Archway

Economic Paper

ARCHWAY ECONOMICS

A Sustainable Hub for Dapps

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Archway is an open-source protocol that will allow operation of a blockchain network to be known as the Archway Network. The Archway protocol is under development and subject to change. As such, the protocol documentation and contents of this document may not reflect the current state of the protocol at any given time. The protocol documentation and document content are not final and are subject to change.

Abstract

Applications building on distributed PoS networks must consider whether it is most advantageous to develop a decentralized application that utilizes an independent layer 1 or to build out their own sovereign app chain. The former bequeaths value created by the application to the layer 1 without proper remuneration, while the latter is unnecessarily resource-exhaustive.

Through the economic novelties layed out in this paper and the modules that make them possible, Archway provides a sustainable and incentive aligned arena in which developers are empowered to launch, build, and grow applications of any type or size with the ease and structure of a decentralized application, and the economic extrication of an app chain.

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Preface

This paper assumes the reader has a basic understanding of cryptocurrency markets, as well as familiarity with Ethereum and the Cosmos Ecosystem. This paper references ARCH, which is the native token used on the Archway blockchain. The ARCH token will be used for both gas, and for governance of the protocol by the Archway Community . For an overview of the Archway technical stack, please read the Archway Technical Paper. [1]

[1] Archway, “Technical Overview,” 2022, https://archway.io/assets/archway-technical-paper.pdf

Introduction

Archway is a layer 1 blockchain built using the Cosmos Software Development Kit ("Cosmos-SDK") with the goal of perpetually incentivizing developers to build and maintain the best decentralized applications ("dapps"). Web3 adoption has given rise to the Fat Protocol Thesis ("FPT"), which suggests that the underlying protocols will accrue more value than the dapps built on top of them. This is notably unlike what we've seen in Web2, which is a moniker for the internet most people are familiar with, where applications accrue the vast majority of value despite reliance on underlying protocols. An example of this would be how Facebook captures the value from the application rather than the underlying protocol, HTTP. According to the FPT, smart contract platforms are set up to accrue value to the protocol rather than the dapp. For example, Ethereum accrues the value derived from Uniswap.[2] While this has arguably been the case in the past, an inflection point has been passed where there is now an abundance of layer 1 protocols, and a lack of heavily utilized applications. Furthermore, heavily utilized applications often opt to create their own layer 1 or app chain, as a means to theoretically capture more of the value they create, which aligns with the crux of the FPT.[3] Archway is positioning itself both to facilitate the growth of the app chain ecosystem, as well as to be a more attractive layer 1 on which to build and launch heavily utilized dapps. This paper will address the positioning of Archway and the underlying problems it solves, token functionality and economics, potential attack vectors and mitigation mechanisms and finally enumerate the parameters that will be subject to Archway Community governance.

Building in the Cosmos ecosystem connects Archway to over 50 chains through the Inter-Blockchain Communication protocol ("IBC"). With built-in interoperability and an open-source SDK, it is easy to see why Cosmos is a home to so many app chains. An app chain also needs to coordinate and grow a strong, decentralized validator set of node-operators, which typically requires significant inflationary rewards to incentivize providing security to the network. Archway is designed to work seamlessly with both dapps and app chains.

[2] Joel Monegro, "Fat Protocols", August 8, 2016, Union Square Ventures, https://www.usv.com/writing/2016/08/fat-protocols/

[3] Bai Ze Research Institute, "With the rise of the APP Chains, what is its past life, present life and future?", Blocking, 2022, https://blocking.net/38870/with-the-rise-of-the-app-chains-what-is-its-past-life-present-life-and-future/

Economic innovation and remuneration of value captured are the primary differentiators between Archway and other layer 1 protocols. From a developer's perspective, it is logical that they would prefer to retain the value they create, which is the antithesis of the FPT. However, these same developers must also consider both the economic and opportunity costs associated with creating and operating an independent app chain. Archway provides a great middle ground for dapp developers with its hybrid approach, where dapp creators will earn rewards proportional to the utility their dapp creates for the Archway network, while also providing a more rewarding access point for interchain accounts and multi-chain applications. Additionally, as outdated token models struggle to adapt to new ideologies and regulatory requirements change, the adaptability of Archway's token model provides flexibility to address future unknowns.

Integrated Cosmos Base Features

Built using the Cosmos-SDK, it is important to expand upon which basic features are adopted from the generic stack, and which are unique to the Archway blockchain. Only a select few of the Cosmos-SDK modules utilized by Archway are enumerated below due to their economic significance.

Token Mint Module

The x/mint module sets the parameters for inflation on the Cosmos Hub blockchain.[4]

The six parameters included are:

1. **MintDenom** - The denomination of token minted
2. **InflationRateChange** - A factor of and limit to the speed at which the inflation rate changes
3. **InflationMax** - The maximum rate that new tokens can be minted, proportional to the supply
4. **InflationMin** - The minimum rate that new tokens can be minted, proportional to the supply
5. **GoalBonded** - The target proportion of staking participation relative to supply
6. **BlocksPerYear** - The system's assumed number of blocks that will be produced in one year

[4] Cosmos, "Mint Module," accessed April 22, 2023, https://github.com/cosmos/cosmos-sdk/blob/df4d6d1a4cd9fa0247f9db9378db857d95a1c1cb/x/mint/README.md.

Parameter	ATOM
MintDenom	uatom
InflationRateChange	13%
InflationMax	20%
InflationMin	7%
GoalBonded	67%
BlocksPerYear	6,311,520

When determining the values for these parameters, the intent was not to shy away from perpetual inflation, but rather to incentivize staking tokens at a rate that will sufficiently secure the blockchain and protect it from potential attack vectors. When the ‘GoalBonded’ threshold is reached, the incentives gradually decrease, as bonded rates above the threshold produce diminishing returns in regards to the network security.

Perpetual inflation is a notable improvement in terms of efficiency in comparison with many prior layer 1s with fixed maximum supplies. Monetaristic inflation provides the opportunity to decentralize perpetual expenditure by diluting all holders, while providing incentives for activating what is deemed desired functionality. Incentivizing stakers and validators is meant to encourage honest node behavior and provide economic security, but is not inherently optimized for increasing the chain’s security posture. Rather, the current state decentralizes the expense of infrastructure provision, one of the many expenses of a network. In addition, Archway will be diverting part of the monetaristic inflation to reward the developers whose contracts are being utilized on-chain, which incentivizes the prolonged and sustained development of well maintained dapps. This parameter will be called ‘Dev Inflation Tokens’ (“DIT”), and will be a fixed percentage of the overall inflation, beginning at 25%, and governable by the Archway Community.

On Archway, time (to the millisecond) will be factored into each block. This will not only enable accurate and consistent inflation, but will also provide ease of use to users and builders on the network. Upgrades and product releases can take place by specifying times and instituting triggers on the proceeding block as opposed to specifying block heights with very rough time estimations.

Parameter	ARCH
MintDenom	aarch (atto)
Inflation	10%
DIT	25%

This version of the x/mint module will be included in Archway. All parameters and parameter types will be subject to governance by the Archway Community. With lower inflation parameters, Archway aims to create a more stable and consistent long-term economic model, while still providing sufficient rewards to incentivize security.

Auth Module

The x/auth module handles accounts and authentication.[5] For the purposes of this paper, it is important to understand that this module contains multiple 'AnteHandlers' (validity checks) such as signature verification and fee reduction. In Cosmos-SDK the 'Fee Collector' is a special type of module account that stores network fees from transactions in order to disburse them to validators. While the x/auth module will be integrated into the Archway blockchain, the scope and function of the 'Fee Collector' will be altered so that gas fees will be split between being burned and remunerating developers, not being distributed to validators and network stakers.

Fee Grant Module

The x/feegrant module permits accounts to grant allowances, in which case the granting wallet will subsidize the Gas fees for the grantee.[6] While this module has been part of Cosmos-SDK for quite some time, its utility gets substantially magnified when used in conjunction with Archway's innovative design. In essence, since rewards are reverted back to the developers, the granting wallet can be perpetually replenished.

This mechanism could be utilized by dapps to reduce the barrier to entry for users. To provide an example, the use of the x/feegrant module could allow NFT games to offer a 'try before you buy' package, where the gas fee is subsidized for the first NFT minted by each user, so that the user can try the game without even owning the native token.

[5] Cosmos, "Auth Module," accessed April 22, 2023, https://github.com/cosmos/cosmos-sdk blob/2418c3ef2e6f74fd6e7575b743fc1da4b53ab972/x/auth/README.md.

[6] Cosmos, "Fee Grant Module," accessed April 22, 2023, https://github.com/cosmos/cosmos-sdk/blob/main/x/feegrant/README.md.

A Decentralized Exchange ("DEX") could allow users to purchase the native gas token on the dapp without requiring traders to first use a competitor or faucet.

Previously, the drawback was that grants were essentially permanent giveaways, but in conjunction with the x/tracking and x/rewards modules, they're now customizable, refillable permission slips.

Other Cosmos-SDK Modules

All other current Cosmos-SDK modules will be implemented into the Archway blockchain with no significant changes. This includes but is not limited to, x/staking and x/slashing modules. To learn more about the policies and procedures pertaining to staking, and the conditions and levels of slashing, please refer to the Cosmos-SDK Github.[7]

Archway Unique Features

There are several key components unique to the Archway blockchain that work in unison not only to ensure aligned incentives amongst developers, node operators, and network stakers, but also to protect the Archway blockchain from malicious action. Two new modules have been developed to provide the technical capacity to enact these components. For the first time a structured fee marketplace will be instituted in Cosmos. Additionally, the blueprints for dynamic data-driven parameters are in place.

[7] Cosmos Module Tree, accessed April 22, 2023, https://github.com/cosmos/cosmos-sdk/tree/main/x.

Value Capture Engine

Rewards Module

The x/rewards module enables calculation and distribution of rewards to smart contracts.[8] This module also introduces the protocol governed minimum Price of Gas ("mPoG"). Currently, the validators of Cosmos-SDK chains independently set their own minimum gas prices, often allowing for 0 or near 0 fees to be paid. This price floor enables consistent and verifiable rewards for developers, in addition to protecting the chain from spam attacks.

Tracking Module

The x/tracking module enables the tracking of Gas consumption on Execute and Migrate operations in smart contracts.[9] The module abstracts transaction information into Contract Operation Objects ("COOs") which can properly ensure that Gas consumption per contract interaction is both reported and remunerated properly. This protects the Contract Secured Revenue ("CSR") of each contract called, preventing bypassing through proxy-contracts.

Gas Rebates

Typically, in the Cosmos ecosystem, the gas for transactions is redistributed alongside inflation to network stakers through the Proof-of-Stake ("PoS") validator nodes. This usually accounts for an inconsequential percentage of the staking rewards as annual monetaristic inflation is often 20% or higher. Contrarily, Ethereum has a much lower inflation rate, higher usage, and burns gas spent, further limiting the dilution through an increase in supply. [10]

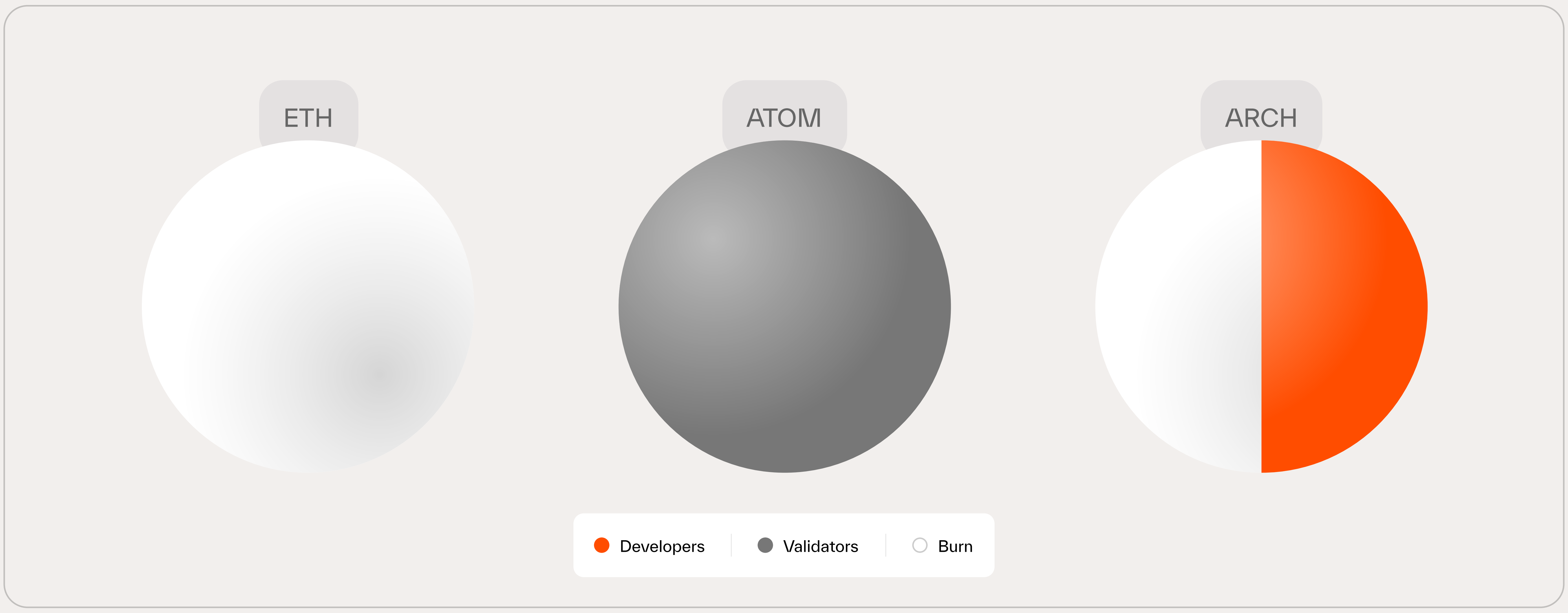
Archway will use a modified version of Ethereum's gas approach, burning a base 50% of minimum gas spent, and distributing the other 50% of gas spent to the creator of the contract the gas was spent on, or a wallet specified by said contract creator. This ensures that if the contract a developer builds is being used, then the supply of ARCH will be reduced in comparison to inactivity, and the developer is rewarded for driving value to the Archway protocol. Note that this is a 50% split of the base fee; situations in which gas prices exceed the mPoG will be discussed more in depth in Appendix C.

[8] Archway, "Rewards Module," 2022, https://github.com/archway-network/archway/tree/main/x/rewards.

[9] Archway, "Tracking Module," 2022, https://github.com/archway-network/archway/tree/main/x/tracking.

[10] Ethereum, "Eip-1559," May 6, 2022, https://github.com/ethereum/EIPs/blob/master/EIPS/eip-1559.md.

A visual comparison of gas distribution on Ethereum, Cosmos Hub, and Archway is as follows:



Dev Inflation Tokens

Developers are not limited to receiving only 50% of the gas spent on their contracts, in addition they can receive up to the same amount of gas spent through distribution of inflation rewards. Currently the standard Cosmos-SDK includes the aforementioned x/mint module, distributing rewards to stakers through validators, which is meant to incentivize security on the chain by decentralizing the perpetual expenditure of infrastructure provision.

But, with many layer 1 protocols having substantial economic security compared to the relative on-chain activity, and many node operators receiving generous incentives for said security, a strategic decision to further optimize for developer incentives through inflation appears to be an optimal path. The Dev Inflation Tokens per Block ("DITB") is the amount of ARCH reserved for developers from inflation in a given block. The disbursement efficiency of the DITB will be predicated upon an optimal fill percentage ("OFP") derived from dependencies on protocol parameters such as inflation and minimum price of gas ("mPoG"). The DITB will be a fixed percentage of ARCH tokens minted each block, and will be distributed evenly in accordance with how much gas was spent, with a cap of the remaining 50%. This ensures that the most a developer could earn from an interaction with their contract is equal to 100% of the fees spent on said interaction. Examples are viewable in the appendix.[11]

The Dapp Treasury will store unused DITB, and will at routine intervals give bonuses to the most successful dapps, incentivize testnets and/or hackathons, and potentially sponsor grants to other teams that want to build on Archway.

[11] Appendix A

Contract Premiums

Beyond the aforementioned gas-based rewards, a customizable fee layer will be added as well. In essence, creators can set their own usage fee which is added on to the minimum gas needed for the network transaction. For the user's experience, the Contract Premium will be paid alongside the gas fee. The Contract Premium will be a flat fee that is set and can be adjusted by the contract creator. This composable fee layer enables builders to run traditional market analysis and incorporate traditional business models into their products, creating a business layer for builders. Not only can dapps charge custom premiums for different contract executions, but those building network tooling can also charge the dapps using their tooling through custom premiums. This provides routes to sustainability for both dapps catering to end users and builders of network goods and services, who have previously been forced to rely heavily on grants and external payments. Example simulations are viewable in the appendix.[12]

Setting up these premiums allows for more predictable and flexible economic models for both dapps and public goods built on Archway. Furthermore, Contract Premiums allow for a simpler funding model than designing unnecessarily convoluted smart contracts in order to use more gas as a means to game the Gas Rebates.

Smart Target Parameters

As data is gathered and the developing needs of the Archway ecosystem are better understood, not only can the Community vote to change fixed parameters, but dynamic formulas can factor in Smart Target Parameters ("STP"), that automatically adjust dependent parameters on either a block-to-block or time-based basis in accordance with whatever the smart target is.

For example, should an STP be set to "2.5% Net Inflation", the parameters for inflation, DIT, mPoG, and the change in the Price of Gas ("ΔPoG") could all adjust in a single weighted formula to accommodate that smart target. The same could be set for any number of important and agreed upon metrics as voted upon by the Archway Community. This could ensure goals are reached, or provide an easier and more objective means of approaching them than currently exists. No STPs will be set at the initialization of this economic model.

[12] Appendix B

Potential Attack Vectors

An integral part of all game theory simulations is identifying ways to break or misuse the model. This includes not only seeing if there are ways to break it from a profitability and sustainability standpoint, but also quantifying the economic cost of potential attacks. The following will outline several potential attack vectors and the solutions that are being deployed to mitigate them.

If expected ARCH gas-based rewards are to be perfectly correlated with the amount of gas spent on contract interactions, it is imperative to understand what gas fees will cost. If gas fees are too high, users might not interact with dapps on the chain. If gas fees are too low, the incentives to build on Archway as opposed to elsewhere are less enticing. To protect against gas fees that are too low, the mPoG begins at 900 GWAY (0.0000009 ARCH).

Optimistic Rollups

While the mPoG guarantees a price floor by which to calculate expected gas rewards, an optimistic rollup solution could bypass any reward expectation, canceling the expected sustainability of dapps. By handling computation off-chain, optimistic rollups minimize the amount of gas required, and can bunch many transactions through in a single block. While this is beneficial for scaling a congested layer 1 blockchain, minimizing the amount of gas required on a dapp can nullify the expected rewards.

Spam Attacks

Gas exists to prevent the network from being spammed.[13] If transactions were free, then anybody could queue any number of transactions, the nodes would quickly fall out of sync, and the blockchain would halt. Blockspace is limited, and gas enables it to be orderly commoditized. If, therefore, contract creators were to be fully reimbursed the gas fees spent, then a malicious actor could create their own contracts and use them endlessly, congesting and shutting down the Archway blockchain.

[13] Muhammad Saad, "Contra-*: Mechanisms for countering spam attacks on blockchain's memory pools," Journal of Network and Computer Applications, 179(102971), April 1, 2021, https://www.sciencedirect.com/science/article/abs/pii/S1084804520304227.

Solution

With the aforementioned risks in mind, it is imperative that the ARCH tokenomics are designed to protect the safety and integrity of the blockchain, with the primary objective still being to reward contract creators and provide a platform that allows economic customization for dapp builders. The result is a carefully catered and Archway Community governed modularly adjustable model that both resembles unornamented Cosmos Delegated Proof-of-Stake ("DPoS") blockchains as well as Ethereum's EIP-1559, while adding several types of developer rewards.

Contract creators will have 3 distinct forms of rewards: Gas rebates, DIT, and Contract Premiums. In Cosmos, gas spent is redistributed to the validators and stakers, but typically makes up a very small percent of their rewards, as the bulk comes from inflationary emissions. In Ethereum, gas spent is burned, but an optional tip for priority is allotted to validators. On Archway, 50% of base gas spent (based on mPoG) will be burned, and 50% will go to the contract creators in the form of Gas Rebates. As the PoG increases, still 50% of the added cost will reimburse contract creators, with the remaining 50% of the heightened cost due to increased demand burned, though this can be independently altered through governance. Contract creators will receive the minimum of either their section of the 25% of minted ARCH, or the remaining 50% of Gas spent on their contract, ensuring that under no circumstances could they receive more ARCH than they'd spend if interacting with their own contracts. Contract Premiums will help ensure available customization exists to protect contract creators from potential Gas nullification through something like an optimistic rollup. By having reflexive Gas prices spam attacks will increase in cost rapidly, and notably outpace the increase in developer rewards, necessitating burning significant amounts of the ARCH token to carry out an attack of any significant duration. This renders spam attacks both impractical and deflationary. Example simulations are viewable in the Appendix.[14]

With more throughput thanks to the Cosmos-SDK and the tokenomic parameters opting for slower ΔPoG in comparison to Ethereum, the Archway chain can stay affordable to use much longer, while still adequately protecting itself. With the parameter and data layout, the community is welcome and encouraged to run simulations with different parameters. Many simulations have been run and the current parameters were set upon, but all are subject to change via Community governance in accordance with chain needs and community input.

[14] Appendix C

Dapp v App Chain

Once armed with a proper understanding of the costs of running an independent app chain, and the rewards available to dapp creators on Archway, a proper cost-benefit analysis ("CBA") can be done. The following will be a sample analysis on a potential dapp's CBA.

Cost-Benefit Analysis

The following is a simplification of the advantages of being either a dapp or app chain:

	Archway Dapp	App Chain
Sovereignty	○	●
Scalability	○	●
Barrier of Entry - User	○	●
Barrier of Entry - Builder	●	○
Lower Costs	●	○
Network Effects	●	○

Ensuing will be an exploration into the margin of advantage in each category.

Sovereignty

App chains are fully customizable, setting their core parameters wherever they'd like, assuming the technical capacity. Rate limits such as block size and block speed can be fully controlled. Furthermore, there won't be competition for blockspace, ensuring consistent costs for users, and control of scalability and uptime.

Dapps on Archway are quite customizable, but are subject to the Archway blockchains parameters and Community governance.

Conservative expectations for the Archway protocol based on parameters in place are:

Max Gas/block	300,000,000
Block time	6 seconds

Further examples of potential blocktime and Max Gas are available in Appendix D.[15]

The marginal returns of sovereignty will be different for each dapp based on their requirements. If a dapp runs heavy computations that will require 200,000,000 Gas, or absolutely has to have block times of 1 second or less, then the marginal returns on being an app chain could be incredibly high. If the parameters in place by the Archway blockchain are not significantly restrictive, or are even similar to those of a theoretical app chain that a product would run, then the marginal returns on being an app chain are incredibly low.

Scalability

App chains have the capacity to scale to the extent their technology and hardware allow. Cosmos can theoretically handle up to 10,000 transactions per second ("TPS") while Ethereum is stuck under 60.[16] The validator set can be customized based on needs for scalability and decentralization, further enabling the composability of app chains.

An Archway dapp is limited to the scalability of Archway. Though the Archway blockchain boasts the same high scalability as the rest of the Cosmos, the specific customization of validator sets is not available, and the dependency on the Archway blockchain and their validator set to consistently upgrade to best practices is a risk. Furthermore, users of the dapp must compete for blockspace with all other dapps built on the same blockchain. If an NFT mint slows down the blockchain and/or drastically raises gas prices, users of the dapp are subject to the effects.

At some point in a dapps growth a migration to an app chain could be warranted. If/when that is the case, a side-chain can be spun up, and a dapp can migrate to being an app chain, and even an initial validator set can be readily integrated through the use of Interchain Security ("ICS") with the Archway blockchain's validator community.[17]

[15] Appendix D

[16] Rahul Nambiampurath, "What is Cosmos?," The Defiant, September 15, 2022, https://thedefiant.io/what-is-cosmos/.

[17] Gaia, Interchain Security Docs, accessed April 22, 2023, https://github.com/cosmos/gaia/blob/main/docs/interchain-security.md.

This available migration strategy allows teams to start small and grow into an app chain if required, rather than forcing the more expensive option during a project's infancy.

The marginal returns of scalability are only significant if the Archway blockchain gets congested or if a specific application has unique requirements. It's further lowered for early-stage applications due to the availability and support offered for migrations to an app chain at a later date.

Barrier to Entry

A hurdle for many Web3 projects is a high barrier to entry, both for users and developers. App chains have the benefit of their native tokens being the gas token for the network, and also the composability to lower the gas fees all the way to 0 (though risking aforementioned spam attacks when doing so). By using the x/feegrant module in conjunction with Archway's x/rewards module, dapps have the ability to fully subsidize gas fees for new users as well, lowering the barrier of entry significantly in comparison to dapps on other layer 1 protocols. Therefore the marginal return of the lowered barrier of entry of an app chain for onboarding users is low. With the added cost and difficulty of building, maintaining, and supporting an entire blockchain however, the barrier of entry for teams wanting to build an application is substantial. Therefore the marginal return on lowering the developmental barrier of entry by simply building a dapp on an already well-maintained and integrated blockchain is very significant.

Costs

The cost difference between operating a dapp and an app chain can be very significant. To better understand the spread, an itemization of potential infrastructure, personnel, security, and opportunity costs is required.

Infrastructure

In order to function, an app chain needs an independent validator set, block explorer integration, wallet integration, public remote procedure calls ("RPCs"), IBC Relayers, and independent security, all of which does not come cheap.

The following are a conservative example of potential expenses:

Infrastructure	1 Year Cost
Node Operation	$100,000
Block Explorer	$0
Archive Nodes	$5,000
Public RPCs	$60,000
IBC Relayers	$10,000
Security (stakers)	$2,000,000
Wallet Integration	$200,000

Even if a developer achieves better prices than this suggests, all of these costs are nullified when building a dapp on Archway. For further comparison, Ethereum, with a 4% inflation and over $188B market capitalization is currently paying stakers over $7.5B per year to secure their blockchain. Atom, with a 20% inflation and over $3.5B market capitalization is currently paying stakers over $700M per year to secure their blockchain. $2M is not a particularly high estimate, and is equivalent to a scenario in which ATOM has a $10M market capitalization with its current inflation rate.

Personnel

When running an app chain, in addition to building, maintaining, and operating an application, a team is also responsible for doing the same for a blockchain. This is not a small task, and requires multiple additional staff members

Personel	1 Year Cost
Protocol Engineer	$150,000
Protocol Engineer	$150,000
DevOps Engineer	$150,000
DevOps Engineer	$150,000

Opportunity Costs

In addition to the summation of expenses an application would accrue should they choose to launch an app chain, the opportunity cost of missed developer rewards on Archway must also be factored.

A template calculator for reward estimation could be built as follows:

Contracts *(a)*	PremiumC *(b)*	txs/month *(c)*	tx gas *(d)*	mPoG *(e)*	Monthly Rewards *(f)*
Name	x	x	x	0.0000009	*PRODUCT(C2:E2)+B2*C2*

With this, a decentralized application team could use their actual tx gas amounts and run simulations with different contract premiums, volumes, and ARCH prices, to simulate expected opportunity cost.

Network Effects

Dapps on Archway have a distinct advantage of a pre-existing community of users, builders, and other dapps. Collaborative partners are easier to find, as incentives align for all dapps to succeed, which would drive value to the shared chain. While this is somewhat the case for all layer-1s, as adoption drives demand for the gas token, it is especially true for Archway, as adoption also decreases supply of the gas token.

Not only are the costs of infrastructure, integrations, and personnel negated, but the services offered by the replacements and their networks extend beyond those of mere employees. Marketing, education, tutorials, early users, and an immediate and aligned audience are all part of the network effects that are inherited when building a dapp, but can be barriers to adoption and growth if starting as an app chain.

Summary

The decision for new applications to either build a dapp or an app chain is not one to be taken lightly. Each team should make their own CBA, and analyze the marginal returns of sovereignty, scalability, and barrier of entry in relation to the needs and specs of their application. The summation of the mock one addressed here follows. This is a hypothetical analysis reflecting estimated costs that may not reflect actual costs for any given project and should not be relied upon other than as a hypothetical example.

Expense	Cost/Year
Node Operation	$100,000
Block Explorer	$0
Archive Nodes	$5,000
Public RPCs	$60,000
IBC Relayers	$10,000
Security (stakers)	$2,000,000
Wallet Integration	$200,000
Protocol Engineer	$150,000
Protocol Engineer	$150,000
DevX Engineer	$150,000
NetX Engineer	$150,000
Opportunity Cost	$500,000
Total	$3,475,000

This hypothetical example suggests an additional nearly $3.5M in expenses year 1 for an app chain that is not applicable to a dapp built on Archway. For many applications that are compatible with the gas limits and block times offered by the Archway blockchain, launching as a dapp on Archway is much more feasible and economically viable.

Interchain Accounts and Multichain Applications

As Cosmos and other ecosystems develop frameworks for interconnected blockchains, the growth of interchain accounts and multichain applications is inevitable. Contracts and messages on one chain will trigger contracts and messaging on others. This maturation will provide app chains the opportunity to utilize Archway as an access point, making them privy to some of the network effects currently available to dapps, and additional economic modularity through Archway's novel rebates and premiums. This opportune utilization of the Archway blockchain as an archway into the multichain space is the reason behind its name. It further shows the potential scalability of Archway, as heavy computation can eventually be migrated to independent app chains, while only necessitating users interact directly with the Archway Hub.

Conclusion

The tech-stack of Archway, largely inherited from the Cosmos-SDK, supports far more economic customization and scalability than on Ethereum or other layer 1 chains. The economic stability offered by Archway's lower net inflation is more stable than that of ATOM, and more incentive-aligned toward developers than that of Ethereum. The reflexive Gas limits and pricing is more smoothly structured and adaptable than Ethereum's EIP-1559. Archway is aiming to better the economics of Ethereum and the tech-stack of Cosmos to create a secure and scalable dapp hub where developers are empowered to work for themselves, and startups are positioned to thrive.

Archway will combat perpetual inflation with counter-inflationary mechanics organically through the utility of the chain. The reflexivity and Community governed parameters ensure protection of the chain and nodes, relaying security therefore to the dapps built on the network. As Web3 scales, Archway's growth will not be limited to the blockspace available on its own chain, but rather it can act as a rewarding access point to multichain applications, giving composability to developers, and convenience to end users.

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Metrics and Parameters

Independent Variables

Things that are factored in formulas, but not directly within the control of the Community:

t = BlockTime in Seconds
Supply = TotalSupply of ARCH

Parameters

These are itemized, and easily changeable in the codebase. These are dependencies for other metrics, but have no dependencies themselves.

$Inflation = 10\%$	Based on total supply
$tax_{cp} = 6\%$	Community Pool Tax
$tax_{eg} = 4\%$	Ecosystem Grants Tax
$tax_{af} = 0\%$	Archway Foundation Tax
$mPoG = 0.000000900$	ARCH/gas
$\Delta PoG_{max} = 0.05$	5%
$DIT = 25\%$	of pre-tax ARCH inflation
$MaxGas_{max} = 600000000$	Gas
$MaxGas\Delta t = \log_4 (2+t) \times 200000000$	Min(this or $MaxGas_{max}$)
$GTmPoG_{dev} = 50\%$	Gas rebate above mPoG

Key Metrics

These are metrics that will be monitored closely and may be used to determine if/when parameters should be adjusted. These are dependencies, and impactable in the code through changing parameters.

$tax = tax_{cp} + tax_{eg} + tax_{af}$	Total tax
$DITB = DITR \times t \times (1\text{-}tax)$	DIT per Block in ARCH
$OFP = \frac{2 \times DITB}{mPoG \times MaxGas}$	Optimal Fil Percentage
$MintR = \frac{Inflation \times Supply}{31557600}$	ARCH minted per second
$MintB = MintR \times t$	ARCH minted per block
$TPS = \frac{TxB}{t}$	Txs per second experienced
$TPS_{max} = (MaxGasB/s) \times GasC_{avg}$	Txs per second possible
$Equilibrium: MintR = BurnR$	Measured in TPS

Dependent Variable Formulas

- PoG - Price of Gas (in ARCH, conversion not required)

$$PoG_n = MAX(mPoG,(PoG_{(n-1)} + (0.5\text{-}FP_{(n-1)}) \times (-2 \times \Delta PoG_{max} x PoG_{(n-1)})))$$

- MaxGas - Max Gas per Block

$$MaxGas_n = MIN(MaxGas_{max}, (log_4(2+t) \text{ x } 200000000))$$

Appendix A

Developer Rewards

OFP derivation – the following are hypothetical scenarios reflecting estimated data inputs for illustrative purposes only. These data inputs may not be consistent with data from actual transaction activity on the Archway blockchain and these scenarios should not be relied upon other than as hypothetical examples.

Assume:

- The max block size for a 6-second block is 300,000,000 Gas
- The initial mPoG is 0.0000009 ARCH/Gas (900 GWAY)
- MintR is 3.17 ARCH/s

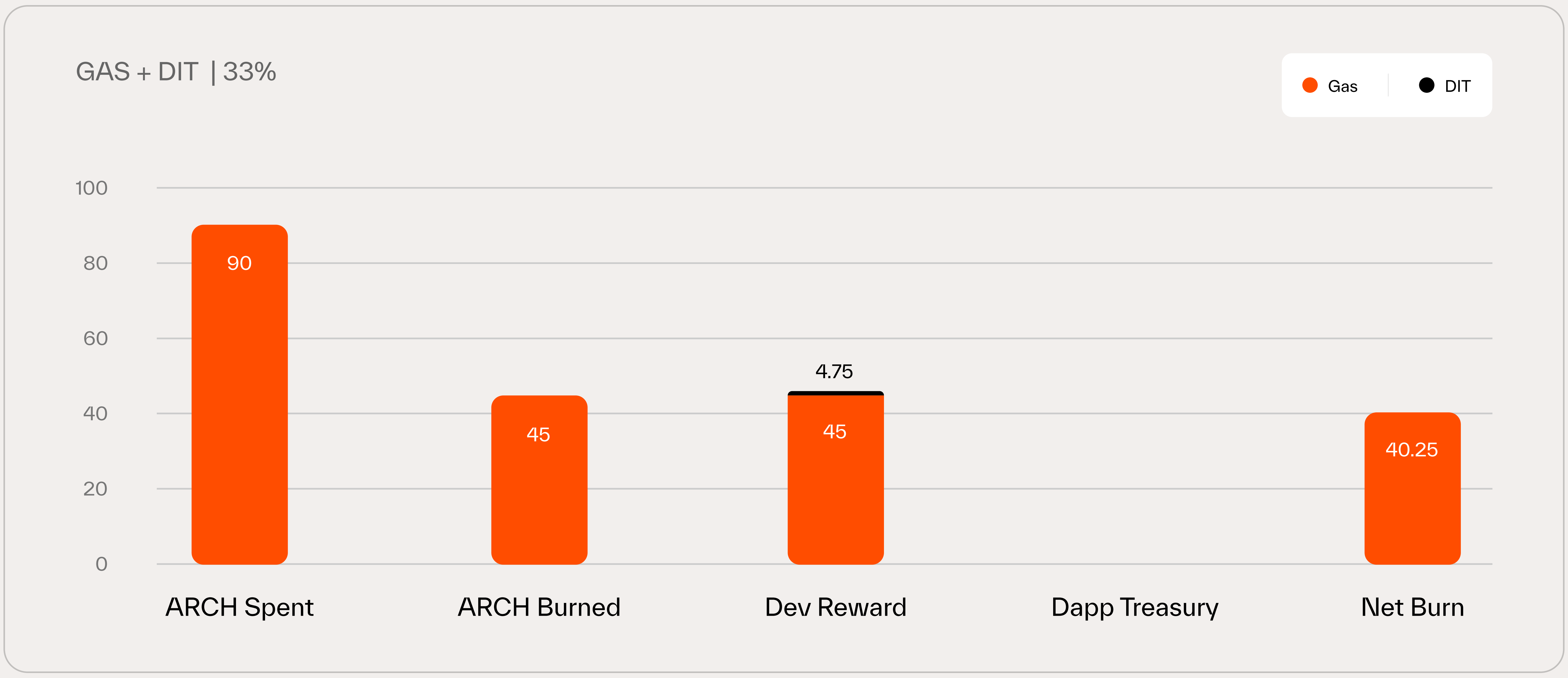
So:

- 270 ARCH is the maximum possible amount of Gas spent, as it would fill the entire block.
    - 300,000,000 Gas × 0.0000009 ARCH/Gas = 270 ARCH
- 135 ARCH is the maximum possible amount of Gas rebate in the block
    - 270 ARCH x 50% = 135 ARCH
- 4.755 ARCH is the *DIT*B
    - 3.17 ARCH/s ×6s ×25% DIT=4.755 ARCH
- 3.52% OFP
    - 4.755/135

This means that if 3.52% of the block is filled, or 10.56M gas is used in a block, that developers will earn the full 100% of fees accrued on their contracts. If more gas is used, then developers will receive less than 100% of fees accrued. If less gas is used, developers will still receive 100% of fees accrued, and the remaining DIT will rollover to the Dapp Treasury.

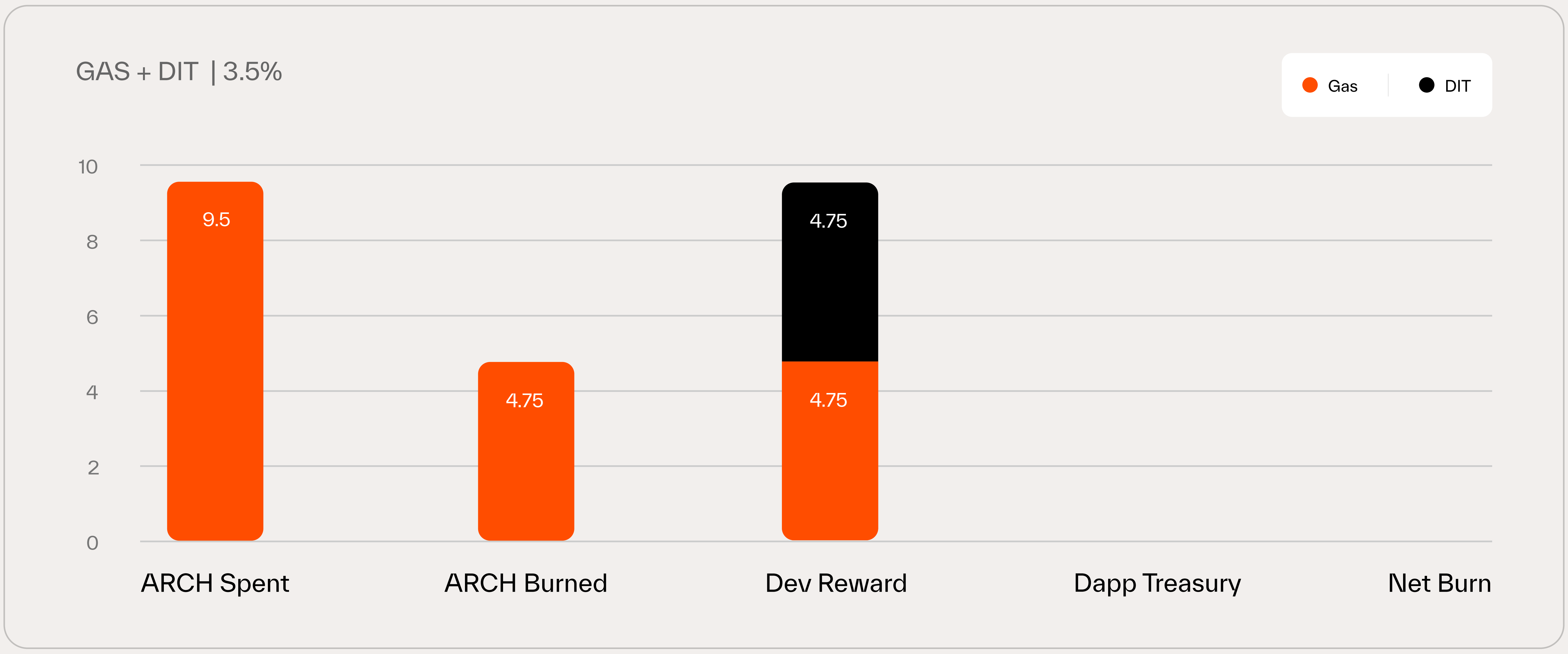
Assume 6s blocktime, and 900 GWAY mPoG:

A. If 100,000,000 Gas is spent, a 33% filled block:



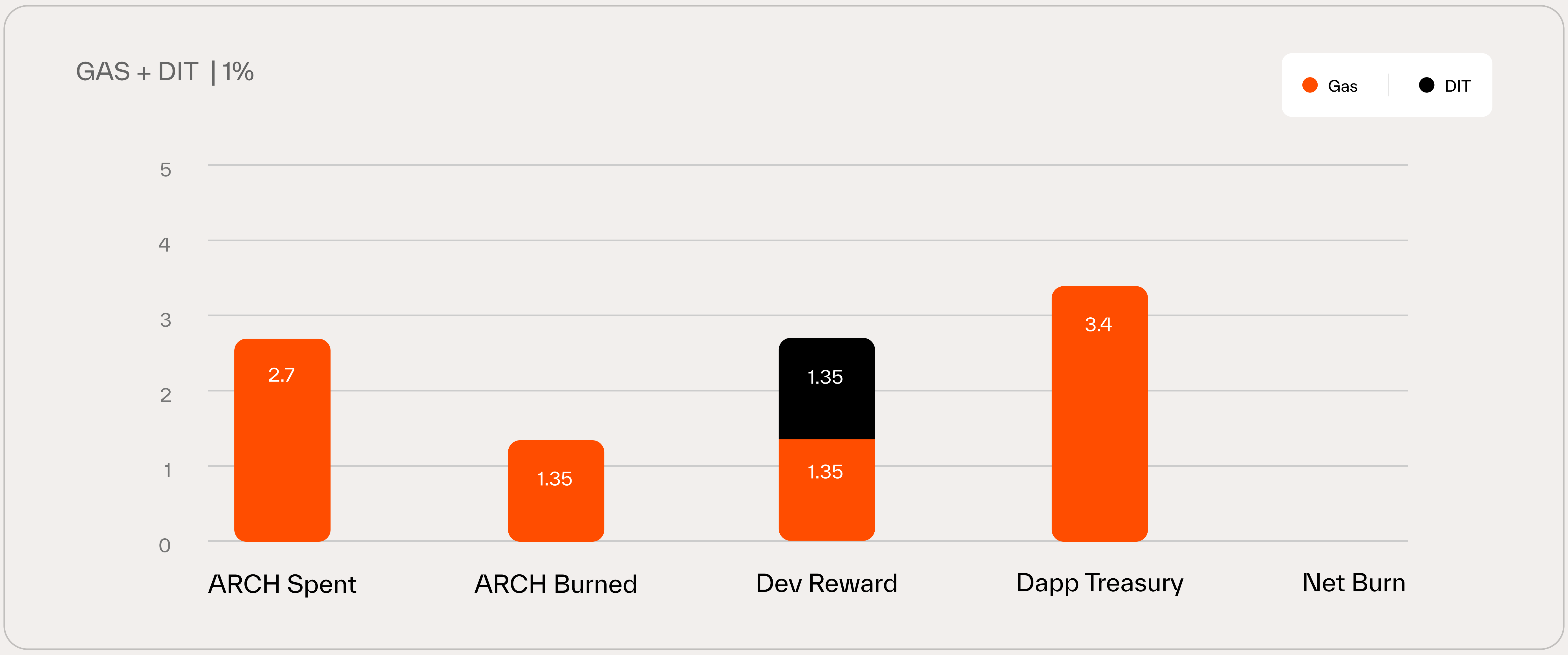
1. 100,000,000 x 0.0000009 = 90 ARCH spent in Gas
    a. 45 ARCH gets burned
    b. 45 ARCH is sent to contract creators
    c. DITB = 4.755 ARCH
        i. 3.17 ARCH/s Inflation ×6s×25% DIT
2. 45 ARCH > 4.755 ARCH
    a. Contract creators are reimbursed 10.57% of their second half of Gas spent.
    b. So, 90 ARCH was spent in Gas, 45 ARCH was burned, and contract creators earned 49.755 ARCH, 60.57% of the Gas spent on their contracts.

B. If 10,560,000 Gas is spent, a 3.52% filled block:



1. 10,560,000 x 0.0000009 = 9.5 ARCH spent in Gas
    a. 4.75 ARCH gets burned
    b. 4.75 ARCH is sent to contract creators
    c. DITB = 4.75 ARCH
2. 4.75 ARCH = 4.75 ARCH
    a. Contract creators are reimbursed 100% of their second half of Gas spent.
    b. So, 9.5 ARCH was spent in Gas, 4.75 ARCH was burned, and contract creators earned 9.5 ARCH, 100% of the Gas spent on their contracts.

C. If 3,000,000 Gas is spent, a 1% filled block:



1. 2,700,000 x 0.0000009 = 2.7 ARCH spent in Gas
    a. 1.35 ARCH gets burned.
    b. 1.35 ARCH is sent to contract creators.
    c. DITB = 4.75 ARCH
2. 1.35 ARCH < 4.75 ARCH
    a. Contract creators are reimbursed 100% of their second half of Gas rewards
    b. The other 3.4 unclaimed ARCH are sent to the Dapp Treasury.
    c. So, 2.7 ARCH was spent in Gas, 1.35 ARCH was burned, and contract creators earned 2.7 ARCH, 100% of the Gas spent on their contracts.

Appendix B

Contract Premiums

The following are hypothetical scenarios reflecting estimated data inputs for illustrative purposes only. These data inputs may not be consistent with data from actual transaction activity on the Archway blockchain and these scenarios should not be relied upon other than as hypothetical examples.

Contract Premium Examples

A single contract 'X' has a tx Gas of 400,000 and sets a flat Contract Premium of 0.1 ARCH

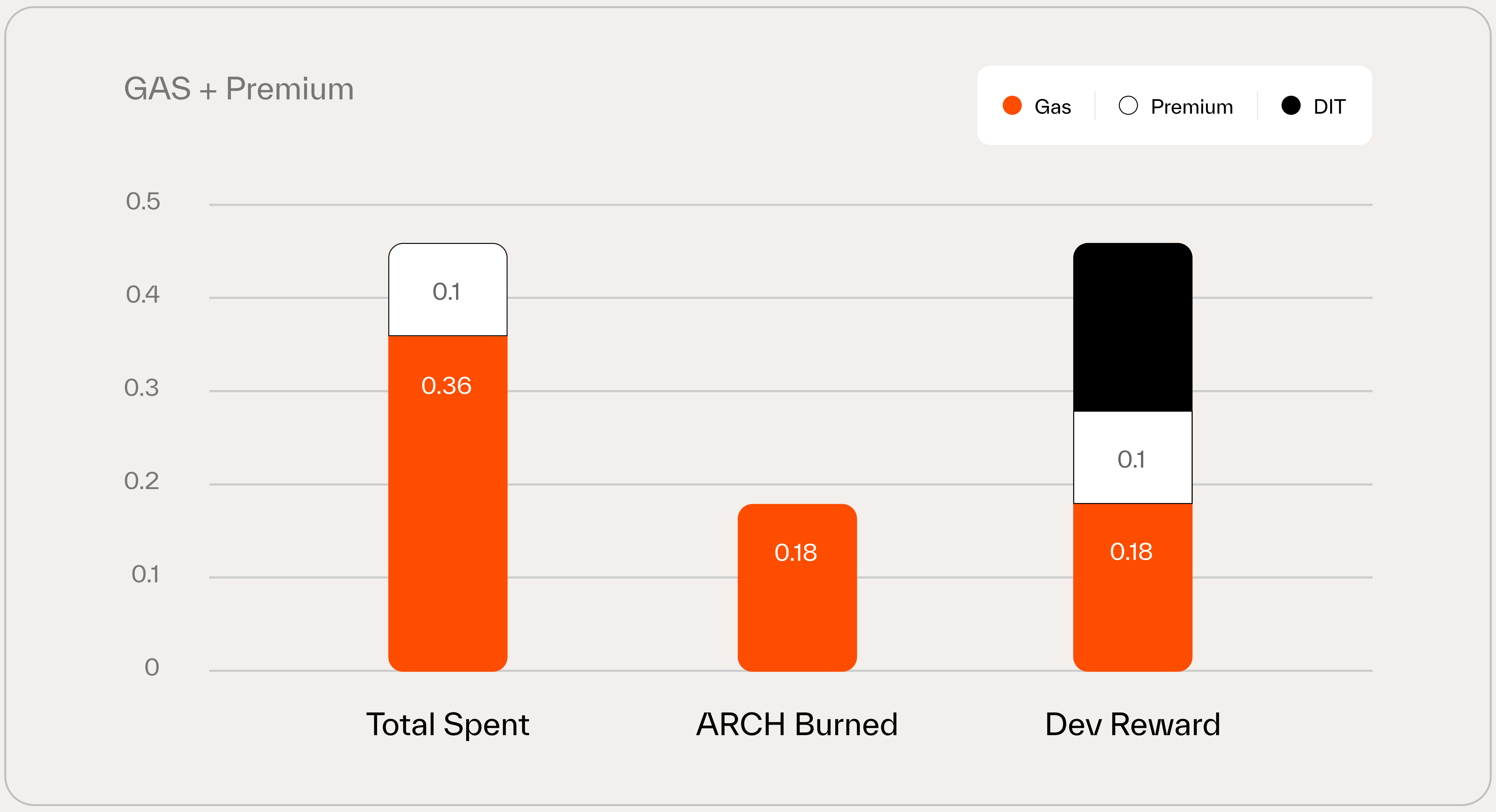
a. 400,000 x 0.000000900 (mPoG) = 0.36 ARCH spent on Gas

b. 0.1 ARCH is spent on the Premium

c. Overall, the user spends 0.46 ARCH

   i. 0.18 ARCH gets burned

   ii. up to 0.46 ARCH is earned by the creator of 'X'



B. An oracle contract 'Q' with an avg tx gas of 9,000 gets queried 2,000,000 times per month, and sets a contract premium of 0.01 ARCH

a. 9,000 x .0000009 = 0.00081 ARCH spent on Gas per interaction
b. 0.01 ARCH is spent on the Premium
c. Overall query costs 0.01081 ARCH
    i. 0.000405 ARCH gets burned per query
    ii. Up to 0.01081 ARCH is earned by the oracle
d. Times 2M queries per month
    i. 1,620 ARCH spent on Gas
    ii. 20,000 ARCH spent on Contract Premium payments
    iii. 810 ARCH burned

Appendix C

Solution Simulations

In the below parameter chart, the orange boxes represent parameters that can be altered through Community governance. The blue boxes are truths, often derived from the parameters (or the Avg tx Gas from Terra Blockchain data) that are useful in the following simulations. Note that we will show simulations with a fixed time of 6s/block, but time itself is an independent variable, and the formulas (such as MaxGas) have it dynamically factored in.

The following are hypothetical scenarios reflecting estimated parameter values for illustrative purposes only. These parameter values may not be consistent with actual parameter values used on the Archway protocol and these scenarios should not be relied upon other than as hypothetical examples.

Initial Supply	**1,000,000,000**
1 GWAY =	0.000000001
mPoG (GWAY)	900
Avg Premium (ARCH)	0.05
MaxΔPoG	5.00%
Inflation	10%
MintR	3.17
$MaxGas_{max}$	600,000,000
Tax	10%
Avg Tx Gas	480,000
$GTmPoG_{dev}$	50.00%
DIT	25.00%

The following formulas can be used for running simulations with blockchain data, and are useful in quantifying the rewards for dapps as well as the expenses for congesting the chain.

$$MaxGas = \begin{cases} \log_4 (2+t) \times 200000000 & t \leq 62 \\ 600000000 & t > 62 \end{cases}$$

$$FP_n = \frac{GasB_n}{MaxGasB_n}$$

$$MintB_n = \frac{t_n \times Supply_{(n-1)} \times Inflation}{31557600}$$

$$PoG_n = MAX(mPoG, (PoG_{(n-1)} + (0.5 - FP_{(n-1)}) \times (-2 \times \Delta PoG_{max} \times PoG_{(n-1)})))$$

$$Burn_n = \left(\frac{GasB_n \times mPoG}{2} \right) + (GasB_n \times (PoG_n - mPoG) \times (1 - GTmPoG))$$

$$DITB_n = (1 - tax) \times Mint_n \times DIT$$

$$TotalFee_n = GasB_n \times PoG_n + PremiumB_n$$

$$DevRewards_n = \begin{cases} TotalFee_n - Burn_n + \frac{DITB_n \times FP_n}{OFP_n}, & FP < OFP \\ TotalFee_n - Burn_n + DITB_n, & FP \geq OFP \end{cases}$$

$$SpamCost_n = max(0, TotalFee_n - DevRewards_n)$$

These formulas, as subject to the parameters set, can be used to test the parameters in place. If FP is to be set for comparison, then any individual parameter can be (and has been) set to being an independent variable.

The parameters set above were settled upon, but are never final, as they can be adjusted through the Archway Community's governance. Using these parameters we can run tokenomic simulations with variable TPS (as a means of getting variable FP) and receive data outputs for DevRewards and SpamCost.

Simulation 1

10 minute Spam Attack

Assume:

- 6s block times
- 480000 Avg Gas/Tx
- 0.05 ARCH PremiumC$_{avg}$

Block	Max Gas	TPS	FP	PoG	Total Fee	Mint	Burn	DITB	Dev Rewards	Spam Cost
1	300,000,000	104	100%	900	301	19	135	4.28	170	131
2	300,000,000	104	100%	945	314	19	142	4.28	177	137
3	300,000,000	104	100%	992	328	19	149	4.28	184	144
4	300,000,000	104	100%	1,041	343	19	156	4.28	191	152
5	300,000,000	104	100%	1,093	359	19	164	4.28	199	159
6	300,000,000	104	100%	1,148	375	19	172	4.28	207	168
7	300,000,000	104	100%	1,205	392	19	180	4.28	216	176
8	300,000,000	104	100%	1,265	410	19	189	4.28	225	185
9	300,000,000	104	100%	1,328	429	19	199	4.28	234	195
10	300,000,000	104	100%	1,394	449	19	209	4.28	244	205
11	300,000,000	104	100%	1,464	470	19	219	4.28	255	215
12	300,000,000	104	100%	1,537	491	19	230	4.28	266	226
13	300,000,000	104	100%	1,613	514	19	242	4.28	277	237
14	300,000,000	104	100%	1,694	539	19	254	4.28	289	249
15	300,000,000	104	100%	1,778	564	19	266	4.28	302	262
16	300,000,000	104	100%	1,867	590	19	280	4.28	315	275
17	300,000,000	104	100%	1,960	618	19	294	4.28	329	289
18	300,000,000	104	100%	2,057	647	19	308	4.28	344	304
19	300,000,000	104	100%	2,160	678	19	323	4.28	359	319
20	300,000,000	104	100%	2,268	710	19	340	4.28	375	335
21	300,000,000	104	100%	2,381	744	19	357	4.28	392	352
22	300,000,000	104	100%	2,499	780	19	374	4.28	410	370
23	300,000,000	104	100%	2,624	817	19	393	4.28	428	389

24	300,000,000	104	100%	2,755	856	19	413	4.28	448	408
25	300,000,000	104	100%	2,892	897	19	433	4.28	469	429
26	300,000,000	104	100%	3,036	941	19	455	4.28	490	450
27	300,000,000	104	100%	3,187	986	19	477	4.28	513	473
28	300,000,000	104	100%	3,346	1,033	19	501	4.28	537	497
29	300,000,000	104	100%	3,513	1,083	19	526	4.28	562	522
30	300,000,000	104	100%	3,688	1,136	19	552	4.28	588	548
31	300,000,000	104	100%	3,872	1,191	19	580	4.28	615	576
32	300,000,000	104	100%	4,065	1,249	19	609	4.28	644	604
33	300,000,000	104	100%	4,268	1,309	19	639	4.28	675	635
34	300,000,000	104	100%	4,480	1,373	19	671	4.28	706	667
35	300,000,000	104	100%	4,704	1,440	19	704	4.28	740	700
36	300,000,000	104	100%	4,938	1,510	19	740	4.28	775	735
37	300,000,000	104	100%	5,184	1,584	19	776	4.28	812	772
38	300,000,000	104	100%	5,442	1,661	19	815	4.28	851	811
39	300,000,000	104	100%	5,714	1,743	19	856	4.28	891	851
40	300,000,000	104	100%	5,999	1,828	19	898	4.28	934	894
41	300,000,000	104	100%	6,297	1,917	19	943	4.28	979	939
42	300,000,000	104	100%	6,611	2,011	19	990	4.28	1,026	986
43	300,000,000	104	100%	6,941	2,110	19	1,039	4.28	1,075	1,035
44	300,000,000	104	100%	7,287	2,214	19	1,091	4.28	1,127	1,087
45	300,000,000	104	100%	7,650	2,323	19	1,146	4.28	1,181	1,141
46	300,000,000	104	100%	8,031	2,437	19	1,203	4.28	1,238	1,198
47	300,000,000	104	100%	8,432	2,557	19	1,263	4.28	1,298	1,258
48	300,000,000	104	100%	8,852	2,682	19	1,326	4.28	1,361	1,321
49	300,000,000	104	100%	9,293	2,815	19	1,392	4.28	1,427	1,387
50	300,000,000	104	100%	9,756	2,953	19	1,461	4.28	1,497	1,457
51	300,000,000	104	100%	10,242	3,099	19	1,534	4.28	1,569	1,530
52	300,000,000	104	100%	10,753	3,252	19	1,610	4.28	1,646	1,606
53	300,000,000	104	100%	11,289	3,412	19	1,691	4.28	1,726	1,686
54	300,000,000	104	100%	11,851	3,581	19	1,775	4.28	1,810	1,771
55	300,000,000	104	100%	12,442	3,758	19	1,863	4.28	1,899	1,859
56	300,000,000	104	100%	13,062	3,944	19	1,956	4.28	1,992	1,952
57	300,000,000	104	100%	13,713	4,139	19	2,054	4.28	2,089	2,049

58	300,000,000	104	100%	14,397	4,343	19	2,156	4.28	2,192	2,152
59	300,000,000	104	100%	15,114	4,558	19	2,263	4.28	2,299	2,259
60	300,000,000	104	100%	15,867	4,784	19	2,376	4.28	2,412	2,372
61	300,000,000	104	100%	16,658	5,021	19	2,495	4.28	2,530	2,490
62	300,000,000	104	100%	17,489	5,269	19	2,619	4.28	2,655	2,615
63	300,000,000	104	100%	18,360	5,530	19	2,750	4.28	2,785	2,745
64	300,000,000	104	100%	19,275	5,805	19	2,887	4.28	2,922	2,882
65	300,000,000	104	100%	20,236	6,092	19	3,031	4.28	3,066	3,026
66	300,000,000	104	100%	21,244	6,394	19	3,182	4.28	3,217	3,177
67	300,000,000	104	100%	22,303	6,711	19	3,340	4.28	3,376	3,336
68	300,000,000	104	100%	23,415	7,044	19	3,507	4.28	3,542	3,502
69	300,000,000	104	100%	24,582	7,394	19	3,681	4.28	3,717	3,677
70	300,000,000	104	100%	25,807	7,761	19	3,865	4.28	3,900	3,861
71	300,000,000	104	100%	27,093	8,146	19	4,057	4.28	4,093	4,053
72	300,000,000	104	100%	28,444	8,551	19	4,260	4.28	4,295	4,255
73	300,000,000	104	100%	29,861	8,975	19	4,472	4.28	4,507	4,468
74	300,000,000	104	100%	31,349	9,421	19	4,695	4.28	4,730	4,691
75	300,000,000	104	100%	32,912	9,889	19	4,929	4.28	4,964	4,925
76	300,000,000	104	100%	34,552	10,380	19	5,175	4.28	5,210	5,170
77	300,000,000	104	100%	36,274	10,896	19	5,432	4.28	5,468	5,428
78	300,000,000	104	100%	38,082	11,438	19	5,703	4.28	5,739	5,699
79	300,000,000	104	100%	39,980	12,006	19	5,987	4.28	6,023	5,983
80	300,000,000	104	100%	41,973	12,603	19	6,286	4.28	6,321	6,282
81	300,000,000	104	100%	44,065	13,229	19	6,599	4.28	6,635	6,595
82	300,000,000	104	100%	46,261	13,887	19	6,928	4.28	6,964	6,924
83	300,000,000	104	100%	48,567	14,578	19	7,273	4.28	7,309	7,269
84	300,000,000	104	100%	50,987	15,303	19	7,636	4.28	7,671	7,632
85	300,000,000	104	100%	53,528	16,064	19	8,016	4.28	8,052	8,012
86	300,000,000	104	100%	56,196	16,863	19	8,416	4.28	8,451	8,412

87	300,000,000	104	100%	58,997	17,702	19	8,835	4.28	8,871	8,831
88	300,000,000	104	100%	61,937	18,583	19	9,276	4.28	9,311	9,271
89	300,000,000	104	100%	65,024	19,507	19	9,738	4.28	9,774	9,734
90	300,000,000	104	100%	68,265	20,478	19	10,223	4.28	10,259	10,219
91	300,000,000	104	100%	71,668	21,497	19	10,733	4.28	10,768	10,729
92	300,000,000	104	100%	75,240	22,567	19	11,268	4.28	11,303	11,264
93	300,000,000	104	100%	78,989	23,690	19	11,829	4.28	11,865	11,825
94	300,000,000	104	100%	82,926	24,869	19	12,419	4.28	12,455	12,415
95	300,000,000	104	100%	87,059	26,107	19	13,038	4.28	13,073	13,034
96	300,000,000	104	100%	91,398	27,407	19	13,688	4.28	13,723	13,684
97	300,000,000	104	100%	95,954	28,771	19	14,370	4.28	14,406	14,366
98	300,000,000	104	100%	100,736	30,204	19	15,086	4.28	15,122	15,082
99	300,000,000	104	100%	105,757	31,707	19	15,838	4.28	15,874	15,834
100	300,000,000	104	100%	111,028	33,286	19	16,627	4.28	16,663	16,623

So if the blockchain was spammed for 10 minutes (100 blocks assuming 6 seconds per block):

- 347,541 ARCH, or 0.0347% of the TGE supply, would be burned
    - If the attack lasted for another 10 minutes, this would rise to 45,358,385 or over 4.5% of the total TGE supply
- The attacker would experience a net cost of 347,113 ARCH
- The average tx fee for a non-malicious user making a single computational transaction at the end of this would be 53 ARCH
- It would take 96 blocks (nearly 10 more minutes) of inactivity to get the PoG back down to mPoG of 900 GWAY.

Now though this may seem extreme to some, this is with notably lower change in gas price and block size than ethereum, and works incredibly smoothly with lower usage.

Furthermore, if congestion becomes common, Archway Community's governance can raise the MaxGas limit as well as lower the mPoG.

Simulation 2

2 minute 15 TPS

Block	Max Gas	TPS	FP	PoG	Total Fee	Mint	Burn	Net Mint	Net Inflation
1	300,000,000	15	14%	900	43	19	19	-0.42	-0.22%
2	300,000,000	15	14%	900	43	19	19	-0.42	-0.22%
3	300,000,000	15	14%	900	43	19	19	-0.42	-0.22%
4	300,000,000	15	14%	900	43	19	19	-0.42	-0.22%
5	300,000,000	15	14%	900	43	19	19	-0.42	-0.22%
6	300,000,000	15	14%	900	43	19	19	-0.42	-0.22%
7	300,000,000	15	14%	900	43	19	19	-0.42	-0.22%
8	300,000,000	15	14%	900	43	19	19	-0.42	-0.22%
9	300,000,000	15	14%	900	43	19	19	-0.42	-0.22%
10	300,000,000	15	14%	900	43	19	19	-0.42	-0.22%
11	300,000,000	15	14%	900	43	19	19	-0.42	-0.22%
12	300,000,000	15	14%	900	43	19	19	-0.42	-0.22%
13	300,000,000	15	14%	900	43	19	19	-0.42	-0.22%
14	300,000,000	15	14%	900	43	19	19	-0.42	-0.22%
15	300,000,000	15	14%	900	43	19	19	-0.42	-0.22%
16	300,000,000	15	14%	900	43	19	19	-0.42	-0.22%
17	300,000,000	15	14%	900	43	19	19	-0.42	-0.22%
18	300,000,000	15	14%	900	43	19	19	-0.42	-0.22%
19	300,000,000	15	14%	900	43	19	19	-0.42	-0.22%
20	300,000,000	15	14%	900	43	19	19	-0.42	-0.22%

So if the blockchain was utilized at this level for 2 minutes (20 blocks assuming 6 seconds per block):

- 389 ARCH, or 3.24 ARCH/s, is burned
  - The mint rate is currently 3.17%, so this makes it net deflationary, despite Stakers still sharing 7.5% inflation, and devs an additional 2.5%
- The PoG never deviates above the mPoG
- This moderate and stress-less usage would still be utilizing 7M Gas/s, which is much higher than Ethereum's 1.25M Gas/s.
- In this 2 minute sample, developers earned 564 ARCH, or 4.7 ARCH/s.

Simulation 3

2 minute 3 TPS

Block	Max Gas	Tx/Sec	FP	Mint	Burn	Net Mint	Net Inflation	DITB	Dev Rewards	Treasury
1	300,000,000	2	2%	19	3	16.43	8.63%	4.28	6	1.69
2	300,000,000	2	2%	19	3	16.43	8.63%	4.28	6	1.69
3	300,000,000	2	2%	19	3	16.43	8.63%	4.28	6	1.69
4	300,000,000	2	2%	19	3	16.43	8.63%	4.28	6	1.69
5	300,000,000	2	2%	19	3	16.43	8.63%	4.28	6	1.69
6	300,000,000	2	2%	19	3	16.43	8.63%	4.28	6	1.69
7	300,000,000	2	2%	19	3	16.43	8.63%	4.28	6	1.69
8	300,000,000	2	2%	19	3	16.43	8.63%	4.28	6	1.69
9	300,000,000	2	2%	19	3	16.43	8.63%	4.28	6	1.69
10	300,000,000	2	2%	19	3	16.43	8.63%	4.28	6	1.69
11	300,000,000	2	2%	19	3	16.43	8.63%	4.28	6	1.69
12	300,000,000	2	2%	19	3	16.43	8.63%	4.28	6	1.69
13	300,000,000	2	2%	19	3	16.43	8.63%	4.28	6	1.69
14	300,000,000	2	2%	19	3	16.43	8.63%	4.28	6	1.69
15	300,000,000	2	2%	19	3	16.43	8.63%	4.28	6	1.69
16	300,000,000	2	2%	19	3	16.43	8.63%	4.28	6	1.69
17	300,000,000	2	2%	19	3	16.43	8.63%	4.28	6	1.69
18	300,000,000	2	2%	19	3	16.43	8.63%	4.28	6	1.69
19	300,000,000	2	2%	19	3	16.43	8.63%	4.28	6	1.69
20	300,000,000	2	2%	19	3	16.43	8.63%	4.28	6	1.69

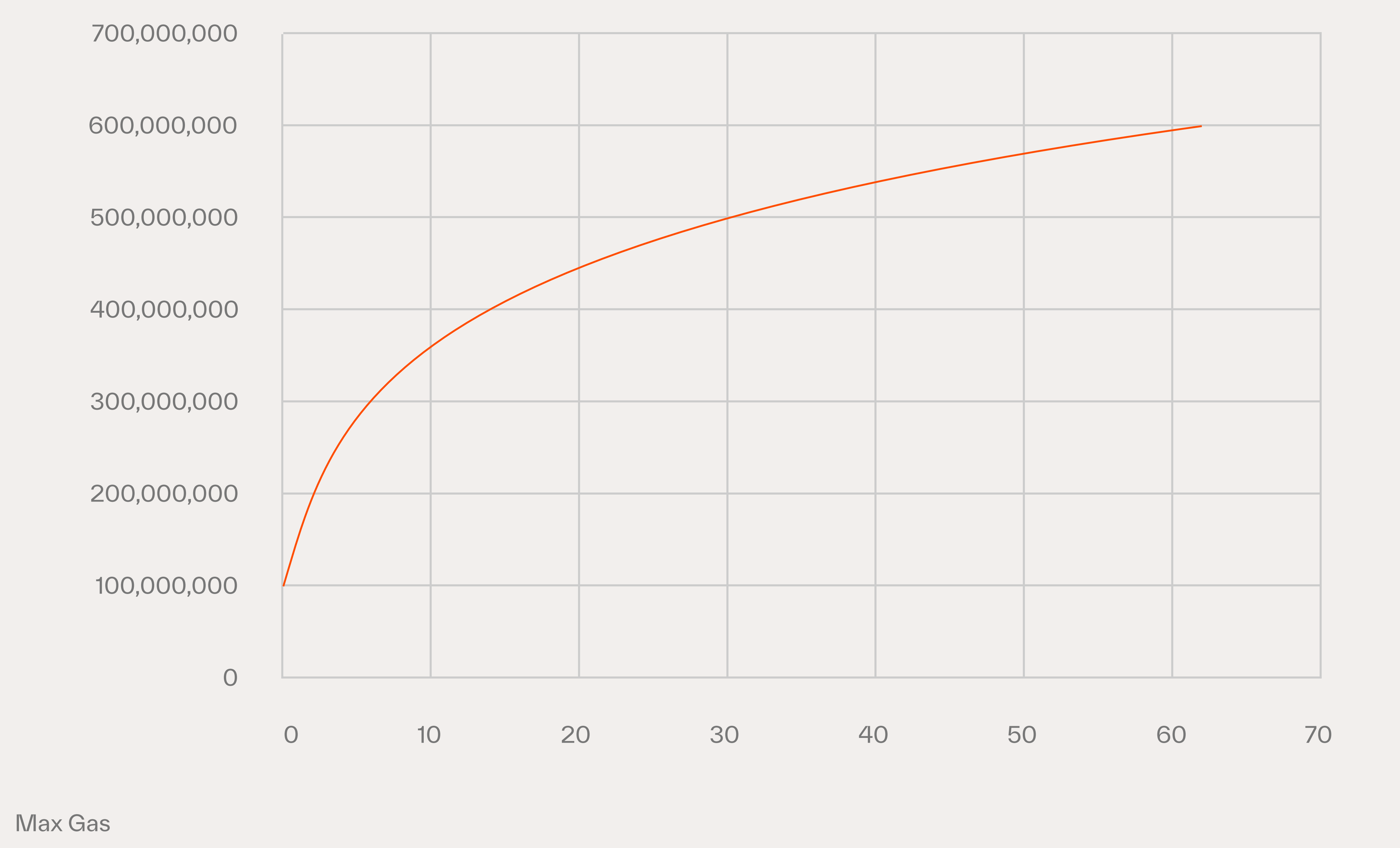
So if the blockchain was utilized at this level for 2 minutes (20 blocks assuming 6 seconds per block):

- 52 ARCH, or 0.43 ARCH/s, is burned
  - The mint rate is 3.17 ARCH/s, making the net mint rate 2.74 ARCH/s, and the Net Inflation rate 8.63%

- Since this usage is less than the OFP, there is excess DITB not distributed to dapps, as they would earn over 100% of the fees spent on their contracts if it were.
    - Over these 2 minutes, 33.8 ARCH is rolled over into the Dapp Treasury, which is to be used for dapp bonuses, incentivizing testnets and hackathons, and additional developer onboarding expenses.
- This light and stress-less usage would be utilizing 160k Gas/s, which is much lower than Ethereum's 1.25M Gas/s.
- In this 2 minute sample, developers earned rewards equal to 100% of the fees spent using their contracts.

Appendix D

Max Gas



Since blocktime is not fixed in Tendermint's consensus model, Archway will use the formula:

$$f(t) = \begin{cases} \log_4 (2+t)*200000000 & t \leq 62 \\ 600000000 & t > 62 \end{cases}$$

This formula for MaxGas is governed by the Archway Community.

A logarithmic rate limit enables the chain to be protected without missing blocks when overloaded, while still incentivizing and optimizing for fast blocktimes. With this flexible MaxGas parameter, the Archway protocol will allow for greater TPS the faster the blocktime.

Let's compare 20 seconds of chain activity with 1, 5, and 10 second blocktimes.

1	5	10
158,496,250		
158,496,250		
158,496,250	280,735,492	
158,496,250		
158,496,250		358,496,250
158,496,250		
158,496,250		
158,496,250	280,735,492	
158,496,250		
158,496,250		
158,496,250		
158,496,250		
158,496,250	280,735,492	
158,496,250		
158,496,250		358,496,250
158,496,250		
158,496,250		
158,496,250	280,735,492	
158,496,250		
158,496,250		
3,169,925,001	1,122,941,969	716,992,500

Though the MaxGas is larger on longer blocks, having shorter blocks allows for more computation to take place on the blockchain.

BlockTime	MaxGasB	MaxGas/s
1	158,496,250	158,496,250
2	200,000,000	100,000,000
3	232,192,809	77,397,603
4	258,496,250	64,624,063
5	280,735,492	56,147,098
6	300,000,000	50,000,000
7	316,992,500	45,284,643
8	332,192,809	41,524,101
9	345,943,162	38,438,129
10	358,496,250	35,849,625

Under the current formula, If the Archway chain ran at a 2-second average block time, it could process twice as much computation as if it ran at a 6-second blocktime, all while the proper amount of ARCH is being emitted through the x/mint module.

Glossary

- gway = 0.000000001 ARCH (conversion required)
- PoG = Price of Gas (in ARCH, conversion not required)
  - PoG_n = *Price of Gas for* $Block_n$
  - *mPoG =* ***parameter*** *for minimum Price of Gas, in ARCH*
  - *GTmPoG = the amount of gas spent greater than what it would've been if at mPoG*
  - $GTmPoG_{dev}$ = ***parameter*** *for what percent of GTmPoG goes to* Gas_{rebate}
  - ΔPoG_n = *The percent change in PoG from* $Block_{(n-1)}$ *to* $Block_n$
    - *Suggest:* PoG_{18} *=1000 GWAY, and* FP_{18} *=70%;*
      - ΔPoG_{19} *=2%;*
      - PoG_{19} *=1020 GWAY*
  - ΔPoG_{max} = ***parameter*** *for maximum change in price between blocks*

- Premium = non-Gas Price (in ARCH) charged to interact with a contract
  - PremiumC = Price (in ARCH) to interact with a specific contract
    - For contract "Q";
    - $PremiumC_Q$ *= 0.05 ARCH*
  - PremiumB = total amount paid in premiums in a specific block
    - For block "n";
    - $PremiumB_n$ *= 23.22 ARCH*

- Inflation = **parameter** for how much ARCH should be emitted
  - 10%
  - $Inflation_{net}$ *= Inflation - Burn*

- DIT = parameter for Dev Inflation Tokens; pre-tax percentage of inflation reserved for devs;
  - DITB = Amount of ARCH minted towards the DIT in a block
    - For block "n"
    - $DITB_n = (1 - tax) \times MintB_n \times DIT$
    - $DITB_n$ *= 4.09 ARCH*

- DITR = per second rate of ARCH mint for DIT
  - DITR = $\frac{(1\text{-}tax) \times DIT \times Inflation \times Supply}{31557600}$
    - For block “n”;
    - Inflation=10%; Supply=1,000,000,000 ARCH
    - $DITR_n = 0.71\ ARCH/s$

- DevRewards = total developer rewards (in ARCH)
  - DevRewards=GasR+DIT+Premium
  - DevRewardsC = total developer rewards from a specific contract interaction
    - DevRewardsC = GasCr+MIN((GasCsm/2),(DITB×GasCs÷GasBs))+PremiumC
  - DevRewardsB = total developer rewards in a specific block
    - DevRewardsB = GasBr+MIN((GasBsm/2),DITB)+PremiumB

- Gas = units of computation
  - GasC = Gas required for a specific contract
    - For Contract “Q”;
    - $GasC_Q = 480,000$
  - GasCs = amount (in ARCH) spent on a specific contract
    - GasCs = GasC×PoG
    - For Contract “Q”; PoG = 1000 gway
      - $GasCs_Q = GasC_Q \times PoG$
      - $GasCs_Q = 0.480\ ARCH$
  - GasCsm = amount of ARCH spent in GasCs when PoG = mPoG
    - GasCsm = GasC×mPoG
    - For Block “n”; PoG = 1000 gway
    - $GasCs_n = 0.480\ ARCH$
    - $GasCsm_n = 0.432\ ARCH$
  - GasCr = Gas Rebate (in ARCH) from one contract interaction
    - $GasCr = \frac{GasCsm}{2} + (PoG - mPoG) \times GasC \times GTmPoG_{dev}$
    - For Block “n”; (.432, 0.000001, 0.0000009, 480000, 50%)
      - $GasCr_n = 0.24\ ARCH$
        - *Note: while* $GTmPoG_{dev} = 50\%$*; GasCr = GasCs/2*

- BurnC = Amount of ARCH burned from one contract interaction
    - BurnC = $\frac{GasCsm}{2}$ + $(PoG - mPoG) \times GasC \times (1\text{-}GTmPoG_{dev})$
    - BurnC = $GasCs - GasCr$
        - *Note: while* $GTmPoG_{dev}$ *= 50%; BurnC = GasCr =* $\frac{GasCs}{2}$
- GasB = amount of Gas used in a specific block
    - $GasB = FP \times MaxGas$
    - *For Block "n"; FP = 20%; MaxGas = 300,000,000*
        - $GasB_n = 60{,}000{,}000$
- GasBs = amount of ARCH spent on Gas in a specific block
    - $GasBs = GasB \times PoG$
    - *For Block "n"; PoG = 944 gway*
        - $GasBs_n$ *= 56.64 ARCH*
- GasBsm = amount of ARCH spent in GasBs when PoG = mPoG
    - $GasBsm = GasB \times mPoG$
    - *For Block "n";*
        - $GasBsm_n$ *= 54 ARCH*
- GasBr = total gas rebate (in ARCH) in a block
    - $GasBr = \frac{GasBsm}{2} + (PoG\text{-}mPoG) \times GasB \times GTmPoG_{dev}$
    - *For Block "n";*
        - $GasBr_n$ *= 28.32 ARCH*
- BurnB = total amount burned (in ARCH) in a specific block
    - $BurnB = \frac{GasBsm}{2} + (PoG\text{-}mPoG) \times GasB \times (1\text{-}GTmPoG_{dev})$
    - $BurnB = GasBs - GasBr$
        - *Note: while* $GTmPoG_{dev}$ *= 50%; BurnB = GasBr =* $\frac{GasBs}{2}$

- MaxGas = Max Gas per Block
    - *For block "n";* t_n *=4.000s*
    - $MaxGas_n = 258{,}493{,}250$
- MaxGasΔt = **parameter** formula which determines MaxGas based on t
    - $MaxGas\Delta t = \log_4(2+t) \times 200{,}000{,}000$
    - $MaxGas_{max}$ = ***parameter*** *for maximum limit for MaxGas*

- Mint = Amount of ARCH tokens minted
    - *MintR = Mint Rate; ARCH/s*
        - $MintR = \frac{Inflation \times Supply}{31557600}$
    - *MintB = Amount of ARCH tokens minted in a block*
        - *For Block "n";*
        - $MintB_n = MintR \times t_n$
- FP = Fill Percentage; the percent of available gas used
    - $FP_n = \frac{GasB_n}{MaxGasB_n}$

1. *OFP = Optimal Fill Percentage, the maximum fill percentage at which GasBr+DITB=GasBs*

- t = Time in seconds
- Treasury = Amount of ARCH sent to the dapp treasury
    - $Treasury = MAX(0, (DITB \times (1 - \frac{FP}{OFP}))))$
- *Equilibrium = Point at which* $Inflation_{net} = 0$*; in tps*
    - *MintB = BurnB*
- TPS = Transactions per Second (for calculations assuming 480,000 Gas per tx)
- tax = Sum of all inflation taxes
- Supply = Total supply of ARCH

Archway

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