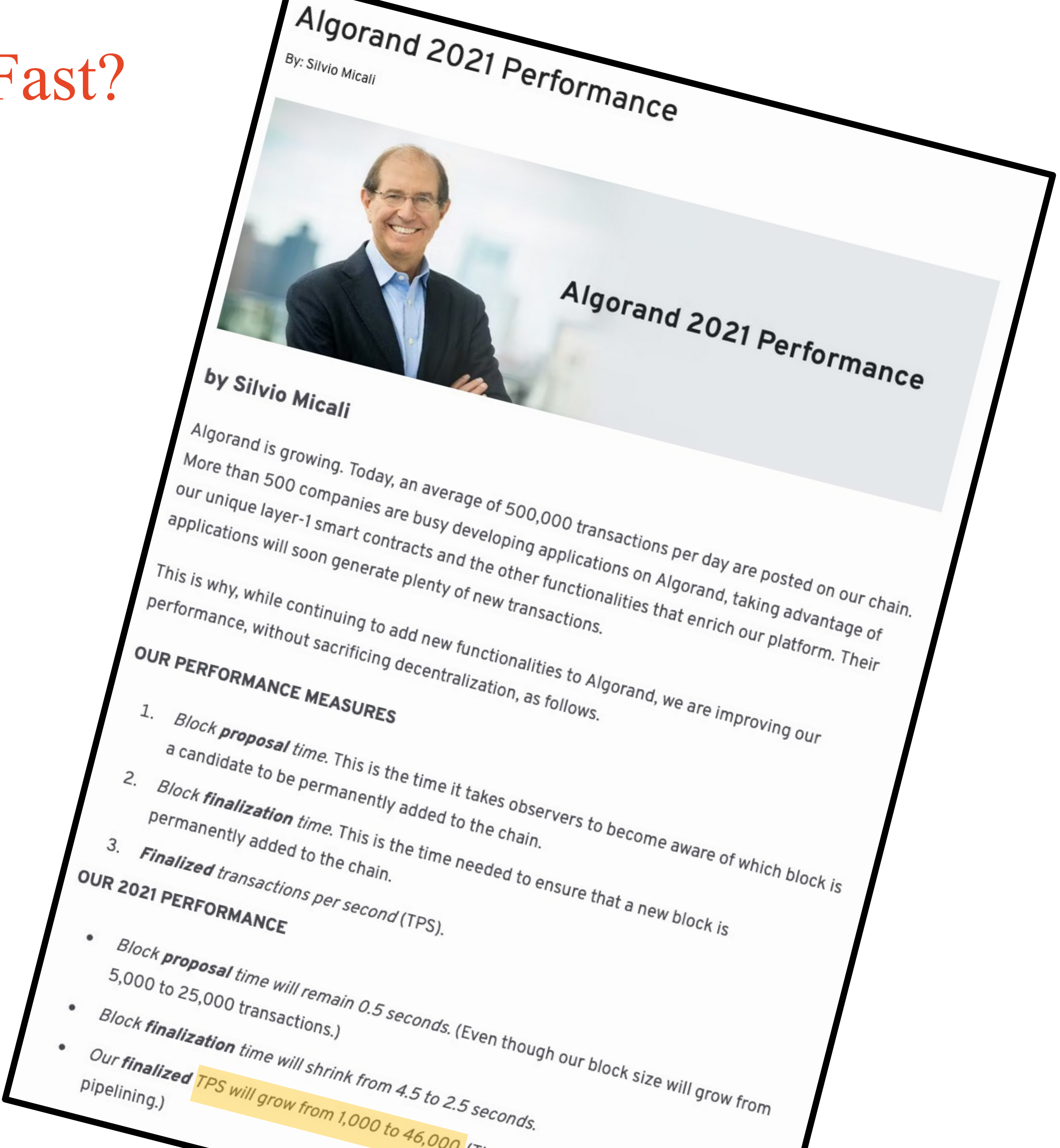
Are Blockchains Fast?



Algorand 2021 Performance

By: Silvio Micali

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.

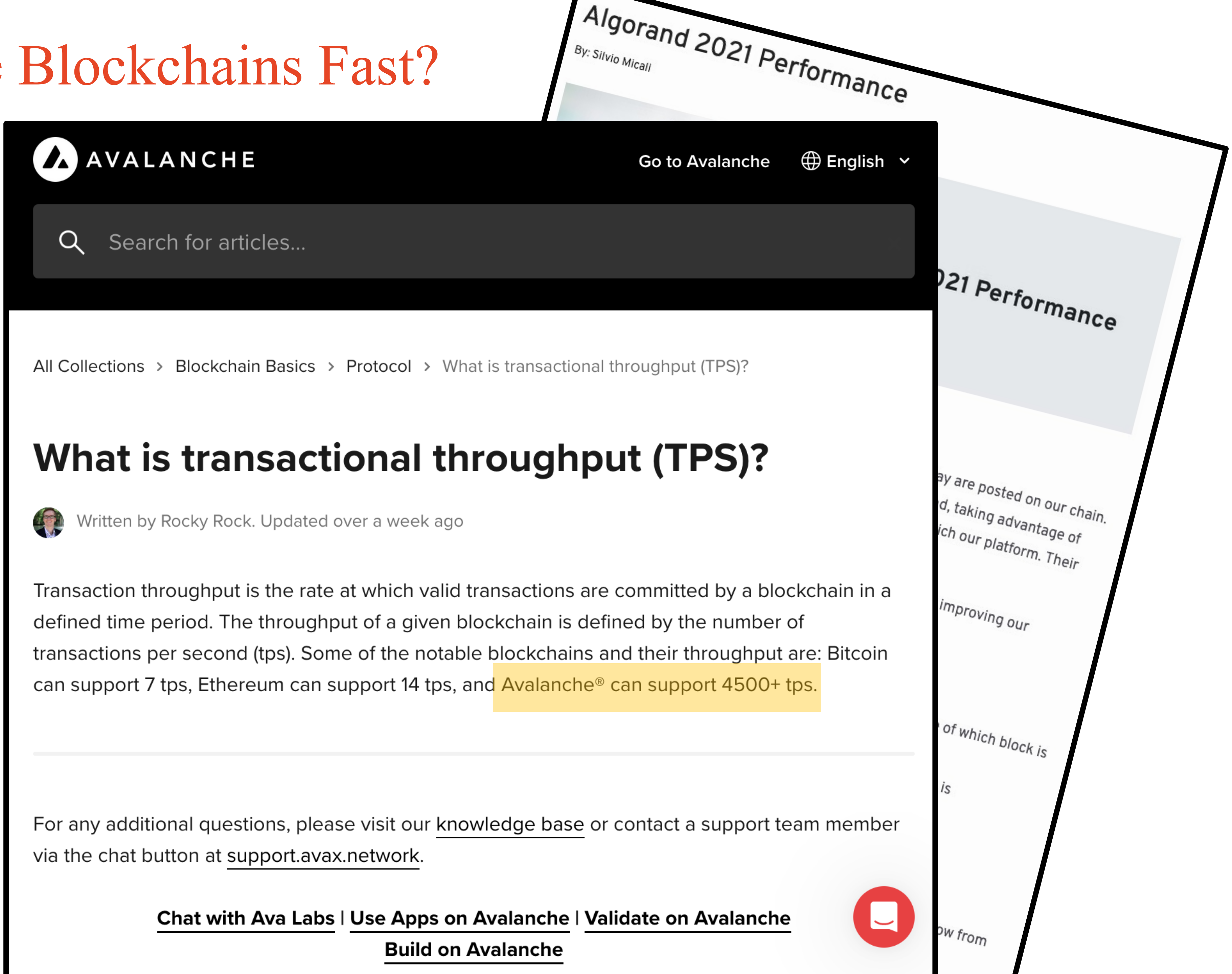
OUR PERFORMANCE MEASURES

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* (T... pipelining.)

Are Blockchains Fast?


Algorand 2021 Performance

By: Silvio Micali

AVALANCHE

Go to Avalanche

English

Search for articles...

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

What is transactional throughput (TPS)?

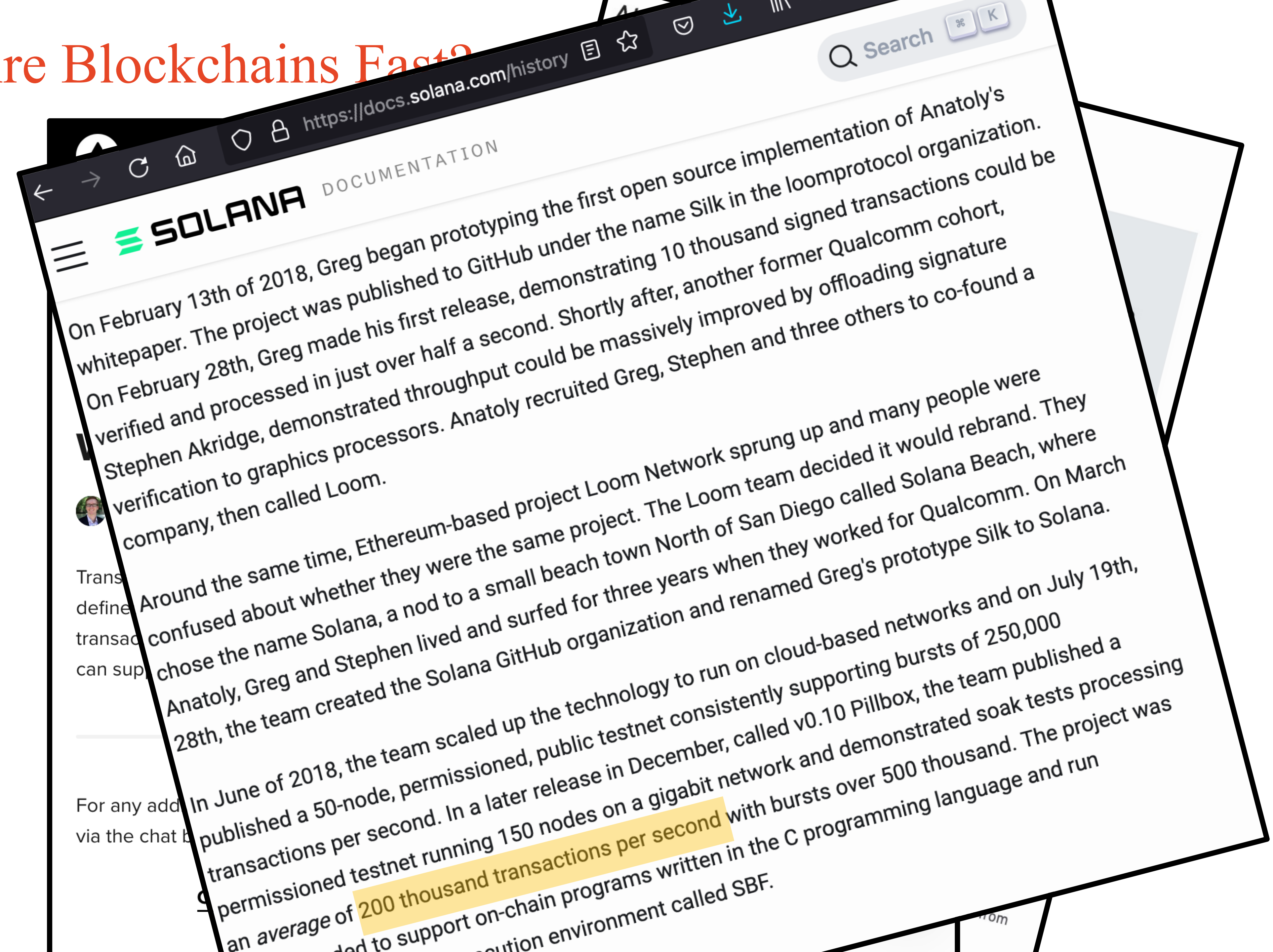
Written by Rocky Rock. Updated over a week ago

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.

For any additional questions, please visit our knowledge base or contact a support team member via the chat button at support.avax.network.

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

Are Blockchains Fast?



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 ... ded to support on-chain programs written in the C programming language and run ... cution environment called SBF.

Experimental Settings?

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]

Experimental Settings?

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

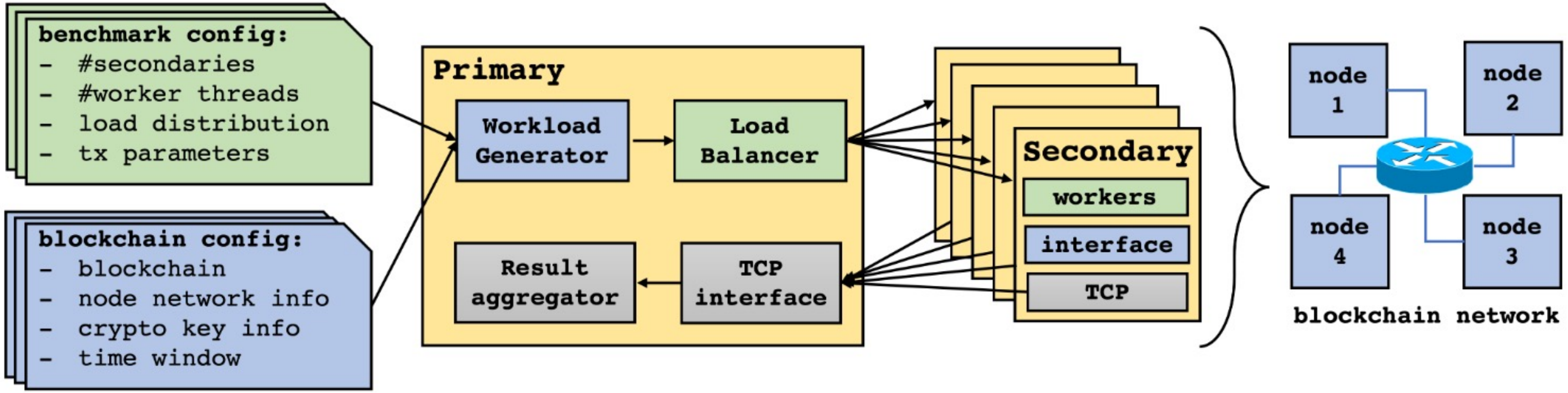
Experimental Settings?

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`

Diablo: A benchmark Suite for Blockchains

Vincent Gramoli (University of Sydney, EPFL, Redbelly Network)
Rachid Guerraoui (EPFL)
Andrei Lebedev (University of Sydney, EPFL)
Chris Natoli (University of Sydney)
Gauthier Voron (EPFL)

Diablo benchmarking framework



Blockchain Evaluations

Blockchain	Property	Consensus	VM	DApp language
Algorand	probabilistic	BA*	AVM	PyTeal
Avalanche	probabilistic	Avalanche	geth	Solidity
Diem	deterministic	HotStuff	MoveVM	Move
Quorum	deterministic	IBFT	geth	Solidity
Ethereum	eventual	Clique	geth	Solidity
Solana	eventual	TowerBFT	eBPF	Solidity

Available and Evaluated Artifacts

Code and documentation available at http://diablobench.github.io

Diablo: A Benchmark Suite for Blockchains

Vincent Gramoli
University of Sydney
Sydney, Australia
EPFL
Lausanne, Switzerland
vincent.gramoli@sydney.edu.au

Rachid Guerraoui
EPFL
Lausanne, Switzerland
rachid.guerraoui@epfl.ch

Andrei Lebedev
University of Sydney
Sydney, Australia
EPFL
Lausanne, Switzerland
andrei.lebedev@sydney.edu.au

Chris Natoli
University of Sydney
Sydney, Australia
chrisnatoli.research@gmail.com

Gauthier Voron
EPFL
Lausanne, Switzerland
gauthier.voron@epfl.ch

Artifacts Available acm V1.1

Artifacts Evaluated acm Functional V1.1

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 select blocks to be appended to the chain. As a drawback it makes it difficult for the application developer to choose the right blockchain to support their applications. In particular, the scalability and performance one can obtain from a specific blockchain is typically unknown. The claimed results are often obtained in isolation by the developers of the blockchain themselves. The experimental conditions corresponding to these results are generally missing and the lack of details make these results irreproducible.

In this paper, we propose the most extensive evaluation of blockchain to date. First, we show how the experimental settings impact the performance of 6 state-of-the-art blockchains and argue for more detailed experiments. Second, and to cope with this limitation, we propose a unifying framework to evaluate blockchains on the same ground. The

Each of these consists of a separate protocol offering distinctive features like speed, a new financial service, scalability, etc. Although a number of these variants could, in theory, be running on multiple instances of the same blockchain, they are often packaged as their own standalone blockchain implementation. A recent survey [28] highlights the breadth of the blockchain landscape through 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 small subset of all blockchain implementations that exist today.

This plethora of blockchain proposals raises the question of which proposal is the ideal blockchain for a particular application. Unfortunately, most of these proposals are not reported in scientific publications. They are at best described in the form of white papers that present a 10-000-foot-view of their implementation details. As an example, the Ethereum yellow paper [41] presents the technicalities of the Ethereum

Blockchain Evaluations

Blockchain	Property	Consensus	VM	DApp language
Algorand	probabilistic	BA*	AVM	PyTeal
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Ethereum	eventual	Clique	geth	Solidity
Solana	eventual	TowerBFT	eBPF	Solidity
Smart Redbelly	deterministic	DBFT	SEVM	Solidity

Decentralized Applications (DApps)

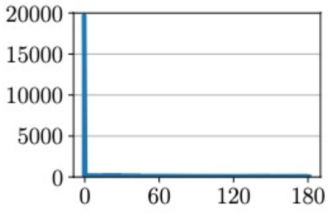
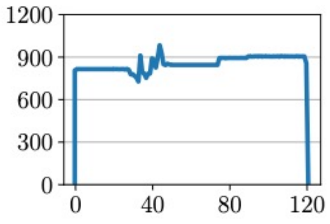
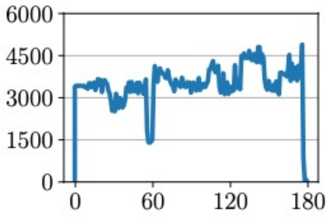
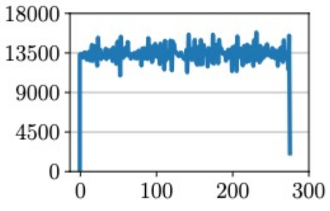
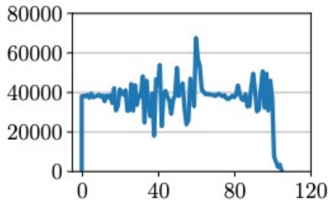
DApp	Exchange	Mobility service	Web service	Gaming	Video sharing
Workload					
Source trace	NASDAQ	Uber	FIFA	Dota 2	YouTube
Characteristics	Burst	Compute intensive	Contended	High sending rate	Very high sending rate

Table 2. Decentralized applications (DApps) used as DIABLO benchmarks and their associated workload based on real traces. Each graph shows the number of submitted transactions (y-axis) per second (x-axis).

Experimental Settings

Configuration	Blockchain nodes number	#vCPUs	memory	Regions
`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)

Experimental Settings

No GPU
No special instructions

Configuration	Blockchain nodes			Regions
	number	#vCPUs	memory	
`datacenter`	10	36	72 GiB	Ohio
`testnet`	10	4	8 GiB	Ohio
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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)

Experimental Settings

Real Network

Configuration	Blockchain nodes number	#vCPUs	memory	Regions
`datacenter`	10	36	72 GiB	Ohio
`testnet`	10	4	8 GiB	Ohio
`devnet`	10	4	8 GiB	all
`community`	200	4	8 GiB	all
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Best setup for Algorand

	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
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Round trip time (ms)

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`community`	200	4	8 GiB	all
`consortium`	200	8	16 GiB	all

Best setup for
Avalanche and Solana

	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
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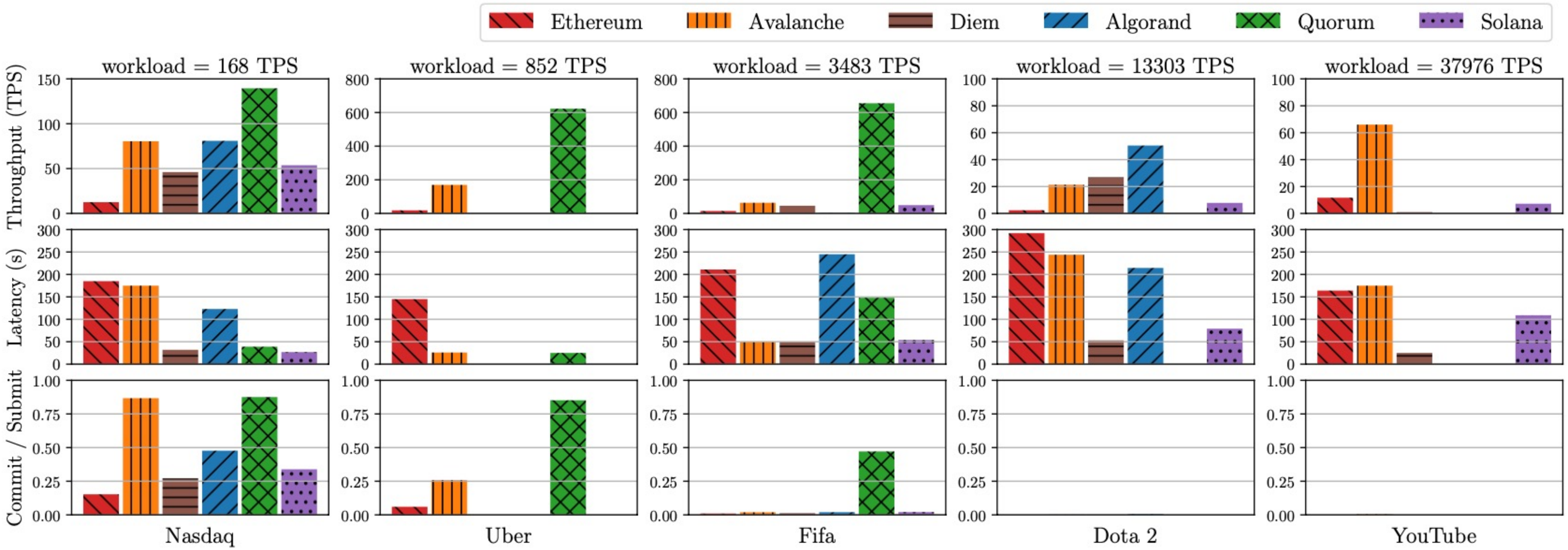
Round trip time (ms)

Bandwidth (Mbps)

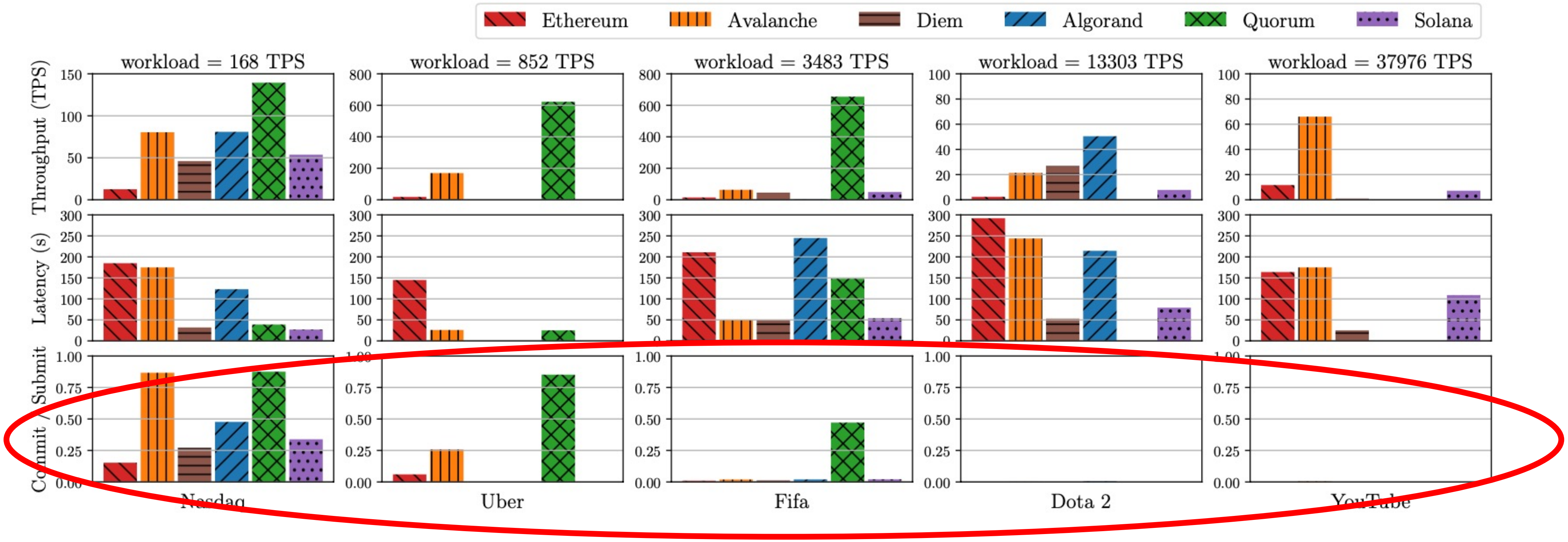
Large Scale Evaluations

200 blockchain nodes, each with 8 vCPUs, 16 GiB memory, from 10 countries in 5 continents (enough secondaries)

Comparison Overview

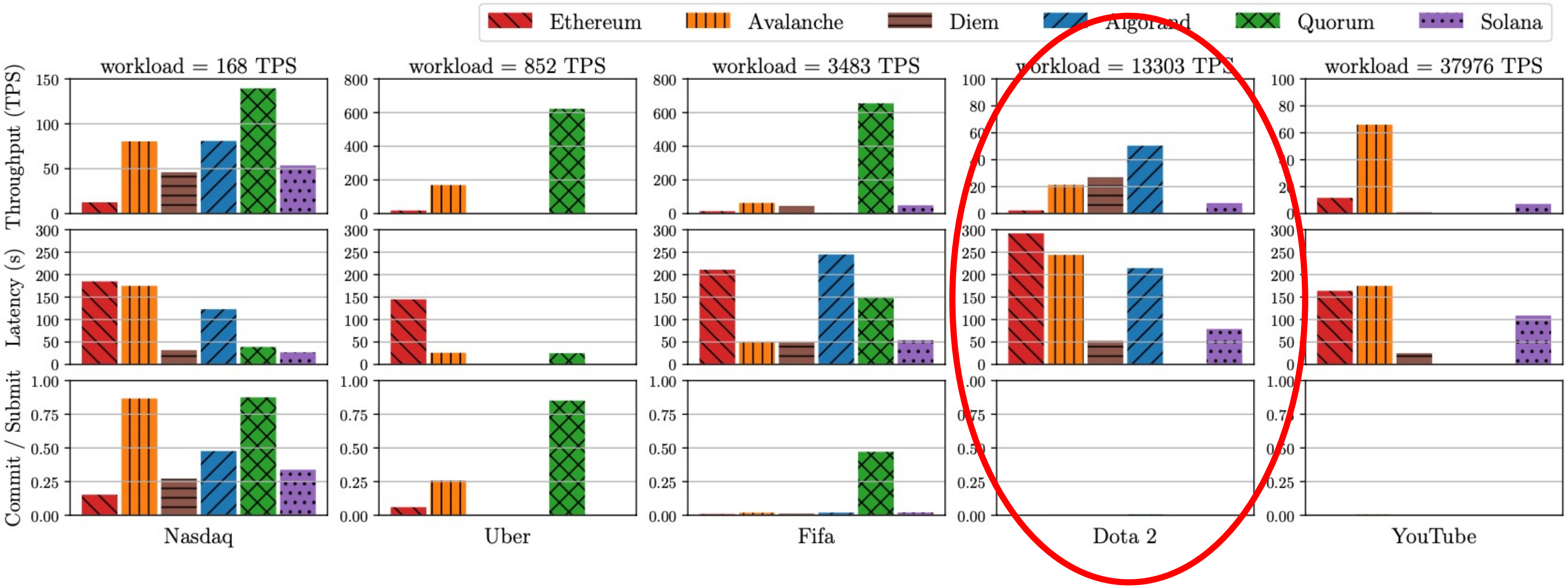


Comparison Overview



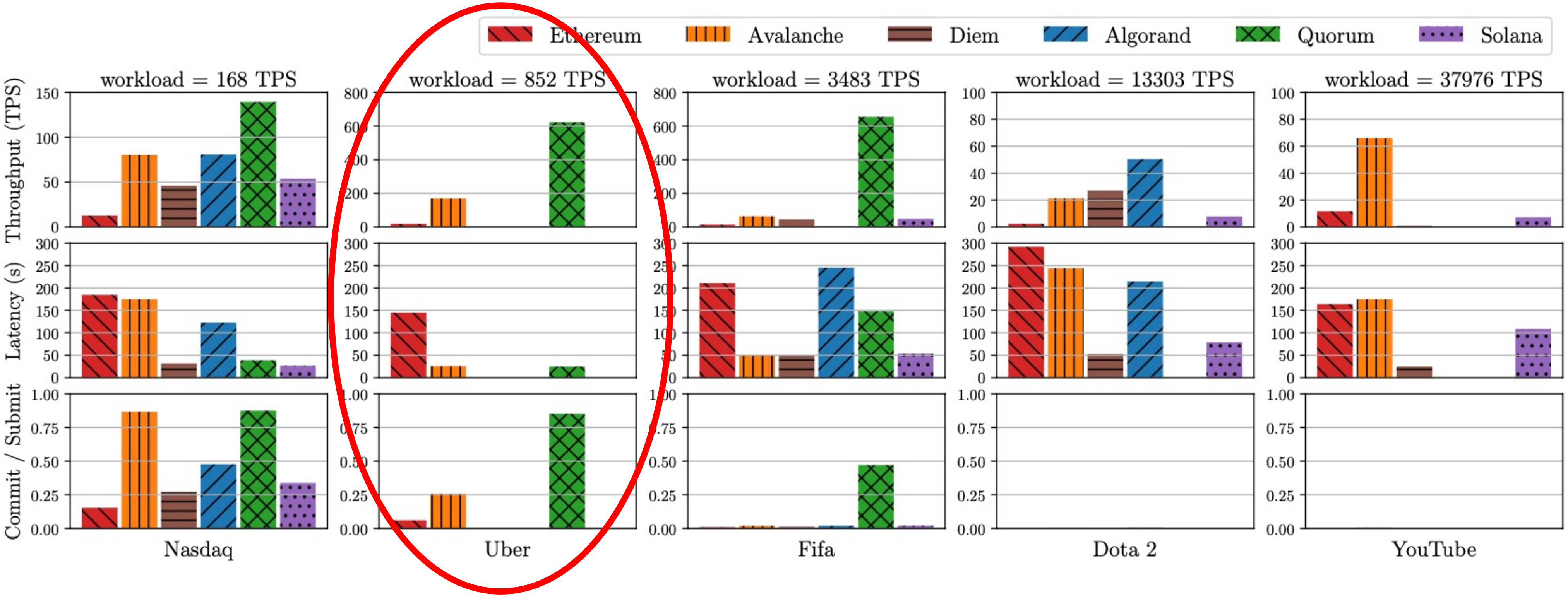
None of the blockchains can commit all transactions of any DApp

Comparison Overview



No blockchains have a higher throughput than 66 TPS
even though the sending rate is almost constant

Comparison Overview



Algorand, Diem and Solana cannot commit any transaction due to a "budget exceeded" error

Smart Redbelly Blockchain (SRBB)

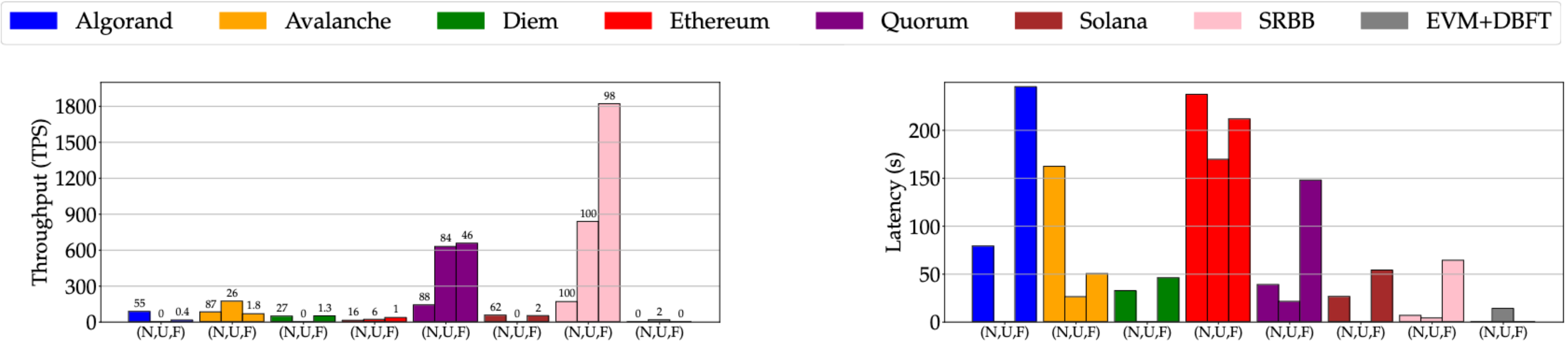


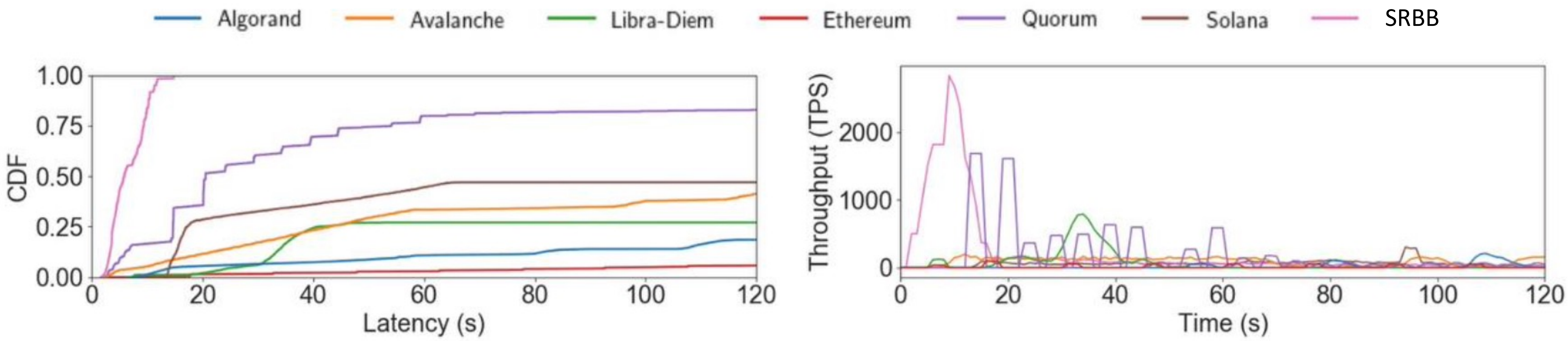
Fig. 2: Throughput (y-axis) and commit percentage (top of the bar) for NASDAQ, Uber and FIFA workloads (i.e., (N,U,F) is NASDAQ, Uber and FIFA)

Fig. 3: Latency (y-axis) for NASDAQ, Uber and FIFA workloads (i.e., (N,U,F) is NASDAQ, Uber and FIFA)

Smart Redbelly Blockchain: Reducing Congestion for Web3. D. Tennakoon, Y. Hua, V. Gramoli. 37th IEEE International Parallel & Distributed Processing Symposium (IPDPS), 2023.

Red Belly: A secure, fair and scalable open blockchain. T. Crain, C. Natoli, V. Gramoli. IEEE Symposium on Security and Privacy (S&P), 466-483, 2021.

Smart Redbelly Blockchain (SRBB)



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Red Belly: A secure, fair and scalable open blockchain. T. Crain, C. Natoli, V. Gramoli. IEEE Symposium on Security and Privacy (S&P), 466-483, 2021.

Related Work and Conclusions

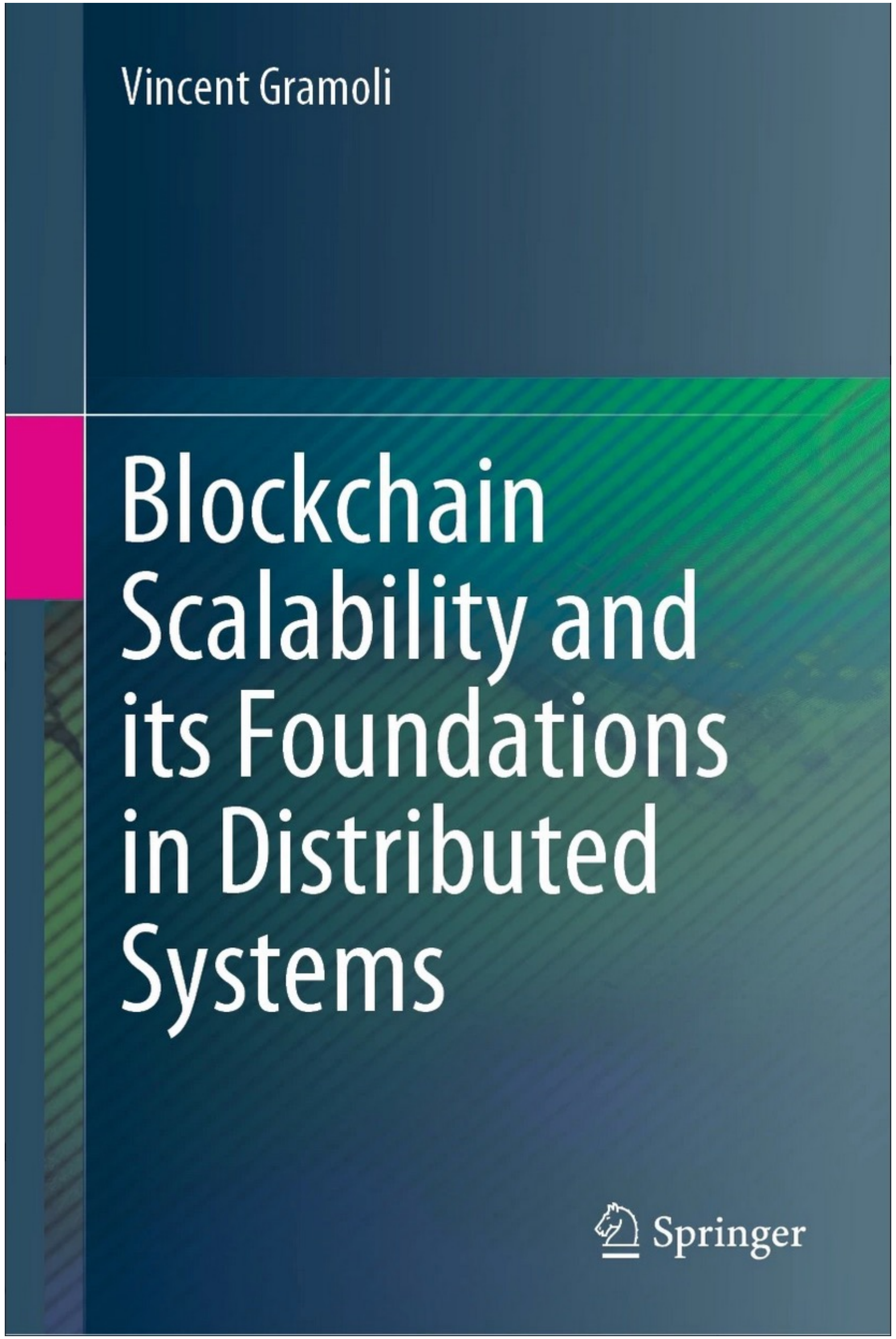
Prior blockchain benchmarks were not realistic

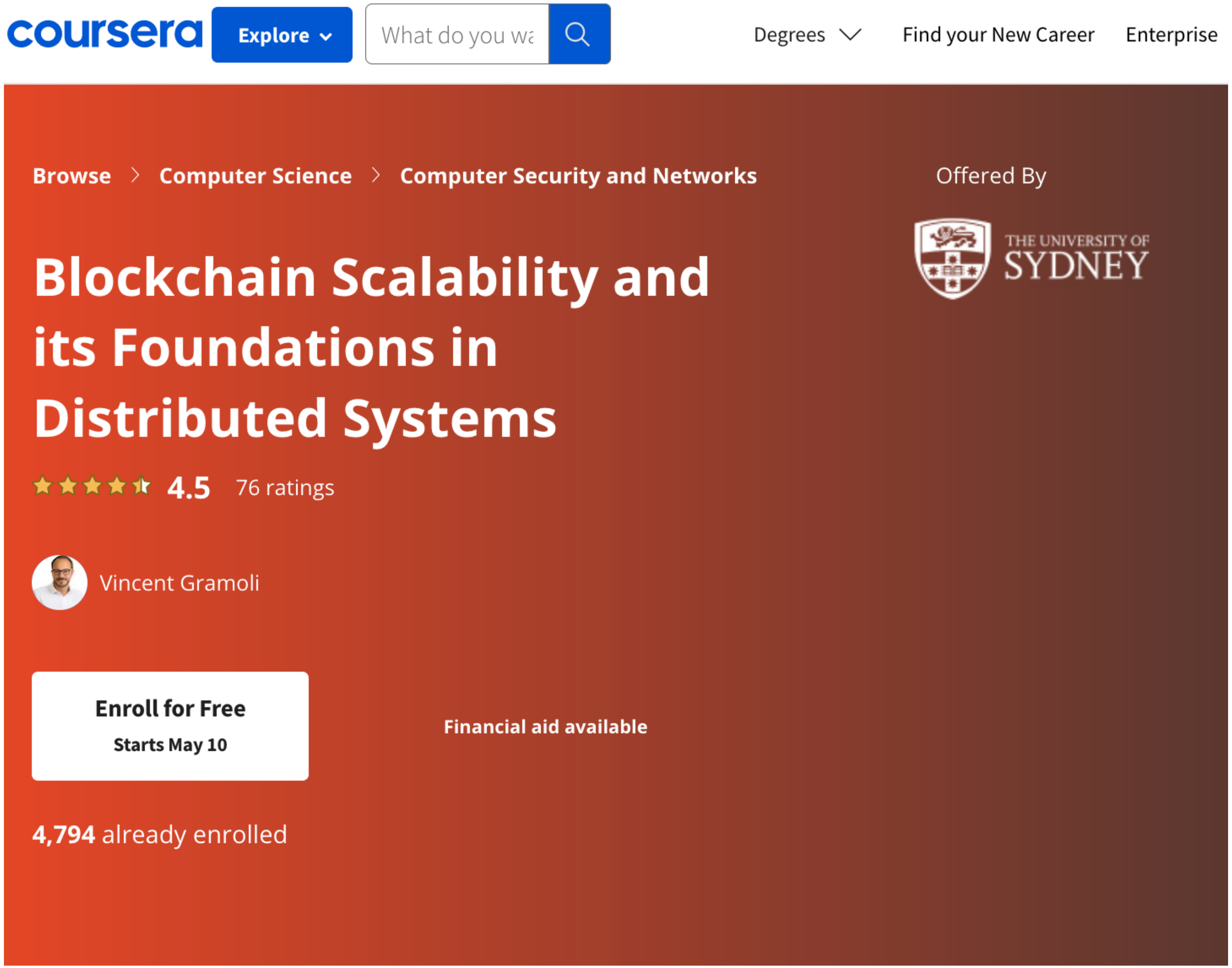
- Hyperledger Caliper has synthetic workloads
  https://hyperledger.github.io/caliper/
- Blockbench features YCSB and SmallBank but no real traces
  Anh Dinh, Wang, Chen, Liu, Chin Ooi, Tan. BLOCKBENCH: A Framework for Analyzing Private Blockchains. SIGMOD 2017

Diablo allows to assess blockchains on the same ground

- One can easily add blockchains to it
- One can easily add DApps to it
- The dataset, code, documentation are publicly available

Feel free to contribute to Diablo by adding blockchains or DApps


Vincent Gramoli
Blockchain Scalability and its Foundations in Distributed Systems
Springer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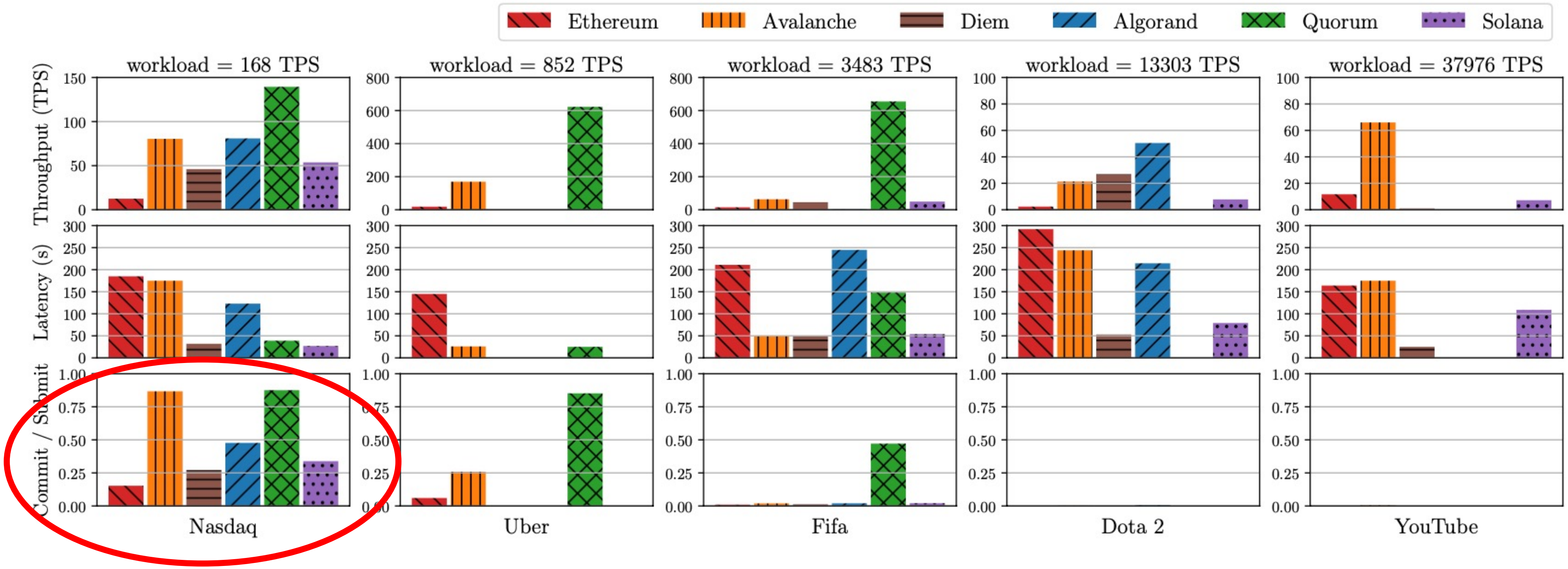
Offered By
THE UNIVERSITY OF SYDNEY
Blockchain Scalability and its Foundations in Distributed Systems
4.5 76 ratings
Vincent Gramoli
Enroll for Free
Starts May 10
Financial aid available
4,794 already enrolled

Feedbacks

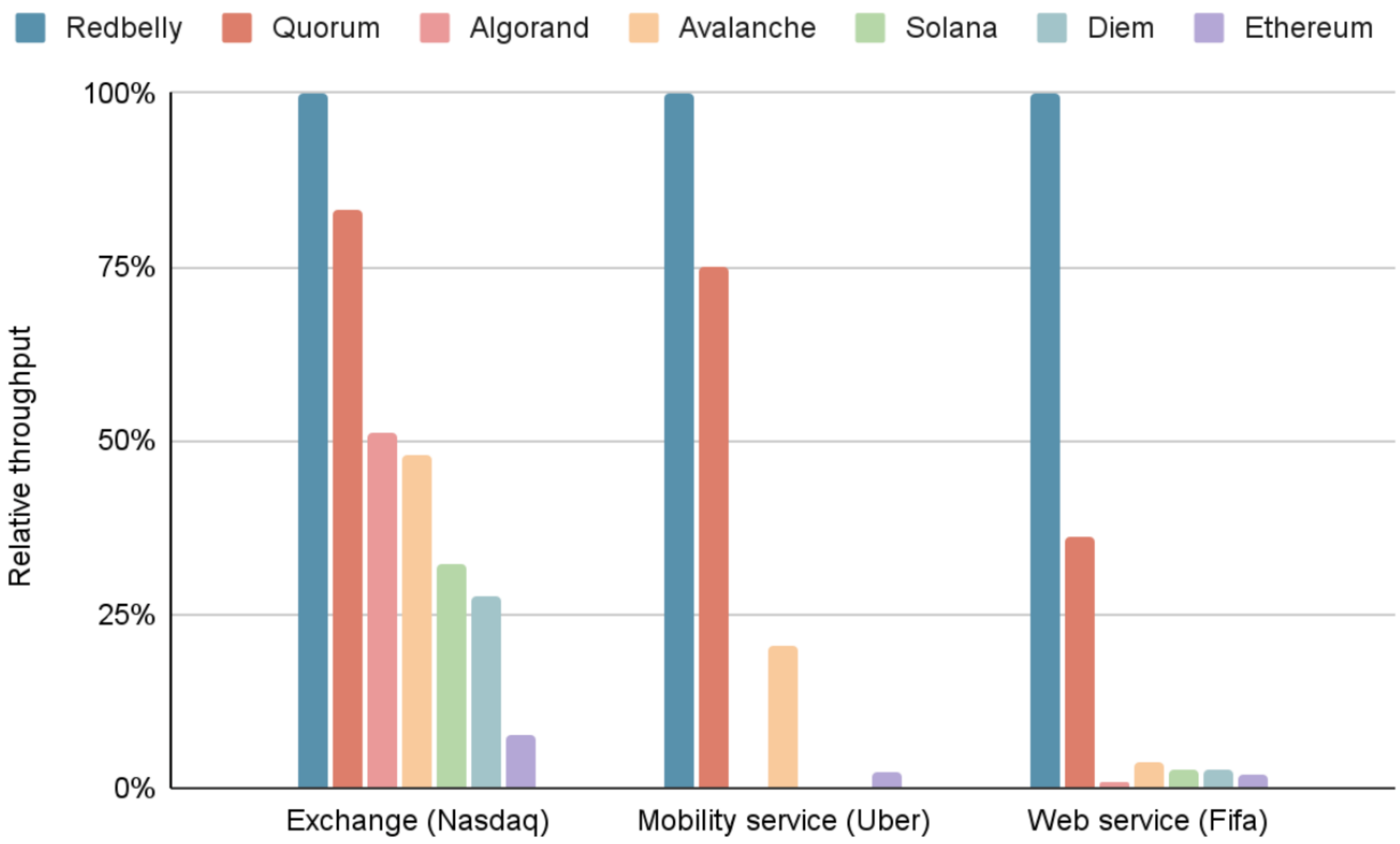
- Solana development team confirmed that c5.xlarge instances were insufficient
- Avalanche team confirmed that C-Chain was using the London update
- Diem informed us that we could not speedup the account creation
- Algorand confirmed that 1000+TPS was peak throughput obtained on load tests

Comparison Overview



Nasdaq w/ lowest
average sending rate (168TPS)
=> Quorum and Avalanche commit >86% txs
Other blockchains commit <47% txs

Smart Redbelly Blockchain (SRBB)



Smart Redbelly Blockchain: Reducing Congestion for Web3. D. Tennakoon, Y. Hua, V. Gramoli. Proceedings of the 37th IEEE International Parallel & Distributed Processing Symposium (IPDPS), 2023