What is Gas Limit?

Ethereum prevents transaction spamming and it also rewards miners by charging a particular gas fee on all transactions.

Every block contains a max amount of gas that can be collected from transactions.

Gas limit can also be set as a configuration parameter.

The max TPS (transactions per second) can be calculated as:

$$TPS = \frac{Gas_{Limit}}{Tx_{Gas} * Block_{Time}}$$

Where,

GasLimit = Block gas limit

TxGas = gas needed to compute the simplest transaction

Source: https://blog.coinfabrik.com/on-ethereum-performance-evaluation-using-poa/

Block Size and Block Interval must satisfy:

$$\frac{\text{block size}}{\text{X\% effective throughput}} < \text{block interval.}$$

Source: https://fc16.ifca.ai/bitcoin/papers/CDE+16.pdf

Summary:

As seen in the above relation, Block Interval and Throughput are directly proportional to each other. It means that the effective throughput decreases when the block interval is decreased.

Consider an example:

A blockchain with 1GB blocks every 10 minutes.

In order for nodes on the network to stay in sync with the chain, they will need to download and verify the validity of 1GB worth of block data, every 10 minutes.

Any node(s) which cannot do this, will decrease the effective throughput of the network.

Now, what will happen if you decrease the block interval to 1 minute?

Suddenly, a lot of nodes that could download and process that data within 10 mins will no longer be able to keep up with the rest of the network.

It is because now they only have a minute to do the same thing which they previously did in 10 minutes.

Therefore, the effective throughput will decrease, since a much smaller percent of nodes will be able to engage and contribute to the network.

Source:
https://bitcoin.stackexchange.com/questions/76203/how-are-block-interval-block-size-and-effective-throughput-related

Paper:

Block Gas Limits vs. Transactional Throughput: A performance analysis of the Ubiq platform.

I am mentioning important points from the paper which are relevant for the project, for faster understanding.

The above paper explains (in short) the relation between gas limit and throughput as:

When the gas limit is higher, the block is larger as well.
If the block is huge, it will take much longer for the block to propagate throughout the network and this, in turn, results in lower transaction throughput.

The paper defines total transactions as “number of transactions included within the current block”.
It defines block time as “time difference between the current block and parent block”.
Block gas usage is defined as “gas consumed in processing transactions for the current block”.
It also defines **difficulty** as “total mining difficulty up to the current block.” (something we did not consider)

The paper is comparing the performances of Ubiq and Ethereum.

In this case, they are benchmarking both blockchain systems in steps of following gas limits (in millions): 4,8,16,20,40,80.

The did the following 3 experiments:

1. Block time vs block number (changing gas limit as mentioned above)
2. Difficulty level vs block number (changing gas limit as mentioned above)
3. Gas limit vs block number (changing gas limit as mentioned above)

This is the result that they achieved for Ethereum:

TABLE II: Ethereum Overall Measurements

Gas Limit	Tx Per Second	Avg Block Time (sec)	Avg difficulty
4,000,000	2.569	93.055	131072
8,000,000	4.405	49.730	131081.846
16,000,000	5.420	106.843	131074.0
20,000,000	3.767	63.730	131076.923
40,000,000	1.827	91.250	131078.0
80,000,000	2.352	105.841	131076

Source: https://www.whiteblock.io/wp-content/uploads/2019/07/ubiq-report.pdf

Summary:

The relation between gas limit and throughput is non-linear.
The optimal throughput can be figured out by plotting gas limit vs throughput for a particular blockchain system.
An interesting parameter mentioned in this paper is the **difficulty level.** It means how difficult is it to find the hash of a block.
Another parameter that affects throughput is **Latency**.

Based on this paper, my understanding is that we can find the optimal throughput by changing the gas limit. However, in my opinion, we should also consider the Difficulty Level to verify the optimal throughput reading that we find.

The following article is a good reference:
https://hackernoon.com/how-to-reduce-block-difficulty-in-ethereum-private-testnet-2ad505609e82

White Paper	C1 (Automation)	C2 (Optimization)	Comment
BLOCKBENCH: A framework for Analyzing Private Blockchains. (https://www.comp.nus.edu.sg/~ooibc/blockbench.pdf)	Addressed	Partially Addressed	Why Partially Addressed? - It does not analyze the relationship between throughput and gas limit or block interval.
Block Gas Limits vs. Transactional Throughput: A performance analysis of the Ubiq platform. (https://www.whiteblock.io/wp-content/uploads/2019/07/ubiq-report.pdf)	Not Addressed	Partially Addressed	Why Partially Addressed? - It considers parameters based on the Proof of Work consensus algorithm as well. For example, "difficulty".
Performance Analysis of Consensus Algorithm in Private Blockchain (https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=8500557)	Not Addressed	Partially Addressed	Why Partially Addressed? - It does not analyze the relationship between throughput and gas limit or block interval. The paper shows how the throughput changes based on the consensus settings and the varying number of transactions.