Poster: When Blocks Go Missing: The Timeliness and Trustworthiness of Blockchain RPC Providers

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Abstract

Contrary to blockchain's trustless vision, most applications built atop blockchain require trust in third-party Remote Procedure Call (RPC) providers. Applications rely on these RPC providers to be performant (announce new blocks timely) and reliable (no missing blocks/transactions) to provide good user experience and security guarantees. In this paper, we perform the first large-scale, longitudinal study to evaluate the timeliness and trustworthiness of 16 RPC providers for BNB Smart Chain (BSC) across 6 223 blocks and 123 773 transactions. We identify significant variability: some providers are inconsistent, miss valid blocks/transactions, or are seconds slower than others. Our findings suggest that the implicit trust assumptions are often violated, which may leave users confused and even vulnerable to attacks.

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1 Introduction

Blockchain systems are seen as a model of decentralized trust, where participants do not need to rely on any "trusted third party" to verify the state of the system [3]. However, most participants of the blockchain ecosystem today—specifically applications built on top of blockchains, such as wallets, explorers, and decentralized applications (DApps)—diverge sharply from this vision. Instead of having users run their own full nodes, these applications typically rely on third-party RPC providers to read from and write to the blockchain [2]. When the RPC providers are delayed or faulty, this reliance creates asymmetric information: users may see stale balances, duplicate their transactions thinking it has been dropped, or even be vulnerable to front-running attacks.

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Provider	Endpoint Base Address	Repos
Binance	https://bsc-dataseed.binance.org/	14,500
GetBlock	https://go.getblock.io/	4,400
Ankr	https://rpc.ankr.com/bsc/	2,900
BSCRPC†	https://bscrpc.com/	1,200
Dwellir	https://api-bsc-mainnet-full.dwellir.com/	1,200
PublicNode	https://bsc-rpc.publicnode.com/	490
1RPC	https://1rpc.io/bnb/	478
OMNIA	https://endpoints.omniatech.io/v1/bsc/mainnet/	446
QuickNode	https://<instance>.bsc.quiknode.pro/	392
Infura	https://bsc-mainnet.infura.io/v3/	308
RPC Fast	https://bsc-mainnet.rpcfast.com/	188
OnFinality	https://bnb.api.onfinality.io/	157
Chainstack	https://bsc-mainnet.core.chainstack.com/	88
Moralis	https://site1.moralis-nodes.com/bsc/	18
InfStones	https://api.infstones.com/bsc/mainnet/	3
RockX	https://bsc.w3node.com/	2

Table 1: Sixteen RPC providers for BSC that we test on.

2 Methodology

In this paper, we actively query and measure the timeliness and trustworthiness of sixteen RPC providers for the BNB Smart Chain (BSC) [1], a popular EVM-based blockchain often used for DApps, which commonly rely on RPC providers.

2.1 RPC Provider Selection

We compiled a list of sixteen BSC RPC providers, as shown in Table 1. They include a mix of providers from CompareNodes's list of best public endpoints and prestigious private endpoints. The providers have varied popularity, which we approximate by the number of public GitHub repositories referencing them. However, we note that this is an imperfect proxy. Some providers may be more popular among commercial users who do not publish their code; or include API keys in the URL, which discourages committing the URL publicly.

2.2 Measuring Providers

2.2.1 Measuring Timeliness. We measure the timeliness of each RPC provider by measuring their lag in reporting the generation of the latest block. Since BSC generates a new block every 3 seconds [1], we query each RPC provider for the latest block every second. When a new block is detected by any provider, we repeatedly query all providers for the latest block until all providers report the new block, and record the time taken.

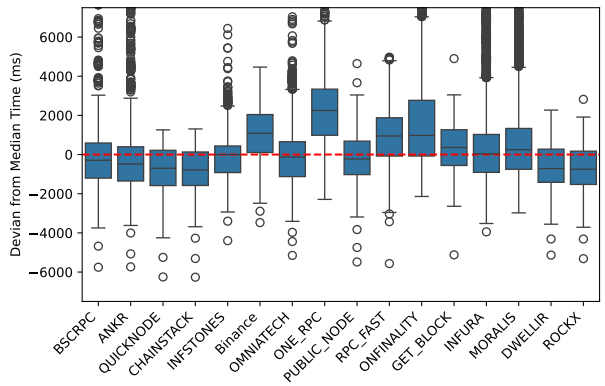


Figure 1: The deviations from median time of new blocks reported by each RPC service. Negative is faster.

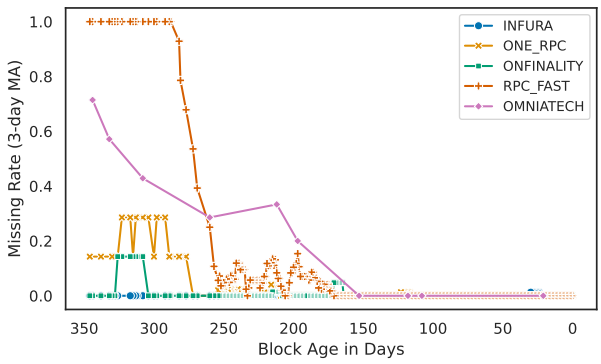


Figure 2: The missing rate of blocks per RPC provider, calculated as 3-day Moving Average. The block age is the difference between query and block timestamp.

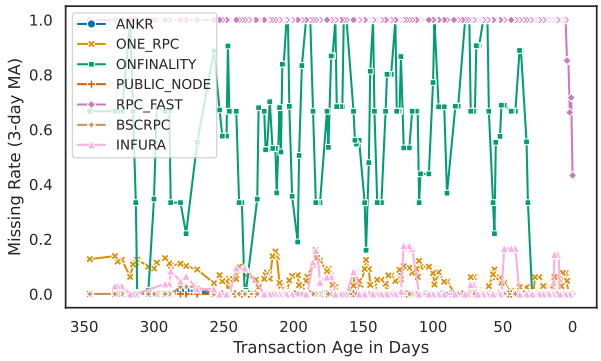


Figure 3: The missing rate of transactions per RPC provider, calculated as 3-day MA.

2.2.2 Measuring Trustworthiness. We measure if different RPC providers return consistent data for the same set of blocks and transactions through differential testing. We uniformly select blocks in the most recent 10 million blocks (approximately in the last 347 days) and query all RPC providers for the block data, including its transactions. We then query all RPC providers for each transaction in the block by hash, and compare the returned data. If any provider fails to return the block or transaction data, we retry up to three times to rule out transient service errors.

3 Results

We ran measurement for timeliness across 6 223 blocks, and trustworthiness for 2 140 blocks and 123 773 transactions.

Some RPC providers are slower by more than a second. We recorded the median time when half of the RPC providers reports each new block, and plot the distribution of deviations from median per RPC provider in Figure 1. Four RPC providers, including the most popular Binance RPC, are consistently slower than the median by more than a second. Worse, there is a long tail of slow responses up to 105 seconds (not shown in figure) for four different providers.

Some RPC providers report older blocks as nonexistent. We plot the 3-day moving average rate if an RPC provider reports blocks as nonexistent in Figure 2. Five RPC providers exhibited missing blocks. Missing rates show sharp increase for blocks older than 6 and 8 months, some up to 100%.

Some RPC providers report random transactions as nonexistent. We plot the same rate for transactions in Figure 3. Seven providers reported varied missing rates from less than 20% to almost 100%, which seems independent of transaction age. RPC Fast, the exception, has an aggressive missing rate for transactions older than a day. Another interesting observation is that many providers show external inconsistencies (e.g., they return the transaction when we query the block, but reports it missing when we query by tx hash).

4 Conclusion

We discovered that a fourth of the RPC providers we tested are consistently seconds slower, with a long tail up to 105 seconds. Nearly half of the providers have missing records for blocks and transactions. Many providers report even recent transactions as nonexistent and are inconsistent with themselves. These failures pose real security risks: stale data enables front-running attacks, missing records can censor transactions or defraud users by tricking them into resubmitting valid transactions, and inconsistent states undermine consensus assumptions. Although RPC providers are de facto trusted third parties, our findings suggest that many do not live up to the trust. Fundamentally, if the blockchain promise of transaction persistence is violated, we might as well design a chain that does not forever grow in space.

A Ethics

We queried publicly available data and respected rate limits.

References

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