

Non-Linear Servicer Stake Weighting – Appendix

Analysis and justification of a non-linear stake weighting update of the PIP-22 parameters.

Parameter Update Proposal by:

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Disclaimer

This work was produced by Pocket Scan Technologies LLC, a company operating on the Pocket Network.

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Changelog

v1.0	2022-09-13	First version.
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1 Abstract

This document contains the appendixes of the proposal by the same name.

In the appendixes the main graphs observed in section 4 of the main document are reproduced for other chains. Please remember that all these other chains are less stable than chain 0009 or have fewer relays (see section 4.1 of the main document).

The appendix have the chains ordered by their global variation, from most stable to less stable followed by the analysis of all together under the section title *Network*. At the end of the document the main results are compiled in a series of tables.

2 Polygon Mainnet (0009)

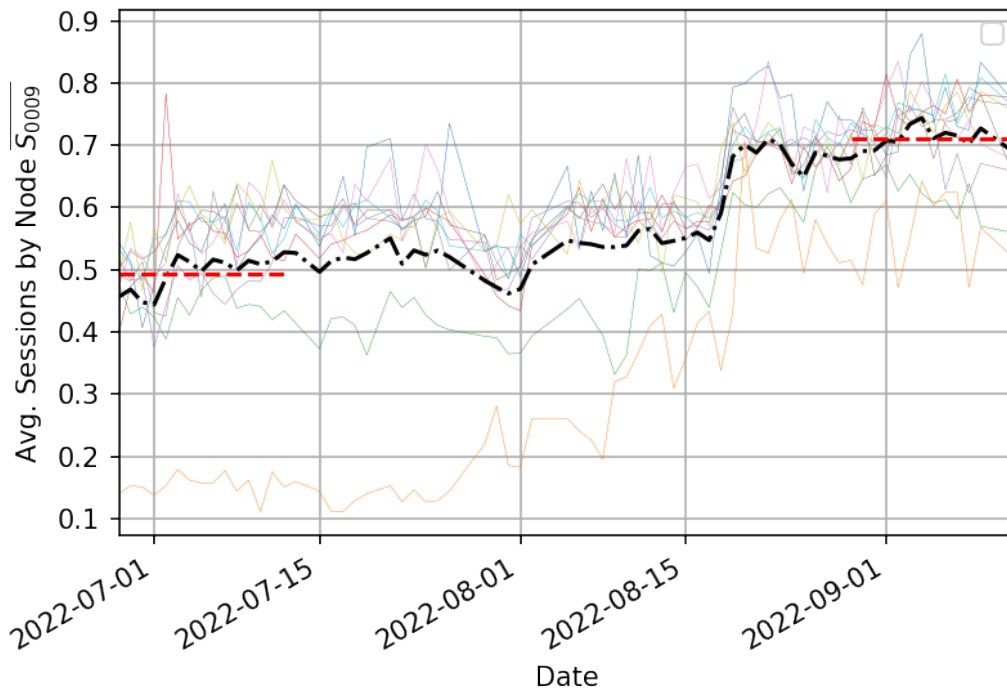


Figure 1: Polygon Mainnet (0009) : Evolution of the average number of sessions that a node serve in 24 HS (\bar{S}_c) for the blockchain 0009 as a function of the date. The thin lines represent different node providers, the black line represents the average. The red segments represent the means at the start and end of the period respectively. The average at the beginning is 0.49 and at the end 0.71 sessions by node.

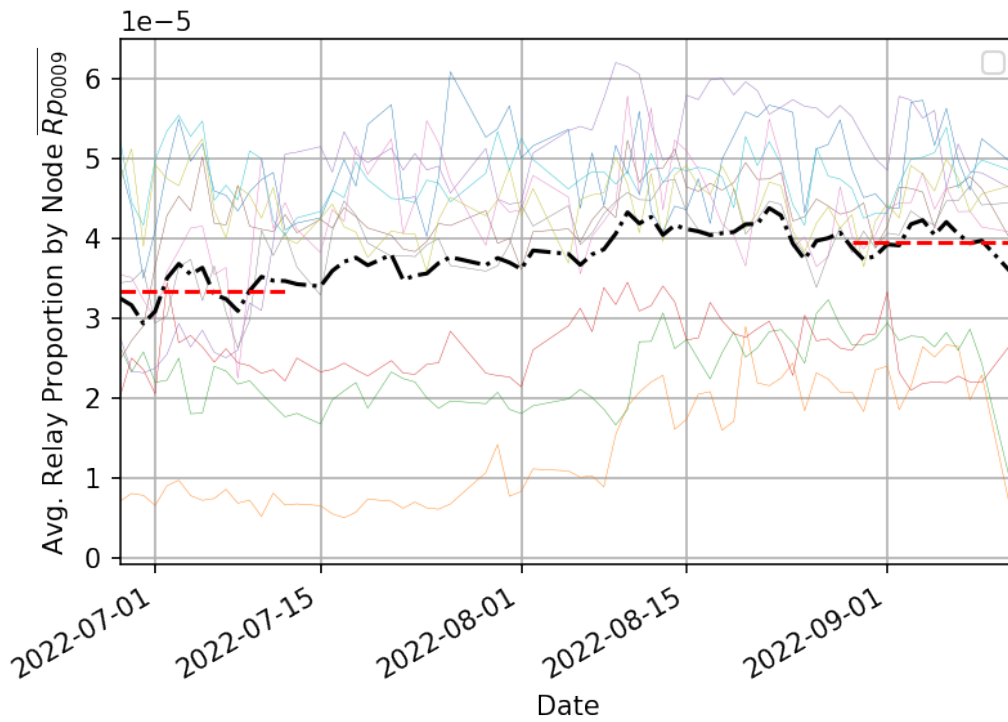


Figure 2: Polygon Mainnet (0009) : Evolution of the average relay proportion that a node work in 24 HS ($\overline{Rp_c}$) for the blockchain 0009 as a function of the date. The thin lines represent different node providers, the black line represents the average. The red segments represent the means at the start and end of the period respectively. The average at the beginning is 3.34×10^{-5} and at the end 3.95×10^{-5} .

$$Vr_c = \frac{variation(\overline{Rp_{0009}}^{ini}, \overline{Rp_{0009}}^{end})}{variation(\overline{S_{0009}}^{ini}, \overline{S_{0009}}^{end})} = \frac{0.18}{0.44} = 0.41 \quad (1)$$

Table 1: Polygon Mainnet (0009) : Changes in the number of sessions by node and relays proportion worked by node prior and post PIP-22.

	Prior	Post	change
Avg. Sessions ($\overline{S_{0009}}$)	0.49	0.71	44%
Avg. Worked Relays Prop. ($\overline{Rp_{0009}}$)	3.34×10^{-5}	3.95×10^{-5}	18%

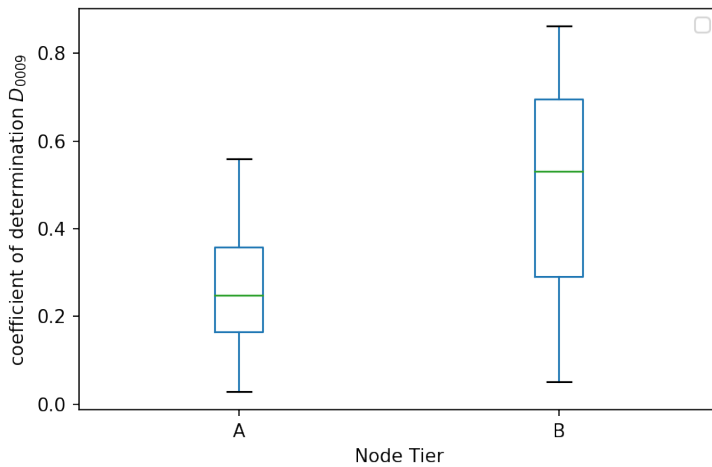


Figure 3: Polygon Mainnet (0009) : Coefficients of Determination D_c in chain $c = 0009$ for the tested providers grouped using the avg. QoS threshold of $QoS = 0.3s$. Faster nodes are in Tier A, slower ones in Tier B.

Table 2: Polygon Mainnet (0009) : Determination coefficients statistics for each group of node providers. Faster nodes are in Tier A, slower ones in Tier B.

Tier	mean D_{0009}	std D_{0009}
A	0.27	0.18
B	0.48	0.41

3 Fantom (0049)

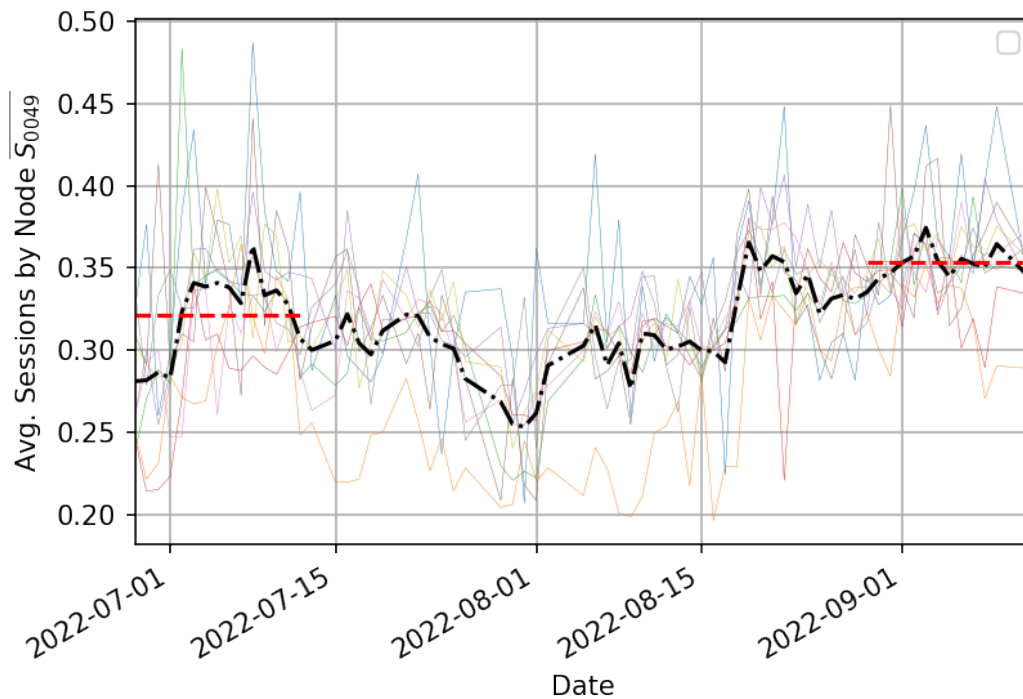


Figure 4: Fantom (0049) : Evolution of the average number of sessions that a node serve in 24 HS ($\overline{S_c}$) for the blockchain 0049 as a function of the date. The thin lines represent different node providers, the black line represents the average. The red segments represent the means at the start and end of the period respectively. The average at the beginning is 0.32 and at the end 0.35 sessions by node.

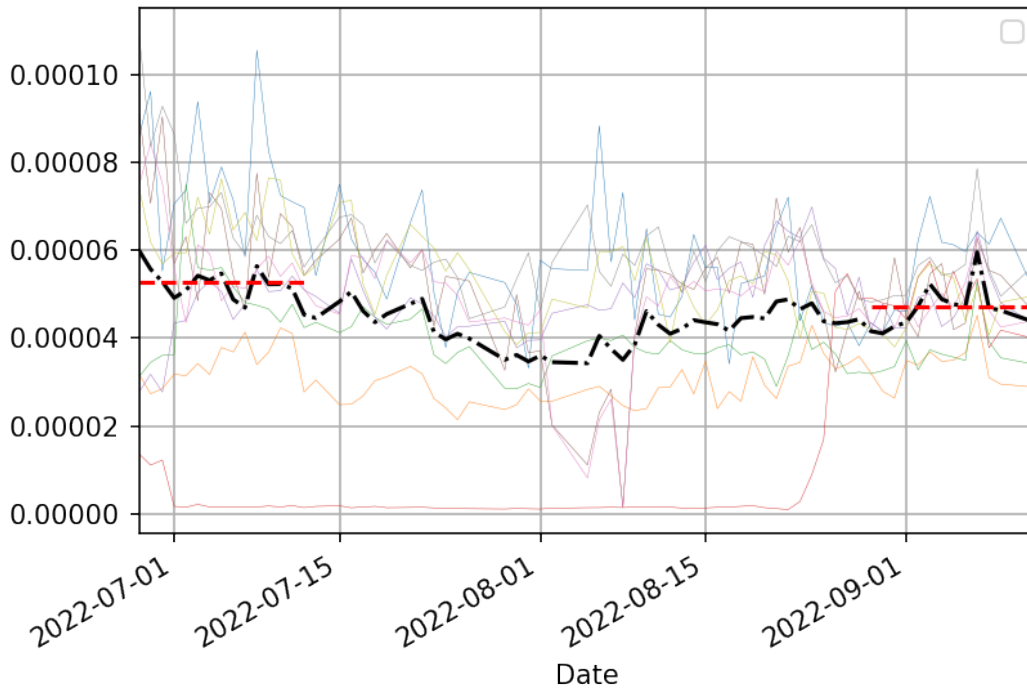


Figure 5: Fantom (0049) : Evolution of the average relay proportion that a node work in 24 HS ($\overline{Rp_c}$) for the blockchain 0049 as a function of the date. The thin lines represent different node providers, the black line represents the average. The red segments represent the means at the start and end of the period respectively. The average at the beginning is 5.27×10^{-5} and at the end 4.72×10^{-5} .

$$Vr_c = \frac{\text{variation}(\overline{Rp_{0049}}^{ini}, \overline{Rp_{0049}}^{end})}{\text{variation}(\overline{S_{0049}}^{ini}, \overline{S_{0049}}^{end})} = \frac{0.09}{-0.10} = -0.9 \quad (2)$$

Table 3: Fantom (0049) : Changes in the number of sessions by node and relays proportion worked by node prior and post PIP-22.

	Prior	Post	change
Avg. Sessions ($\overline{S_{0049}}$)	0.32	0.35	9%
Avg. Worked Relays Prop. ($\overline{Rp_{0049}}$)	5.27×10^{-5}	4.72×10^{-5}	-10%

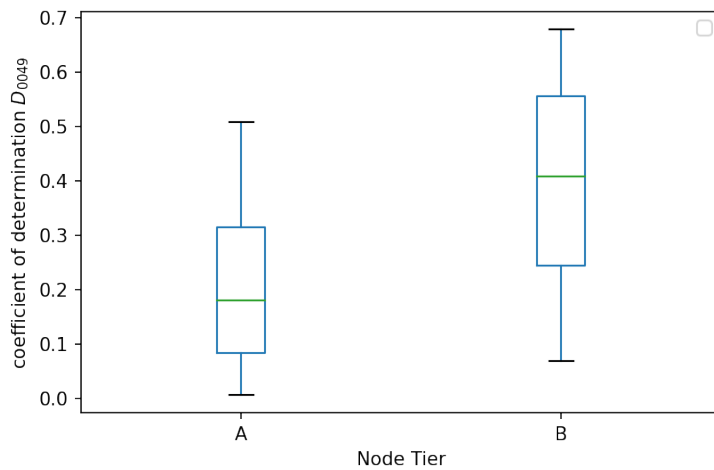


Figure 6: Fantom (0049) : Coefficients of Determination D_c in chain $c = 0049$ for the tested providers grouped using the avg. QoS threshold of $QoS = 0.3s$. Faster nodes are in Tier A, slower ones in Tier B.

Table 4: Fantom (0049) : Determination coefficients statistics for each group of node providers. Faster nodes are in Tier A, slower ones in Tier B.

Tier	mean D_{0049}	std D_{0049}
A	0.22	0.22
B	0.39	0.26

4 Gnosis - xDai (0027)

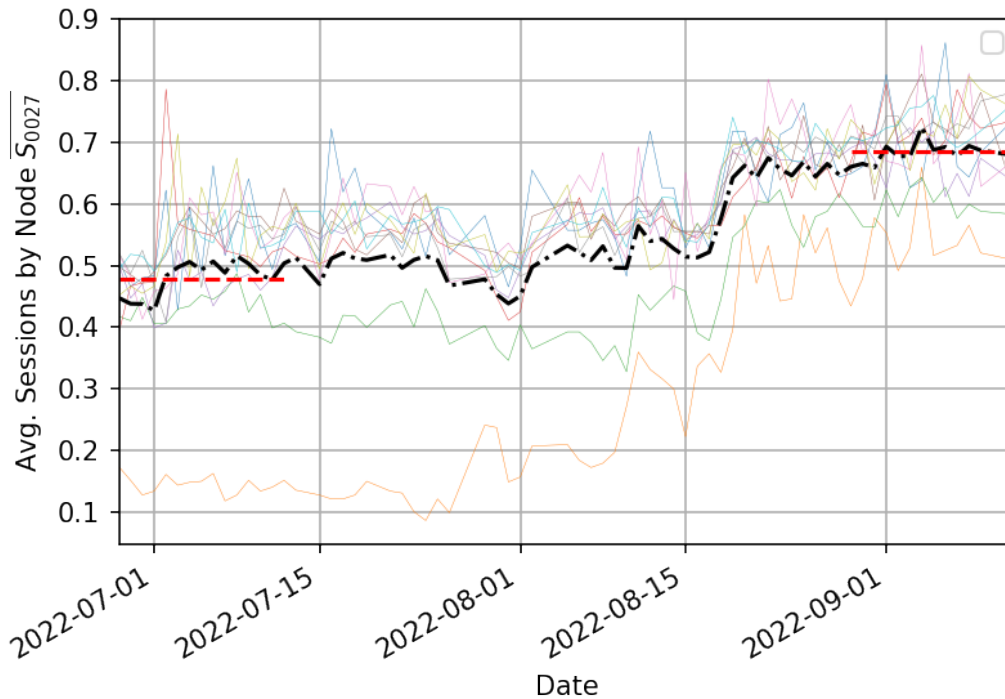


Figure 7: Gnosis - xDai (0027) : Evolution of the average number of sessions that a node serve in 24 HS (S_c) for the blockchain 0027 as a function of the date. The thin lines represent different node providers, the black line represents the average. The red segments represent the means at the start and end of the period respectively. The average at the beginning is 0.48 and at the end 0.68 sessions by node.

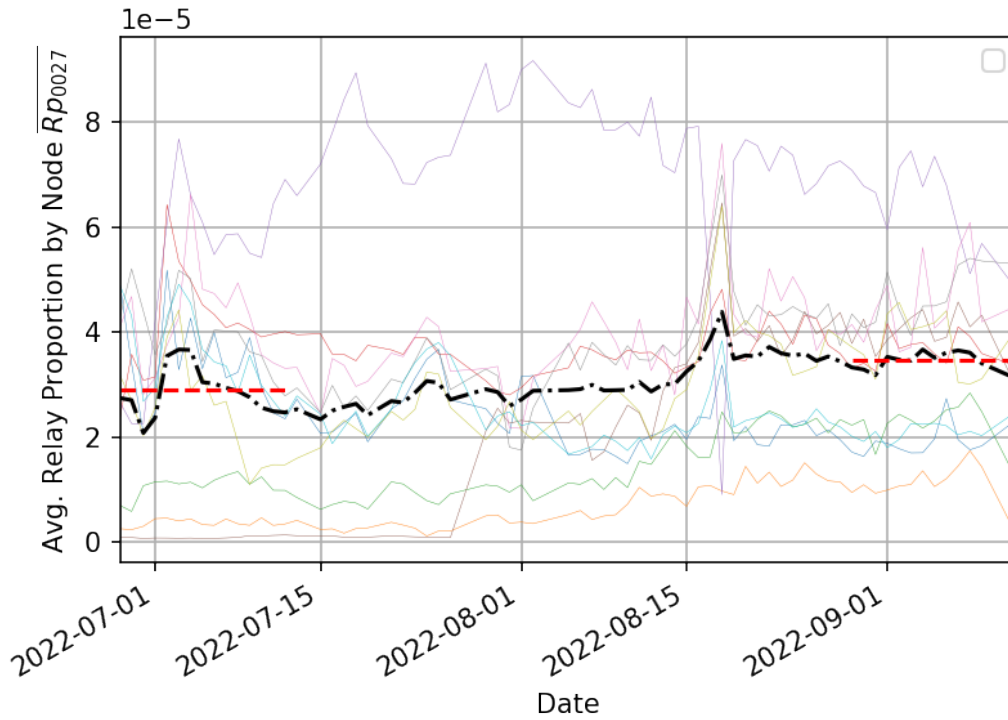


Figure 8: Gnosis - xDai (0027) : Evolution of the average relay proportion that a node work in 24 HS ($\overline{Rp_c}$) for the blockchain 0027 as a function of the date. The thin lines represent different node providers, the black line represents the average. The red segments represent the means at the start and end of the period respectively. The average at the beginning is 2.89×10^{-5} and at the end 3.46×10^{-5} .

$$Vr_c = \frac{\text{variation}(\overline{Rp_{0027}}^{ini}, \overline{Rp_{0027}}^{end})}{\text{variation}(\overline{S_{0027}}^{ini}, \overline{S_{0027}}^{end})} = \frac{0.20}{0.43} = 0.46 \quad (3)$$

Table 5: Gnosis - xDai (0027) : Changes in the number of sessions by node and relays proportion worked by node prior and post PIP-22.

	Prior	Post	change
Avg. Sessions ($\overline{S_{0027}}$)	0.48	0.68	43%
Avg. Worked Relays Prop. ($\overline{Rp_{0027}}$)	2.89×10^{-5}	3.46×10^{-5}	20%

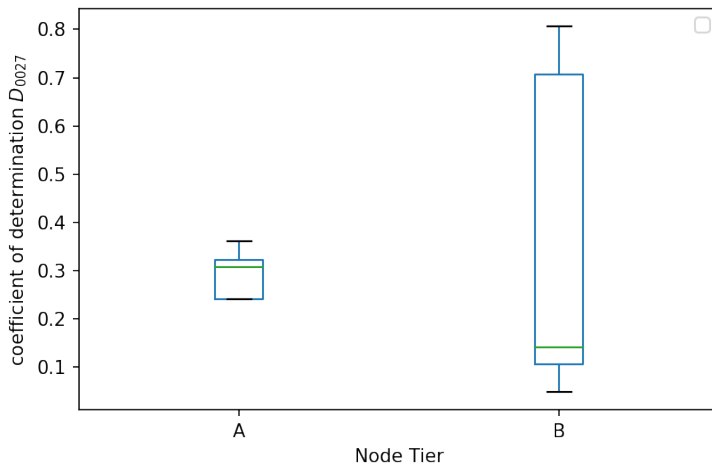


Figure 9: Gnosis - xDai (0027) : Coefficients of Determination D_c in chain $c = 0027$ for the tested providers grouped using the avg. QoS threshold of $QoS = 0.3s$. Faster nodes are in Tier A, slower ones in Tier B.

Table 6: Gnosis - xDai (0027) : Determination coefficients statistics for each group of node providers. Faster nodes are in Tier A, slower ones in Tier B.

Tier	mean D_{0027}	std D_{0027}
A	0.25	0.14
B	0.36	0.36

5 Harmony Shard 0 (0040)

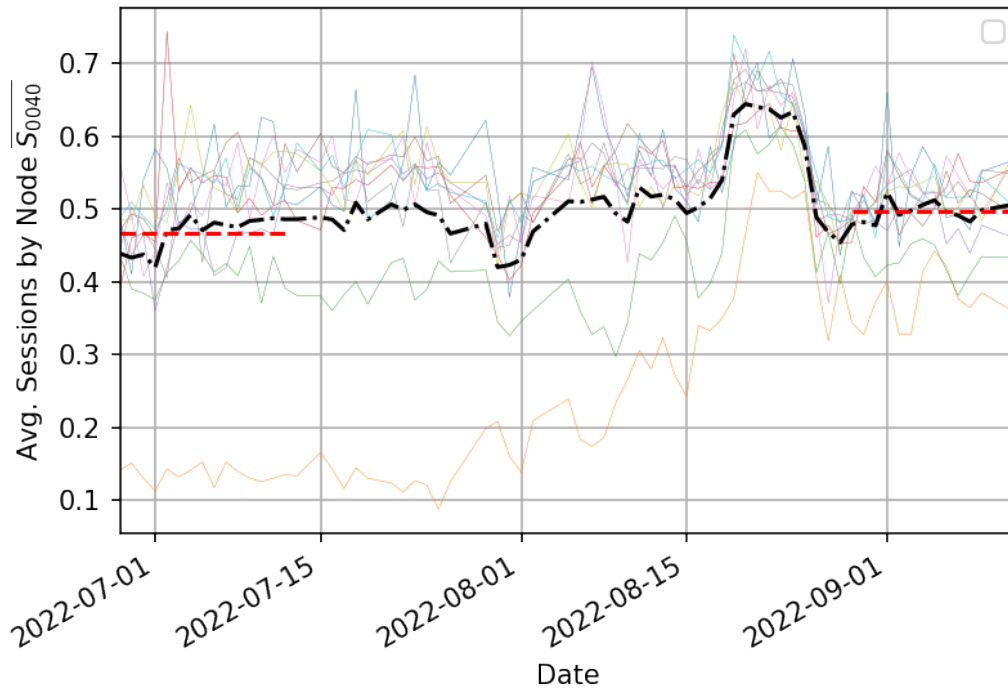


Figure 10: Harmony Shard 0 (0040) : Evolution of the average number of sessions that a node serve in 24 HS (\bar{S}_c) for the blockchain 0040 as a function of the date. The thin lines represent different node providers, the black line represents the average. The red segments represent the means at the start and end of the period respectively. The average at the beginning is 0.47 and at the end 0.50 sessions by node.

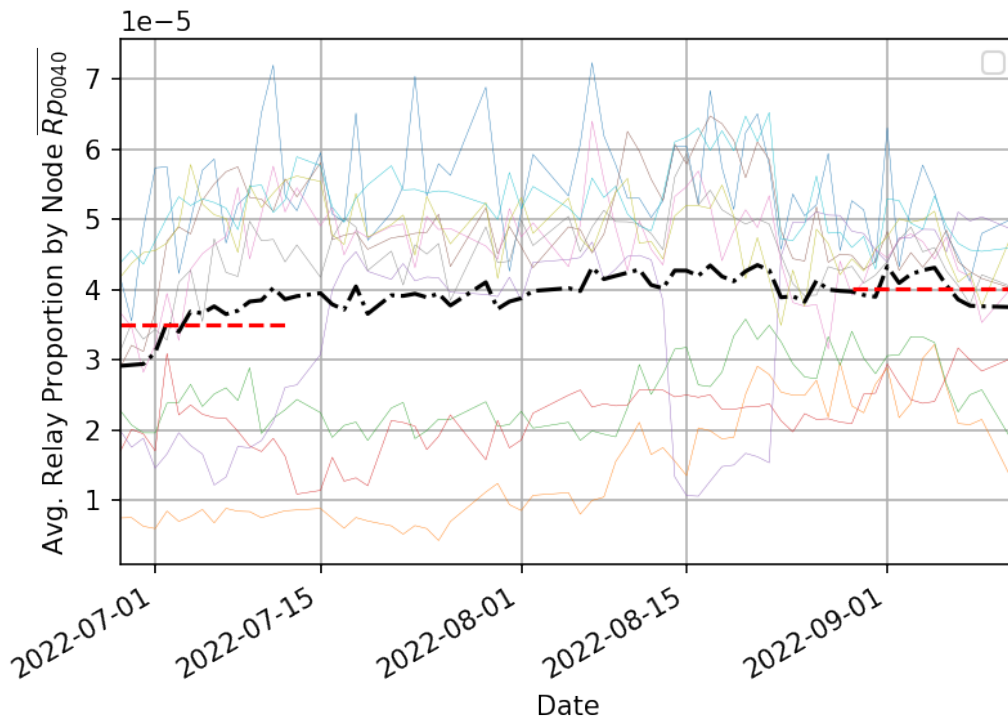


Figure 11: Harmony Shard 0 (0040) : Evolution of the average relay proportion that a node work in 24 HS ($\overline{Rp_c}$) for the blockchain 0040 as a function of the date. The thin lines represent different node providers, the black line represents the average. The red segments represent the means at the start and end of the period respectively. The average at the beginning is 3.50×10^{-5} and at the end 4.02×10^{-5} .

$$Vr_c = \frac{\text{variation}(\overline{Rp_{0040}}^{ini}, \overline{Rp_{0040}}^{end})}{\text{variation}(\overline{S_{0040}}^{ini}, \overline{S_{0040}}^{end})} = \frac{0.15}{0.07} = 2.14 \quad (4)$$

Table 7: Harmony Shard 0 (0040) : Changes in the number of sessions by node and relays proportion worked by node prior and post PIP-22.

	Prior	Post	change
Avg. Sessions ($\overline{S_{0040}}$)	0.47	0.50	7%
Avg. Worked Relays Prop. ($\overline{Rp_{0040}}$)	3.50×10^{-5}	4.02×10^{-5}	14%

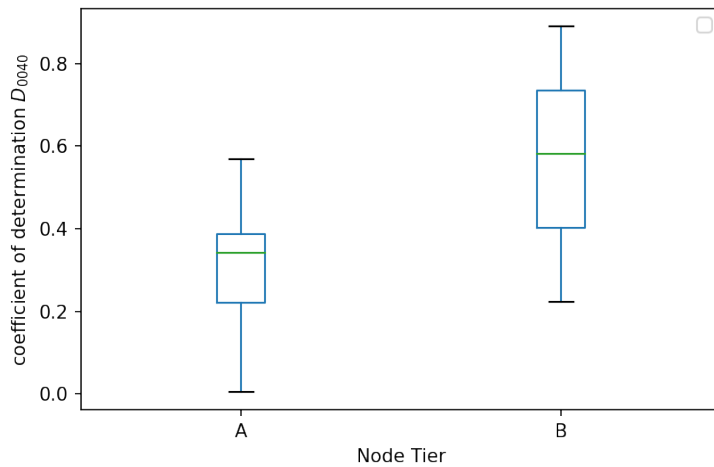


Figure 12: Harmony Shard 0 (0040) : Coefficients of Determination D_c in chain $c = 0040$ for the tested providers grouped using the avg. QoS threshold of $QoS = 0.3s$. Faster nodes are in Tier A, slower ones in Tier B.

Table 8: Harmony Shard 0 (0040) : Determination coefficients statistics for each group of node providers. Faster nodes are in Tier A, slower ones in Tier B.

Tier	mean	std
	D_{0040}	D_{0040}
A	0.31	0.18
B	0.56	0.33

6 FUSE Mainnet (0005)

Note: Changed QoS Threshold to 0.2s to obtain even groups.

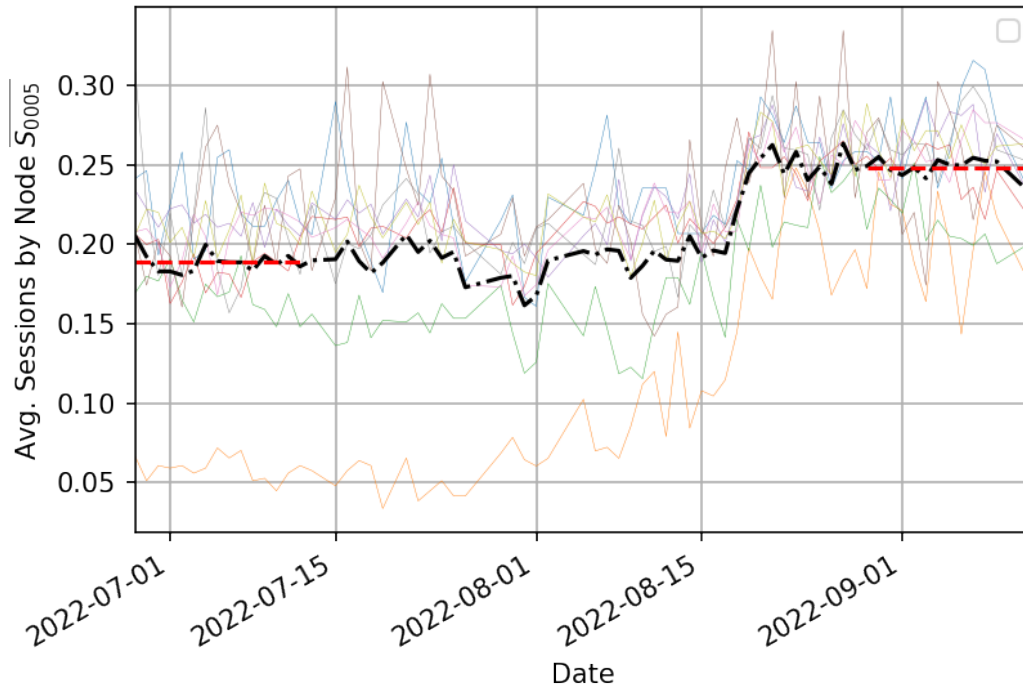


Figure 13: FUSE Mainnet (0005) : Evolution of the average number of sessions that a node serve in 24 HS (S_0) for the blockchain 0005 as a function of the date. The thin lines represent different node providers, the black line represents the average. The red segments represent the means at the start and end of the period respectively. The average at the beginning is 0.19 and at the end 0.25 sessions by node.

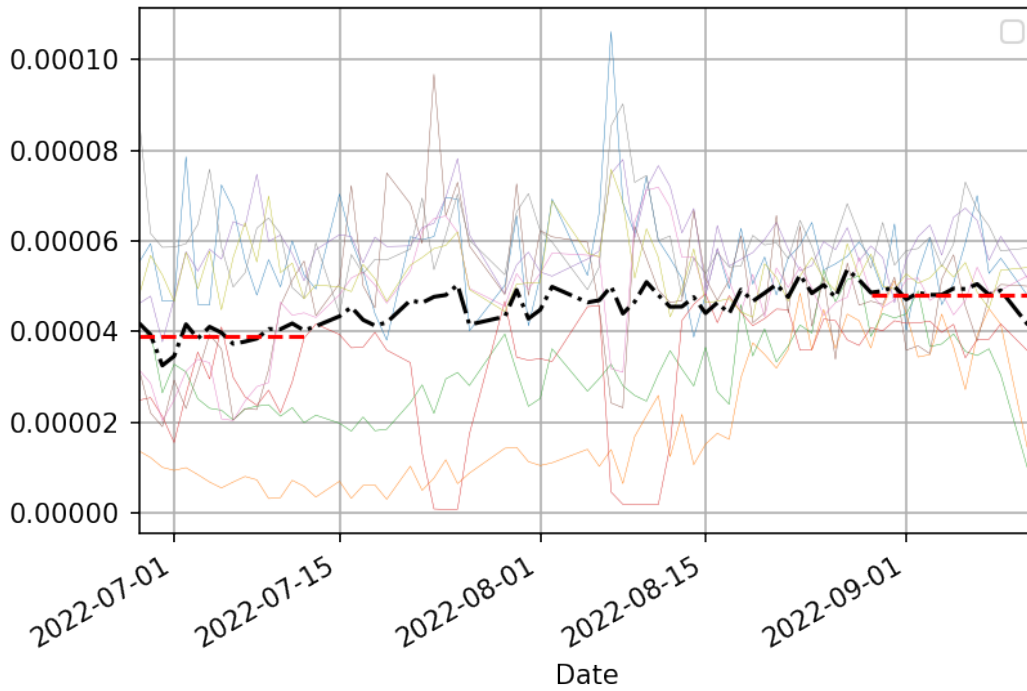


Figure 14: FUSE Mainnet (0005) : Evolution of the average relay proportion that a node work in 24 HS (\overline{Rp}) for the blockchain 0005 as a function of the date. The thin lines represent different node providers, the black line represents the average. The red segments represent the means at the start and end of the period respectively. The average at the beginning is 3.89×10^{-5} and at the end 4.80×10^{-5} .

$$Vr_c = \frac{variation(\overline{Rp_{0005}}^{ini}, \overline{Rp_{0005}}^{end})}{variation(\overline{S_{0005}}^{ini}, \overline{S_{0005}}^{end})} = \frac{0.23}{0.31} = 0.74 \quad (5)$$

Table 9: FUSE Mainnet (0005) : Changes in the number of sessions by node and relays proportion worked by node prior and post PIP-22.

	Prior	Post	change
Avg. Sessions ($\overline{S_{0005}}$)	0.19	0.25	31%
Avg. Worked Relays Prop. ($\overline{Rp_{0005}}$)	3.89×10^{-5}	4.80×10^{-5}	23%

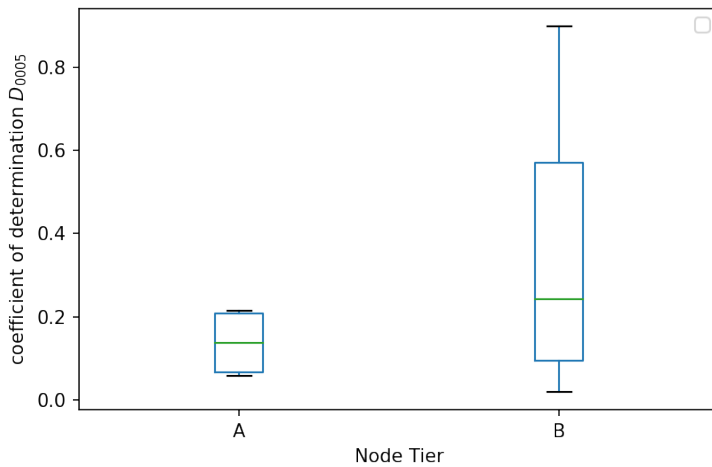


Figure 15: FUSE Mainnet (0005) : Coefficients of Determination D_c in chain $c = 0005$ for the tested providers grouped using the avg. QoS threshold of $QoS = 0.2s$. Faster nodes are in Tier A, slower ones in Tier B.

Table 10: FUSE Mainnet (0005) : Determination coefficients statistics for each group of node providers. Faster nodes are in Tier A, slower ones in Tier B.

Tier	mean	std
	D_{0005}	D_{0005}
A	0.14	0.08
B	0.36	0.36

7 BSC Mainnet (0004)

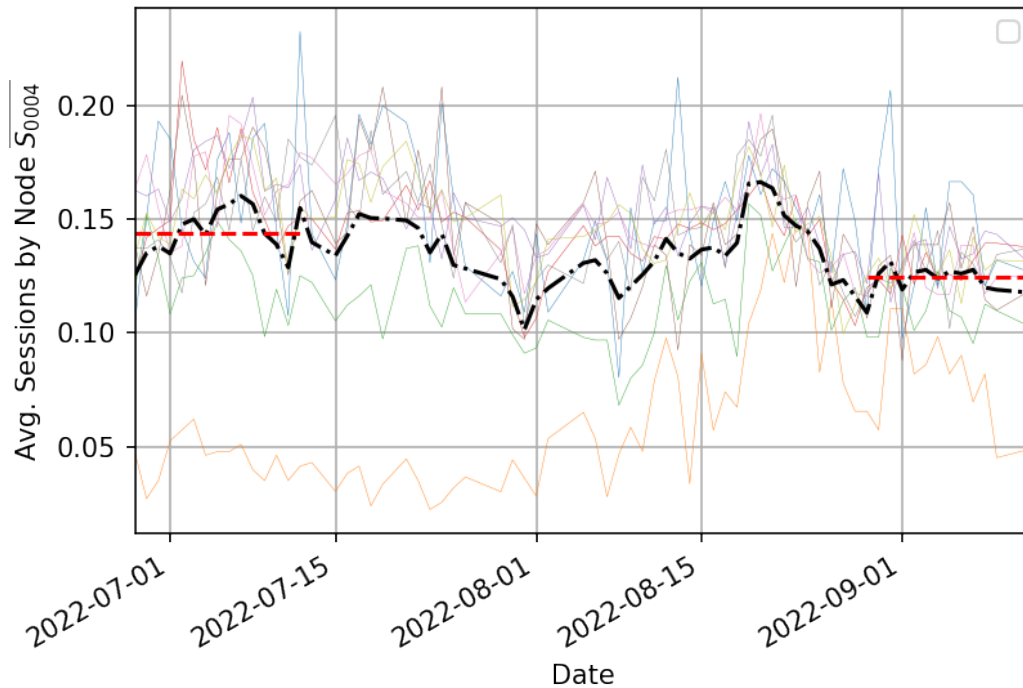


Figure 16: BSC Mainnet (0004) : Evolution of the average number of sessions that a node serve in 24 HS (\bar{S}_c) for the blockchain 0004 as a function of the date. The thin lines represent different node providers, the black line represents the average. The red segments represent the means at the start and end of the period respectively. The average at the beginning is 0.14 and at the end 0.12 sessions by node.

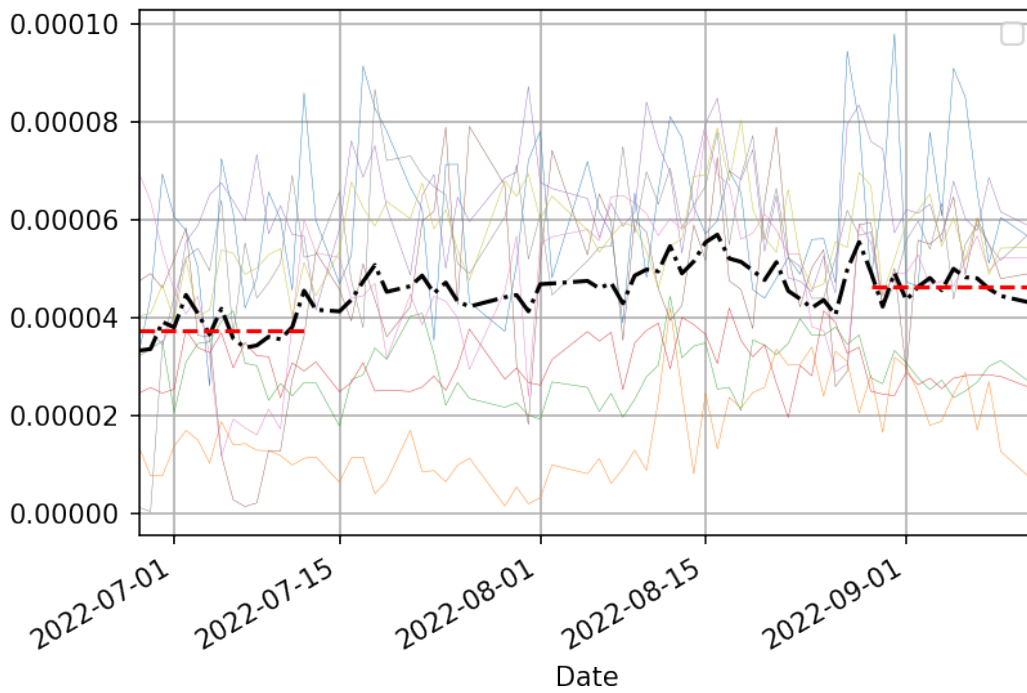


Figure 17: BSC Mainnet (0004) : Evolution of the average relay proportion that a node work in 24 HS ($\overline{Rp_c}$) for the blockchain 0004 as a function of the date. The thin lines represent different node providers, the black line represents the average. The red segments represent the means at the start and end of the period respectively. The average at the beginning is 3.73×10^{-5} and at the end 4.62×10^{-5} .

$$Vr_c = \frac{\text{variation}(\overline{Rp_{0004}}^{ini}, \overline{Rp_{0004}}^{end})}{\text{variation}(\overline{S_{0004}}^{ini}, \overline{S_{0004}}^{end})} = \frac{0.24}{-0.14} = -1.71 \quad (6)$$

Table 11: BSC Mainnet (0004) : Changes in the number of sessions by node and relays proportion worked by node prior and post PIP-22.

	Prior	Post	change
Avg. Sessions ($\overline{S_{0004}}$)	0.14	0.12	−14%
Avg. Worked Relays Prop. ($\overline{Rp_{0004}}$)	3.73×10^{-5}	4.52×10^{-5}	19%

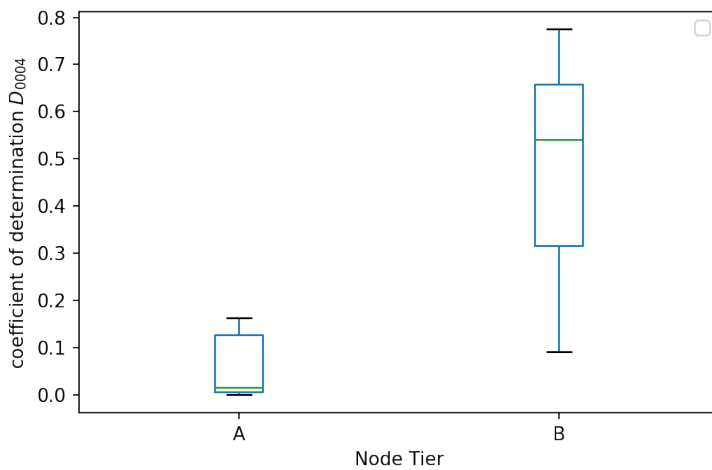


Figure 18: BSC Mainnet (0004) : Coefficients of Determination D_c in chain $c = 0004$ for the tested providers grouped using the avg. QoS threshold of $QoS = 0.3s$. Faster nodes are in Tier A, slower ones in Tier B.

Table 12: BSC Mainnet (0004) : Determination coefficients statistics for each group of node providers. Faster nodes are in Tier A, slower ones in Tier B.

Tier	mean D_{0004}	std D_{0004}
A	0.10	0.15
B	0.47	0.35

8 Ethereum (0021)

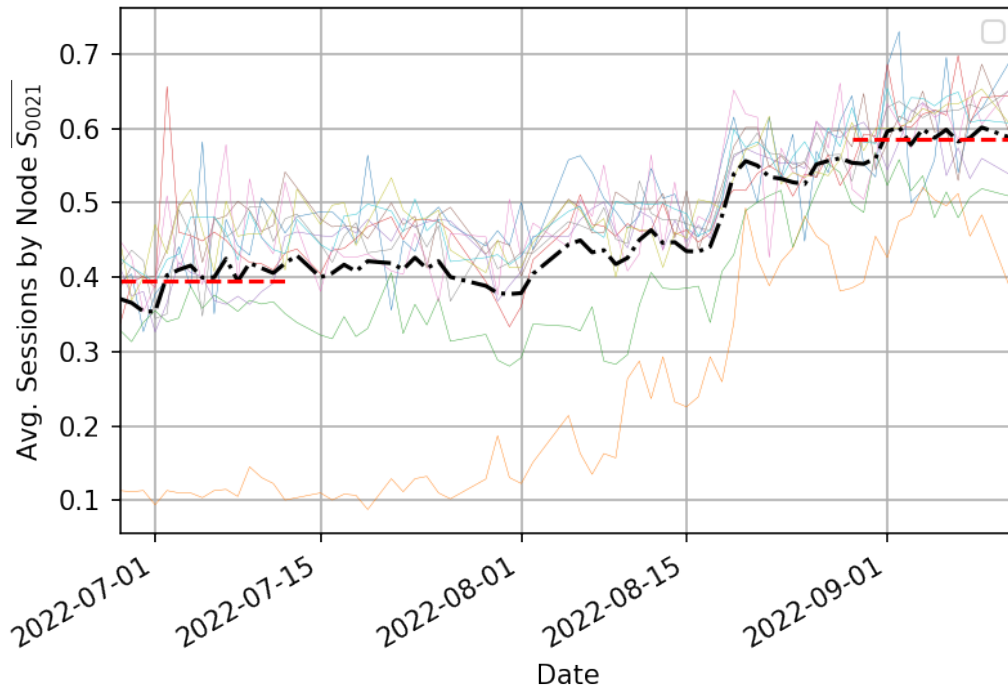


Figure 19: Ethereum (0021) : Evolution of the average number of sessions that a node serve in 24 HS (\bar{S}_c) for the blockchain 0021 as a function of the date. The thin lines represent different node providers, the black line represents the average. The red segments represent the means at the start and end of the period respectively. The average at the beginning is 0.39 and at the end 0.58 sessions by node.

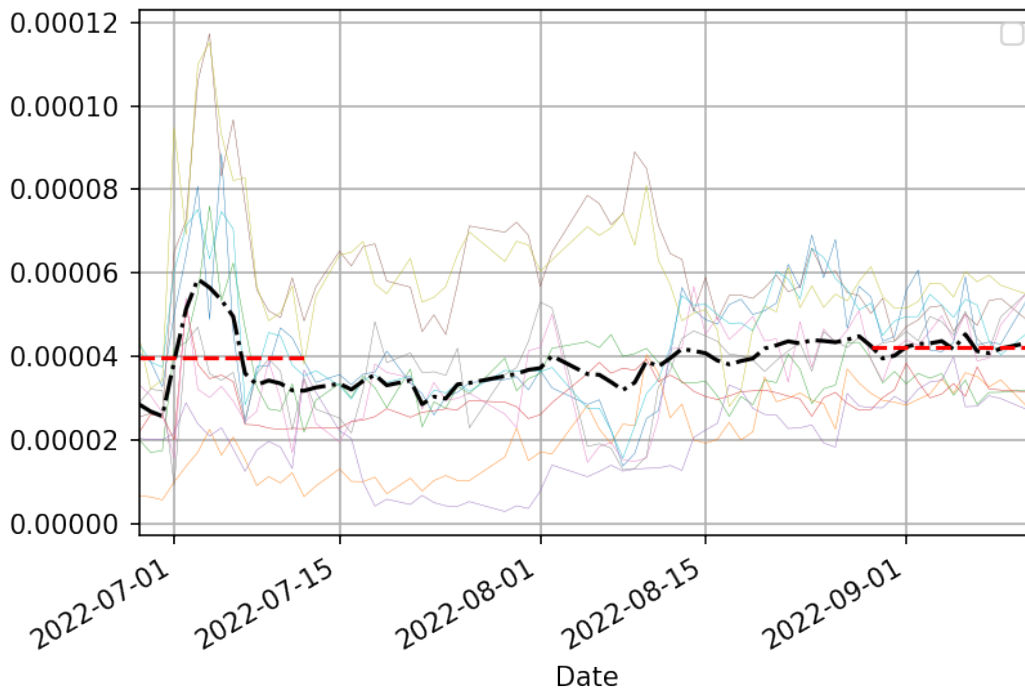


Figure 20: Ethereum (0021) : Evolution of the average relay proportion that a node work in 24 HS ($\overline{Rp_c}$) for the blockchain 0021 as a function of the date. The thin lines represent different node providers, the black line represents the average. The red segments represent the means at the start and end of the period respectively. The average at the beginning is 3.98×10^{-5} and at the end 4.21×10^{-5} .

$$Vr_c = \frac{\text{variation}(\overline{Rp_{0021}}^{ini}, \overline{Rp_{0021}}^{end})}{\text{variation}(\overline{S_{0021}}^{ini}, \overline{S_{0021}}^{end})} = \frac{0.06}{0.48} = 0.13 \quad (7)$$

Table 13: Ethereum (0021) : Changes in the number of sessions by node and relays proportion worked by node prior and post PIP-22.

	Prior	Post	change
Avg. Sessions ($\overline{S_{0021}}$)	0.39	0.58	48%
Avg. Worked Relays Prop. ($\overline{Rp_{0021}}$)	3.98×10^{-5}	4.21×10^{-5}	6%

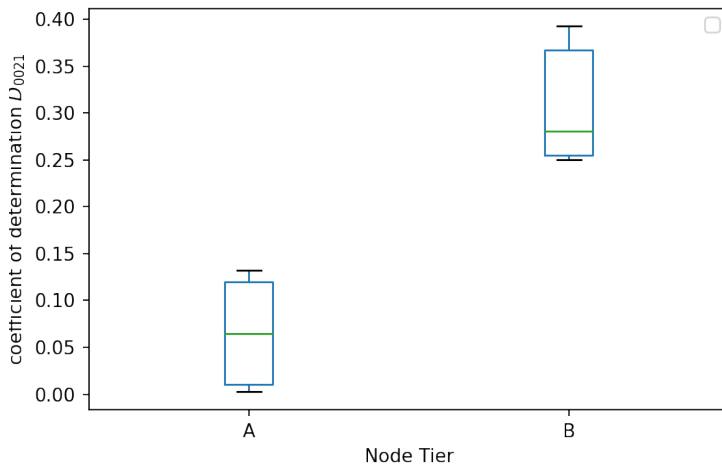


Figure 21: Ethereum (0021) : Coefficients of Determination D_c in chain $c = 0021$ for the tested providers grouped using the avg. QoS threshold of $QoS = 0.3s$. Faster nodes are in Tier A, slower ones in Tier B.

Table 14: Ethereum (0021) : Determination coefficients statistics for each group of node providers. Faster nodes are in Tier A, slower ones in Tier B.

Tier	mean D_{0021}	std D_{0021}
A	0.07	0.07
B	0.32	0.24

9 DFKchain Subnet (03DF)

Note: Changed QoS Threshold to 0.2s to obtain even groups.

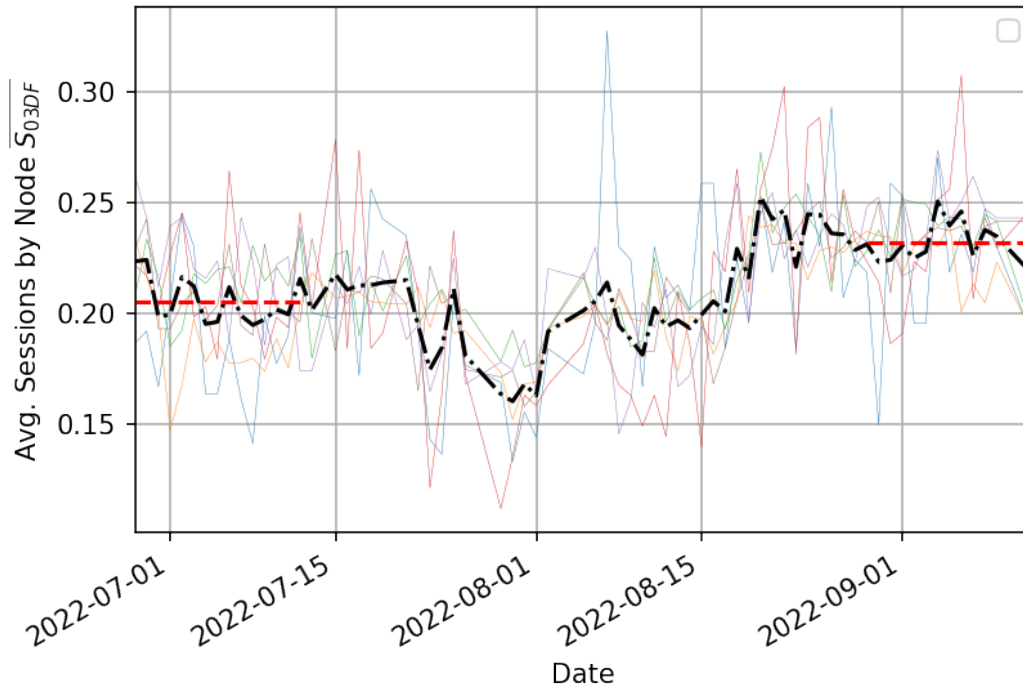


Figure 22: DFKchain Subnet (03DF) : Evolution of the average number of sessions that a node serve in 24 HS ($\overline{S_c}$) for the blockchain 03DF as a function of the date. The thin lines represent different node providers, the black line represents the average. The red segments represent the means at the start and end of the period respectively. The average at the beginning is 0.20 and at the end 0.23 sessions by node.

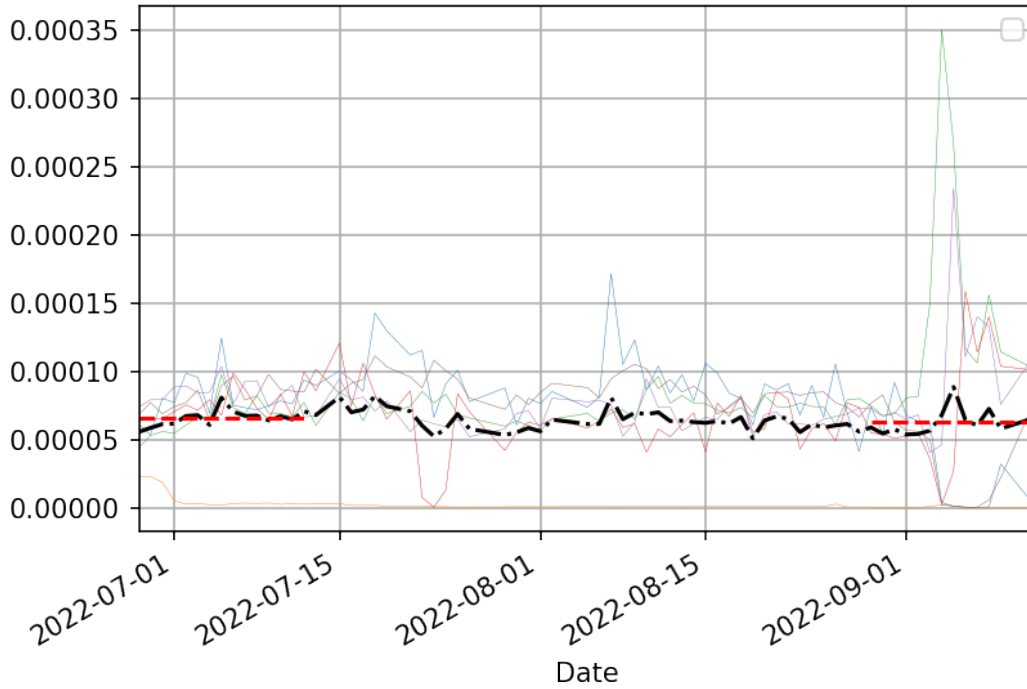


Figure 23: DFKchain Subnet (03DF) : Evolution of the average relay proportion that a node work in 24 HS ($\overline{Rp_c}$) for the blockchain 03DF as a function of the date. The thin lines represent different node providers, the black line represents the average. The red segments represent the means at the start and end of the period respectively. The average at the beginning is 6.55×10^{-5} and at the end 6.30×10^{-5} .

$$Vr_c = \frac{\text{variation}(\overline{Rp_{03DF}}^{ini}, \overline{Rp_{03DF}}^{end})}{\text{variation}(\overline{S_{03DF}}^{ini}, \overline{S_{03DF}}^{end})} = \frac{-0.04}{0.13} = -0.30 \quad (8)$$

Table 15: DFKchain Subnet (03DF) : Changes in the number of sessions by node and relays proportion worked by node prior and post PIP-22.

	Prior	Post	change
Avg. Sessions ($\overline{S_{03DF}}$)	0.20	0.23	13%
Avg. Worked Relays Prop. ($\overline{Rp_{03DF}}$)	6.55×10^{-5}	6.30×10^{-5}	−4%

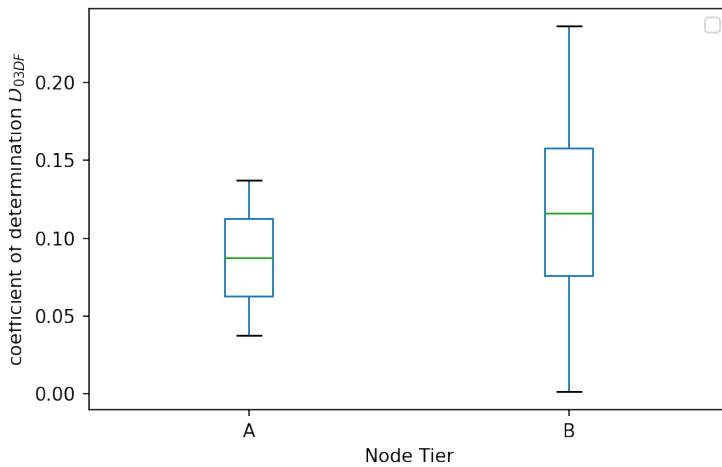


Figure 24: DFKchain Subnet (03DF) : Coefficients of Determination D_c in chain $c = 03DF$ for the tested providers grouped using the avg. QoS threshold of $QoS = 0.2s$. Faster nodes are in Tier A, slower ones in Tier B.

Table 16: DFKchain Subnet (03DF) : Determination coefficients statistics for each group of node providers. Faster nodes are in Tier A, slower ones in Tier B.

Tier	mean	std
	D_{03DF}	D_{03DF}
A	0.09	0.07
B	0.12	0.10

10 Network

Notes:

- We included this analysis but it must be used with extreme care. We want to analyze variations between sessions and relative changes in relays, not absolute changes. THESE RESULTS SHOW RELATIONS NOT ABSOLUTE CHANGES.
- The figure 26 will show a reduction of the total relay proportion. This does not mean that there are fewer relays per node. Remember that all chains are weighted the same way, then variations on chains with low number of relays are affecting in the same way that variations in chains with high number of relays. This is intended.
- Excluded DFKchain Subnet (03DF) due to high instability at the end of the period.

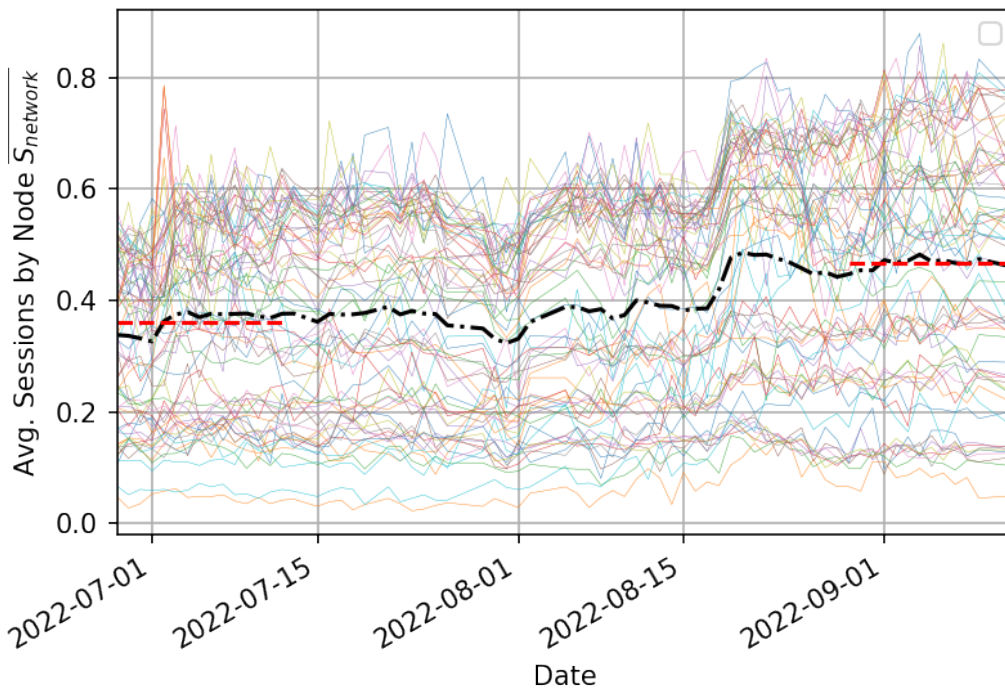


Figure 25: Network : Evolution of the average number of sessions that a node serve in 24 HS ($\overline{S_c}$) for the all tested blockchains as a function of the date. The thin lines represent different node providers, the black line represents the average. The red segments represent the means at the start and end of the period respectively. The average at the beginning is 0.36 and at the end 0.47 sessions by node.

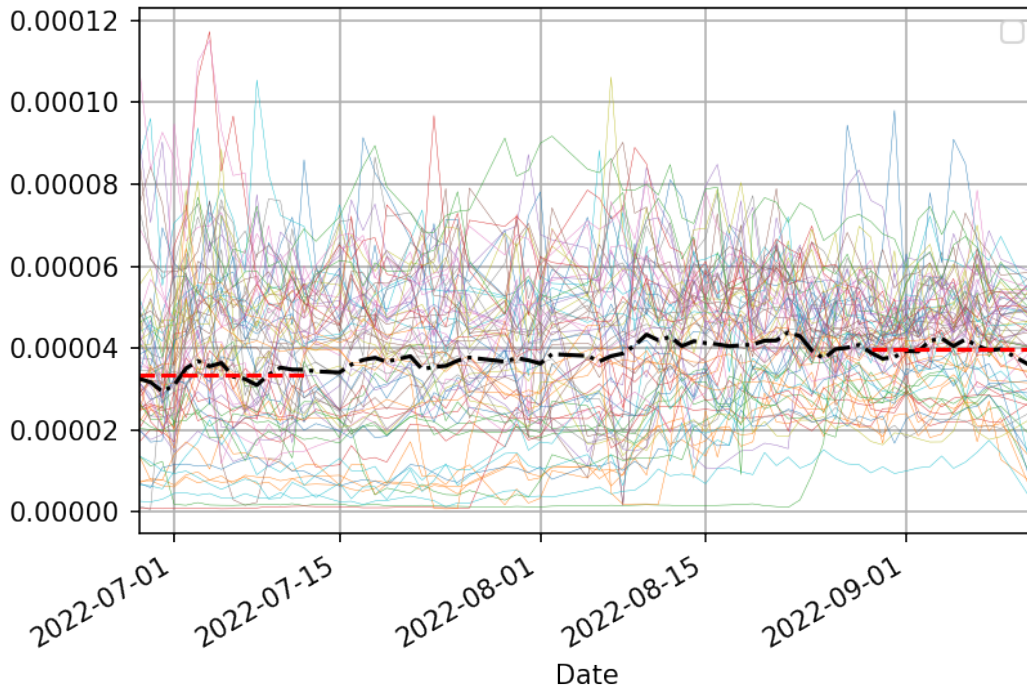


Figure 26: Network : Evolution of the average relay proportion that a node work in 24 HS ($\overline{Rp_c}$) for all the tested blockchains as a function of the date. The thin lines represent different node providers, the black line represents the average. The red segments represent the means at the start and end of the period respectively. The average at the beginning is 3.34×10^{-5} and at the end 3.95×10^{-5} .

$$Vr_c = \frac{\text{variation}(\overline{Rp_{network}}^{ini}, \overline{Rp_{network}}^{end})}{\text{variation}(\overline{S_{network}}^{ini}, \overline{S_{network}}^{end})} = \frac{0.18}{0.29} = 0.62 \quad (9)$$

Table 17: Network : Changes in the number of sessions by node and relays proportion worked by node prior and post PIP-22.

	Prior	Post	change
Avg. Sessions ($\overline{S_{network}}$)	0.36	0.47	29%
Avg. Worked Relays Prop. ($\overline{Rp_{network}}$)	3.34×10^{-5}	3.95×10^{-5}	18%

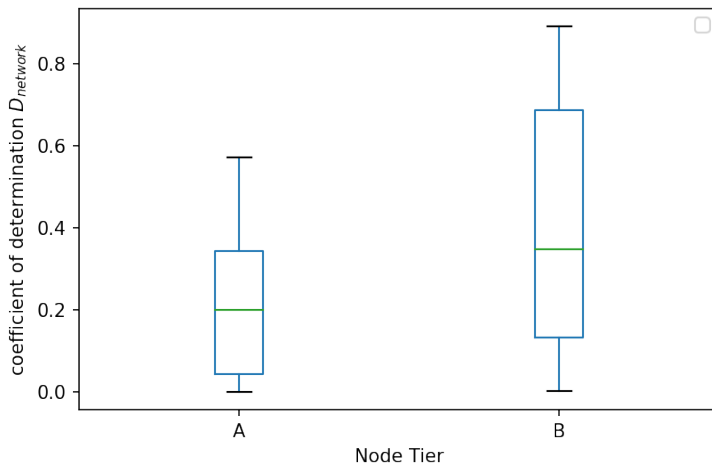


Figure 27: Network : Coefficients of Determination D_c in all the tested chains for the tested providers grouped using the avg. QoS threshold of $QoS = 0.3s$. Faster nodes are in Tier A, slower ones in Tier B.

Table 18: Network : Determination coefficients statistics for each group of node providers. Faster nodes are in Tier A, slower ones in Tier B.

Tier	mean	std
	$D_{network}$	$D_{network}$
A	0.22	0.20
B	0.41	0.29

11 Table Compilations

Table 19: Relation between the variation of relays and the variation of sessions for each study case ordered by stability of the network.

Blockchain	Variation Coefficients Vr_c
Polygon Mainnet (0009)	0.41
Fantom (0049)	−0.91
Gnosis - xDai (0027)	0.46
Harmony Shard 0 (0040)	2.14
FUSE Mainnet (0005)	0.74
BSC Mainnet (0004)	−1.71
Ethereum (0021)	0.13
DFKchain Subnet (03DF)	−0.30
Network	0.62

Table 20: Changes in the number of sessions by node prior and post PIP-22.

Blockchain	Prior	Post	change
Polygon Mainnet (0009)	0.49	0.71	44%
Fantom (0049)	0.32	0.35	9%
Gnosis - xDai (0027)	0.48	0.68	43%
Harmony Shard 0 (0040)	0.47	0.50	7%
FUSE Mainnet (0005)	0.19	0.25	31%
BSC Mainnet (0004)	0.14	0.12	−14%
Ethereum (0021)	0.39	0.58	48%
DFKchain Subnet (03DF)	0.20	0.23	13%
Network	0.36	0.47	29%

Table 21: Changes in relays proportion worked by node prior and post PIP-22.

Blockchain	Prior	Post	change
Polygon Mainnet (0009)	3.34×10^{-5}	3.95×10^{-5}	18%
Fantom (0049)	5.27×10^{-5}	4.72×10^{-5}	−10%
Gnosis - xDai (0027)	2.89×10^{-5}	3.46×10^{-5}	20%
Harmony Shard 0 (0040)	3.50×10^{-5}	4.02×10^{-5}	14%
FUSE Mainnet (0005)	3.89×10^{-5}	4.80×10^{-5}	23%
BSC Mainnet (0004)	3.73×10^{-5}	4.52×10^{-5}	19%
Ethereum (0021)	3.98×10^{-5}	4.21×10^{-5}	6%
DFKchain Subnet (03DF)	6.55×10^{-5}	6.30×10^{-5}	−4%
Network	3.34×10^{-5}	3.95×10^{-5}	18%

Table 22: Determination coefficients means for each group of node providers in each of the tested networks. Faster nodes are in Tier A, slower ones in Tier B.

Blockchain	Tier A mean D_c	Tier B mean D_c
Polygon Mainnet (0009)	0.27	0.48
Fantom (0049)	0.22	0.39
Gnosis - xDai (0027)	0.25	0.36
Harmony Shard 0 (0040)	0.31	0.56
FUSE Mainnet (0005)	0.14	0.36
BSC Mainnet (0004)	0.10	0.47
Ethereum (0021)	0.07	0.32
DFKchain Subnet (03DF)	0.9	0.12
Network	0.22	0.41