Blockchain Energy Consumption: Unveiling the Impact of Network Topologies

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1506 UNIVERSITÀ DEGLI STUDI DI URBINO CARLO BO

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- **The sustainability challenge**: High energy consumption raises environmental concerns.
- **The role of network topology** impacts workload distribution, latency, and overall blockchain energy efficiency.

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- Despite its significant impact on workload distribution, and communication latency, network topology remains largely overlooked.

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4. Assessing the feasibility of achieving comparable performance in a cost-effective cluster setup.

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- Comparing network configurations to determine which optimize energy consumption while maintaining performance.

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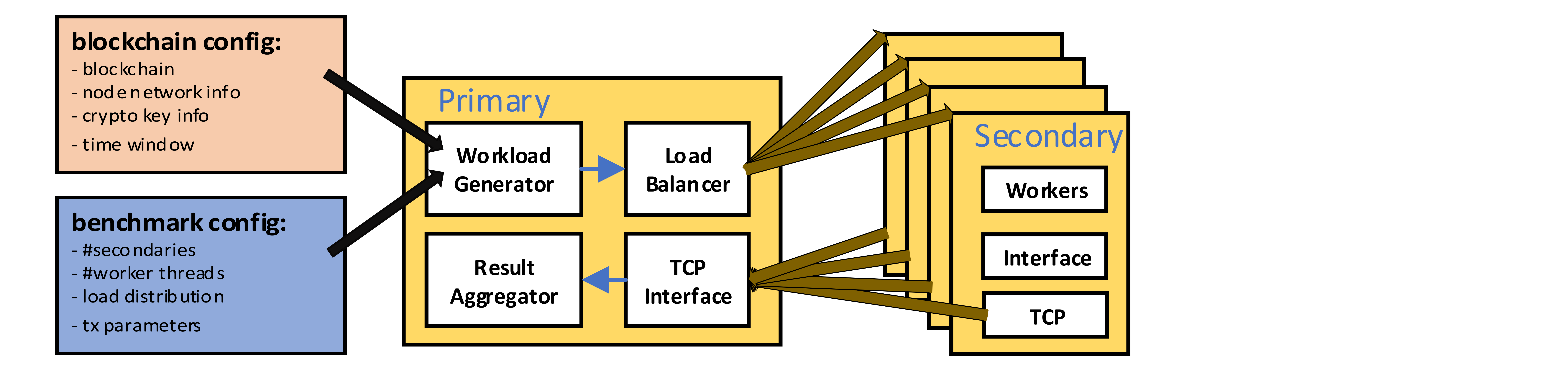

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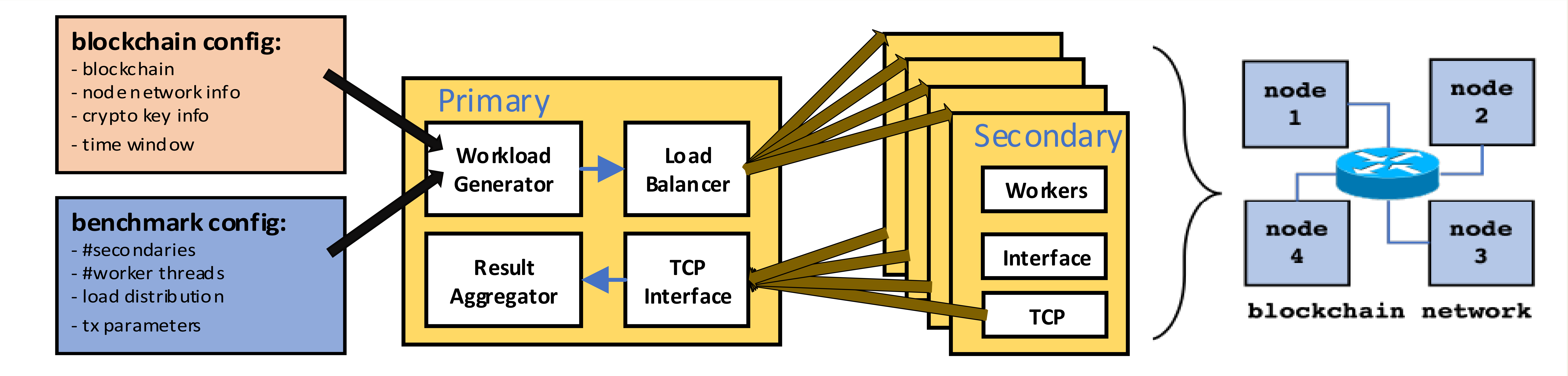

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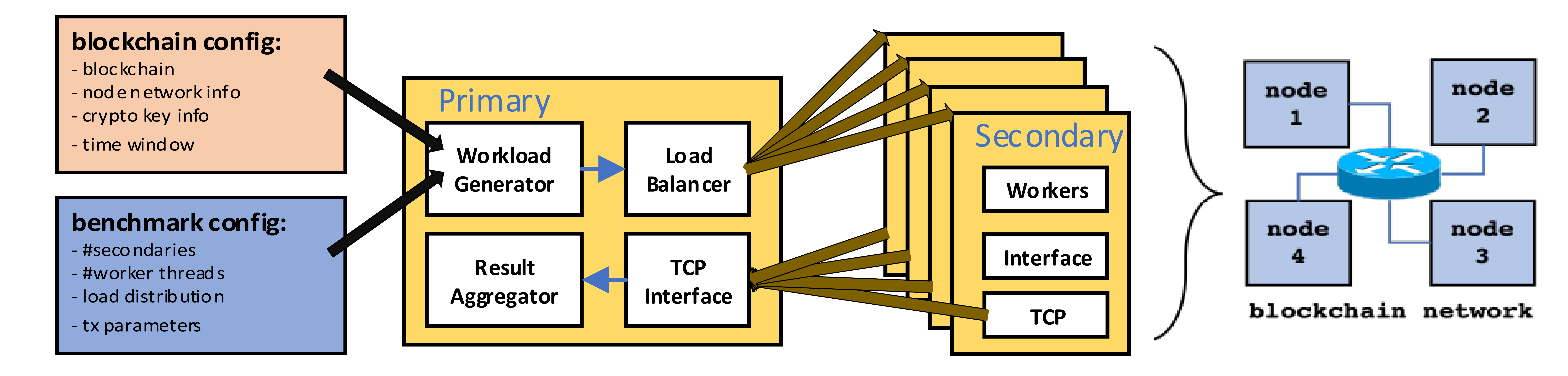

- **Primary** element transmits a description of the transactions to Secondaries elements, waits for all of them to be ready and informs when to start the benchmark.
- Each **Secondary** sends its results to the Primary and an aggregator collects them indicating the timestamps that can be used to generate time series, analyze latencies, etc.

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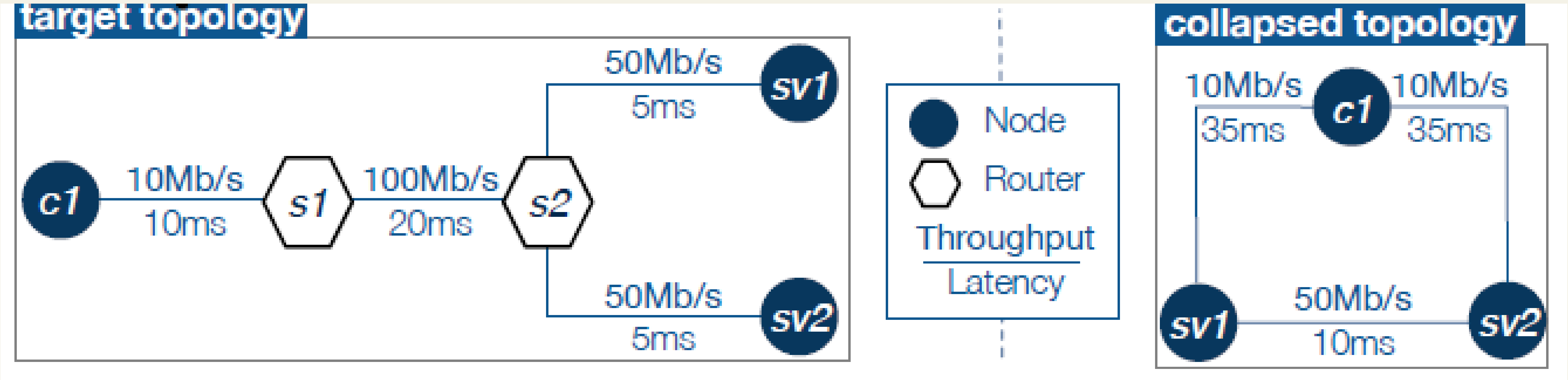

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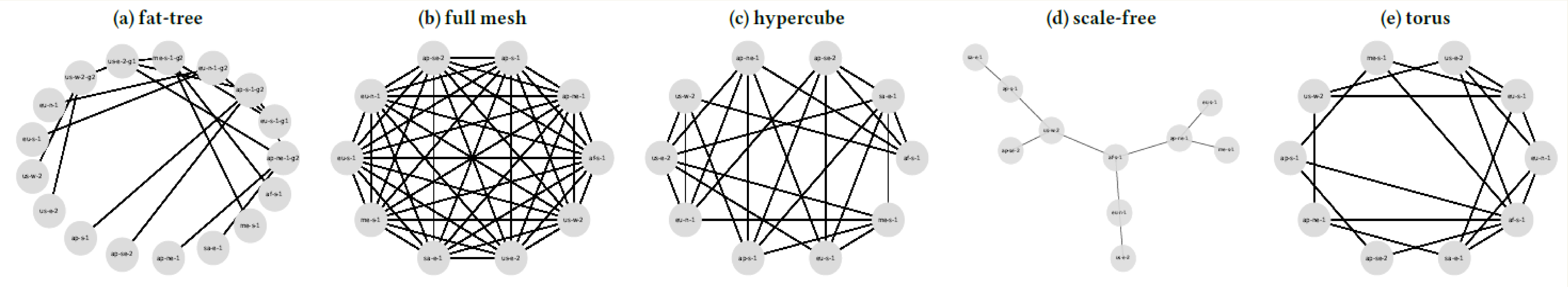

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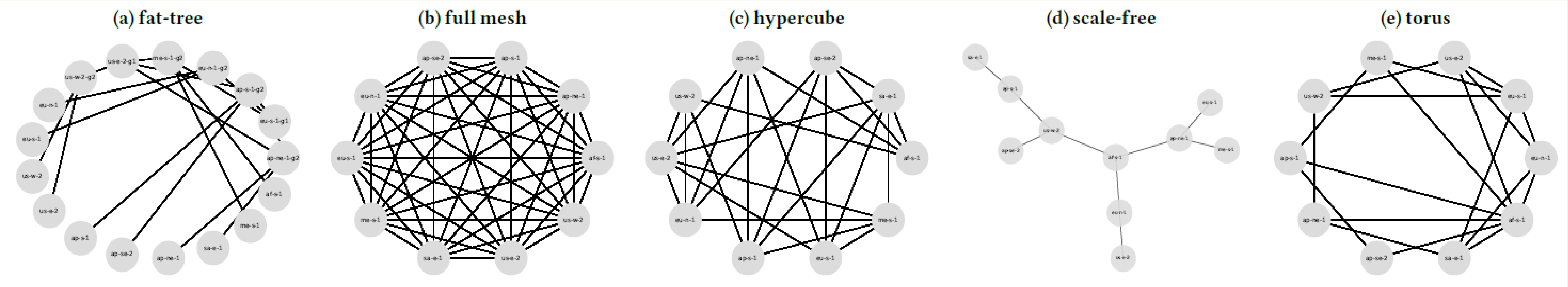

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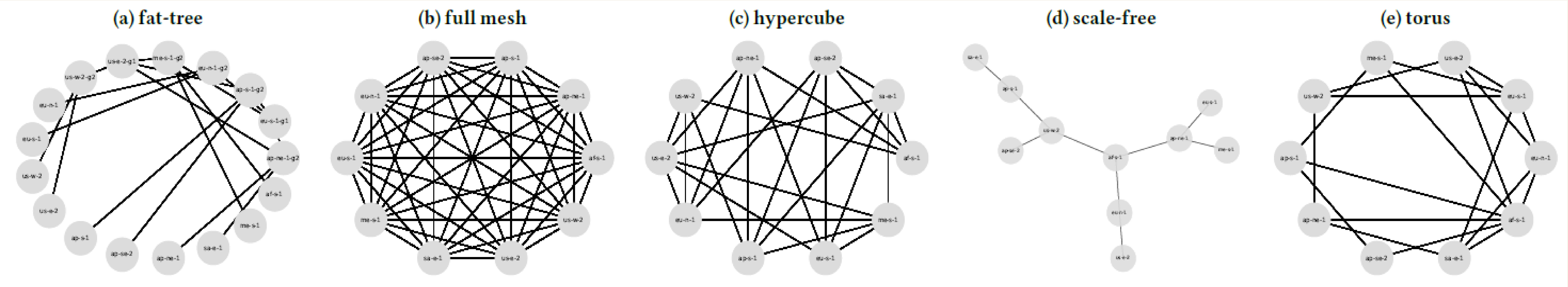

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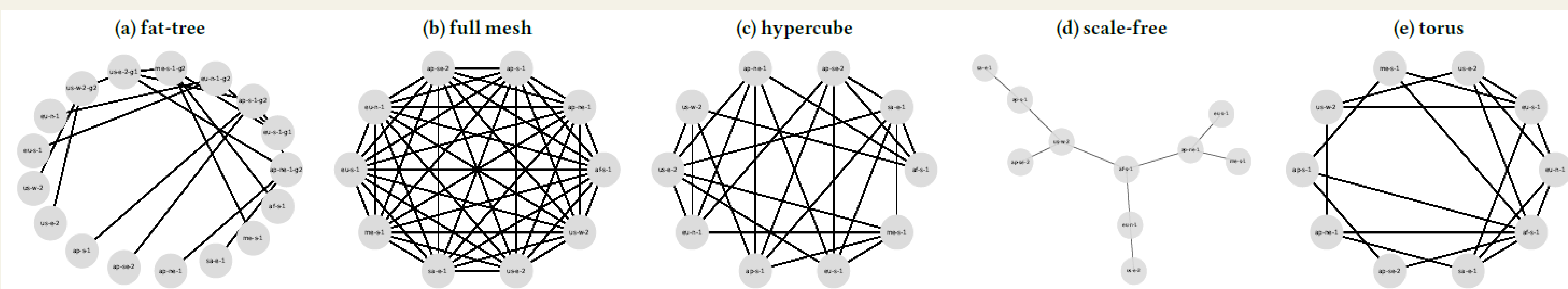

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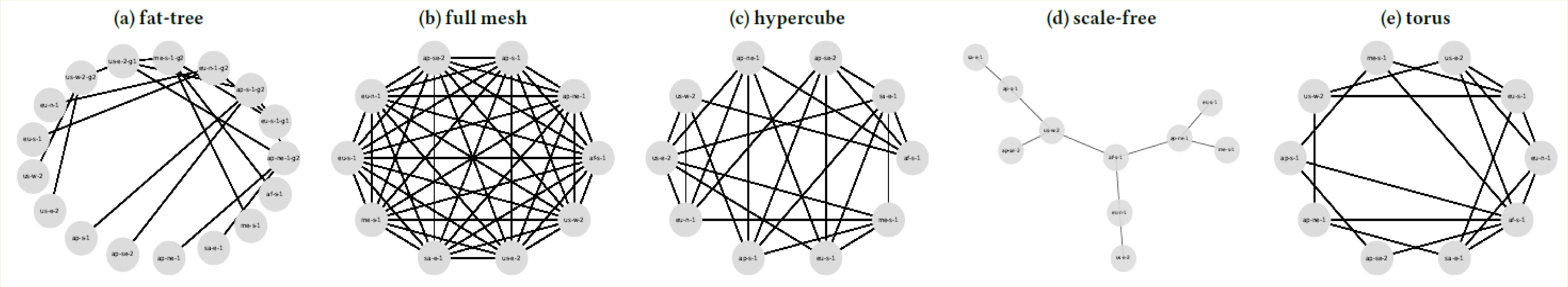
- ***Torus.*** Resembling a grid where each node is connected to its adjacent nodes in a wrap-around fashion.



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Ethereum	Clique [70]	geth	Solidity	10−20 [4]	10−15 [67]
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- ***GAFAM.*** Implemented as a financial market smart contract with functions to buy and check the availability of the stocks for Google, Apple, Facebook, Amazon and Microsoft. The workload operates for 3 minutes, peaking at 19,800 TPS before stabilizing between 25 and 140 TPS. For simplicity, we have rounded the peak to 20,000 TPS.

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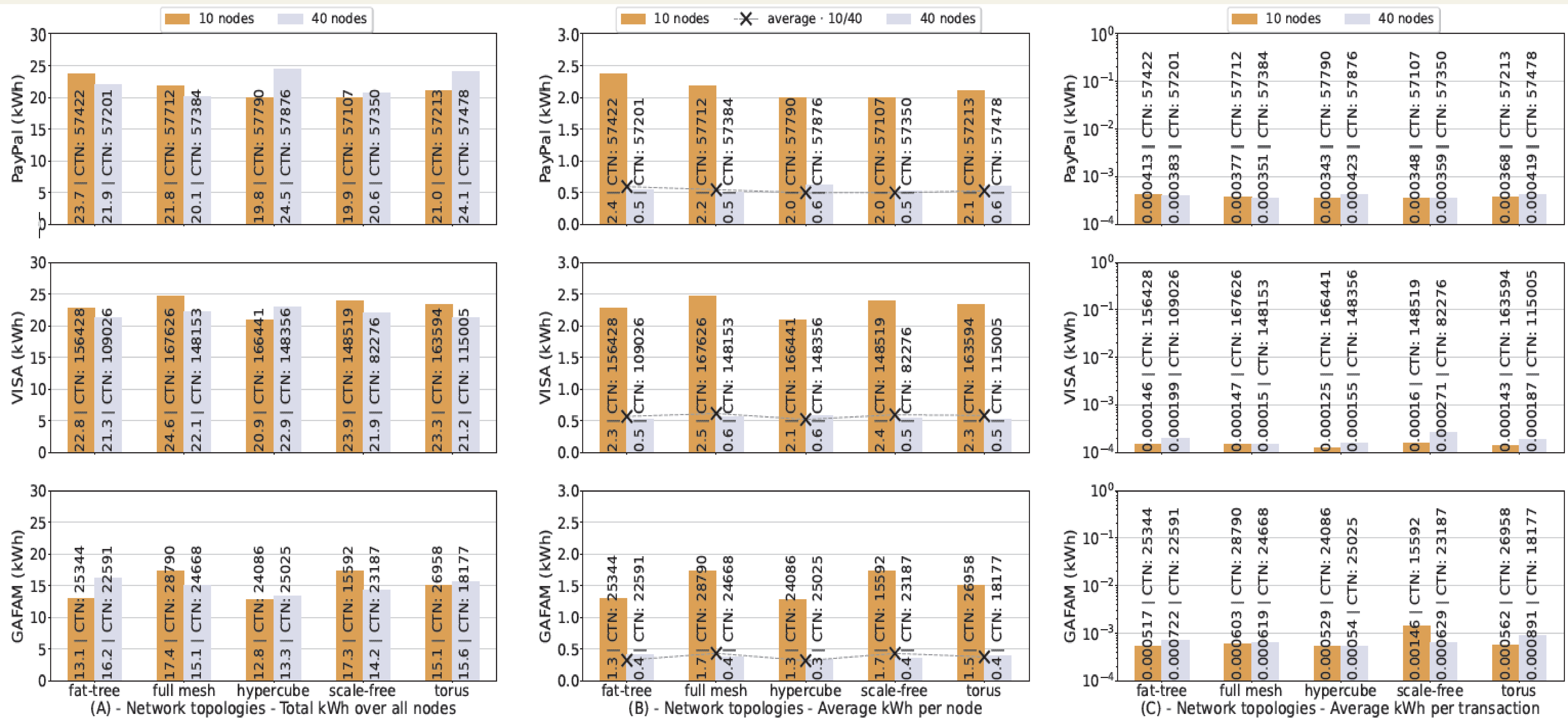
- **Solana** demonstrates high energy demands and operational failures in larger node setups.

RESULTS #1

Algorand energy consumption (kWh)



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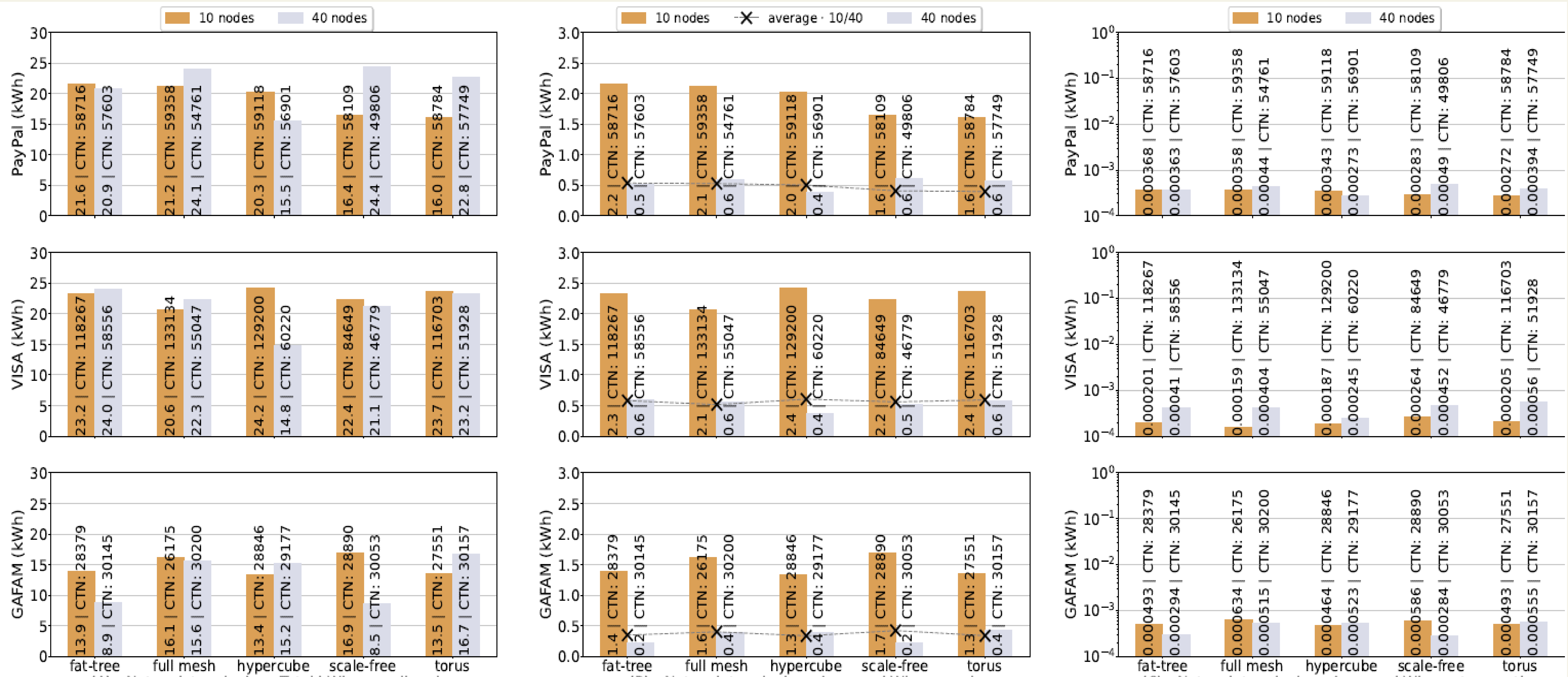
Diem energy consumption (kWh)



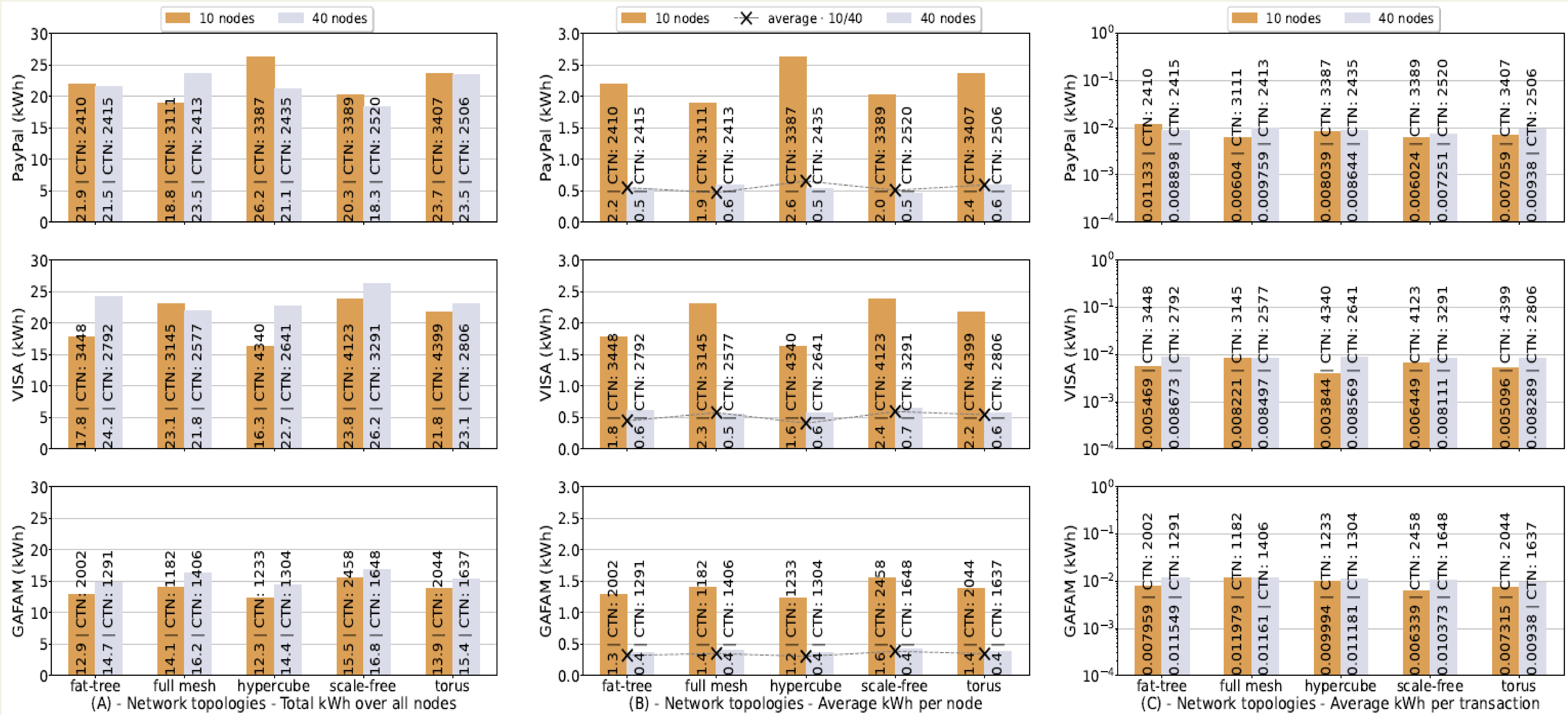
(A) - Network topologies - Total kWh over all nodes

(B) - Network topologies - Average kWh per node

(C) - Network topologies - Average kWh per transaction

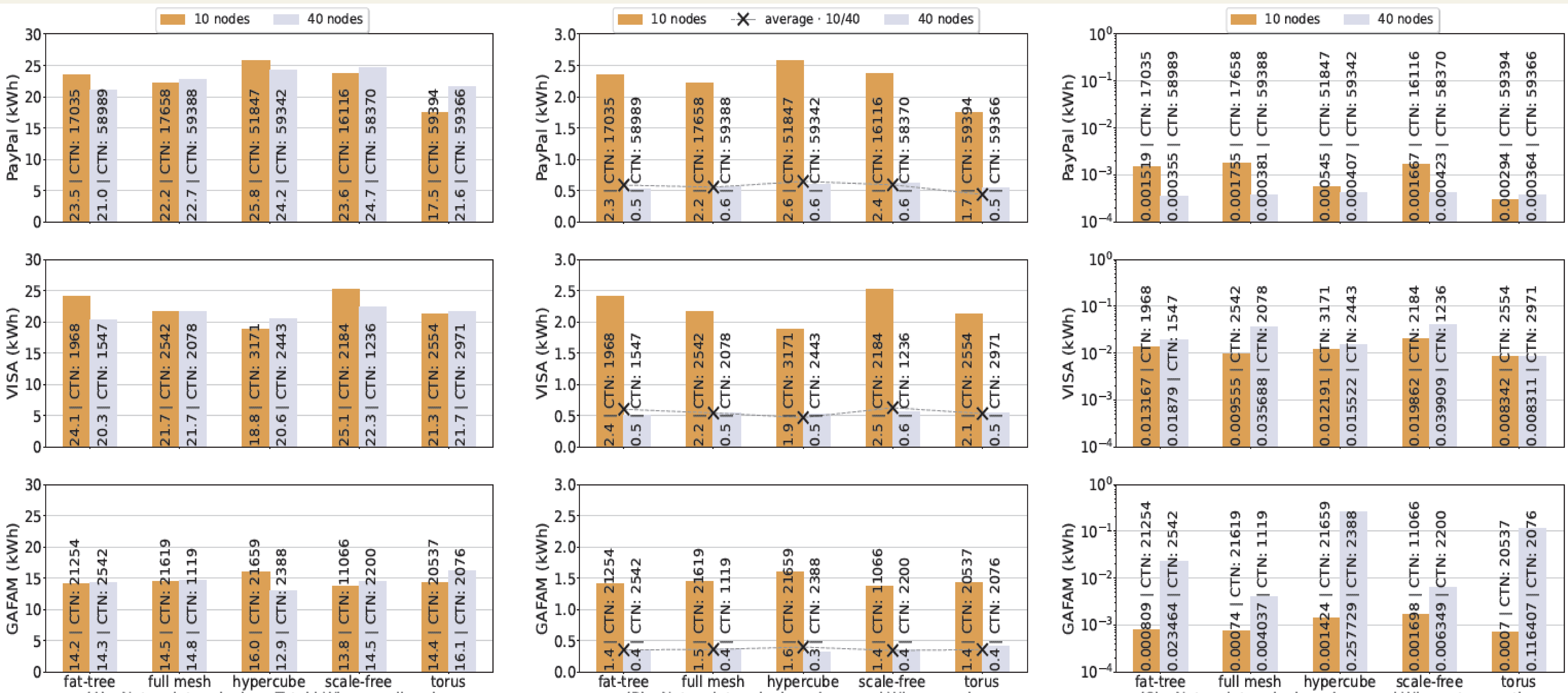
RESULTS #3

Ethereum Clique energy consumption (kWh)



RESULTS #4

Quorum IBFT energy consumption (kWh)



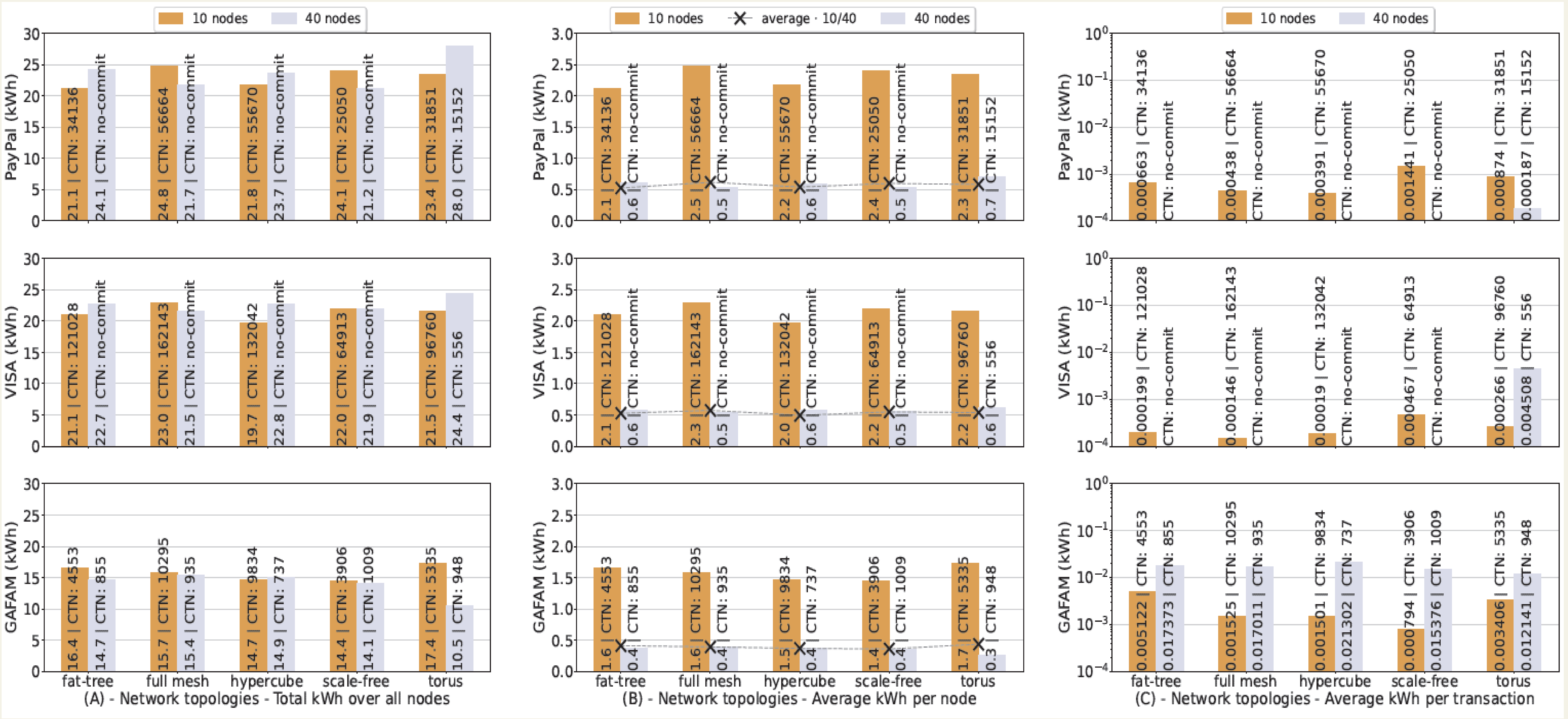
(A) - Network topologies - Total kWh over all nodes

(B) - Network topologies - Average kWh per node

(C) - Network topologies - Average kWh per transaction

RESULTS #5

Solana energy consumption (kWh)



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- Implement and compare other (potentially new) blockchain protocol as well as topologies and workloads.

Thanks for your attention

References

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