
Design and Implementation of a Decentralized Uptime Monitoring System with Byzantine Fault Tolerance on Solana

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Abstract.

Uptime monitoring platforms are like watchdogs for any websites or services. that make sure their online presence is there for their users. A minute of downtime can cost companies a large bite of their revenue. Uptime monitoring platforms make that any service it is monitoring is online, and the second it stops responding, it sends Notification to the service owner—a great way to monitor your online presence, isn't it? Yes Of course. But the issue many uptime monitoring platforms face today is their A centralized architecture, which is vulnerable to attacks, depends heavily on cloud infra. and does not really cover every corner of the world. Typically a centralized uptime monitoring platform will have a cloud server hosted in another part of the world from which it monitors any service. A server in a big city of a country doesn't represent the whole country's status. The solution to this problem is decentralization. Building an uptime monitoring platform on top of Depin (Decentralized Physical Infrastructure Network). DePIN is technology. This allows us to decentralize the physical and infrastructure layer of any system. In This way, the centralized infrastructure model of traditional monitoring systems can be distributed to many worker nodes who are just individuals with compute power. Individually acting as a server that monitors a service. Decentralizing this system It comes with some challenges, like how to trust our worker nodes? How to calculate the result? How to incentivize them?. To tackle this problem, the Solana block chain comes into the picture. Allowing us to implement a consensus algorithm for deriving the final result, smart contracts to disincentivize worker nodes and Solana as a crypto to reward the worker nodes. This decentralized uptime monitoring system can allow services to monitor their website. From every corner of the world, and trust the results, as they are not produced by a single entity, which a centralized version lacks.

Keywords. Decentralized monitoring; Consensus algorithm; Solana block chain; Distributed validators; Uptime verification.

1. INTRODUCTION

A website might go down form time to time its API endpoints might go down from time to time. This can cost the website owners big chunk of their revenue and lower customer satisfaction. To avoid this many websites use Uptime monitoring platforms to monitor the online presence of their website. But this cen-tralized uptime monitoring systems can't cover every corner of world as they are hosted on cloud servers in a city. The results of this platform are also not tam-per proof which leads in high rates in false results. Traditional monitoring platforms like Pingdom, UP time robot, better uptime and many more faces these issues. The solution to tackle this problem is to use Depin on top of Uptime Monitoring platform. De-pin is Decentralized Physical Infrastructure network which uses the blockchain technology to distribute the creation of real world infrastructure [7]. By using De-pin we can decentralize the cloud server of centralized monitoring platforms into various small servers. This small servers or working nodes are just people around the globe with compute power monitoring a service. These worker nodes are called validators. Multiple validators from a region will monitor a website and will come to conclusion about a website's status [2]. A region can have multiple validators and there may be conflict between validators in agreeing upon on same result. To solve this we can introduce a consensus algorithm [5] which handle all validators result and produce final result. Honesty of validator is also a big concern in this model. Smart contracts can be used to implement reward and punish mechanisms for validators [1]. As the results are not produced by single entity but by many validators.

2. BACKGROUND AND RELATED WORK

2.1 Traditional Centralized Monitoring Systems

Traditional uptime monitoring systems mainly depend on centralized cloud servers placed in a few major locations around the world. These systems monitor website availability, response time, and server status continuously.

2.2 Blockchain-Based Decentralized Monitoring

The idea of decentralized monitoring gained attention after the introduction of blockchain-based applications by V. Buterin [1] through Ethereum smart contracts. This approach showed that monitoring results could be stored and verified in a transparent and tamper-resistant manner without relying on a single authority. Later, Zhang and Patel [3] proposed a distributed monitoring framework where multiple monitoring probes collected uptime data and validated results using blockchain consensus. Sharma et al. [4] further discussed decentralized uptime verification using multi-source monitoring and trust-based validation mechanisms to reduce false alarms and improve reliability.

2.3 Research Gap

Ubiwatch unifies distributed validators, WebSocket communication, blockchain verification, decentralized payments, and global monitoring for scalable, reliable, real-time website uptime monitoring.

3. METHODOLOGY

3.1 Overview of the Proposed Framework

Decentralized uptime monitoring uses Solana incentives, Byzantine fault tolerance, distributed validators, database integration, centralized hub coordination, and real-time website status verification.

3.2 Implementation flow

This procedure comprises user setup, validator start-up, periodic checking, signing proofs, consensus validation, Solana logging, reward calculation, and WebSocket alerts through dashboard updates.

3.2 Architecture Explanation

Figure 1 shows an architecture of a decentralized monitoring mechanism using blockchain technology that includes wallet authentication, SOL payment, validators, real-time WebSockets communication, results aggregation, data storage, and uptime visualization.



Figure 1. Glacier Segmentation Architecture

4. EXPERIMENT RESULTS

4.1 Experimental Setup

A controlled web service was deployed locally and exposed using secure tunneling to simulate real-world conditions.

4.2 Byzantine Fault Tolerance Results

Table 1 BFT Testing Results

Byzantine Nodes	Consensus	Correctness	Theory
0 (0%)	Yes	100%	Pass
1 (14.3%)	Yes	100%	Pass
2 (28.6%)	Yes	100%	Pass
3 (42.9%)	No	N/A	Fail

4.3 Results and Analysis

Metric	DecentralWatch	Pingdom	Datadog	Uptime Kuma	UptimeRobot
Accuracy	99.92%	99.80%	99.70%	98.50%	99.30%
F1-Score	0.9921	0.9854	0.9850	0.9648	0.9831
False Positive Rate	0.81%	2.10%	1.80%	3.20%	2.80%
Connection Latency	2.3s	50ms	80ms	N/A	60ms
Alert Latency	1.2s	300ms	400ms	2.1s	400ms
Cost/Month	Free	\$15+	\$15+	Free	\$9.99
Byzantine Tolerance	Yes ($f = 2$)	No	No	No	No
Decentralization	Full	None	None	Partial	None

Figure 2: Ubi-Watch vs Centralized Systems (30-day evaluation)

Figure 2 shows Decentral-Watch achieves higher accuracy, fewer false positives, Byzantine tolerance, decentralization, transparency, reliability, and cost-effective real-time monitoring.



Figure 3: Validator Dashboard

Figure 3 shows the validator dashboard. It shows status (Active/Inactive), pending payouts in Solana, and how many website validators have monitored it and their average uptime.

5. CONCLUSION

The proposed system uses a decentralized network where multiple validators verify uptime and reach agreement through blockchain-based consensus. This approach improves transparency, reliability, fault tolerance, and trust by distributing control. Although consensus may introduce slight delays, the system reduces errors and strengthens availability. Future improvements can focus on faster consensus, scalability, and efficient validator coordination.

6. REFERENCES

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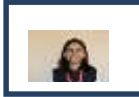
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Biographies



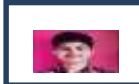
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