World Mobile Chain: A blockchain based solution to empower a sharing economy for telecommunications infrastructure

World Mobile Token Ltd.
Research Lab
British Virgin Islands
research@worldmobiletoken.com

***Abstract*—A shared economy model to deliver network infrastructure would enable improvements in efficiencies of network design and operation, as well as provide a more fluid delivery of connectivity to users of a network.**

The use of blockchain in this model enables the removal of intermediaries and a layer of cost from the delivery mechanism. It also enables the rapid expansion of the network thanks to the transparency provided by smart contracts, which allow the participants to have a provable and guaranteed rewards system. We propose a solution to the global problem that nearly half of the world is still not connected, as highlighted by the United Nations [1].

This solution aims to address the affordability issue, as well as the more efficient use of network resources, to enable connectivity to be provided in a more distributed and decentralised manner.

I. Introduction

INTERNET access is considered to be a key enabler of human rights [2] and governments around the world are committed to provide universal and affordable Internet access by 2030 [3]. There are over 1,000 mobile operators across the world [4] that have invested trillions of dollars [5] into network infrastructure. Large tech companies have been investing billions [6] [7] in attempting to reach the unconnected through the use of a number of new technological approaches [8].

However, in 2021, nearly half of the population of the world is still not connected to the Internet according to United Nations estimates. This lack of connectivity is not simply a matter of being unable to make phone calls or send messages. In the modern world, where there is a rapid shift to move the majority of services online, this digital divide [9] is causing a lack of access to basic services such as education, healthcare and commerce.

The technology to deliver wireless Internet access using 3G has been available for 20 years since its commercial launch in 2001, however, the current approach of mobile operators has meant that they have been unable to bridge the digital divide. Large tech companies have also been unable to solve the problem and, most recently, Alphabet (Google's parent company) has shut down its Loon project [10] due to it being commercially unviable.

We propose a solution to this problem by addressing key issues in the current business models of existing network operators. Existing network operators are only expected to reduce their 60% operational costs at a CAGR of just -0.21% between 2019 and 2026 [11]. Our solution is to provide affordable connectivity in rural communities that is sustainable both in terms of economics and also in terms of energy consumption. Our solution addresses both of these issues, firstly, the energy consumption of current operators constitutes between 20 – 40% of network operating costs [12] and we provide a lower power intensive architecture combined with a solar and battery solution to significantly reduce these costs. Secondly, we introduce the concept of a sharing economy, which not only has the benefit of reducing operational costs such as maintenance, security and leasing costs, but also creates a self sustaining model, as node operators become incentivised in the growth and expansion of the network and its services.

II. Sharing Economy

In this paper, we discuss the introduction of a new sharing economy model to the industry, concentrating on minimising the significant operational cost constraints faced by current operators [11]. Responsibility for operating and maintaining the network is shared with communities and local businesses, which significantly reduces the operational costs of the business. The design brings distribution and decentralisation of nodes on the network to deliver more rapid growth and more efficient allocation of network resources throughout.

The creation of this sharing economy enables lower operational costs and more efficient allocation of resources, moreover, the distributed nature of a sharing economy that is token based [13] makes the model highly scalable from a deployment perspective. Rather than relying on a centralised network operator to analyse the capacity and demand requirements of the network, which is forever in flux, the growth of the network becomes demand driven by the communities that need access. These communities and businesses become node operators, having a share in the economy and earning from providing the coverage in their region.

III. Network Overview

In order for the sharing economy to operate, a distributed network is established according to the following architecture.

A. Node Types

There are three layers of nodes in the proposed network model (World Mobile Chain):-

- Earth Nodes - provide authentication, identity, blockchain, internode communication, telecommunications services.
- Air Nodes - provide coverage and Internet access to users.
- Aether Nodes - provide the link to legacy telecommunications operators.

*1) **Earth Nodes**:* The Earth Nodes are defined as the containers of the core logic of the World Mobile Chain system. They function as the brain of the system that interconnects all the other types of nodes, and are composed of a number of software modules, communicating through the central module called The Internode API. The rest of the modules provide an authentication layer (Decentralised Identity (DID) module), a ledger layer (blockchain module), and a telecommunications layer (telecom module). The DID module provides the interface to a digital ID solution. In the blockchain module, a distributed ledger [14] records all the transactions that take place on the network. For economical and performance, but also for privacy purposes, some transaction data is segregated into the public ledger component, which is anonymised and links to the private component, that contains the full data of the transaction in an encrypted distributed ledger. The settlement of these transactions on the public ledger is done either in batches or as a single transaction depending on its priority, while the private ledger is stored in real-time. The telecom module handles the communications functions of the network. Earth Nodes can operate from anywhere in the world, however, the routing of traffic within the network has a weighting towards closer nodes to improve performance and quality of services. In the same way that Bitcoin [15] has a number of node types, the Earth Node operator may select to run different elements of the Earth Node depending on the specification of their hardware.

The Internode API is responsible for the communication between all nodes and subsystems throughout the network. The API acts as the bridge and translator between the DID module, the telecom module and the blockchain. It also provides the communication between the Earth Nodes, Air Nodes and Aether Nodes as well as interfacing with third party applications. The primary responsibilities of this module are:

- Processing user registration and authentication requests
- Financial transactions - including balance checking and making payments
- Handling service requests - requests for access to services
- Handling telecommunications events (call attempts, call started, call ended, sms sent, Internet data connection, etc.) and storing them into the blockchain
- Handling and storing Quality of Service (QoS) and other quality measurements in the blockchain
- Simplifying the complexity of the business logic to the rest of the system, calling the appropriate smart contracts and performing all the actions necessary for each one of the use cases
- Enforcing that rules and contracts set in the blockchain are followed by the telecom module

The DID module is responsible for interfacing with the decentralised digital identity solution for creation and maintenance of user digital identities.

- Identity registration
- Credential management
- Authentication

The blockchain module provides security, immutability, transparency and privacy. Key responsibilities of the blockchain:

- Financial ledger - user account balances and record of transactions
- Reward mechanism - processing of rewards for the nodes to ensure automated payments once conditions of smart contracts are met
- Distributed secure storage - of user data and metadata through public blockchain and private data vault (e.g. user aliases and telephone numbers, KYC, call logs, etc.)

The Telecommunications Module is a key module within the overall architecture, responsible for the following processes:

- Call signalling - signalling layer of the calls enabling call setup and teardown
- Media routing - media layer of the calls for voice and video communication
- Message routing - messaging layer for transmission of P2P and SMS messaging
- Service management - processing service requests
- QoS monitoring - analysis and real time recording of the network quality including Mean Opinion Score, jitter, packet loss, etc.
- Self healing network - analysis and algorithms for operating network and updating of distributed routing tables
- Distributed hash tables for nodes - node address tables required for routing

*2) **Air Nodes**:* The Air Nodes are defined as the nodes which provide the access layer. These are the nodes which provide the access to the network. Air Nodes are deployed in different hardware configurations depending on the capacity and location requirements, from a single user through to an entire community. The software module for each hardware configuration provides the same core functionality.

Each user that connects to the network first connects through an Air Node in order to access the network. This is done by the Air Node passing the user authentication details to the Earth Nodes using the Internode API. The authentication process confirms the identity of the user and the Earth Nodes respond with the account balance available for the user as well as the list of available services for the user. The Air Node meters the usage of the user through the node and sends this transaction on completion of the session back to the Earth Node. The Air Nodes provide coverage for a local area and are located in areas where connectivity is required.

*3) **Aether Nodes**:* The Aether Nodes interface with legacy telecommunications networks and handle the protocol translations, media transcoding and process the routing of traffic to these networks. Each country requires a minimum of one Aether Node in order to provide service. The Aether Node operators are required to meet local regulations and have the necessary licenses to operate the service.

IV. Node Quality Grading System

The network operates a node quality grading system which is used throughout the solution as the source of information for managing quality and incentives for node operators.

These historic quality and health check parameters include values such as local latency between nodes, jitter checks, packet loss, upload and download speed tests, node uptime and several other metrics, together with mean opinion scores.

The quality grades for each of the nodes detailing these parameters will be publicly available for the node operators and the general public, by the use of a side chain [16]. Our node grading system stores all previously scored grades for each node, identified by a hardware fingerprint, in order to calculate the “Historic Grade”, that will be used as a weight in the random selection together with “Today’s Grade”, the most recent results of the health checks and performed communications.

Any node that falls under the defined threshold for the grade will not be included in the random selection pool for the communication being handled, until those grades improve by the way of performing better on the automated background health check.

V. Incentivising the Sharing Economy

The sharing economy has been designed with a set of incentives to encourage participants to grow the network and provide coverage in areas where there is lack of coverage and good service. Our solution uses an incentive model whereby operators are rewarded for providing good quality services and increased coverage, which are the desired outcomes. At the heart of the incentive model is a utility token called World Mobile Token, which is a digital token that is issued with the purpose of allowing the participants on the network to provide a service on the network, and be rewarded accordingly for it.

A. *World Mobile Token (WMT)*

The primary role of WMT is to incentivise both token holders that want to support the operation of the network by way of delegating their WMT stake to a node operator (stakers) as well as node operators that operate their own nodes. There is a finite aggregate supply of 2 billion WMT of which only a fraction will be circulating at inception.

The network incentives can be broken down as follows:

1) Transaction Fees: Denominated in WMT and will be paid to node operators, who may in turn share the fees with participants who have staked WMTs to their nodes.

The aggregate revenues of node operators will equal the aggregate network fees on World Mobile Chain. Stakers will be able to stake their tokens to node operators of choice and will in turn be awarded a share of transaction fees.

Node operators may choose to operate independently or may compete for token holders to stake their tokens. In the case of competing for token holders, node operators are required to disclose their proposed fees per transaction as part of this selection process (operational costs). This process should in turn promote competitive resource pricing on the network: It is in the interest of the node operator to attract a large delegated stake from token holders, as the higher the total stake delegated to the node operator, the better probability of being chosen to process transactions and hence a higher potential reward.

2) Inflation Rewards: 29% of the aggregate WMT supply is allocated towards inflation rewards, which will be shared between node operators and stakers. Inflation will reduce over time ensuring higher rewards at the early stage of the network and the system will reach nil inflation in year 20. This ensures a balance between the risk and the rewards for node operators at the various stages of maturity of the network.

B. Incentives for Operating Earth Nodes

Earth Node operators are required to stake a number of tokens in order to participate in the network. The minimum number of tokens required to operate an Earth Node is a variable defined in the initial blockchain parameters as 100,000 tokens. Any future decision to change this parameter will be done in collaboration with the token holders through a vote. Token holders that do not have the required number of tokens or technical knowledge to operate a node are able to delegate their stake to an Earth Node operator and share in their rewards proportionally to their stake once the Earth Node operator's operational costs are deducted. Earth Node operational costs are publicly visible and defined by the operator when advertising their delegation pool to token holders.

Each Earth Node on the network shares the rewards of the network proportionally according to a number of factors. Firstly, rewards are earned by producing blocks and committing them to the blockchain. These blocks contain not only the financial settlement of the different uses of services of the network, but also metadata derived from it, for example the hash reference to the Call Details Record (CDR). Secondly, node operators are rewarded for their participation in providing services to users of the network such as routing of communications traffic (voice, sms, etc).

The selection mechanism of a node either to produce a block or to provide services such as routing communications requires different logic and rewards.

Node Selection

There are two types of operations that an Earth Node can be selected to perform, and there's different selection criteria for each one of these operations:

- Blockchain Operations

  For blockchain operations such as creating a digital identity or utilising tokens to use a communications service, the selection is purely based on our algorithm, similar to the proof of stake consensus algorithm Ouroboros [17].

  This algorithm takes parameters such as the node's total token stake, the historic availability and reliability, to calculate a score that will be used as a weight for a random selection of the node that we will select to create the next block to be committed to the blockchain, and hence earning the rewards associated to that operation

  This consensus algorithm will be defined in a subsequent technical paper.

- Telecommunications Operations

  The node selection criteria for these operations depends on the type of service being provided as this defines which nodes are available for the service. Earth Nodes publish which services they are providing to the rest of the network.

  The initial services provided by Earth Nodes are:-
  - Communications as a Service (CaaS) - voice and sms services
  - Network as a Service (NaaS) - Internet access services

  In the future additional services may also be provided using the same incentive structure for example Content as a Service (CtaaS) through Content Delivery Nodes or Data as a Service (DaaS) for distributed storage.

Types of Telecommunication Operations

- Communications as a Service (CaaS)

  In the case of CaaS, there are two types of communications routing operations that an Earth Node can be selected for:

  On net calls:

  Air Node1$\rightleftharpoons$Earth Node 1$\rightleftharpoons\ldots\rightleftharpoons$Earth Node N$\rightleftharpoons$Air Node 2

Off net calls:

Air Node1⇌Earth Node 1⇌. . . ⇌Earth Node N⇌Aether Node

For the selection of the Earth Nodes that will handle the routing of the communications, we will utilise intelligent routing algorithms that will ensure a minimum routing time and a minimum quality threshold in the signal, very similar to the routing algorithms used in regular voice over ip (VOIP) and message routing operations, but with several key differences.

The first filter that the Earth Nodes have to pass in terms of being available for selection, is that of a "viable routing" for the communication. For each hop that the communication has to make from one node to another, we will not be limited to selecting the single best option, but a pool of very good options, providing all the nodes that are "in the approximate route" of the call a chance to handle part of the communication.

Secondly, using parameters extracted from the historical data of each node as well as from the data generated by our automatic health check mechanism constantly running in the background of the network, the pool of possible Earth Nodes for the next hop will be filtered again, to reduce it to a set of the best performing candidates.

Finally, one random node from the possible nodes pool will be selected, to ensure a fair distribution of the generated rewards, and the process will be repeated again for each of the hops until the communication reaches its destination.

Even when we want to give node operators a fair chance to participate in each of the communications, the routing algorithm is set up to find the best routes available, which usually means a route with rather less hops than more of them. This is an extra incentive for the node operators to perform well in the different set of health and historic quality check parameters.

- Network as a Service (NaaS)

  In the case of NaaS, the node selection is defined by the coverage of the nodes. In order to have the best probability for selection to provide this service, Earth Nodes need to score higher with their network scoring metrics. They achieve a higher weighting for selection if they are in close proximity to the originating Air Nodes and their network latency is lower.

Earth Node Rewards

Earth Nodes will be rewarded appropriately for each of the types of service that they will provide, and also for block production.

When a user utilises one of the services provided by the node operators, there may be several nodes involved. As an example, on a telephone call, Earth Nodes providing the routing of the call, have two key nodes: origin node and destination node. These two are performing additional work in the routing, as they are the ones responsible for voice encoding and decoding. The result is that all the nodes will be equally rewarded using the fee extracted from the user's consumption of the service, except for those two, which will have a higher reward.

Similarly, on other types of services offered in the network, the rewards will be shared between the nodes selected in the service execution, with extra rewards for the ones performing a higher workload.

All these services will generate transactions and data that need to be settled or stored in both the settlement layer (Cardano's public blockchain) and in the WMC layer (World Mobile Chain, effectively working as a side chain of Cardano). These generated transactions will be batched or grouped in blocks, and using WMC's consensus protocol, closely based on Cardano's Ouroboros protocol [17], an Earth Node will be chosen to produce the block. Producing the block means that the Earth Node will settle in the main chain the financial information and possible metadata or hashes related to all the transactions inside the block, as well as any private encrypted data that needs to be stored in WMC's sidechain.

The rewards for the production of the block will consist of a fixed amount of WMTs that will be deducted from the total service fees included in the block.

C. Incentives for Operating Air Nodes

The main aim for providing the incentives for Air Node Operators is to provide Internet access in areas that currently do not have service. The incentives are directly proportional to the amount of usage of the network. Air Nodes may also provide additional capacity in areas that already have service and therefore, this behaviour is a positive outcome for the network and hence should be rewarded.

Each Air Node on the network shares the rewards on the network proportionally according to a number of factors. Firstly, rewards are earned by providing a service - for providing access and reporting back the quality of adjacent nodes. Secondly, rewards are earned based on the volume of users and traffic that are processed by the node. Finally, extra rewards are earned based on the QoS measured using the metrics as defined under the Node Quality Grading System. The QoS metrics are refined with a quality score provided by users of the network. This enables a more flexible provision of services as some users may be more tolerant of low bandwidth services or intermittent services if it enables them to get Internet access in remote areas which are limited.

Air Node Rewards

The Air Nodes rewards are distributed using the local stable currency according to the local regulations in the country the node is located. Air Node rewards are a proportion of the overall revenue in the country location of the Air Node and scale up to 10% as volumes on the network increase.

Similarly to the method implemented with Earth Nodes the rewards are distributed to the Air Nodes according to the proportion of the service provided by each node in delivery of the service. For example in a village node which has provided delivery of Internet access to its users, there may be a large Air Node in a nearby town, as well as multiple mesh Air Nodes in between the village and the town that work together to deliver the service. Each earn their share in the rewards according to their role in service delivery.

D. Incentives for Operating Aether Nodes

Aether Nodes earn rewards based on the volume of traffic processed by the node. These rewards are distributed using the local stable currency according to the local regulations in the country the node is located. The minimum number of tokens required to operate an Aether node is a variable defined in the initial blockchain parameters as 1,000,000 tokens. Any future decision to change this parameter will be done in collaboration with the token holders through a vote.

VI. Users of the Network

A user of the network is defined as an individual that utilises services provided on the network. These services are varied and initially constitute a set of communications services including Internet access, media and messaging communications. The use of services on the network requires a transaction fee to be spent in the digital token. Therefore the utility of the token increases as more users join the network. As additional services are provided this increases the demand and utility of the token. Additionally, users are able to transfer their digital tokens peer to peer which also enables sharing and distribution of this network utility to other users.

A new wallet is automatically created for every user that registers on the network and is done using a method which does not expose casual users to the complexities of the blockchain. This simplicity for the users will enable rapid adoption of the technology as this has been identified as one of the reasons blockchain has met resistance in utilisation

- due to the complexity of its use [18].

Users will be able to purchase top-ups for the service using the same existing method and infrastructure that they are accustomed to with local currency such as prepaid vouchers and etop-ups through local stores. This facilitates the distribution and on-boarding of customers to the service. The facility to bridge the usage of the service to tokens will be built into the settlement layer of the network through services provided by Earth Node operators.

VII. Use of Blockchain

We propose the use of blockchain as the means to operate this sharing economy [19].

There are a number of factors that have led to using blockchain as part of the proposed solution which are described below.

A. *Transparency*

The telecommunications industry has a number of significant flaws that result in inefficiency in its operation [20]. Our solution records key information and makes this transparent and easily accessible with the use of blockchain technology which improves the ability to manage the network and to enable a self healing network [21] to function.

B. *Privacy*

One of the principles of The Contract for the Web is to respect and protect people's fundamental online privacy and data rights [22]. This has been highlighted as an issue within the telecommunications industry [23] as mobile operators are looking for ways to create new revenue streams. By utilising blockchain in our technology stack, we are putting privacy as a fundamental feature for the users. User data is protected through the use of public/private key infrastructure, as their metadata will be secured in distributed vaults throughout the network, allowing synchronisation between the different devices owned by the user.

C. *Immutability*

According to a report [24], one of the most damaging causes of fraud in the telecommunication industry is the lack of inter-carrier trust. By introducing the blockchain to the equation and bringing a trustless immutable solution [25] to the provision of services, it enables the trust to be regained between all parties and for fraud to be reduced and potentially prevented. This in effect brings cost savings and reductions to the operation and can be passed on to the end users.

D. *Faster Settlement*

In order to operate an efficient sharing economy, the solution that has fast settlement time will rapidly build trust with users as they are no longer reliant on bureaucratic processes or inefficient banking services to deliver the rewards for operating the network. In conjunction with the immutability described previously, this builds trust with the users as they are able to see the immediate benefit of operating the nodes on the network. This encourages more rapid adoption and growth of the network as users begin to self promote and refer the solution to others.

E. *Security*

Vulnerabilities in telecom protocols have been known for many years [26] [27]. Blockchain has been identified as a way to overturn the cyber security paradigm as discussed by [28] due to its features of transparency, immutability and privacy, described above.

VIII. Use of Smart Contracts

In our aim to increase efficiency of the communications network, we have identified that the use of smart contracts [29] [30] is an important part of the strategy. There have been a number of studies into the use and benefits of smart contracts in telecommunications [31] [32] [33] [34] and it is our intention to demonstrate their potential in our solution. It can be quite a challenge for legacy telecommunications operators to incorporate blockchain and smart contracts into their business as it fundamentally disrupts their decades old business models which operate on a centralised infrastructure. Our proposed solution requires the business to be established based on a sharing economy that has blockchain and smart contracts at the very foundation of the business.

The potential efficiencies gained with the use of smart contracts [33] include:-

- Time savings - Transaction time is reduced from days to near instantaneous.
- Cost removal - Administrative overhead and cost of intermediaries are reduced or eliminated.
- Enhanced data quality - Data accuracy is maintained during all transactions.
- Reduced risk - Tampering, fraud and cyber-crime are reduced.
- Increased trust - Shared processes and record-keeping are visible to all concerned parties.
- Reduction/elimination of disputes - Absolute transparency is established as the process executes

These efficiencies equate to a cheaper and faster service bringing overall cost savings and improved scalability as well as better reliability. The ultimate beneficiaries of these improvements are the end users as the service becomes more affordable and enables enhanced coverage to more remote areas.

In terms of the user experience, if users are exposed to a frictionless experience when in contact with the network operator, they inherently become much happier customers. By reducing the amount of administration and bureaucracy in processes such as registration and subsequent authentication through a digital ID, the users are able to quickly access services securely.

The end result for users is that there is a faster service, more accurate billing, transparent information on what they will be charged, less fraud and reduced cost.

IX. Selection of Blockchain

The blockchain module of the Earth node interfaces with a blockchain that satisfies the requirements as detailed in the previous sections. In our solution, Cardano [35] has been selected with its novel Proof of Stake consensus mechanism Ouroboros [17] to provide the settlement layer and its smart contract platform Plutus [36] that provides the functionality for operating the sharing economy.

The enablement of native tokens [37] on Cardano results in a more cost effective smart contract platform with a more efficient network resource model, opening up a better approach to delivery of the sharing economy model.

Although not in the scope of this paper, below is a summary of the key considerations, advantages and benefits of selecting Cardano:-

- Decentralised and open source
- High assurance code - same level of scientific rigour as mission critical systems
- Peer reviewed academic research
- Fast transaction speeds and low transaction fees
- Formally verified Proof of Stake consensus
- The protocol is designed to protect users' privacy rights while taking into account the needs of regulators - a critical factor in telecommunications networks which is a regulated industry
- Focus on Africa as a first territory of deployment for their solutions

X. Digital Identity

Digital identity has the potential to unlock economic value globally, equivalent to 3 to 13 percent of GDP by 2030 [38]. In addition, the use of a digital identity for the telecommunications industry addresses a number of industry problems.

The telecommunication industry is vulnerable to fraud [39] through weak security in the onboarding process. Subscriber fraud is one of the top 5 causes and is one of the fastest growing and most prevalent types of fraud that telecom operators face today. Identity-related fraud accounted for US$29 billion in losses in this report [39]. This issue is addressed in our solution with the introduction of a decentralised digital identity provided to each user and node operator.

The solution that has been selected for the digital identity is Atala Prism [40] which is powered by Cardano [35].

"Cardano provides Decentralized Public Key Infrastructure (DPKI) which is key to enabling records that can be instantly verified by anyone and anywhere. DKPI enables everyone to create or anchor cryptographic keys on the blockchain in a tamper-proof and chronologically ordered way. These keys are used to allow others to verify digital signatures, or encrypt data to the respective identity holder. DPKI is an enabler for verifiable credentials. The Cardano blockchain is ideal for anchoring digital identities as it is highly secure and designed for long-term sustainability." [35]

XI. Inflation Mechanics

The rate of monthly inflation is calculated as the initial rate of inflation divided by the time since launch + 1. The initial rate of inflation is 11.41% p.a. (relative to aggregate supply) and set as such to target a 2bn aggregate WMT supply in year 20. Total token inflation over a 20-year period represents 29% of the aggregate WMT supply.

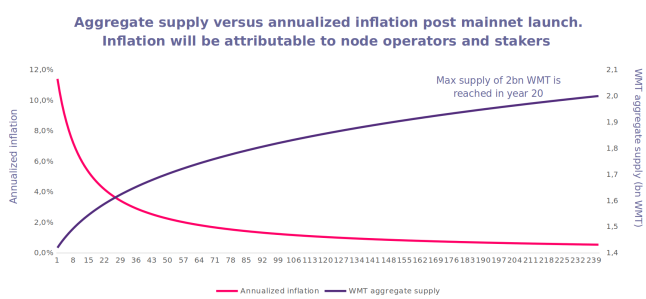

Fig. 1. Monthly inflation vs Supply

XII. Token Distribution

WMTs will be distributed as follows:

- *Private Sale 2.5%*
  The private sale round for WMT is taking place in Q2 2021 to a select number of accredited private investors. Private sale tokens are locked for the first 9 months following the public sale. Private sale tokens will be staked automatically and are eligible for early staking rewards and inflation rewards.

TABLE I
WMTs distribution

Distribution		Lockup terms (months)	
Group	Percentage	Initial Lockup	Monthly Unlocks
Private Sale	2.5%	9	none
Public Sale	10%	none	
Incentive Rewards	3%	none	
Early Staking Rewards	2.5%	none	
Advisors	5.9%	12	24
Co-founders and Team	19.25%	18	24
Partnerships	7.85%	12	24
WM Community Fund	2%	24	48
WM Operations Fund	18%	6	72
Node Operators/Staking	29%	none	

- *Public Sale 10%*
  The public sale in Q2 2021 is aimed at participants who wish to secure the network by operating nodes or through staking. Public sale tokens have no lockups and are eligible for early staking rewards.

- *Incentive Rewards 3.0%*
  WMT allocated to early incentive rewards are reserved for referrals as well as additional early staking rewards should there be any delay in the launch of mainnet.

- *Early Staking Rewards 2.5%*
  World Mobile envisages a 6-month period from the public sale to the launch or mainnet. Tokens have been set aside as early staking rewards to provide the incentives needed to ensure node operators and stakers are ready to transition to securing mainnet upon launch.

- *Advisors 5.9%*
  Advisory tokens which are allotted for strategic work done in legal, technical, and business efforts to advance the adoption of World Mobile Chain. The tokens are unlocked evenly over 24 months, after a 12-month lockup period.

- *Co-founders & Team 19.25%*
  Team tokens are retained for the founders and the core team of World Mobile. The project has been running for over 3 years since conception and includes a successful

proof-of-concept in Tanzania. Although the mainnet is being launched in Q4 2021, the contributions of the founders and the team that have been working on World Mobile Chain has been crucial to releasing the first version and initial deployment of the software and hardware enabling the network. The team will continue to work on World Mobile Chain along with the greater community.

- *Partnerships 7.85%*
  Partnership tokens have been set aside to offer the possibility to strike future deals with key partners who may be able to offer key strategic assistance to furthering the adoption and development of the protocol.

- *WM Community Fund 2.0%*
  Community tokens will be used as grants to support unconnected communities to become part of the network.

- *WM Operations Fund 18.0%*
  Tokens allocated to the operations fund will support parts of the future roll-out of the physical network, over a 6-year period.

- *Node Operators/Staking 29.0%*
  See earlier section.

XIII. Conclusion

We have proposed a solution to the problem of creating a sustainable and affordable network to reach people that are currently facing a digital divide. We created a platform using blockchain and smart contracts to build a more flexible and cost effective system for delivering connectivity in places that are currently not connected. The solution is composed of three types of nodes which each provide a different set of functions. Together they enable the network incentives to make the solution sustainable and encourage good service and growth of the network. The use of blockchain provides the transparency for a sharing economy to be trusted. The sharing economy results in the reduction of operational and maintenance costs of the network which ultimately means connecting people to the Internet using a more affordable solution. This sharing economy platform enables connectivity and digital identity which are the building blocks for all other digital services to be provided to its users - from healthcare, education, entertainment, social media, government services to financial services and commerce.

References

[1] ITU. (2019) Number of internet users 2019. [Online]. Available: https://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx

[2] U. Nations. (2012) The promotion, protection and enjoyment of human rights on the internet. [Online]. Available: https://bit.ly/3fa5VRr

[3] ——. (2020) Sdgs. build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation. [Online]. Available: https://sdgs.un.org/goals/goal9

[4] GSMA. (2021) Definitive data and analysis for the mobile industry. [Online]. Available: https://www.gsmaintelligence.com/data/

[5] A. Mason. (2017) Mobile operator capex spending: Worldwide trends and forecasts 2016–2025. [Online]. Available: https://bit.ly/2PvkCU4

[6] Bloomberg. (2020) Faster internet coming to africa with facebook's usd1 billion cable. [Online]. Available: https://www.bloomberg.com/news/articles/2020-05-14/facebook-china-mobile-to-build-1-billion-sub-sea-africa-cable

[7] T. Verge. (2019) Alphabet spent more than usd1.3 billion last quarter on 'other bets' like loon and waymo. [Online]. Available: https://www.theverge.com/2019/2/4/18211177/alphabet-google-earnings-q4-2018-moonshot-other-bets-spending

[8] C. Cheney. (2018) Connect the unconnected: Making the economics work. [Online]. Available: https://www.devex.com/news/connect-the-unconnected-making-the-economics-work-93666

[9] N. Telecommunications and I. A. U. D. of Commerce. (2010) Falling through the net: Defining the digital divide. [Online]. Available: https://bit.ly/3fhPKRT

[10] FT. (2021) Alphabet punctures loon internet balloon project. [Online]. Available: https://www.ft.com/content/9b7381a5-bbb6-4f31-a18c-d7f568f2b062

[11] A. Mason. (2020) Telecoms opex: worldwide trends and forecast 2017–2026. [Online]. Available: https://bit.ly/3stKq1A

[12] GSMA. (2019) Energy efficiency: An overview. [Online]. Available: https://www.gsma.com/futurenetworks/wiki/energy-efficiency-2/

[13] S. Voshmgir. (2019) What is the token economy?. [Online]. Available: https://www.oreilly.com/library/view/what-is-the/9781492072973/ch01.html

[14] D. Burkhardt. (2018) Distributed ledger. [Online]. Available: https://ieeexplore.ieee.org/abstract/document/8436299

[15] S. Nakamoto. (2008) Bitcoin: A peer-to-peer electronic cash system. [Online]. Available: https://bitcoin.org/bitcoin.pdf

[16] A. Kiayias, A. Russell, B. David, and R. Oliynykov. (2019) Ouroboros: A provably secure proof-of-stake blockchain protocol. [Online]. Available: https://eprint.iacr.org/2016/889.pdf

[17] A. Back, M. Corallo, L. Dashjr, M. Friedenbach, G. Maxwell, A. Miller, A. Poelstra, J. Timón, and P. Wuille. (2014) Enabling blockchain innovations with pegged sidechains. [Online]. Available: http://kevinriggen.com/files/sidechains.pdf

[18] L. Fitzpatrick. (2019) The tipping point for mass blockchain adoption. [Online]. Available: https://www.forbes.com/sites/lukefitzpatrick/2019/08/21/the-tipping-point-for-mass-blockchain-adoption

[19] R. Morgan. (2021) Connecting the unconnected with shared economics. [Online]. Available: https://richmorgan-wm.medium.com/connecting-the-unconnected-with-shared-economics-be5d8ca72810

[20] G. Smith. (2019) The value of transparency for network operators. [Online]. Available: https://www.rcrwireless.com/20190702/opinion/the-value-of-transparency-for-network-operators-reader-forum

[21] B. Heile and C. Elliott. (2000) Self-organizing, self-healing wireless networks. [Online]. Available: https://ieeexplore.ieee.org/document/879383

[22] W. Foundation. (2021) Contract for the web - principle 3. [Online]. Available: https://contractfortheweb.org/principles/principle-3-respect-and-protect-peoples-fundamental-online-privacy-and-data-rights/principle-3-more-information/

[23] A. L. Dahir. (2019) Africa's biggest mobile operator is struggling to protect its users' digital rights. [Online]. Available: https://qz.com/africa/1621834/mtn-fails-on-user-privacy-digital-rights-in-south-africa-nigeria/

[24] L. Papachristou. (2019) Usd32.7 billion lost in telecom fraud annually. [Online]. Available: https://www.occrp.org/en/daily/9436-report-us-32-7-billion-lost-in-telecom-fraud-annually

[25] E. Landerreche and M. Stevens. (2018) On immutability of blockchains. [Online]. Available: https://bit.ly/3w4BDFt

[26] GSMA. (2018) Ss7 vulnerabilities and attack exposure report, 2018. [Online]. Available: https://www.gsma.com/membership/resources/ss7-vulnerabilities-and-attack-exposure-report-2018/

[27] H. Mourad. (2015) The fall of ss7 – how can the critical security controls help? [Online]. Available: https://www.sans.org/reading-room/whitepapers/critical/paper/36225

[28] A. Josshi, M. Han, and Y. Wang. (2018) A survey on security and privacy issues of blockchain technology. [Online]. Available: https://bit.ly/2QHiTMi

[29] N. Szabo. (1996) Smart contracts: Building blocks for digital markets. [Online]. Available: https://bit.ly/3tWyUvX

[30] W. Bank. (2020) Smart contract technology and financial inclusion. [Online]. Available: https://bit.ly/3w6nW95

[31] Deloitte. (2016) How blockchain can impact the telecommunications industry and its relevance to the c-suite. [Online]. Available: https://bit.ly/3w1nBoj

[32] L. S. Kishoregoutham, P. Athul, and P. Damle. (2020) Leveraging blockchain for communication service providers (csp) to combat fraud and enhance revenue. [Online]. Available: https://bit.ly/3d5WVdk

[33] IBM. (2018) Reimagining telecommunications with blockchains. [Online]. Available: https://www.ibm.com/thought-leadership/institute-business-value/report/blockchaintelco

[34] R. Kochhar, B. Kochar, J. Singh, and V. Juyal. (2018) Blockchain and its impact on telecom networks. [Online]. Available: https://bit.ly/2PaSPZt

[35] C. Foundation. (2021) Cardano. [Online]. Available: https://cardano.org

[36] M. Chakravarty, R. Kireev, K. MacKenzie, V. McHale, J. Müller, A. Nemish, C. Nester *et al.* (2019) Functional blockchain contracts. [Online]. Available: https://iohk.io/en/research/library/papers/functional-blockchain-contracts/

[37] M. Chakravarty, J. Chapman, K. MacKenzie, O. Melkonian, J. Müller, M. Peyton Jones, P. Vinogradova, and P. Wadler. (2020) Native custom tokens in the extended utxo model. [Online]. Available: https://iohk.io/en/research/library/papers/native-custom-tokens-in-the-extended-utxo-model/

[38] McKinsey. (2019) Digital identification: A key to inclusive growth. [Online]. Available: https://www.mckinsey.com/business-functions/mckinsey-digital/our-insights/digital-identification-a-key-to-inclusive-growth

[39] CFCA. (2019) 2019 global telecom fraud survey. [Online]. Available: https://bit.ly/3n0jFzW

[40] IOHK. (2021) Atala prism. [Online]. Available: https://www.atalaprism.io/