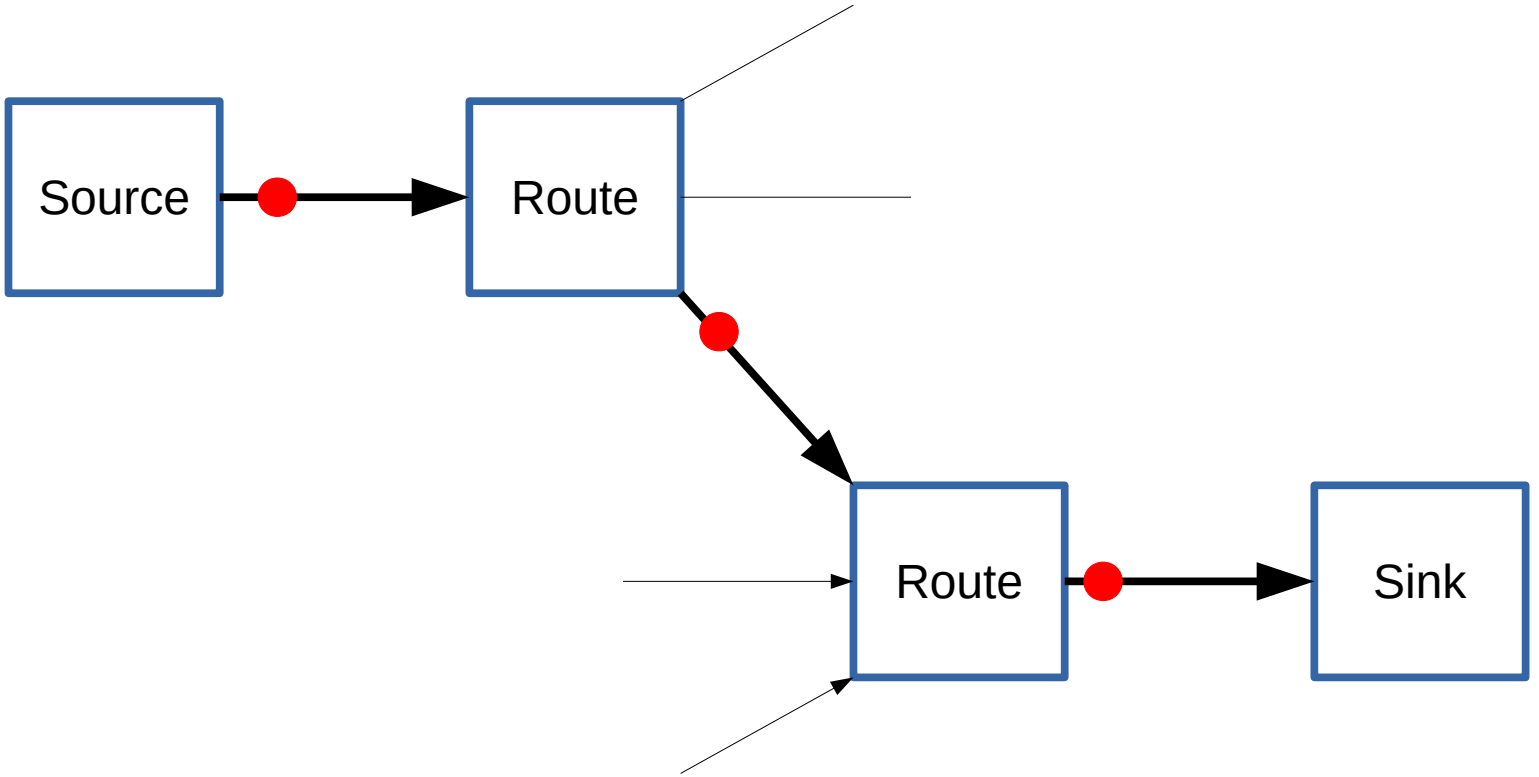
# What are the Market Forces on Fee Rates?

# Profitability vs Lightning Fee Rate

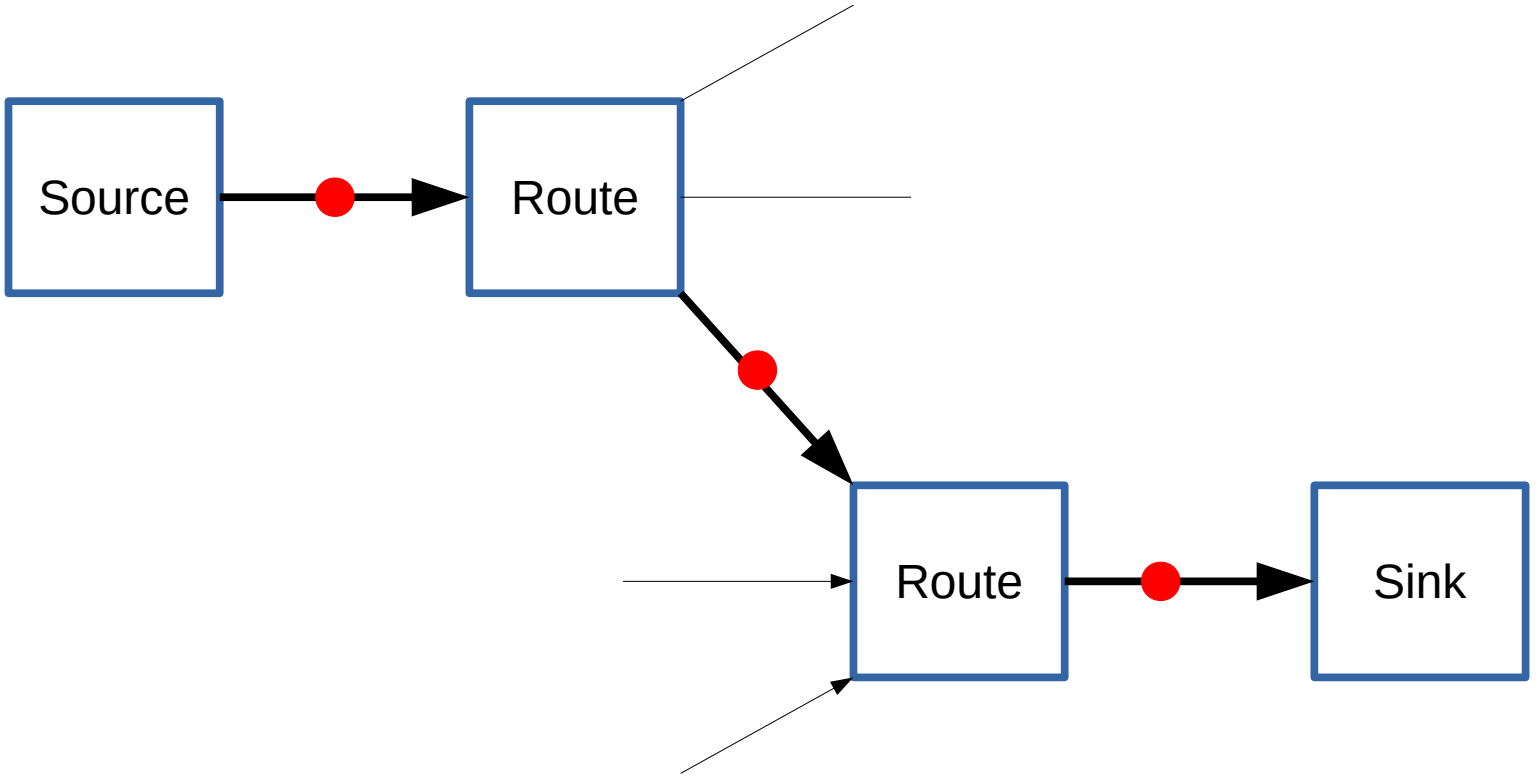



Source: BitMEX Research, "The Lightning Network (Part 2) – Routing Fee Economics"

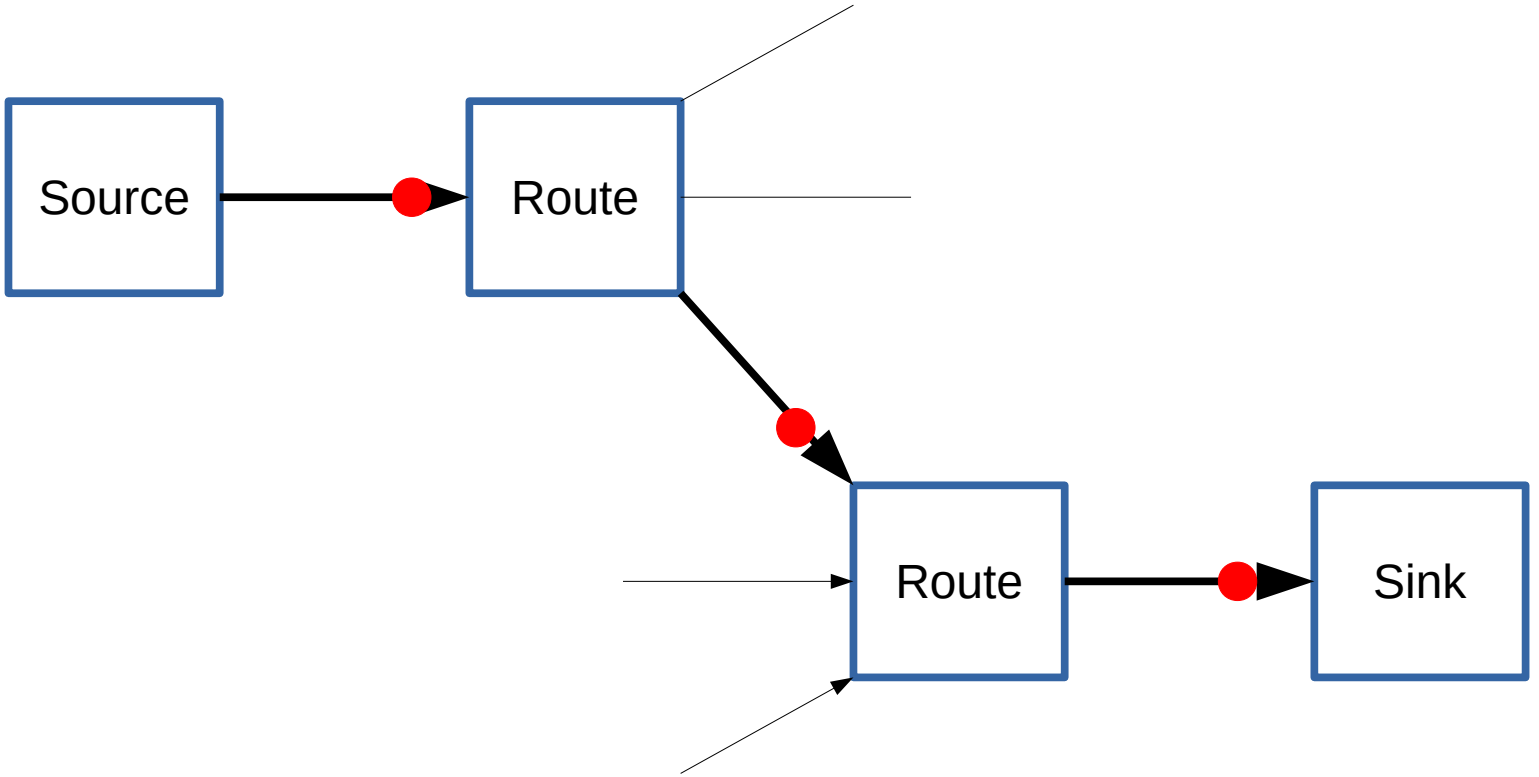
# Linear Payment Flows



# Linear Payment Flows



# Linear Payment Flows

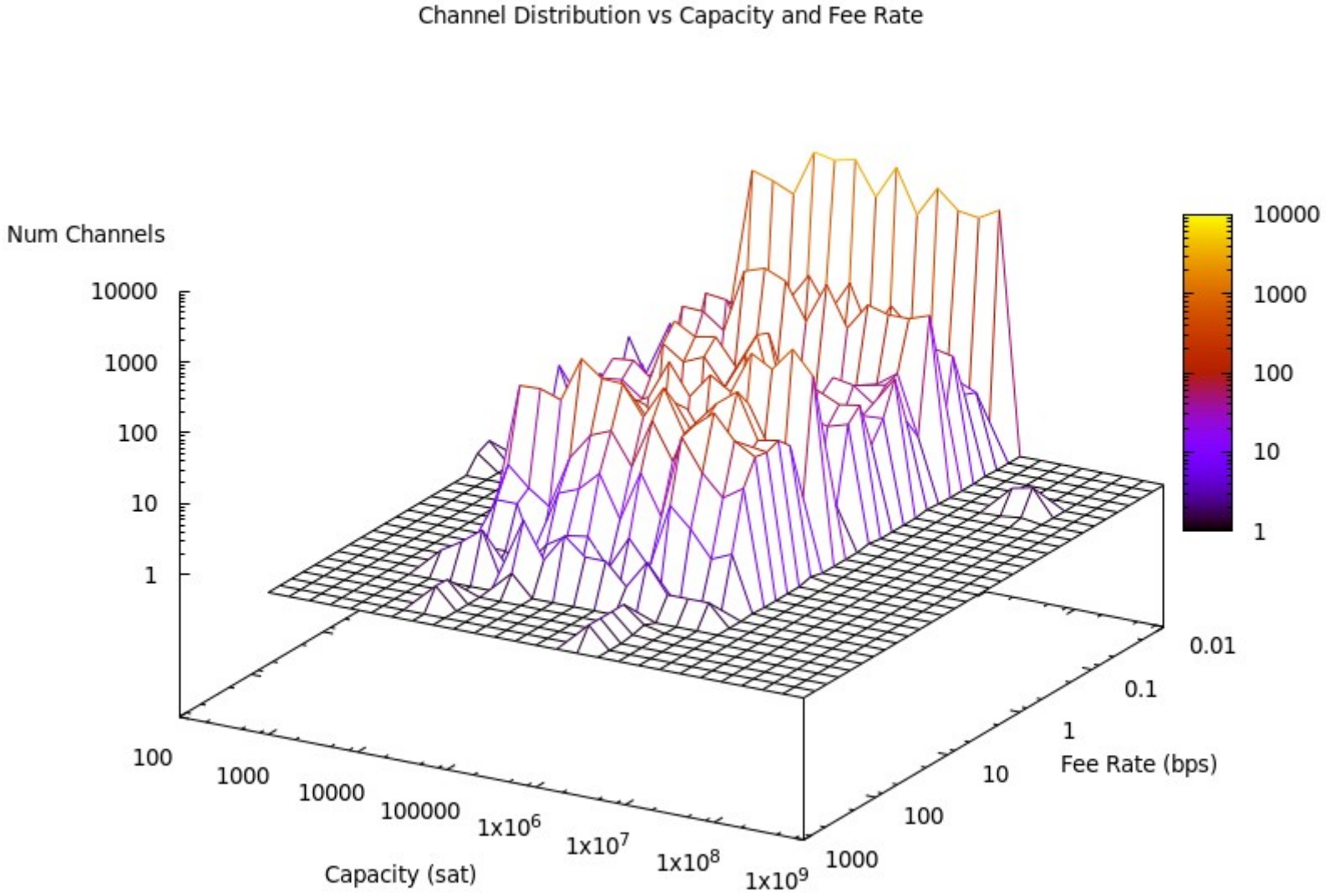


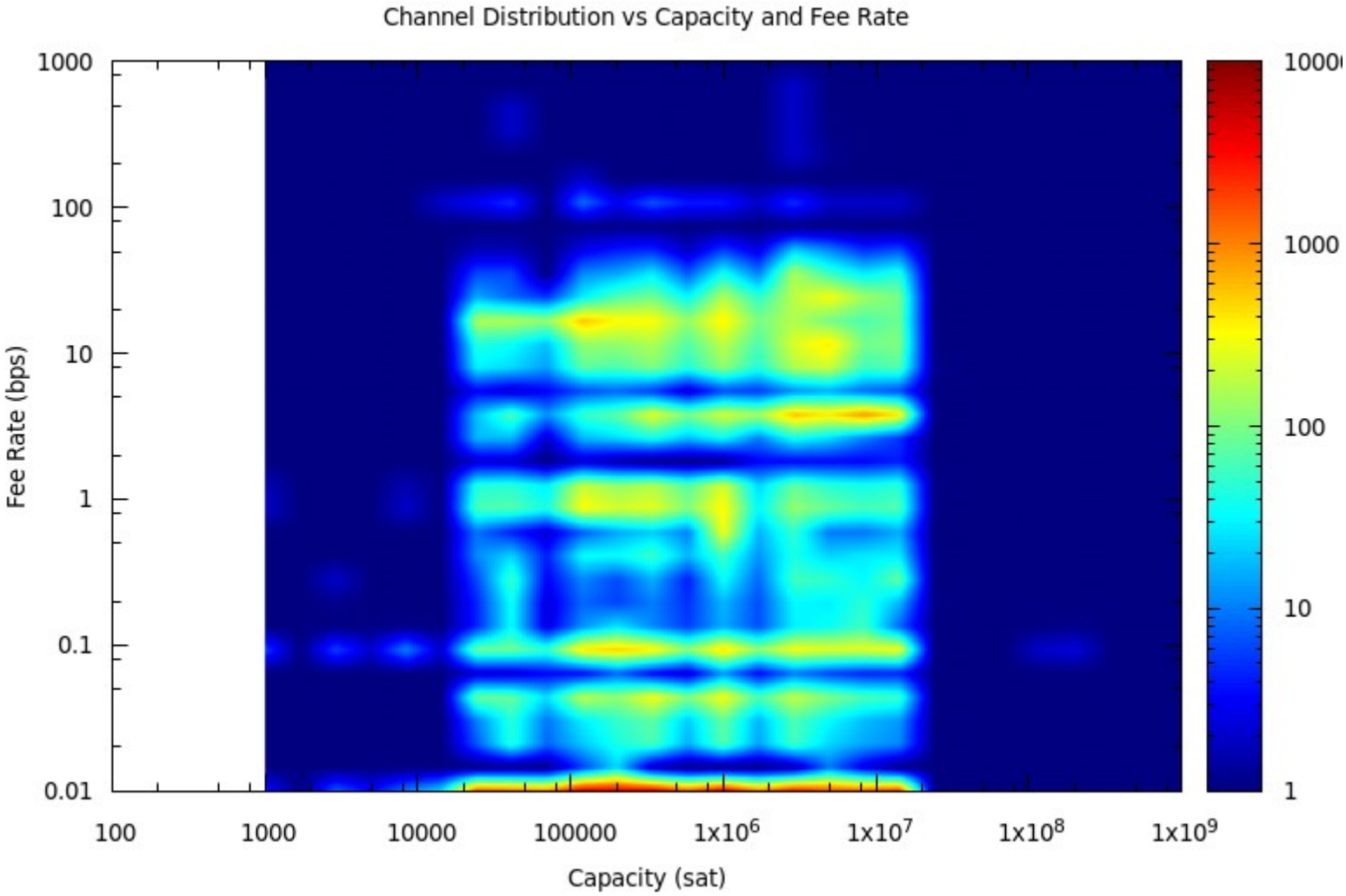
# Methods to Refresh/Replenish Channels

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
Num Channels
10000
1000
100
10
1
100
1000
10000
100000
1x10^6
1x10^7
1x10^8
1x10^9
Capacity (sat)
1000
100
10
1
0.1
0.01
Fee Rate (bps)
10000
1000
100
10
1


Channel Distribution vs Capacity and Fee Rate
Fee Rate (bps)
1000
100
10
1
0.1
0.01
100
1000
10000
100000
1x10^6
1x10^7
1x10^8
1x10^9
Capacity (sat)
1000
100
10
1

# Break-even Fee Calculation

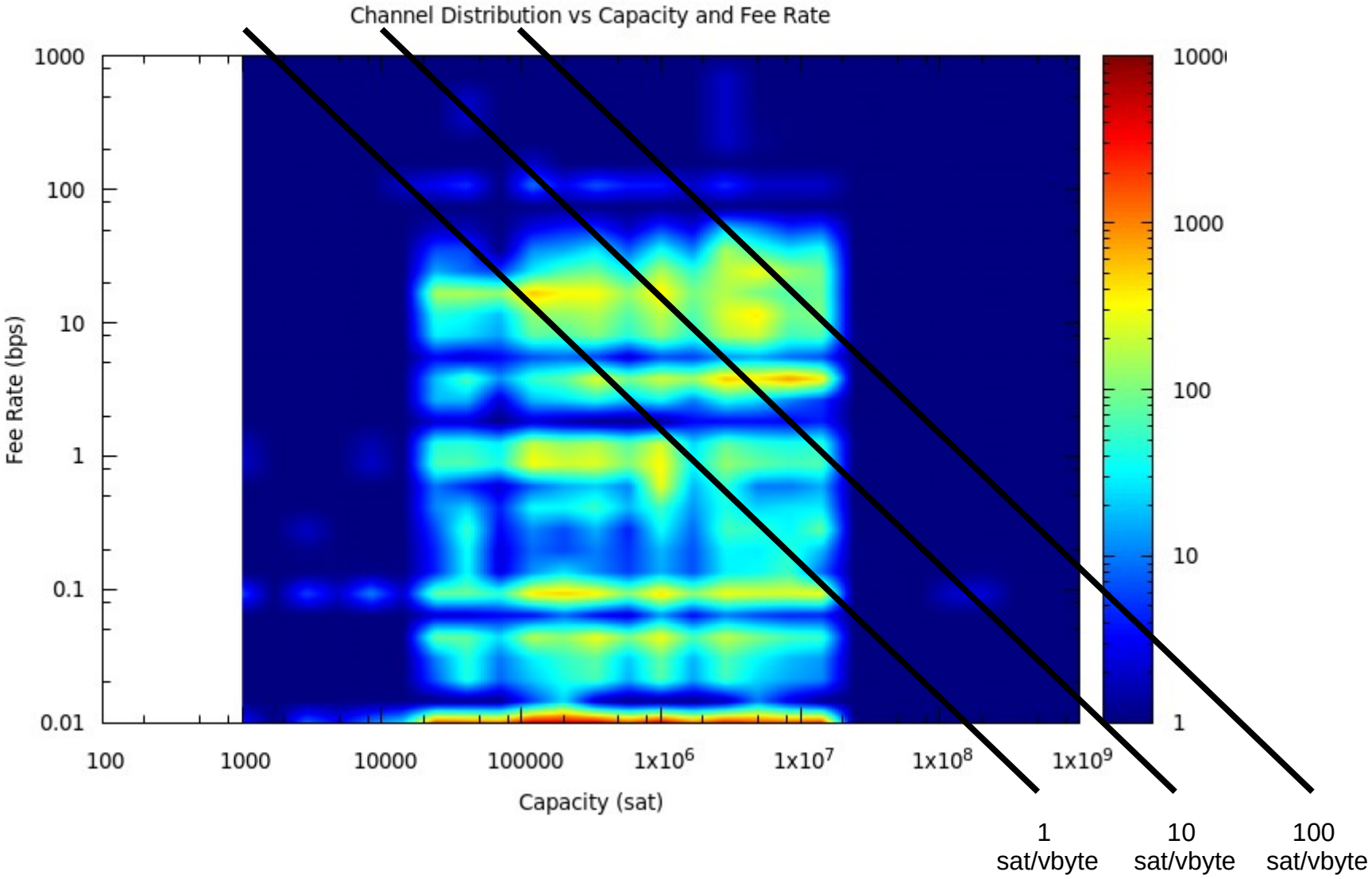
**VSZ**: Virtual size of funding transaction (150 vbyte)

**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)

$$LFR = 10000 * BFR * VSZ / CAP$$


Channel Distribution vs Capacity and Fee Rate
Fee Rate (bps)
1000
100
10
1
0.1
0.01
100
1000
10000
100000
1x10^6
1x10^7
1x10^8
1x10^9
Capacity (sat)
1000
1000
100
10
1
1
sat/vbyte
10
sat/vbyte
100
sat/vbyte

# 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."