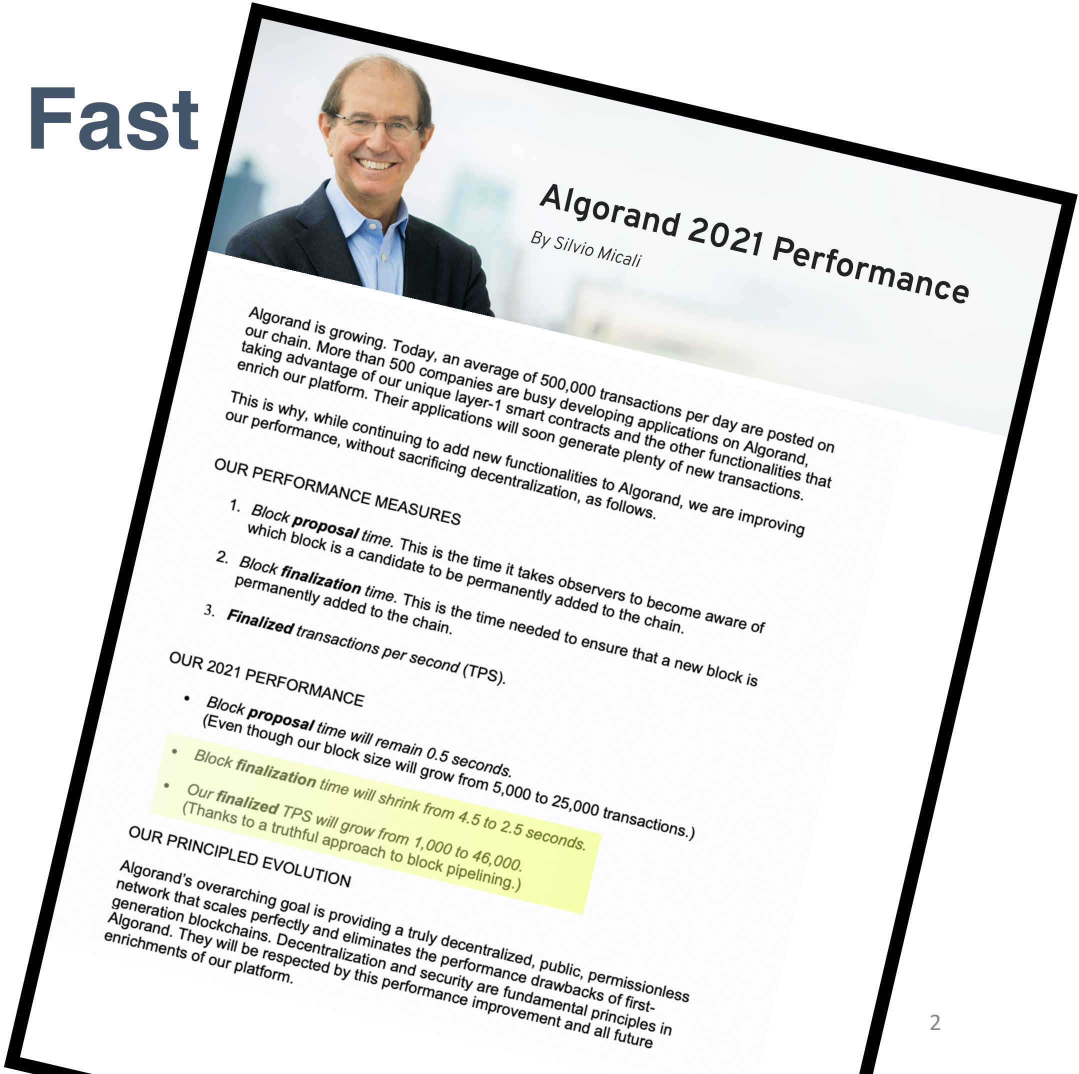
REDBELLY

Beyond Marketing: What is Real TPS?

Feb. 2, 2023

Vincent Gramoli (Redbelly Network / University of Sydney / EPFL)

Blockchains are Fast



Algorand 2021 Performance

By Silvio Micali

Algorand is growing. Today, an average of 500,000 transactions per day are posted on our chain. More than 500 companies are busy developing applications on Algorand, taking advantage of our unique layer-1 smart contracts and the other functionalities that enrich our platform. Their applications will soon generate plenty of new transactions.

This is why, while continuing to add new functionalities to Algorand, we are improving our performance, without sacrificing decentralization, as follows.

OUR PERFORMANCE MEASURES

1. *Block **proposal** time.* This is the time it takes observers to become aware of which block is a candidate to be permanently added to the chain.
2. *Block **finalization** time.* This is the time needed to ensure that a new block is permanently added to the chain.
3. ***Finalized** transactions per second* (TPS).

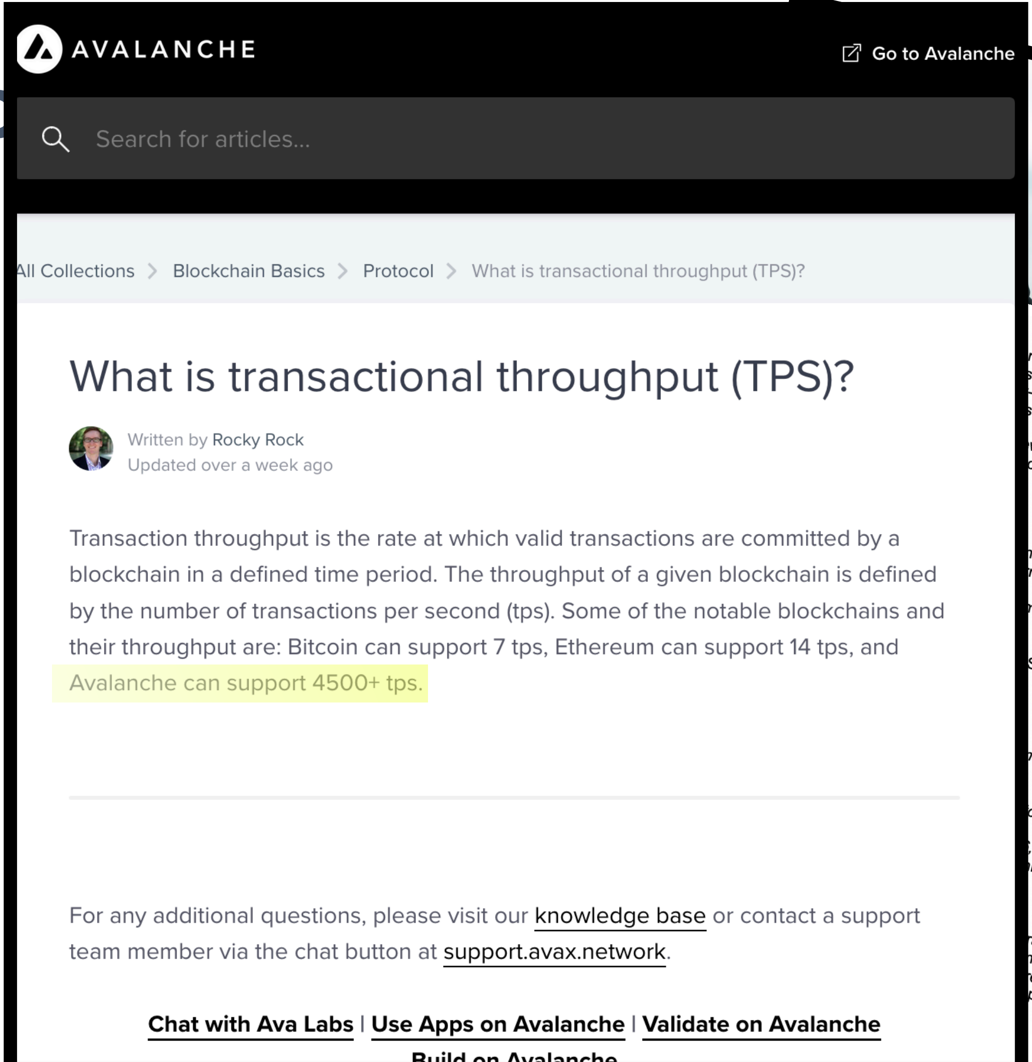
OUR 2021 PERFORMANCE

- *Block **proposal** time will remain 0.5 seconds.* (Even though our block size will grow from 5,000 to 25,000 transactions.)
- *Block **finalization** time will shrink from 4.5 to 2.5 seconds.*
- *Our **finalized** TPS will grow from 1,000 to 46,000.* (Thanks to a truthful approach to block pipelining.)

OUR PRINCIPLED EVOLUTION

Algorand's overarching goal is providing a truly decentralized, public, permissionless network that scales perfectly and eliminates the performance drawbacks of first-generation blockchains. Decentralization and security are fundamental principles in Algorand. They will be respected by this performance improvement and all future enrichments of our platform.

Blo


AVALANCHE

Go to Avalanche

Search for articles...

All Collections > Blockchain Basics > Protocol > What is transactional throughput (TPS)?

What is transactional throughput (TPS)?

Written by Rocky Rock
Updated over a week ago

Transaction throughput is the rate at which valid transactions are committed by a blockchain in a defined time period. The throughput of a given blockchain is defined by the number of transactions per second (tps). Some of the notable blockchains and their throughput are: Bitcoin can support 7 tps, Ethereum can support 14 tps, and Avalanche can support 4500+ tps.

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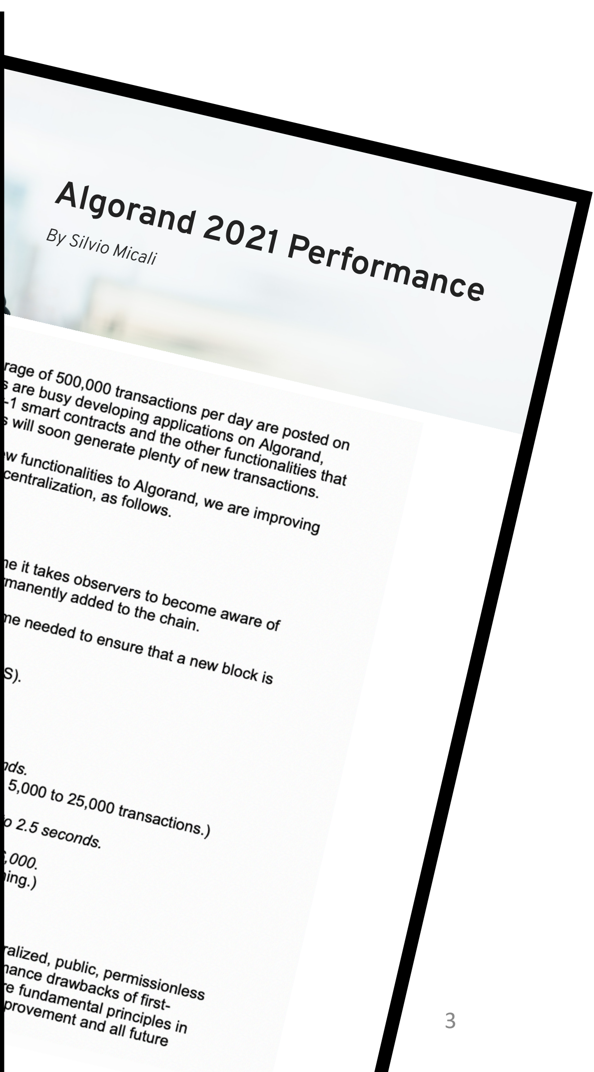
Chat with Ava Labs | **Use Apps on Avalanche** | **Validate on Avalanche**
Build on Avalanche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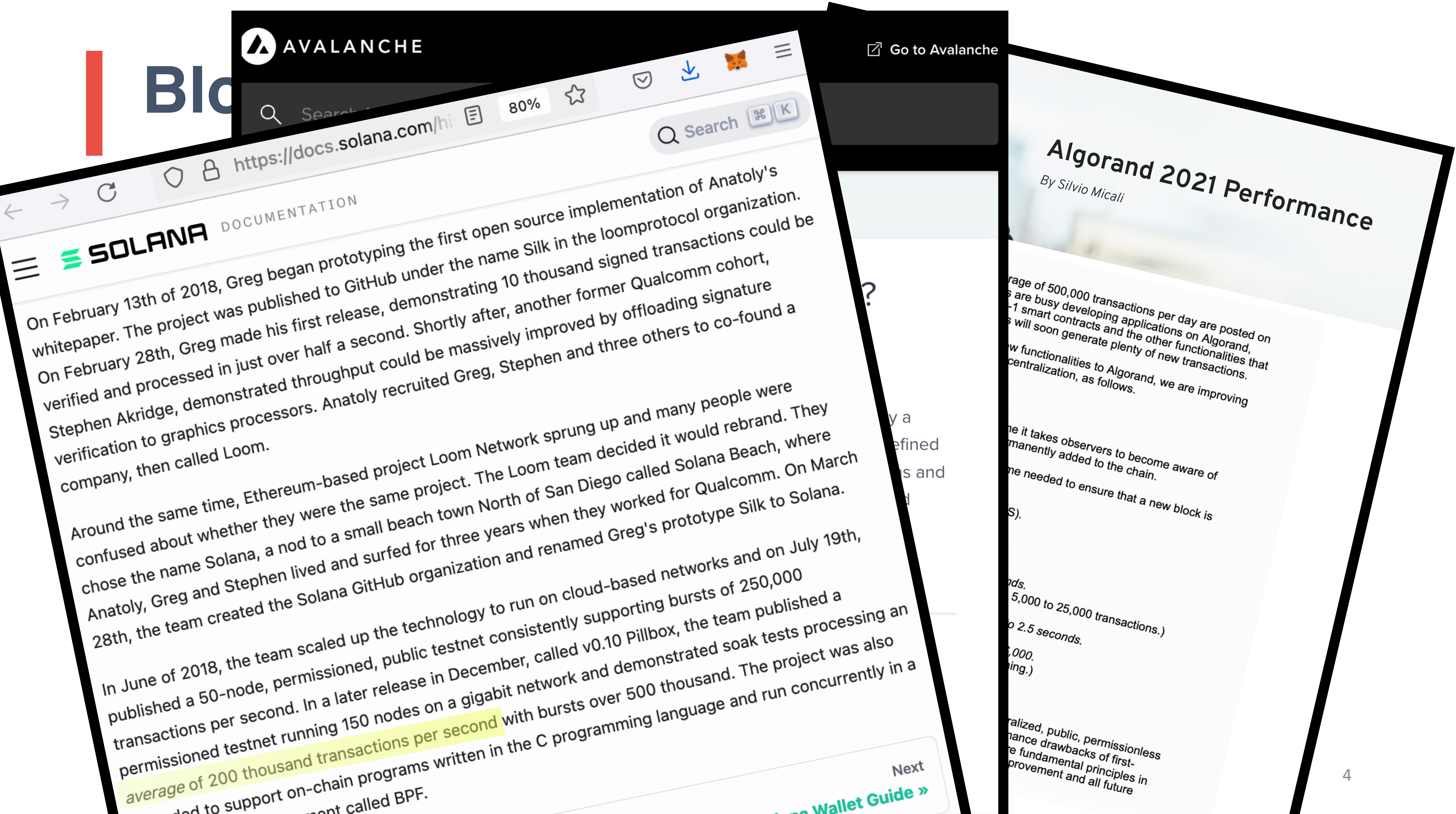


On February 13th of 2018, Greg began prototyping the first open source implementation of Anatoly's whitepaper. The project was published to GitHub under the name Silk in the loomprotocol organization. On February 28th, Greg made his first release, demonstrating 10 thousand signed transactions could be verified and processed in just over half a second. Shortly after, another former Qualcomm cohort, Stephen Akridge, demonstrated throughput could be massively improved by offloading signature verification to graphics processors. Anatoly recruited Greg, Stephen and three others to co-found a company, then called Loom.

Around the same time, Ethereum-based project Loom Network sprung up and many people were confused about whether they were the same project. The Loom team decided it would rebrand. They chose the name Solana, a nod to a small beach town North of San Diego called Solana Beach, where Anatoly, Greg and Stephen lived and surfed for three years when they worked for Qualcomm. On March 28th, the team created the Solana GitHub organization and renamed Greg's prototype Silk to Solana.

In June of 2018, the team scaled up the technology to run on cloud-based networks and on July 19th, published a 50-node, permissioned, public testnet consistently supporting bursts of 250,000 transactions per second. In a later release in December, called v0.10 Pillbox, the team published a permissioned testnet running 150 nodes on a gigabit network and demonstrated soak tests processing an average of 200 thousand transactions per second with bursts over 500 thousand. The project was also ...ded to support on-chain programs written in the C programming language and run concurrently in a ...ment called BPF.

Blockchains are Fast

Blockchain	Claimed TPS
Algorand	1000, 46000
Avalanche	4500
Solana	200,000

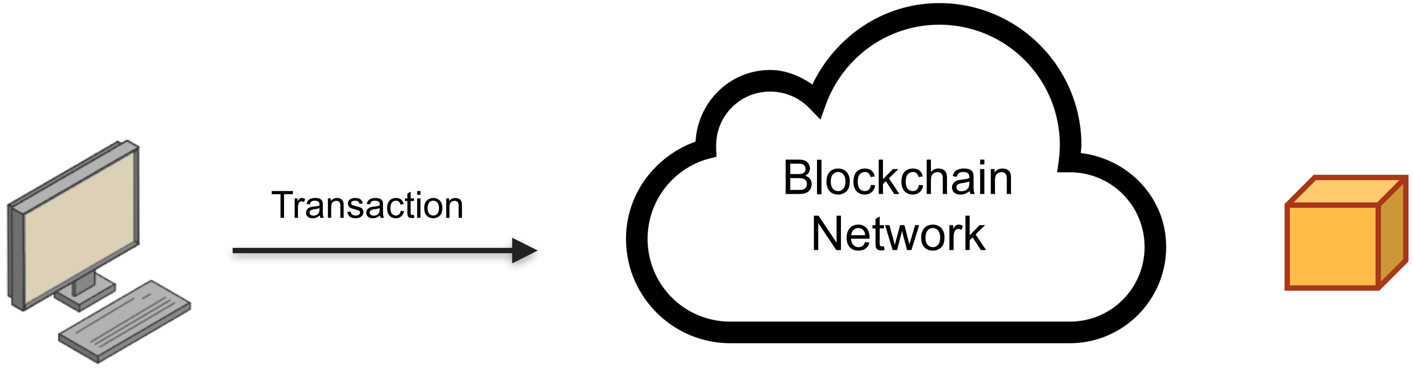
Blockchains are Fast...?

Blockchain	Claimed TPS	Observed TPS
Algorand	1000, 46000	885
Avalanche	4500	323
Solana	200,000	8845

Content

- Definitions
- Impression vs. reality
- Why so much difference?
- Benchmarking
- Conclusion

Definitions



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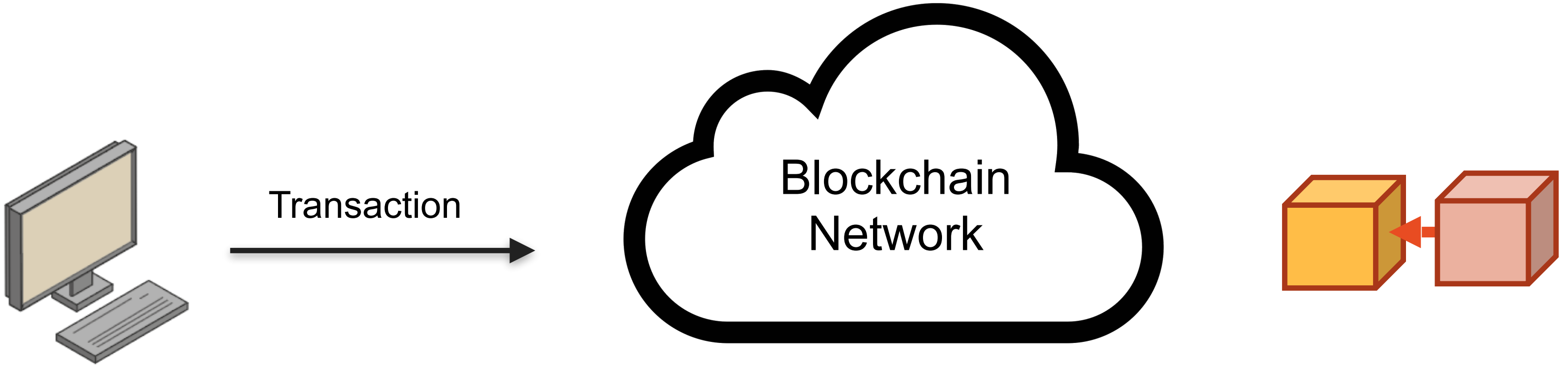
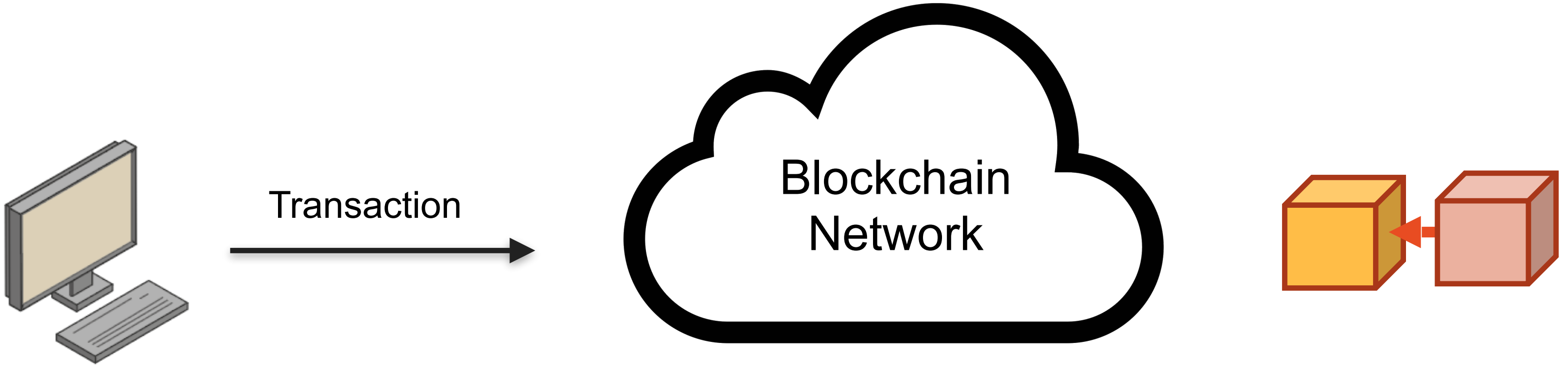


Definitions

TPS (Transactions Per Second): a unit to measure the number of transactions per unit of time.



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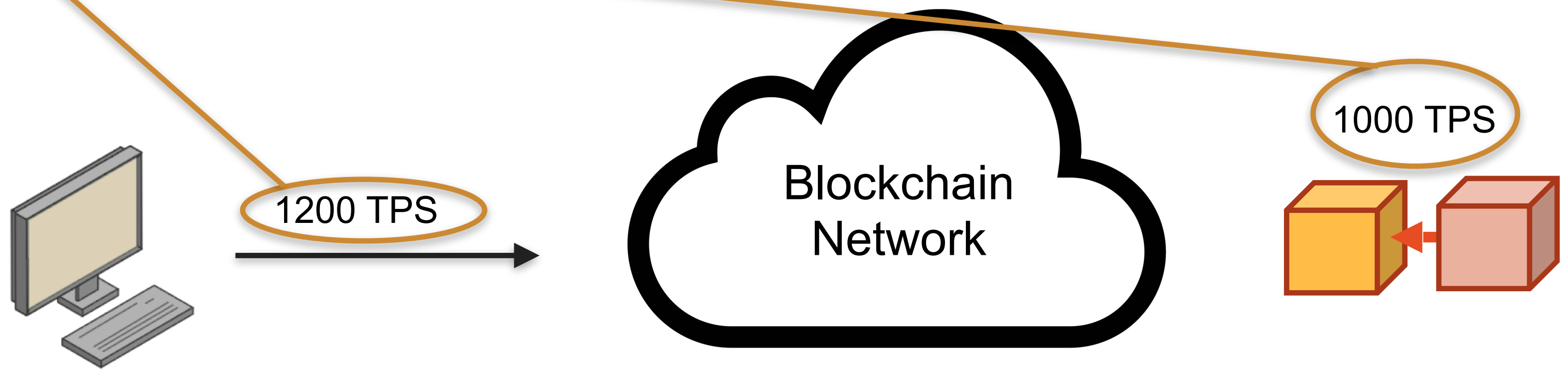

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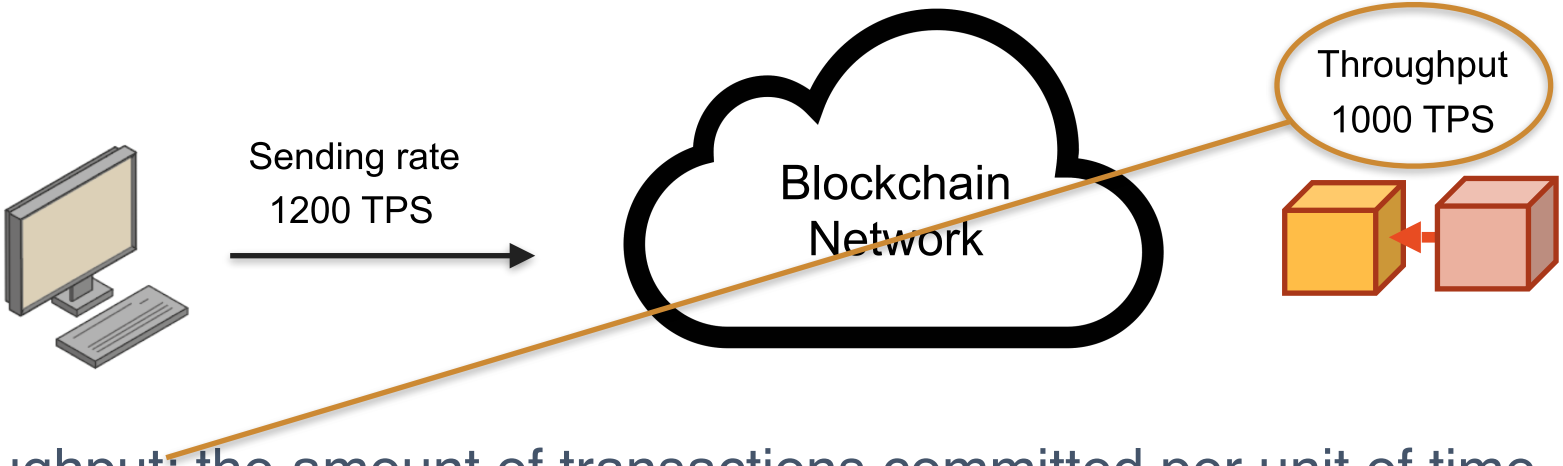

Throughput: the amount of transactions committed per unit of time

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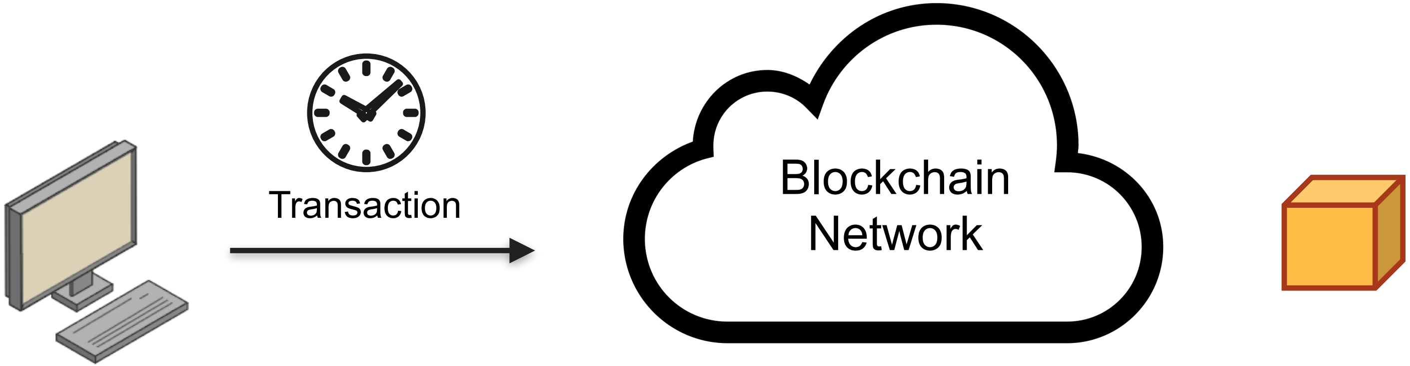

Throughput: the amount of transactions committed per unit of time
Latency: the time needed to commit a transaction

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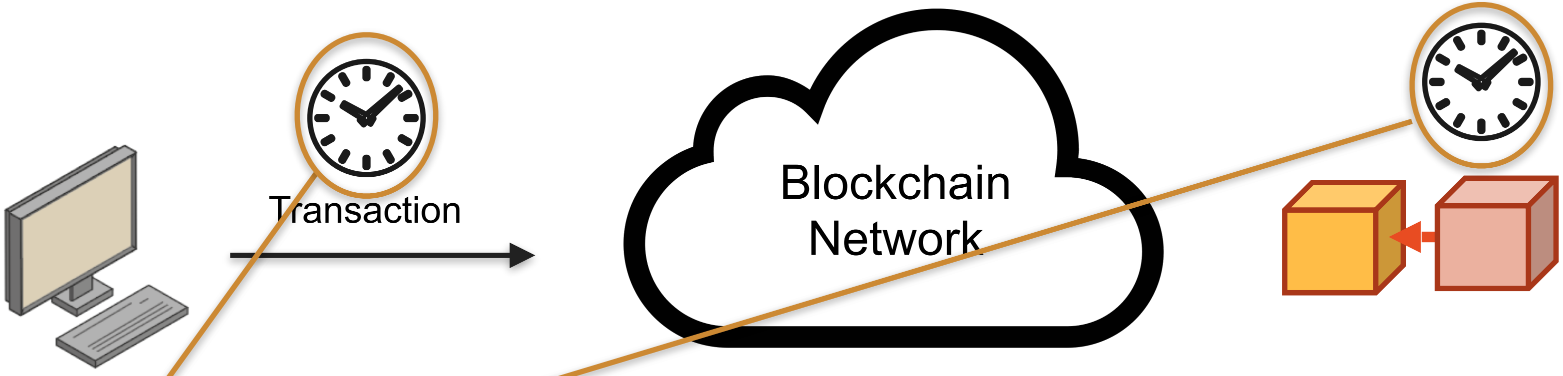

Throughput: the amount of transactions committed per unit of time

Latency: the time needed to commit a transaction

Impression vs Reality

Impression vs. Reality

Blockchain	Claimed results	
	throughput	latency
Algorand	1K–46K TPS [26]	2.5–4.5 s [26]
Avalanche	4.5K TPS [29]	2 s [8]
Solana	200K TPS [34]	<1 s [43]

Gramoli, Guerraoui, Lebedev, Natoli, Voron. Diablo: A Benchmark Suite for Blockchains. EuroSys 2023.

Impression vs. Reality

Blockchain	Claimed results		
	throughput	latency	setup
Algorand	1K–46K TPS [26]	2.5–4.5 s [26]	?
Avalanche	4.5K TPS [29]	2 s [8]	?
Solana	200K TPS [34]	<1 s [43]	150 nodes

Gramoli, Guerraoui, Lebedev, Natoli, Voron. Diablo: A Benchmark Suite for Blockchains. EuroSys 2023.

Impression vs. Reality

Blockchain		Claimed results			Observed results	
	throughput	latency	setup	throughput	latency	setup
Algorand	1K–46K TPS [26]	2.5–4.5 s [26]	?	885 TPS	8.5 s	`testnet`
Avalanche	4.5K TPS [29]	2 s [8]	?	323 TPS	49 s	`datacenter`
Solana	200K TPS [34]	<1 s [43]	150 nodes	8845 TPS	12 s	`datacenter`

Gramoli, Guerraoui, Lebedev, Natoli, Voron. Diablo: A Benchmark Suite for Blockchains. EuroSys 2023.

Why so much difference?

?

Synthetic vs. Realistic Workload

- Synthetic workloads are often expressed in fixed rate
- The rate does not represent variations (e.g., bursts)
- This hides the impact of congestion (e.g., slowdown, crash)
- It is better to evaluate throughput with latency

Experimental Setup

- Simulated networks (artificial networks)
- Emulated networks (artificial delays)
- vCPUs: amount of computational power per node
- Memory: amount of memory available to each node
- Hardware optimizations: special instructions, GPUs, etc.

Distribution

- Most blockchains do not scale well, they accept O(1) transactions independently of the number of validators
- Their performance do not increase with the system size
- But one cannot reasonably test a blockchain on a single node
- Rare blockchains combine proposed blocks into a superblock

Benchmarking

Related Work

- Hyperledger Caliper has synthetic workloads
  https://hyperledger.github.io/caliper/
- Blockbench features YCSB and SmallBank but no real traces
  Tien Tuan Anh Dinh, Ji Wang, Gang Chen, Rui Liu, Beng Chin Ooi, and Kian-Lee Tan. 2017. BLOCKBENCH: A Framework for Analyzing. Private Blockchains. In Proceedings of the 2017 ACM International Conference on Management of Data. 1085–1100
- Stellar was evaluated worldwide but with a focus on latencies
  Marta Lokhava, Giuliano Losa, David Mazières, Graydon Hoare, Nicolas Barry, Eli Gafni, Jonathan Jove, Rafał Malinowsky, and Jed McCaleb. 2019. Fast and Secure Global Payments with Stellar. In SOSP'19
- Algorand was evaluated across the US country. *Yossi Gilad, Rotem Hemo, Silvio Micali, Georgios Vlachos, Nickolai Zeldovich. Algorand: Scaling Byzantine Agreements for Cryptocurrencies in SOSP'17.*
- Redbelly TPS was evaluated worldwide but without comparisons
  Tyler Crain, Christopher Natoli, and Vincent Gramoli. 2021. Red Belly: a Secure, Fair and Scalable Open Blockchain. In Proceedings of the 42nd IEEE Symposium on Security and Privacy (S&P'21)

Diablo: Open Source Framework

Proceedings of the ACM European Conference on Systems (EuroSys) 2023

Artifacts Available acm V1.1

Artifacts Evaluated acm Functional V1.1

Diablo: A Benchmark Suite for Blockchains

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Abstract

With the recent advent of blockchains, we have witnessed a plethora of blockchain proposals. These proposals range from using work to using time, storage or stake in order to

a classification of blockchains, listing 8 different protocols to select nodes that are tasked with proposing blocks, 13 different consensus protocols and 9 data structures to store transaction information. This diversity illustrates a probably

Performance Comparison

200 machines from 10 countries in 5 continents
Various decentralized applications (mobility service, web service, decentralized exchange, gaming…)
7 blockchains

Experimental Setup and Distribution

Configuration	Blockchain nodes			Regions
	number	#vCPUs	memory	
`datacenter`	10	36	72 GiB	Ohio
`testnet`	10	4	8 GiB	Ohio
`devnet`	10	4	8 GiB	all
`community`	200	4	8 GiB	all
`consortium`	200	8	16 GiB	all

	Cape Town	Tokyo	Mumbai	Sydney	Stockholm	Milan	Bahrain	Sao Paulo	Ohio	Oregon
Cape Town		26.1	36.0	20.8	59.8	67.1	33.6	27.1	43.6	35.9
Tokyo	354.0		89.3	112.1	42.1	48.1	66.8	39.3	85.8	108.8
Mumbai	272.0	127.2		75.9	81.3	103.2	336.3	30.8	53.3	48.5
Sydney	410.4	102.3	146.8		32.0	42.4	59.6	31.2	57.0	80.8
Stockholm	179.7	241.2	138.9	295.7		404.6	81.8	48.2	94.7	67.6
Milan	162.4	214.8	110.8	238.8	30.2		105.7	49.4	104.9	70.1
Bahrain	287.0	164.3	36.4	179.2	137.9	108.2		29.9	49.4	38.7
Sao Paulo	340.5	256.6	305.6	310.5	214.9	211.9	320.0		92.3	60.5
Ohio	237.0	131.8	197.3	187.9	120.0	109.2	212.7	121.9		105.0
Oregon	276.6	96.7	215.8	139.7	162.0	157.8	251.4	178.3	55.2	

Round trip time (ms)

Bandwidth (Mbps)

Gramoli, Guerraoui, Lebedev, Natoli, Voron. Diablo: A Benchmark Suite for Blockchains. EuroSys 2023.

Experimental Setup and Distribution

No GPU
No special
instructions

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Real Network

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Best setup for Algorand

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Best setup for Avalanche and Solana

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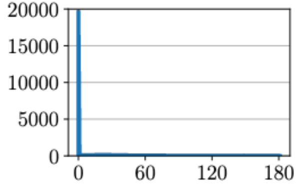
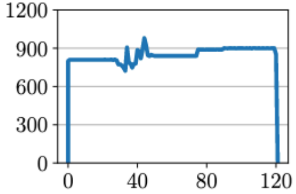
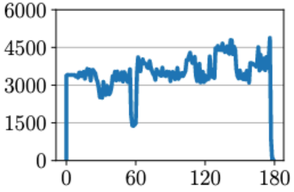
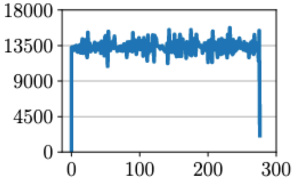
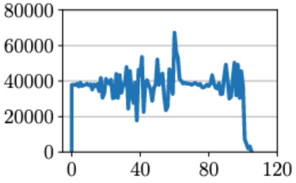
Realistic Workloads with DApps

<table>
<tr><th>DApp</th><th>Exchange</th><th>Mobility service</th><th>Web service</th><th>Gaming</th><th>Video sharing</th></tr>
<tr><td>Workload</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Source trace</td><td>NASDAQ</td><td>Uber</td><td>FIFA</td><td>Dota 2</td><td>YouTube</td></tr>
<tr><td>Characteristics</td><td>Burst</td><td>Compute intensive</td><td>Contended</td><td>High sending rate</td><td>Very high sending rate</td></tr>
</table>

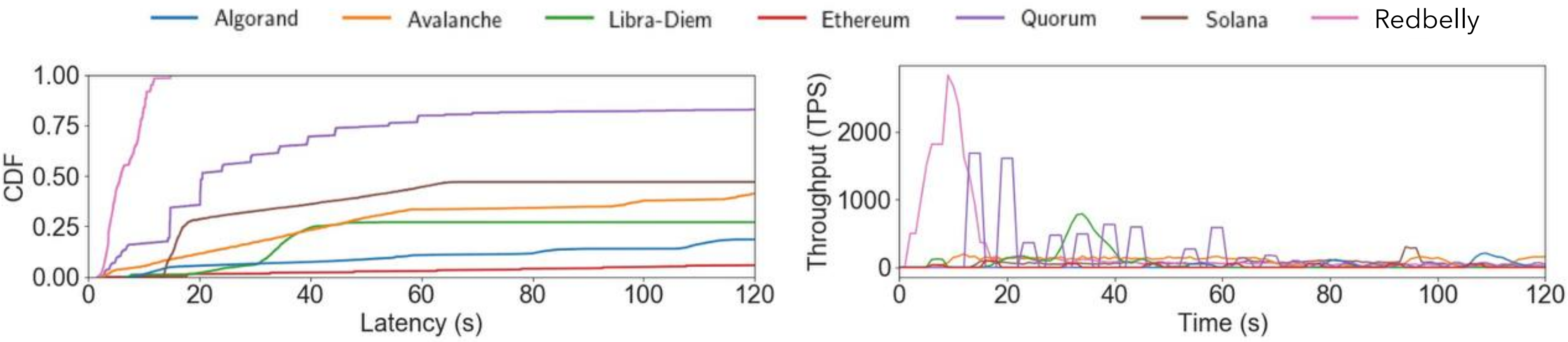
Gramoli, Guerraoui, Lebedev, Natoli, Voron. Diablo: A Benchmark Suite for Blockchains. EuroSys 2023.

Blockchain Comparison

Blockchain	Property	Consensus	DApp language
Algorand	Probabilistic	BA*	PyTeal
Avalanche		Avalanche	Solidity
Diem	Deterministic	HotStuff	Move
Quorum		IBFT	Solidity
Redbelly		DBFT	Solidity
Ethereum	Eventual	Clique	Solidity
Solana		TowerBFT	Solidity

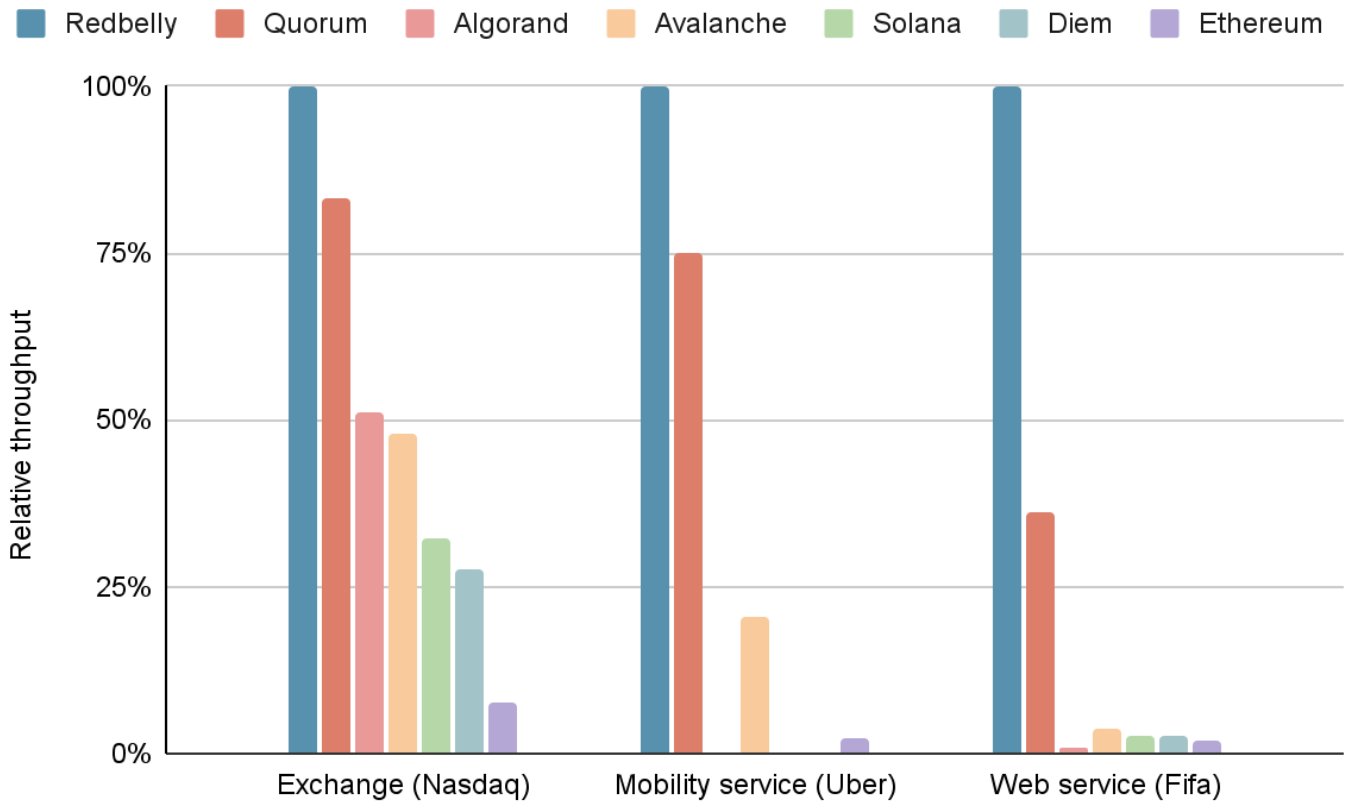
Performance Comparison

Setup: Community, DApp: Exchange/Nasdaq



Tennakoon, Gramoli. Smart Red Belly Blockchain: Reducing Congestion for Web3, IPDPS 2023.

Performance Comparison (con't)



Setup:
Community

Conclusion

Conclusion

- Setup, workloads and distribution impact performance significantly
- It is important to document them for the sake of reproducibility
- Use a well established benchmark to evaluate your blockchain
  - Contribute to https://diablobench.github.io/
- Compare with other blockchains

Conclusion

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