2021 June

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The Investment Implications of Ethereum Improvement Proposal 1559

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Executive Summary

The most expensive blockchain to use in the world is Ethereum.

Users pay in total over $5 million a day in transaction fees to interact with the Ethereum blockchain. In comparison, only 28% of this amount, $1.5 million, is spent by individuals and businesses on Bitcoin, the world's first and largest cryptocurrency by market capitalization.

This July, Ethereum's fee market is expected to undergo a radical change known as Ethereum Improvement Proposal (EIP) 1559. Rather than determining transaction fees through a blind auction-like process, the network will automatically calculate a price based on demand for block space. All users must pay this base price, in order for their transactions to be processed. Instead of going directly to miners, the base transaction fee will be "burned."

EIP 1559 is designed to have a number of positive impacts on the network and the value of ether, including:

- Tie ether explicitly to the use of decentralized applications (dapps)
- Reduce transaction wait times and remove fee-market uncertainty that dampen developer and user adoption of dapps
- Add a bitcoin-like narrative of limited supply

EIP 1559 is not expected to resolve the issue of high fees on Ethereum, which is primarily caused by the network's lack of scalability. EIP 1559 represents a fundamental change to the Ethereum fee market but not Ethereum's blockchain structure or capacity.

It also poses several risks to the network, including:

- Risk of miner capitulation or revolt as a result of a reduction in transaction fees paid to miners
- Risk of developer and user disappointment
- Technological risk in the form of unexpected bugs, hacks or an accidental chain split

In this report, we'll give an overview of how EIP 1559 works and what its intended impacts are to the Ethereum fee market and monetary policy. We'll also explore the economic risks associated with its implementation to different network stakeholders, including investors, miners and users.

How EIP 1559 Works

On Ethereum, all operations require gas in an amount set by the network. The amount of gas required to do something on Ethereum is proportional to the amount of computational energy required to execute those operations.

Whether it is sending a peer-to-peer transfer of value or activating a dapp on the network, there is a cost associated with these actions expressed in units of gas itself.

Operations on Ethereum are executed through the Ethereum Virtual Machine (EVM), which can be thought of as the engine of the network. While gas costs are automatically calculated within the EVM, it is up to users to set a gas price, a rate of conversion between units of gas into units of gwei. (One gwei is one billionth of an ether.)

A Summary of Gas Terminology

Term	Description
Gas	Unit for how much computation work is done.
Gas Price	How much a user is willing to pay per gas for work (in gwei).
Transaction Cost	Gas Used x Gas Price.
Gas Limit	Max gas a user will pay for a specific transaction.
Gas Block Limit	Max gas allowed in a block.

Source: Eric Conner from Medium

Miners, which provide the computing power to run transactions and smart contracts on Ethereum, will usually prioritize the transactions of users who set a high gas price, in order to maximize block rewards.

The higher the gas price, the faster a user's transactions and dapp operations will get executed on the blockchain. In this way, Ethereum's fee market resembles an auction.

For further reading on the fee market of Ethereum, see our report on gas costs.

EIP 1559 would replace Ethereum's auction system of users bidding for block space through variable gas prices with a new transaction pricing mechanism based on gas rates.

Rather than let users decide what their gas price will be, EIP 1559 introduces a base fee – a dynamic rate of conversion from gas to gwei – into the Ethereum protocol, which moves up or down automatically with increases or decreases in activity on the network.

The base fee

The base fee is the minimum gas price required for users to send a transaction or complete an operation on Ethereum under EIP 1559.

It fluctuates in accordance to how much space is being utilized per block on Ethereum. Ideally, each block on Ethereum would contain a maximum of 15 million gas. However, in times of network congestion, EIP 1559 would allow block sizes to increase up to twice this amount.

Whenever a block containing more than 15 million gas is mined, the base fee required by users to execute a transaction would increase by 1.125x (12.5%). Given that a new block on Ethereum is mined roughly every 13 seconds, consistently large blocks (blocks above the 15 million gas threshold) could increase the base fee by a factor of 10 in the span of about 5 minutes or ~20 blocks.

Alternatively, if the number of on-chain transactions is low and block space is being underutilized – which means block sizes are below the target of 15 million gas – then EIP 1559 would automatically adjust the base fee downwards by 12.5% successively until it reaches a lower bound of almost zero.

These adjustments over the long term are designed to ensure gas usage on Ethereum trends towards an average of roughly 15 million gas per block.

The burn mechanism and inclusion fee

The base fee can only be paid in the native cryptocurrency of Ethereum, ether.

Once paid, the base fee is burned and permanently removed from the total circulating supply of ether. The reason for burning the base fee rather than distributing it to miners is to ensure there is no financial incentive for miners to artificially congest the network and keep the base fee high.

Because the base fee is burned, any payments for the base fee by users put downward pressure on ether supply.

There is an additional fee called the "inclusion fee" that users can choose to pay on top of the minimum base fee, which would go directly to miners as a way to provide incentive to handle certain transactions above others.

The inclusion fee is optional in EIP 1559 and is intended only to be used by individuals and businesses requiring the fastest network confirmation times. Its importance increases when the base fee is near zero and there is little to no filtering of non-paying transactions.

SIDEBAR: What does 'almost' zero mean?

The lower bound for the base fee under EIP 1559 is actually 7 wei, which is equivalent to 7×10^{-9} gwei or 7×10^{-18} ETH. It is close to zero, without actually letting base fees sink to a true zero value. It's important that the base fee is never truly zero or else calculations to increase its value by 1.125x or ⅛ through multiplication would get stuck.

Zero multiplied by any number results in zero forever. This is why technically the lower bound for base fees under EIP 1559 is a value close to zero, though not quite zero.

It's similar to how Bitcoin's issuance schedule will also technically never reach zero even after it reaches a 21 million coin cap. New bitcoins will always be issued by the protocol but after a certain point, estimated to be the year 2140, the issuance amounts will be so minute they can be considered zero for all intents and purposes.

Purpose of EIP 1559

Why replace Ethereum's auction-style fee market with an algorithm that automatically sets the gas price? There are a number of reasons.

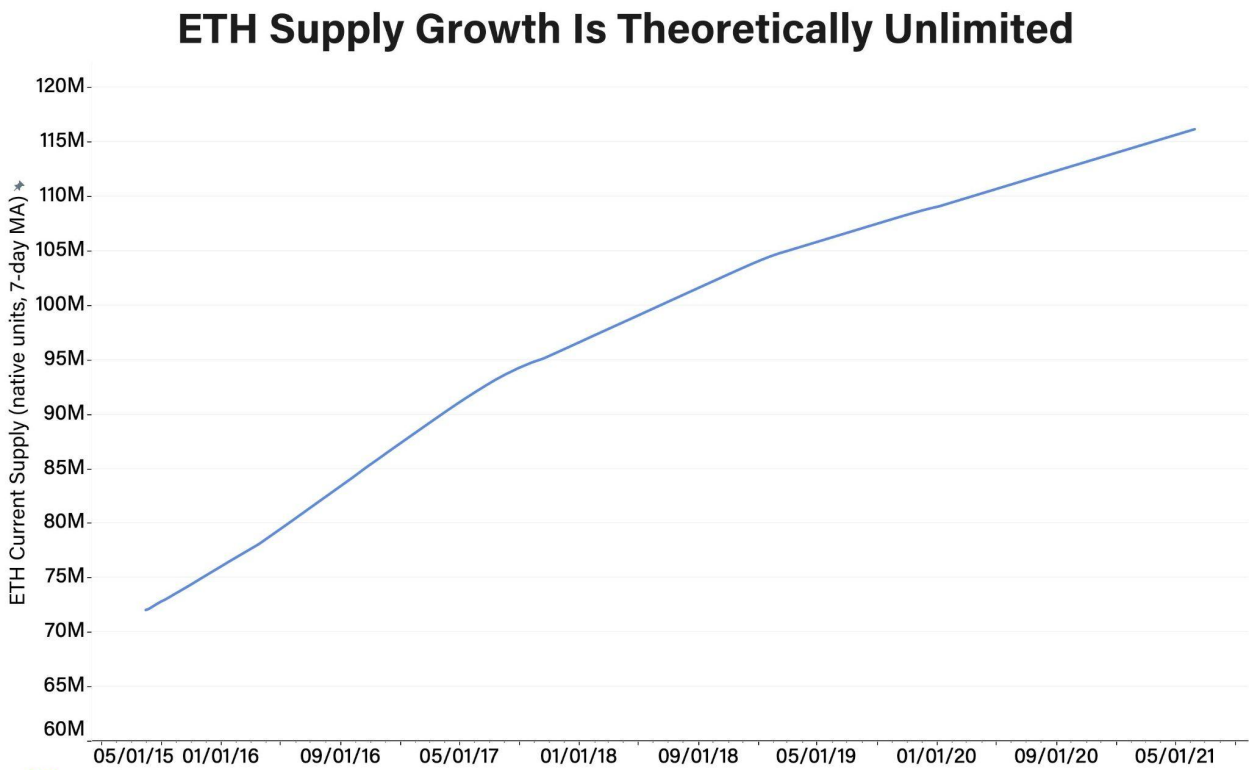
1. EIP 1559 introduces a counterbalance against increasing ether supply.

The supply of ether, unlike bitcoin, is unbounded. Two new coins are issued into circulation every time a block is mined on Ethereum. This means individual holdings of ether are becoming diluted over time as more of the asset becomes available for users to hold and trade.

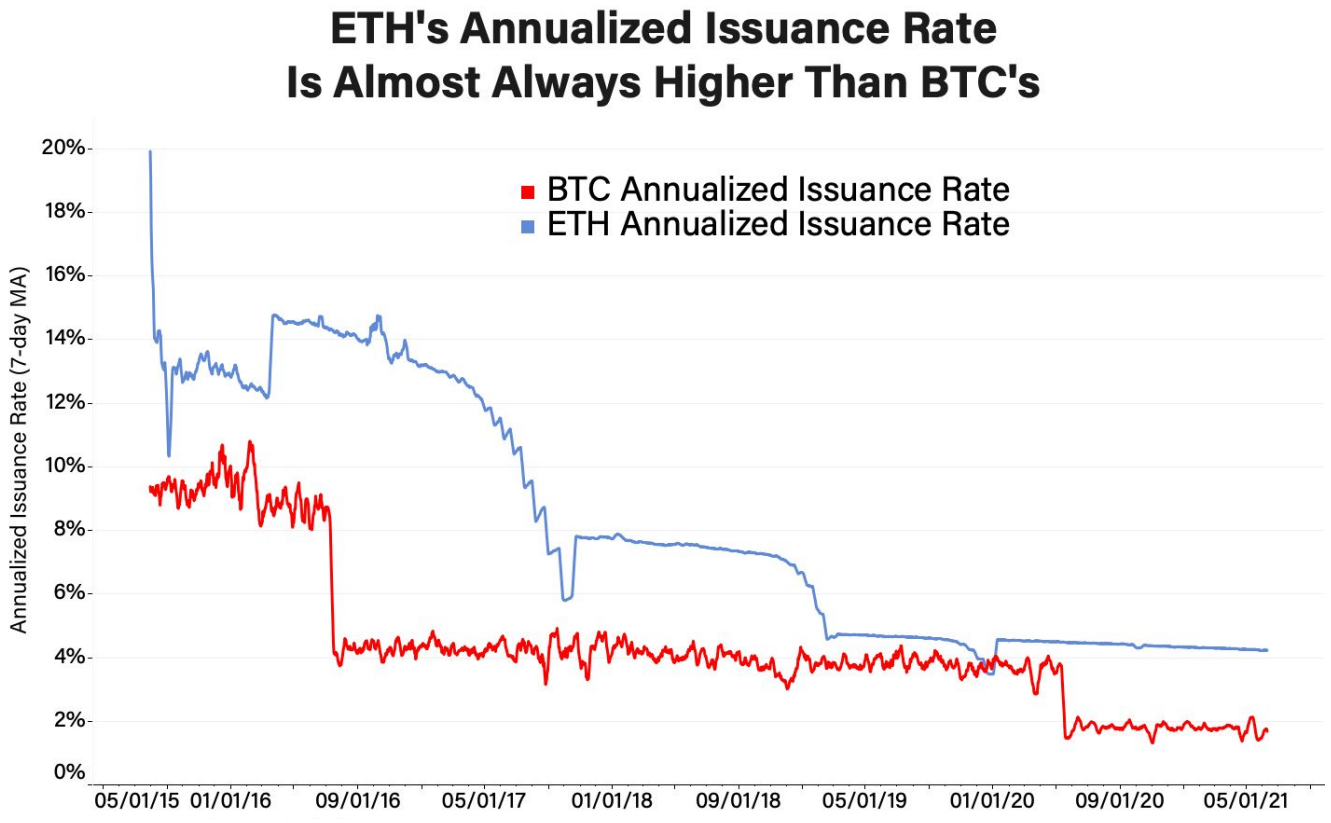
With EIP 1559, the burning mechanism would introduce a programmatic way to take coins out of circulation after they have been issued and offset supply increases on Ethereum without introducing a supply cap. As of May 2021, the annual issuance rate on Ethereum is roughly 4%, while on Bitcoin it has declined to around 1.8% following the network's programmed supply-rate reduction last year.

For further reading on Bitcoin supply reductions, see our report on Bitcoin halving events.

In times of high network activity, the total amount of ETH burned via payments for the base fee could offset and be greater than the amount of ETH being newly issued through block rewards.



Source: Coin Metrics, data as of June 9, 2021



Source: Coin Metrics, data as of June 9, 2021

This would mean a net decrease in ether supply and could potentially mean that, over time, ETH's annual issuance rate drops from 4% to zero or negative figures.

Even in times of low network activity, when base fees are low and total ether supply is not decreasing, there will still be a non-zero amount of ether being removed from circulation. At minimum, burning the base fee creates a modest counterbalance to an ever-growing coin supply.

In the next section of this report, where we discuss the effects of EIP 1559, we'll highlight analysis that gives more detailed estimations and figures for how much ETH could be burned.

2. EIP 1559 is designed to prevent the economic abstraction of ether by requiring the base fee to be paid in Ethereum's native cryptocurrency.

Most transaction fees on Ethereum are already paid in ether. However, there's no explicit requirement that prevents miners from accepting other forms of payment. Users can pay a miner in any currency off-chain in order to have their transaction included at the next block for a gas price of zero.

This is an uncommon but not impossible scenario that does occur on Ethereum. Here's one example on block explorer Etherscan.

Under EIP 1559, the network dynamically sets a base fee that users on Ethereum must pay in ether in order for their transaction to be processed. A miner could theoretically receive an alternative form of payment to prioritize a user's transaction. However, the transaction's base fee requirement would still need to be satisfied regardless in ether at minimum – either by the user or by the miner – in order for the transactions to get included in an Ethereum block.

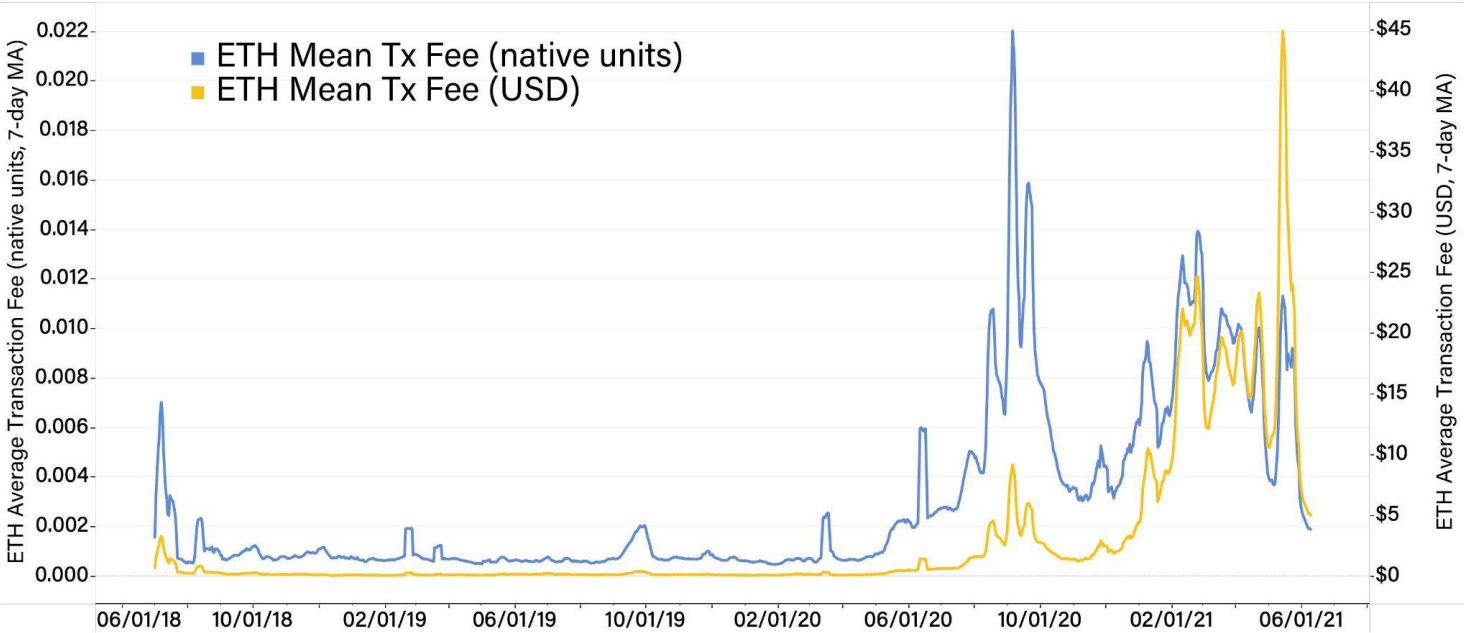
This requirement has a similar effect to nation states requiring their citizens to pay taxes in a local fiat currency. It ties the currency to a specific economy.

In this case, the value of ether as a form of payment for block space on Ethereum is solidified.

3. EIP 1559 is designed to reduce the volatility of transaction fees on Ethereum.

When gas rates are left up to users, average fees can skyrocket at a moment's notice depending on the ups and downs of the crypto markets. Under EIP 1559, fees can only increase and decrease by 1.125x each block. This introduces stability and predictability to Ethereum's notoriously volatile fee market.

Ethereum Fees Vary Sharply



Source: Coin Metrics, data as of June 9, 2021

EIP 1559 is not expected to reduce transaction fees on Ethereum, however.

The issue of high fees is primarily caused by limited network capacity to process transactions. A change in Ethereum's fee market on its own will not impact how many transactions the network is able to handle at once.

To address Ethereum's scalability issues, protocol developers are developing in parallel with EIP 1559 a technology known as blockchain sharding.

More information about sharding in our report about the Ethereum 2.0 upgrade.

4. EIP 1559 is expected to make Ethereum's fee market more efficient in two specific ways.

a) Variable block sizes

As of June 17, 2021, there were over 150,000 user transactions waiting to be processed on Ethereum. Due to each block's limited capacity, miners selectively choose the highest paying transactions in this queue to process first.

All operations on Ethereum including user transactions have a gas requirement that is set in proportion to the amount of computational energy the operation consumes. This not only helps price the cost of operations on the network for users but it also ensures the network cannot be overloaded with too many operations at once through a mechanism called the "block gas limit." (More about this limit in the sidebar.)

Under the current Ethereum fee market, in order to expand block capacity to include more pending transactions and their fees, miners have the ability to incrementally adjust the block gas limit and expand the number of transactions processed in a block.

SIDEBAR: **What is the block gas limit?**

This mechanism restricts how many operations and transactions, measured in units of gas, can be included in a block. The gas limit ensures miners do not submit blocks that are too computationally intensive for the network to safely execute and propagate. However, miners do have some wiggle room to adjust the gas limit by small, incremental amounts of 0.0976% per block. (This figure is unrelated to the base fee adjustments of 12.5% under EIP 1559.)

Changes to the block gas limit require a majority consensus from miners. It is usually in times of extreme transaction congestion or in light of new code optimizations improving network efficiency that miners have successfully voted to raise the gas limit.

The most recent adjustment moving the gas limit from 12.5 million gas to 15 million gas was executed over the course of three days in April 2021 shortly after the activation of the Berlin hard fork, which was a system-wide upgrade containing improvements to Ethereum's fee model.

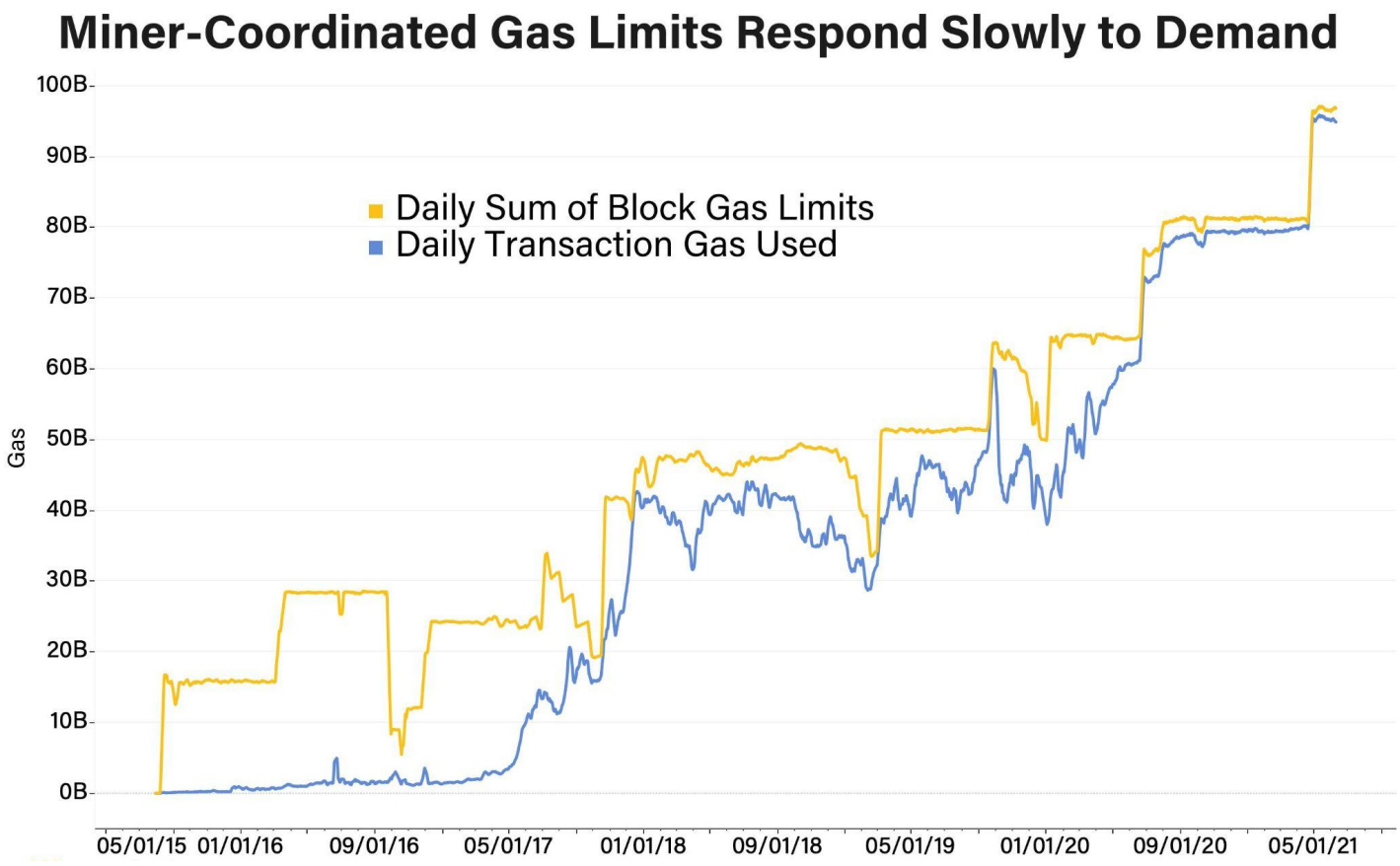
The gas limit of Ethereum at the time of activation will be the new gas target of Ethereum under EIP 1559. The proposed code change makes no assumptions about what the gas target of Ethereum should be but simply inherits the gas limit that the network has already been working with under the collective agreement of miners, which as of May 2021 is a 15 million block gas limit. The activation of EIP 1559 will convert this block gas limit into a gas target.

To adjust the block gas limit, a miner must propose a block with a gas limit that is 0.0976% higher than the previous block's gas limit. So long as 51% of the mining community accepts the block and propagates it to the rest of the network, all blocks thereafter will echo this change to the gas limit and can be further adjusted up or down by 0.0976% again through the same process of consensus.

The block gas limit has been raised a total of six times since the launch of Ethereum in 2015. These raises are coordinated sparingly among miners as larger-sized blocks require more computational energy to propagate and may result in high degrees of network centralization as growing computing and storage requirements of running a node on Ethereum become too burdensome for hobbyist miners to meet.

Under the new proposed fee model of EIP 1559, there's no need for miner consensus and no time wasted incrementally adjusting block capacity because there is no gas limit to adjust. Block sizes are free to float between a fixed range of 0 gas and 30 million gas. In times of network congestion, blocks on Ethereum could be filled at a moment's notice with up to 30 million gas without any lag time by miners.

In lieu of a gas limit, there is a fixed gas *target* of 15 million gas for each block on Ethereum that dictates how much users pay in fees to use the network. This mechanism of rising base fees coupled with the gas target in EIP 1559 is what ensures that the network is not overloaded with consistently large blocks over a long period of time in the absence of a block gas limit.



Source: Coin Metrics, data as of June 9, 2021

b) Accurate fee estimations

Outside of variable block sizes, there is one other aspect of EIP 1559 that is expected to improve Ethereum's fee market efficiency.

Under an auction style structure where users are bidding for block space, if a transaction doesn't have a sufficiently high fee attached to it miners could exclude it from getting into a block for several hours and possibly even days.

The problem here is that there's no easy way to tell what is or isn't a sufficiently high enough fee.

For example, as a user, I could be willing to bid up to $1 for getting a transaction included in the next Ethereum block but if everyone else is bidding $0.05, I only need to bid $0.06. The inefficiencies of Ethereum's auction model for fees means that in this scenario I end up overpaying for my transaction because there's no easy way for me to view how others are pricing their transactions and thereby optimize exactly how much I really should be paying.

Under EIP 1559, there are no price bidding mismatches. If I am willing to bid up to $1 for getting a transaction included in the next Ethereum block and the base fee for the next block ends up being $0.05, the difference is returned back to me.

Since the network sets the optimal price for block space on Ethereum, users don't have to worry about overpaying or underpaying for network resources. That is, unless they are competing for prioritization through the optional inclusion fee, which operates under the same auction model as the current Ethereum fee market.

The base fee is the minimum amount in transaction fees needed for a user to transfer ETH or execute other operations on the blockchain. This minimum cost on users can increase with each passing block, or roughly 13 seconds, if block sizes are above the gas target of 15 million gas.

With each passing block that contains more than 15 million gas in transactions and other network operations the base fee rises and the number of users willing to pay those fees for their transactions to be processed on Ethereum falls.

Every transaction under EIP 1559 is required to specify an upper limit to their total fee amount which dictates each user's maximum willingness to pay for their transaction.

The pool of eligible transactions that meet the base fee requirement by having adequate or higher maximum fee amounts continues to get progressively smaller until block sizes reach its target of 15 million gas.

Any transactions that do not meet the base fee requirement can be resubmitted with a higher maximum fee amount that meets the base fee requirement in order to increase their chances at inclusion in the next block.

Sidebar: Will there be legacy support for non-EIP 1559 transactions?

For the past six years, dapps and wallet services on Ethereum have relied on complex mathematical models and data aggregations to help users price their transactions.

In many cases, these services automatically attach an optimized fee for user transactions in order to abstract away the complexities of estimating bids in Ethereum's auction-style fee market.

Once EIP 1559 is activated, these applications and wallets will need to begin formatting user transactions differently in order to maximize savings on transaction fees.

For example, a wallet such as MyEtherWallet would need to specify a maximum fee limit, called the "maxFeePerGas," and potentially an inclusion fee, called the "maxPriorityFeePerGas," for user transactions to deliver the full benefits of the fee market change.

However, this is not mandatory.

Users and wallets can continue to specify a single gas price for their transactions as usual without specifying new values such as a maximum fee limit or an inclusion fee.

Whether a transaction specifies a maximum fee limit or not, all transactions on Ethereum post-EIP 1559 will be subject to paying a base fee determined algorithmically by the network.

With an EIP 1559-style transaction that specifies both a max fee and inclusion fee, there is the opportunity for users to get a refund on their payment if their max fee is above the base fee of the network.

For example, assuming the base fee is 100 gwei, a transaction formatted for EIP 1559 could specify a maximum fee limit of 250 gwei with 5 gwei specified as the inclusion fee.

Once the transaction is processed, a user would pay 100 gwei in base fee and 5 gwei in inclusion fees. The remaining 145 gwei would be refunded to the user.

> 250 - 100 (base fee) - 5 (inclusion fee) = 145 gwei refunded to the user

In this same example, a user who sends a legacy transaction with a single gas price of 250 gwei would not be refunded any amount.

100 gwei would be burnt as the base fee. The rest of the 150 gwei would be sent to a miner as part of the transaction's inclusion fee.

> 250 - 100 (base fee) - 150 (inclusion fee) = 0 gwei refunded back to the user

Upgrading to EIP 1559-style transactions is designed to deliver gas efficiencies but it is up to the user and dapp developers to take advantage of the new fee market structure.

Network and Investor Effects

Based on the information about what EIP 1559 does and why it was created, we're going to analyze how this proposal is likely to impact three different types of stakeholders on Ethereum: investors, miners and users.

Investors

Ether investors may evaluate the potential impact of EIP 1559 using three potential upside factors:

- Tie ether explicitly to the use of decentralized applications (dapps).
- Improve transaction wait times and remove fee-market uncertainty that dampen developer and user adoption of dapps.
- Add a bitcoin-like narrative of limited supply.

Potential risk factors include:

- Risk of miner attrition as a result of a reduction in miner reward, miner revolt or a contentious hard fork.
- Risk of disappointing developers and end-users by failing to deliver promised fee-market improvements.
- Technological risk inherent to any upgrade, in the form of unexpected bugs, hacks or an accidental chain split.

These upside and risk factors are described in more detail, below.

Upside factors

A 'bitcoin-like' narrative

One of the most common arguments against ether is its unbounded coin supply.

Bitcoin, the world's first cryptocurrency, has a prescribed and capped supply schedule which fuels an important part of its narrative with investors as "digital gold."

While EIP 1559 does not introduce a bitcoin-like supply cap on ether, it does activate a mechanism to curb total supply growth over time by taking a variable amount of ether out of circulation each time a transaction is executed.

Simulations of EIP 1559 as of June 8 suggest the activation of EIP 1559 over the trailing 365 days would have burned a total of 2,967,937 ETH for a net reduction of 76% in ether supply growth over that period.

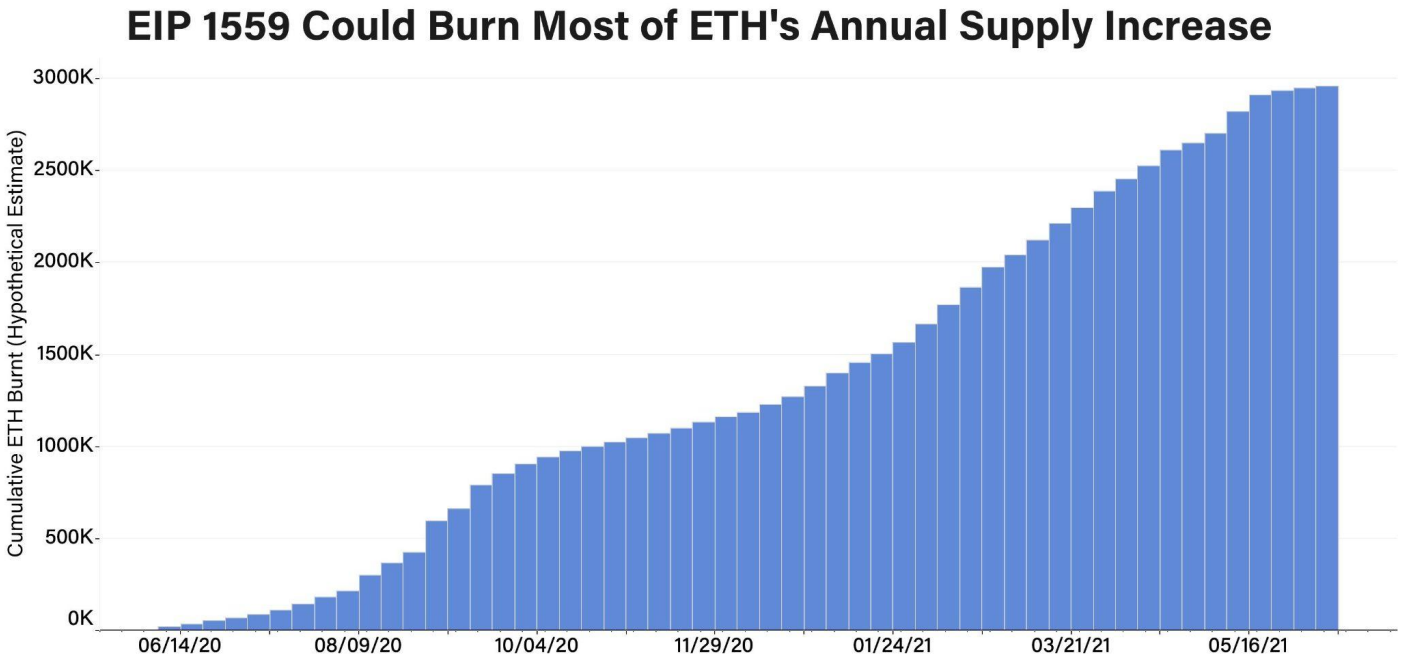
User barrier removal

Ether's present value proposition is as an ambitious technology play for "Web 3" – the next iteration of the internet. EIP 1559 is designed to bolster that narrative with efficiency improvements in the Ethereum fee market.

EIP 1559 should make predicting transaction fees easier for users and dapps. The code change is also designed to increase the flexibility of the network to respond to surges of transaction activity through variable block sizes.

Ether explicitly linked to dapp use

Finally, EIP 1559 is expected to solidify ether's role as a form of payment for using Ethereum's computing resources and interacting with the network's broad ecosystem of dapps.



Source: Dune Analytics, data as the week of June 9, 2021

Risks

Miner capitulation or revolt

Any technology upgrade comes with risk, and the most salient risk posed by EIP 1559 comes with its proposed changes to reward dynamics and payouts to miners, who face reduced earnings for their work with the activation of EIP 1559. Instead of pocketing 100% of transaction fees, miners will only receive tips from users through an optional "inclusion fee," paid electively by users seeking priority for their transactions.

Changing reward dynamics on its own will not impact Ethereum's ability to process blocks or computations. However, there is the potential for disgruntled miners to leave the network, sabotage it or start a competing chain. If a large share of Ethereum miners exit or revolt, block times and network security would be negatively impacted.

Block explorers and privately maintained nodes will reveal the split between fees burnt through the base fee and fees paid out to miners through the inclusion fee. The ratio will be an important indicator for miners especially as it will dictate how much their total revenue changes as a result of EIP 1559.

Disappointed users

As for users and dapp developers, the benefits from EIP 1559 may not prove to be as efficient in practice as they are in theory. A failure to deliver promised fee-market efficiencies could result in user and developer disillusionment. If this occurs, Ethereum competitors such as Binance Smart Chain and Cardano, the two largest smart contract blockchain platforms by market capitalization after Ethereum at time of writing, will undoubtedly seize an opportunity to grab market share.

To gauge the subsequent rewards of EIP 1559 and its impact on users over the long term post-activation, investors can view in real time the number of transactions styled in accordance to the EIP 1559 format as a way of tracking its usefulness in practice through privately maintained nodes or public block explorers.

Technology risk

The activation of EIP 1559 could result in unforeseen bugs or malicious user behaviour.

For example, in the process of testing EIP 1559, Ethereum protocol developers discovered that without setting a cap on the maximum fee limit for a transaction, also known as the "maxFeePerGas," a potential attacker could create arbitrarily large transactions and spam the network.

Additional checks to ensure that users have enough funds to pay for their maximum fee limit were added to code specifications for EIP 1559 to close this loophole.

Several reviews and security audits of EIP 1559 have been crowdfunded by the Ethereum community in order to reduce the potential for unexpected bugs. The development and testing process for EIP 1559 is also entirely open sourced, meaning that anyone can view the code for this upgrade and flag potential loopholes at any point leading up to activation.

Open-source code audits have worked for Ethereum in the past. In January 2019, smart contract audit firm ChainSecurity flagged a security vulnerability in a code change known as EIP 1283 just 48 hours before its activation on the main Ethereum network.

If implemented, EIP 1283 could have provided attackers a loophole in Ethereum's code to steal user funds. Because ChainSecurity had flagged the code bug at the last minute, the activation of EIP 1283 was halted, fixed and released a month later in February.

This is why it is important to closely track community commentary surrounding EIP 1559 leading up to and shortly after its activation. Positive signs of EIP 1559 running smoothly on test networks and additional reviews or analysis of the code by community members are indicators that the risks associated with EIP 1559 are being mitigated.

Finally, investors can also measure the impact of EIP 1559 on ether's total supply and its narrative as a bitcoin-like asset by tracking how much in fees is collected through the base fee on a daily basis in comparison to new coins issued through miner block subsidies.

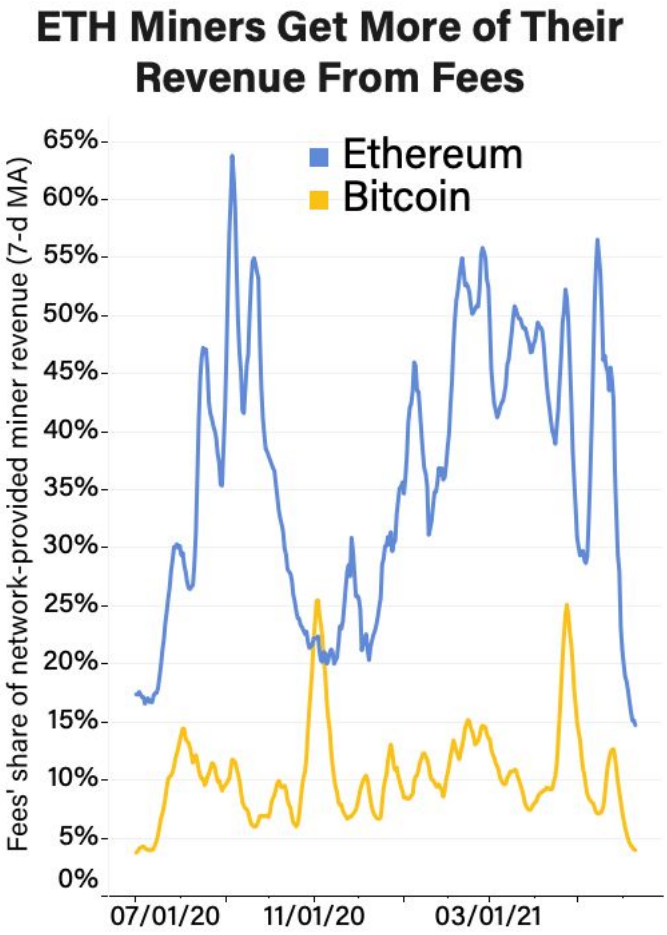
Miners

With the activation of EIP 1559, miners will lose a portion of an income source that has at times made up to three-quarters of their total revenue. On other Proof-of-Work (PoW) blockchains, such as Bitcoin, miners normally earn less than 10% of their revenue from transaction fees.

(For more background on what mining is and how it works, see our report on the Bitcoin halving here.)

On Ethereum, the amount of revenue earned from fees has fluctuated wildly with user demand for block space.

Historically, transaction fees have made up less than 5% of total miner revenue. However, over the past year, due to high network congestion, this percentage has shot up to around 50%.



Source: Coin Metrics, data as of June 9, 2021

One estimation calculates that, assuming 99% of miner revenue from transaction fees is burned under EIP 1559 with only 1% of it being made up through inclusion fees users can offer as an incentive to prioritize transactions, miners would be looking at a 25% decrease in total rewards over the span of 12 months and a 35% decrease over the span of six months.

Another estimation concludes that revenue will decrease 20%-35% at most, even if inclusion fees amount to zero.

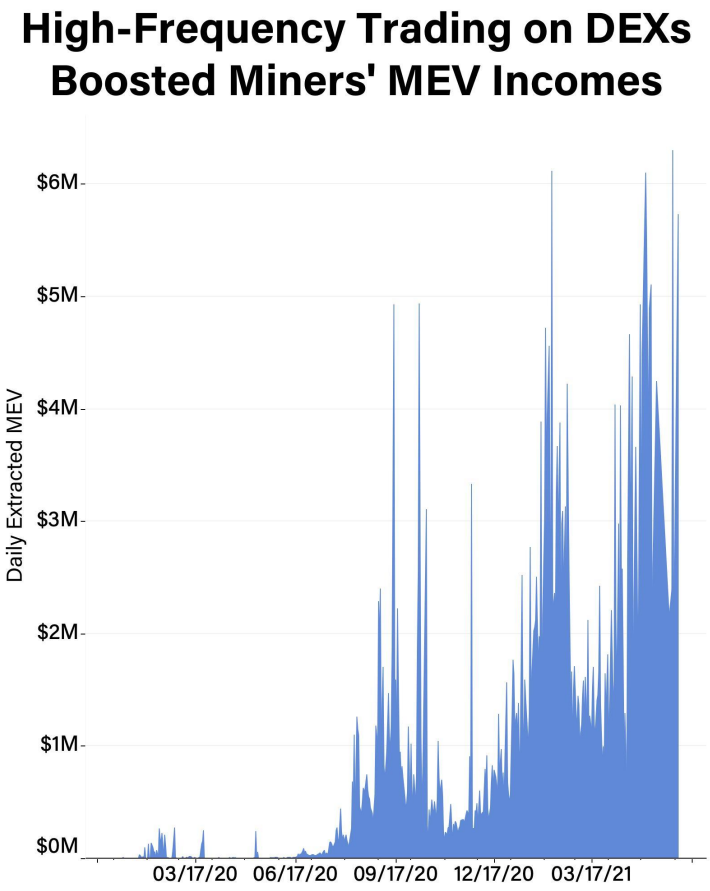
Other sources of miner income

On Ethereum, the block subsidy is 2 ETH/block. This fixed amount of revenue, which used to make up the vast majority of total miner revenue up until mid 2020, will remain the same under EIP 1559.

Miner extractable value (MEV) is another variable source of income that, like transaction fees, waxes and wanes with user activity on the network. It is earned by miners as a direct result of their ability to order transactions within a block.

MEV has become increasingly lucrative as a result of the growing popularity for high-frequency trading on decentralized exchanges (DEXs). Research and development organization Flashbots estimates daily income from MEV has grown from half a million dollars at the start of 2021 to over $6 million as of June 2021.

(More information about MEV and miner income in the next sidebar.)



Source: MEV-Explore, data as of June 4, 2021

Sidebar: Where does miner revenue come from?

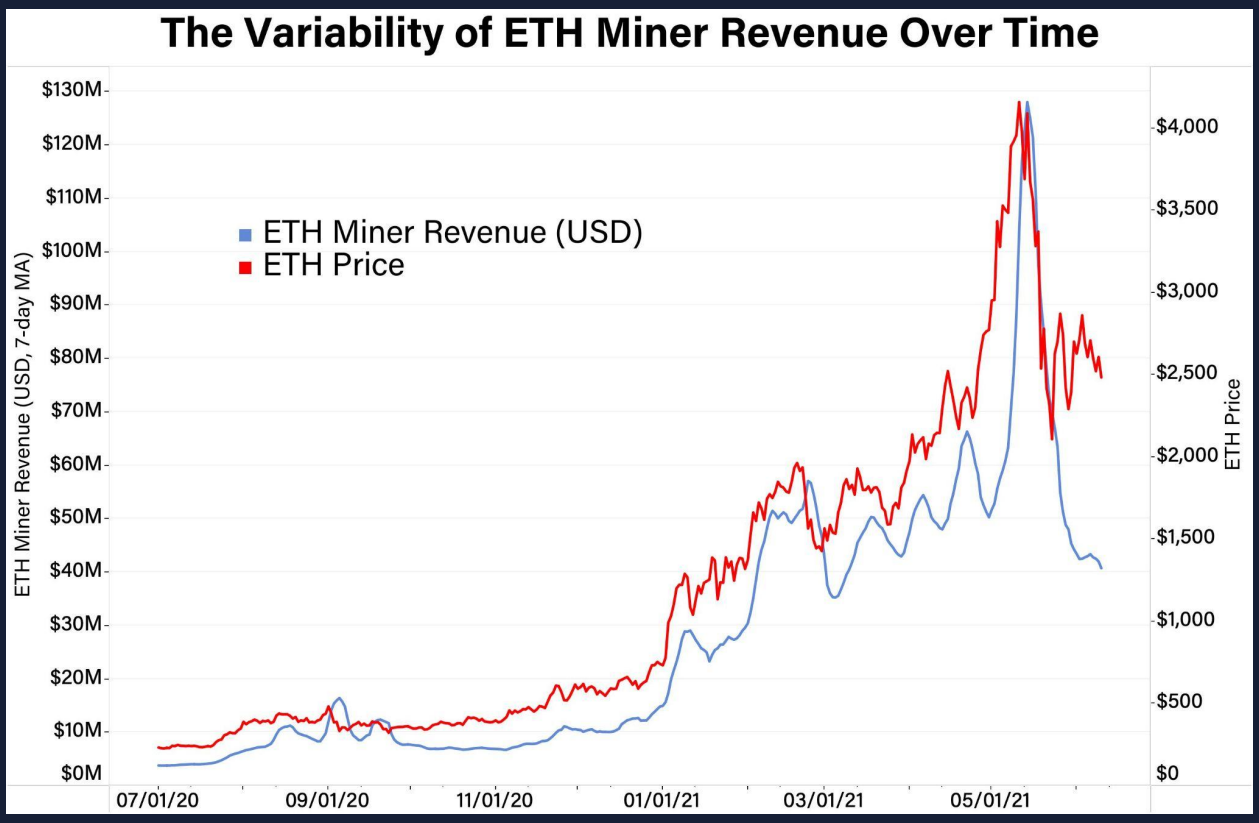
Miner revenue consists of two main sources, a block subsidy and transaction fees. EIP 1559 removes transaction fees as an income source for miners and replaces it with the inclusion fee. Because the inclusion fee is both optional and an additional fee on top of the base fee that users must pay for their transactions, it is likely the income earned from the inclusion fee will be less than what miners would have earned under Ethereum's auction-style fee market.

It is difficult to estimate exactly how much miners can expect to lose in revenue given the variability of the inclusion fee and the difficult-to-quantify revenue that miners can also receive by reordering or censoring transactions on the network.

This third, lesser-known revenue stream, known as miner extractable value (MEV), is becoming increasingly widespread with the growth of decentralized exchanges (DEXs) on Ethereum.

Miners have the ability to earn more rewards from DEX traders who value the speed and order in which their transactions are executed on the blockchain more than the average user does. They also have the ability to take advantage of arbitrage opportunities on DEXs themselves by executing lucrative cryptocurrency trades that front-run DEX traders.

For further reading on MEV income, see this CoinDesk article on the impacts of MEV to Ethereum's future roadmap.



Source: Coin Metrics, data as of June 10, 2021

Impact of Ethereum 2.0 on miners

Once proof-of-stake (PoS) is activated on Ethereum sometime early next year, validator node operators will take over the responsibility of ordering transactions from miners and begin pocketing all three revenue streams: rewards, user inclusion fees and MEV.

For some miners, the remaining revenue opportunity will be great enough to continue operating Ethereum miners right up until the PoS upgrade. At that point, many of these devices will likely have to be scrapped: the most efficient Ethereum miners use highly specialized machines known as ASICs that are not suitable for any task other than producing blocks on Ethereum.

Up until November 2020, Ethereum ASICs were compatible with mining on one other blockchain known as Ethereum Classic. Ethereum Classic is a clone of the original Ethereum blockchain that was spawned in 2016 due to a community disagreement over how to restore lost user funds from a decentralized application called "The DAO."

Both networks supported the same mining algorithm, called "ethash," to produce blocks. Last year, Ethereum Classic underwent a backwards-incompatible upgrade, also known as a "hard fork," to permanently change its mining algorithm and render Ethereum ASICs unusable to mine the network.

If hashing power were to decrease on Ethereum post-EIP 1559, it could not easily move over to alternative blockchains such as Ethereum Classic without investment from miners into new hardware and equipment. The most likely scenario is most Ethereum miners capitulate and implement EIP 1559 together with Ethereum users and developers.

In the next few sections, we'll go into more details about the worst-case scenarios where miners actively choose not to support EIP 1559 by attrition, sabotage or defection. Based on the risks and costs involved with such actions, as well as the reality that miners have a limited runway on Ethereum to earn rewards as a result of the Ethereum 2.0 upgrade, these are all unlikely scenarios but not impossible ones.

Worst-case scenario 1: Miner attrition

For some miners, the reduction in fees as a result of EIP 1559 could make operational costs outweigh the rewards earned on the network. The danger for Ethereum is if enough miners quit before the network has transitioned to a PoS consensus protocol, the network may be vulnerable to a 51% attack.

A 51% attack is when a single miner or cartel of miners gathers enough computational energy, or hashrate, equivalent to more than half the total hashrate.

This has never happened in the history of Ethereum, even when average network hashrate was 1/600th of the level it is currently at today. However, ether's run-up in value increases the potential rewards of such a takeover: hashrate must be measured relative to market cap.

Tracking hashrate immediately following the activation of EIP 1559 will reveal whether miners are dropping out or sticking around. If hashrate falls, this indicates miners are turning off their machines. If hashrate increases, this could indicate that miners anticipate EIP 1559 to positively impact the value of ether and therefore rewards on the Ethereum network.

Worst-case scenario 2: Miner sabotage

It's no secret that EIP 1559 is unpopular with miners. In another 51% attack scenario, a majority of the mining community could reach a consensus and coordinate efforts to sabotage the network. In doing so, miners would have to forego any revenue they could have earned from block subsidies and MEV in the time between such an attack and the transition to PoS. The likelihood of collusive miner sabotage must be measured in terms of the revenue miners would sacrifice by participating in such an attack.

Worst-case scenario 3: Miner defection

In a third problematic scenario, a significant portion of the Ethereum mining community reaches a consensus and coordinates efforts to mine a new version of the Ethereum blockchain without EIP 1559 activated. In doing so, the mining community would be taking a gamble as to how cryptocurrency exchanges and traders would value a new Ethereum network and its native cryptocurrency.

Such splits, known as "contentious hard forks," are not unprecedented. In 2017, the Bitcoin network split because the community was divided over a scalability upgrade known as "segwit." For Ethereum, contention over how to manage lost funds in the wake of the infamous DAO hack in 2016 ultimately led to the creation of Ethereum Classic.

It's debatable whether the forked chains siphoned value from the original chains.

Since dividing into two separate networks, the value of the forked currencies – bitcoin cash and ethereum classic – has not kept pace with the origin chains, as illustrated by this chart:

Asset	Split date	Returns since the split
ETH	July 20, 2016	19,503%
ETC	July 20, 2016	11,489%
BTC	August 1, 2017	1,368%
BCH	August 1, 2017	215%

Source: CoinDesk Research, data as of June 9, 2021

In efforts to prevent a network split but still preserve revenue from transaction fees, the mining community has proposed amendments to the code change. These amendments include changing the proposal so that the base fee is not burned, increasing the 2 ETH per block subsidy to make up for lost revenue, and making adjustments to Ethereum's mining algorithm so that competition for rewards amongst miners is more equitable.

Despite ongoing petitions from certain miners to stop EIP 1559 in its current form from being activated, Ethereum developers have determined to push forward with the code change in July. To gather community sentiment, the Ethereum Foundation, a nonprofit organization dedicated to supporting Ethereum development, have led surveys and outreach about EIP 1559. One of them targeted at decentralized finance (DeFi) application developers recorded 40 "yes" votes from DeFi apps representing over $21 billion value locked on the network.

Users

One of the most pressing issues for Ethereum developers and end users is high fees. EIP 1559 will not address this issue. While the code change is aimed at making optimizations and improvements to the efficiency of Ethereum's fee market, it does not change the fact that Ethereum itself can still only handle a limited number of transactions at a time.

As such, EIP 1559 is an upgrade that, once activated, will continue to have an impact on users and dapp developers even after Ethereum completes its merge to PoS.

For users, the biggest impact from EIP 1559 is likely to be increased transparency and visibility into how fees are determined on Ethereum.

This prevents users from overpaying for their transactions by having excess funds that were not used to pay for the base fee and inclusion fee refunded back to their accounts.

It also prevents unnecessary long wait times for users who underestimate the costs needed to process their transactions on Ethereum by setting a clear threshold, the base fee, that disqualifies certain transactions from inclusion in the next block.

At time of writing, there are close to 150,000 pending transactions on Ethereum. A handful of these transactions have been pending for over five hours and it's not immediately clear as to why. Some of them have an extremely high gas price of over 160 gwei, which is well above the recommended 23 gwei for fast transaction completion times according to gas estimation services like the ETH Gas Station.

It can be a frustrating experience for a user and especially a business such as a cryptocurrency exchange that frequently executes on-chain transfers to be unsure of whether the transaction will be included in the next handful of blocks given an offered gas price, no matter how high.

The problem of high fees stems mainly from the fact Ethereum was not originally designed to be a scalable system that could easily adapt to a fast-growing user base. The reality of Ethereum's growth, both in terms of active users and market value, was unexpected for protocol developers.

This is why developers are currently engineering solutions to introduce long-term scalability and flexibility to Ethereum post-network launch through technologies such as sharding and roll-ups. These code changes will not be ready for activation until sometime in 2022 at the earliest.

Ethereum's upgrade to a PoS consensus protocol is another upcoming code change post-EIP 1559 activation that is estimated to take place sometime next year.

The merge to PoS is not expected to impact the dynamics of Ethereum's fee market. PoS changes the way blocks are produced and secured on Ethereum. However, it does not change the structure of Ethereum's fee market, which is designed to price the cost of and prioritize the order of user transactions.

For further information about PoS, read our full research report on Ethereum 2.0.

What's Next

In March 2021, nearly two years after the first draft of the proposal was released, EIP 1559 was formally accepted by Ethereum protocol developers as a code change for activation on Ethereum through a backwards-incompatible, systemwide upgrade, also called a "hard fork."

The hard fork is tentatively scheduled to go live on July 14, 2021, at block number 12,833,000 is dubbed "London" and will include a number of other less-contentious EIPs focused on network optimizations and security enhancements.

Before activation

As of May 2021, the EIPs bundled into London are undergoing testing on a multi-client Ethereum test network called "Calaveras."

In June, it is expected developers will be ready to activate London on larger, higher-traffic Ethereum test networks including Ropsten, Goerli and Rinkeby.

In early July, Ethereum client teams, which are the developer teams who build out software called "clients" for miners and users to connect to Ethereum, will release finalized versions of the network's new and upgraded code.

Geth is the name of the client that 80% of Ethereum miners and users run on their machines. However, there are other smaller clients such as OpenEthereum, Nethermind and Besu that will also be releasing new software in time for the London upgrade.

After activation

Once London is activated on the main Ethereum network, miners who have upgraded in advance to the latest client software will automatically begin producing blocks under Ethereum's new fee market dynamics. Others who have not upgraded will continue mining the older version of the Ethereum blockchain.

There is the potential with any hard fork activation to see a chain split in the network, with some portion of miners and users running outdated client software. Usually, these chain splits are temporary with the majority of miners congregating to one version of the chain to produce blocks and earn rewards. The minority chain in these cases fizzles out due to a lack of computational energy to progress it forward beyond a few blocks. Since its launch in 2015, Ethereum has been through 10 hard forks and disruptive chain splits have been extremely rare.

All hard forks require coordination from developers, users and miners. It's one of the reasons why developers for the Bitcoin protocol have arguably never released a planned hard fork upgrade. The norm for code changes on Bitcoin is "soft" forks which maintain backwards compatibility with older client versions.

With the London upgrade, Ethereum developers need to give all network stakeholders who run an Ethereum client – be they miners, exchanges or decentralized application developers – fair warning and adequate time to upgrade their systems before the activation of the upgrade. This is to mitigate the possibility of an accidental chain split and prolonged disruptions to the services and applications built on top of the Ethereum network.

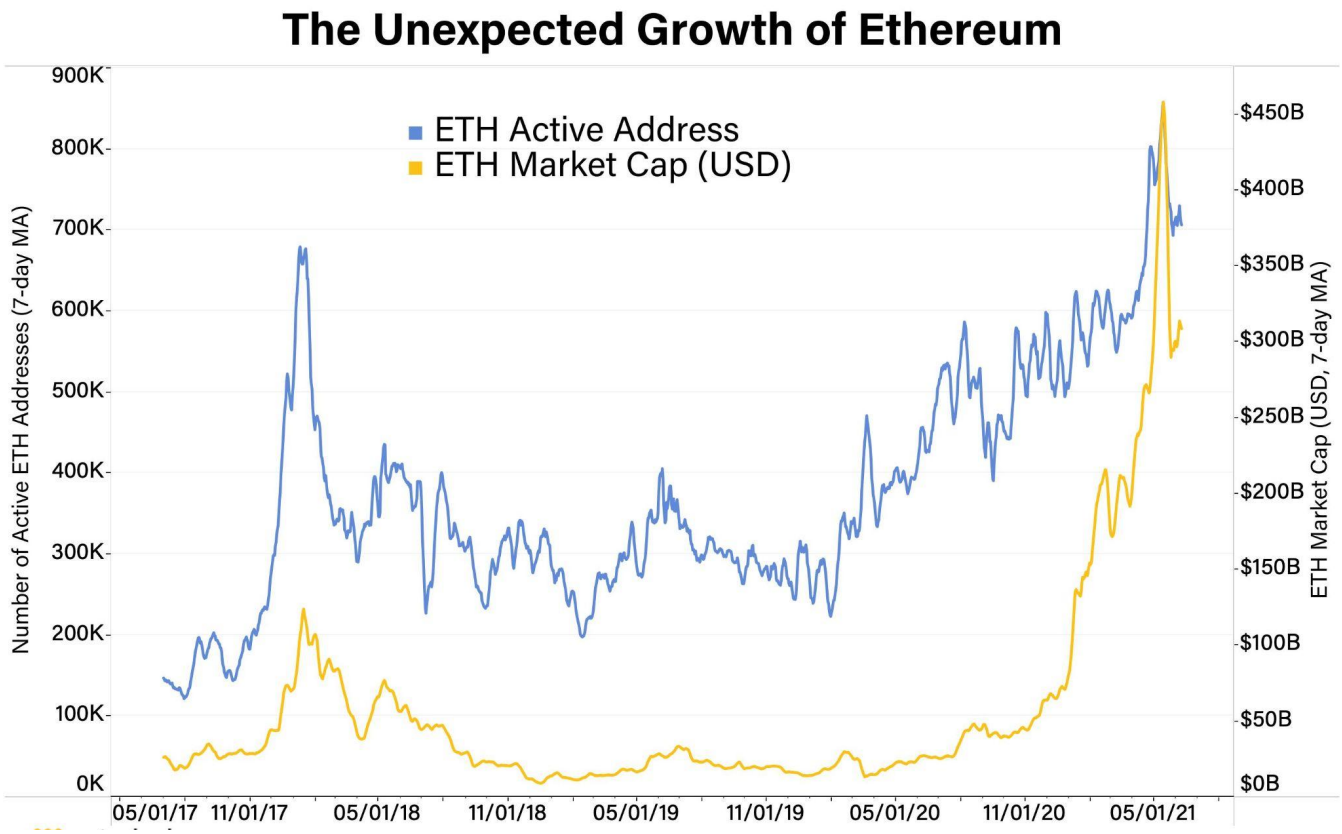
An accidental chain split can be caused by a portion of miners, exchanges and other various network stakeholders being unaware of a planned hard fork upgrade. Without transparent communication from protocol developers about an anticipated code change, services and users sending transactions on Ethereum could suddenly face delays or outages similar to the ones experienced by network stakeholders in November 2020.

Last year, the majority of Ethereum's decentralized finance (DeFi) ecosystem was unable to execute transactions for roughly two hours due to an unexpected code change released on the network.

Several community members spoke out against the lack of transparent communication leading up to the code release, with some calling the event "the most serious issue Ethereum has faced since the DAO [hack]."

In order to avoid an unintentional and disruptive chain split like the one seen last November, protocol developers are leading community initiatives to spread awareness and support for EIP 1559 leading up to its activation date.

These initiatives include public calls with wallet services, one-on-one outreach to large businesses operating on Ethereum and online guides for users who run Ethereum client software to prepare for the upgrade.



Source: Coin Metrics, data as of June 9, 2021

Conclusion

At its core, EIP 1559 is designed to make transaction fees on Ethereum less volatile and more predictable.

The main benefit is for end users who will no longer need to worry about overpaying for their transactions by setting a gas price that is too high. Users who set gas prices too low also won't have to wait needlessly wondering if their transactions will get processed in a block or not. This is expected to have positive consequences for the use and adoption of dapps on Ethereum by making the cost of interactions with these dapps transparent.

The burn mechanism also introduces a negative pressure on supply over time, which strengthens the potential value proposition of ether in investment portfolios as a cryptocurrency with limited supply, like bitcoin. In addition, because payments for the base fee in ether are burned as opposed to being paid out to miners, miners face the possibility of losing up to 35% of their normal revenue.

The loss in revenue could force some miners to shut off their machines as the costs of operating them outweigh the rewards. However, due to the persistence of other streams of miner revenue, such as block subsidies, which historically have made up the majority of total revenue, most miners are likely to still have financial incentives to keep operating on the network post-EIP 1559.

It is one of many protocol changes still to be released on Ethereum that is designed to improve the native currency ether's value proposition as a technology play. As with any significant code change, there are technology risks associated with EIP 1559.

As for the limitations of EIP 1559, there is little in its design aimed at improving network scalability and the problem of high fees. In order to tackle these challenges, developers plan on developing other novel technologies through a similar process of testing and consensus gathering as the one described in this report for EIP 1559.

It could be years before the impacts of EIP 1559 and the changes it introduces to Ethereum's fee market are fully understood, especially as the network undergoes still more radical code changes such as the PoS upgrade.

In this report, we've outlined the core values of EIP 1559, its intended impacts and potential risks ahead of its implementation on the network to prepare investors, users and miners for what they can expect from this long debated and highly anticipated update to the transaction pricing mechanisms of Ethereum.

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