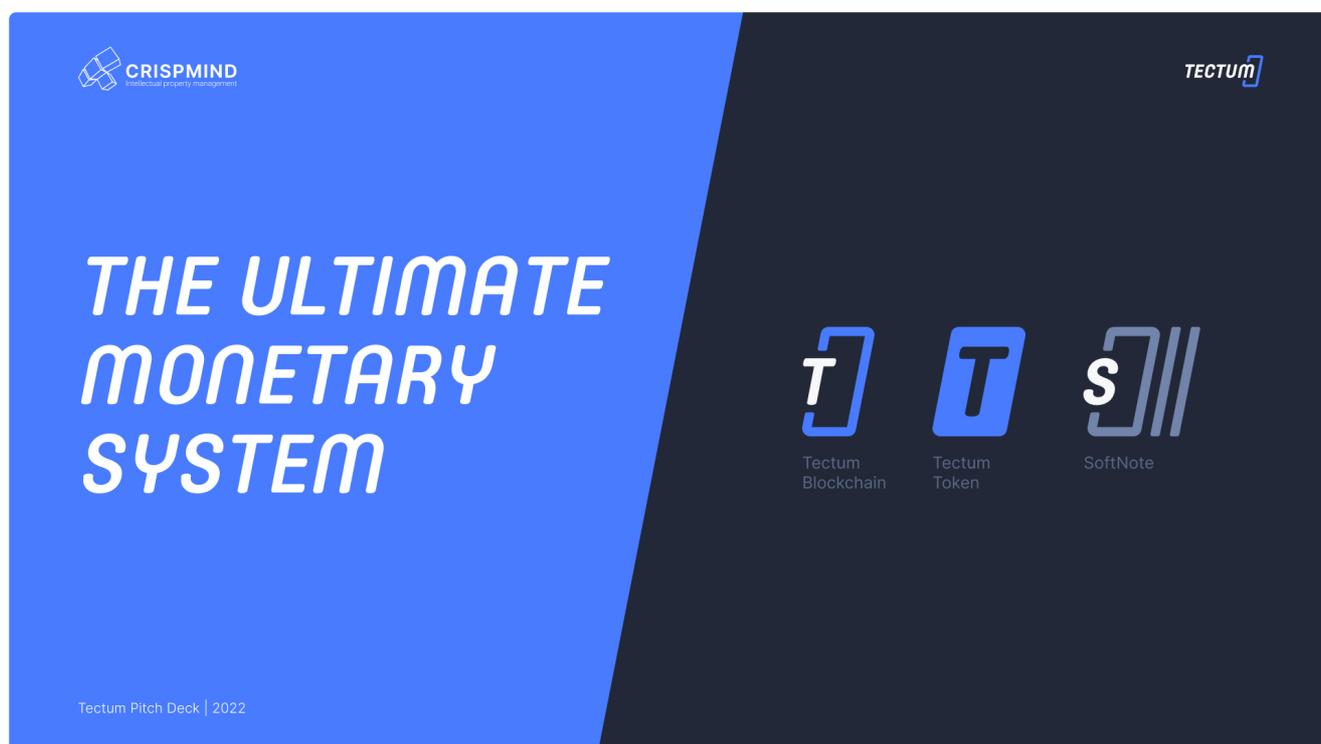# Tectum and SoftNote Whitepaper

I. INTRODUCTION

This whitepaper has been written to give an overview of the architecture and application of the Tectum blockchain and SoftNote product. It will start with a brief history of the Tectum blockchain and some of its broad strengths and after will provide an analysis of Western monetary systems, their evolution, and their problems. The document will then cover an overview of Tectum's three major competitors: Swift, Ripple and the Lightning Network, and will outline the benefits and drawbacks of each system demonstrating a major problem with the current market solutions.

This document will then evaluate the Tectum project as a solution to the highlighted problems and the competitive advantages that Tectum offers in relation to its competitors in the context of the current market will then be detailed. The document will also provide an overview of the technical aspects of the Blockchain architecture, its network protocol, and its consensus mechanism. This white paper will conclude with a description of the TET utility token and its tokenomics, as well as a description of the native coin of the Tectum blockchain TEC, noting that TEC does not function in the same way as other layer one protocol coins such as Ether.

II. Tectum History

1. History of blockchain

Tectum's history starts in the 1980s with one of the project's core developers who worked on software for use in submarines. The computer infrastructure used in submarines is such that it needs to have sufficient redundancy built into its design to be able to remain operational even during partial flooding of the vessel in an emergency causing water damage multiple sites at once. These early systems had some of the properties of a distributed ledger as they needed to be self-healing, redundant and decentralized. After the arrival of blockchains in 2009, the Tectum team realized that it had a relatively superior understanding of distributed ledger technology based on this experience compared to the rest of the nascent blockchain community.

The Tectum project was fortunate in that it did not have to start development of its technologies from scratch after CrispMind Co-founder Alex Guseff acquired the intellectual property associated with these early designs. In addition, the project has the experience of Dimity Stakheev, a core developer of these submarine systems who remains on board with Tectum till today. This long history is the reason that the Tectum blockchain is written in Delphi, as it is one of the oldest and most powerful coding languages. CrispMind Co-Founder Alex Guseff was looking for ways to implement a commercial product based on Tectum, and the SoftNote was the eventual fruition of this undertaking, combining cutting edge blockchain design, with extremely efficient early distributed ledger designs.

2. Strengths of the Tectum protocol

The first strength of the Tectum blockchain lies in its unique block formation protocol, and from the beginning, it was decided that there would be no mining required in the blockchain in order to avoid transaction 'clustering'. Clustering in this context refers to the way that in traditional blockchains such as Bitcoin, transactions build up over time before being released in one go after the block time has elapsed, creating a bottleneck in chain performance. Mining would mean that transactions cannot be validated until a miner has won its next block, therefore slowing network finality down drastically. From day one, the team was convinced that the transaction flow must be even and without clustering into blocks waiting for a given block time to elapse. For example, users must wait up to 10 minutes for a Bitcoin block to be mined before a transaction can be included. The solution was that the premise of the blockchain should be 1 transaction per block, meaning that transactions could flow at a regular pace throughout the network without clustering and waiting for finalisation. Terminal performance (network speed) therefore becomes easier to calculate and measure than under traditional blockchain design.

The next core strength is network mapping. Looking at the Bitcoin network, the Tectum team realised that waiting for 6 confirmations for a transaction to be final was excessively redundant, with all Bitcoin network participants doing unnecessary work. Whilst this creates optimal security for the Bitcoin network, Tectum is intended to be an extremely rapid overlay network and thus must take a different approach to finalisation. When a Bitcoin node broadcasts a transaction, it broadcasts to all the nodes connected to the broadcasting node propagating outwards and transaction confirmations keep accruing for days after a transaction is made. In the Tectum network, a rigid network map is created by an Elect Node each network cycle (200 milliseconds), giving every node a clear instruction as to which other node is its closest peer, eliminating redundancy. By implementing this method Tectum dramatically decreased its network load and improved overall system performance.

The next core strength is the network protocol. This proprietary system allows data to be transmitted over the network with superior capacity. This relates to a way of transmitting an instruction to nodes as to how to reconstruct the next block from the previous block rather than transmitting the raw contents and is discussed in depth later in this paper. Under this system a four-digit integer allows you to recreate an 11-digit number.

The final core strength of the Tectum blockchain is its NoSQL search engine built into the chain architecture which allows enormous amounts of data to be split and stored in a distributed fashion, and simultaneously queried and retrieved faster than a traditional relational database. This aspect is discussed in more detail later in this whitepaper.

III. Monetary systems, their evolution, and their problems

1. Monetary System Requirements

A perfect monetary system should have four main features: security, to prevent counterfeiting and theft, scalability, to enable the system to be used worldwide, fungibility to allow for each unit of currency to have the same value, and decentralisation of control, to avoid manipulation for political gain and the endless temptation by issuers to create more currency. Many monetary systems have arisen over the years, but none, until now, have fulfilled all these requirements.

2. Gold Currency System

Historically, exchange of value was conducted in the form of precious metals such as gold and silver. This physical gold system had high security, as it was impossible for any one person to counterfeit gold, high decentralization, as no individual was in control of the supply, high transparency, total fungibility, but low scalability due to gold transactions being inconvenient due to their weight, size, and indivisibility.

3. Gold standard

To increase scalability, in 1871 the 'gold standard' was created where lighter representations of gold were created in the form of banknotes, that were redeemable for gold and were able to be issued by central banks. The notes were created and handled by banks who stored the backing gold and printed the notes. This system had high security, from the consistent value of gold, high decentralization in theory, as gold was still determining the value of the notes, high scalability, as it was much easier and faster to trade notes but low transparency, but low fungibility as banks didn't declare how much gold they owned and show proof of their reserves. Banks succumbed to the eternal temptation to print currency for which there was no real backing, and therefore eroded trust in the system.

4. Federal reserve

In 1913 the US Federal Reserve was created, which is a private institution that controls all printing of US currency, however, at its inception, each US dollar was backed with a defined amount of gold, physically stored in the federal reserve vaults. This system still had high security, from the secure nature of gold, high scalability, as the notes could now be obtained and exchanged more easily, high transparency, as the federal reserve declared how much gold they had stored and how many notes they were printing. However, it suffered from low decentralization as the federal reserve was in complete control of the printing of notes, and thus susceptible to coercion and control. Because of this centralization, over time the federal reserve was able to leave the gold standard and no longer had any backing for banknotes, leading to the modern fiat financial system we see today. The integration of digital banking improved scalability with high transaction speeds facilitated by many private banks using modern networking protocols, however the public lost trust in the Federal Reserve's ability to manage money supply responsibly, most notably demonstrated by the dramatic increases in M2 money supply seen since 2020. In addition, fractional reserve banking is now allowed where only 10% of depositor funds are kept as a liquidity measure and 90% can be invested by the banks. This practice causes an increase in the money supply. It also causes banks to be insolvent during an economic crisis as depositors attempt to withdraw their money from a risky bank and are unable to. During the 2008 recession the practice of bail-ins were allowed whereby an insolvent bank can seize customer deposits and convert them to equity.

5. Bitcoin

In 2009 Bitcoin was created to overcome this centralization issue and is known as 'digital gold'. The bitcoin protocol is highly secure and has never been hacked, despite enormous incentive by governments and private entities to do so. It has high decentralization as it is impossible for one actor to take control of the network or protocol in isolation, and high fungibility as Bitcoins are all identical. Unfortunately, just like real Gold, bitcoin lacks scalability as the bitcoin system can only facilitate 7 transactions per second. Numerous other cryptocurrencies have attempted to overcome the scalability issue of Bitcoin, but none have succeeded in replicating its other attributes.

IV. Competing systems to address issues with the current monetary system.

We will outline here three attempts to address issues with the legacy financial system – all of which are competitors to Tectum's revolutionary SoftNote solution. They are SWIFT, Ripple and the Lightning Network.

COMPETITIVE ADVANTAGE

THE BLOCKCHAIN

The Tectum blockchain has two major advantages over competitive layer one protocols. Firstly, its speed - Tectum can come to fully decentralized consensus at over 1 million TPS, far eclipsing the speeds possible on other modern chains such as Solana, Avalanche or Polygon.

Second, despite its blistering speed, the chain incorporates distributed database functionality using its 'Hashdrive' technology, making it capable of replicating and storing vast volumes of data, without needing to store the data in the main chain's block space, crowding out other transactions. This makes Tectum capable of data storage, limited only by the total available drive space of the chain's available nodes.

THE SOFTNOTE

The SoftNote platform has several advantages over competing BTC scaling solutions such as the Lightning Network. Firstly, the SoftNote system is significantly simpler in its design than Lightning, with therefore less points of failure and vulnerability. In addition, SoftNote add a layer of privacy to Bitcoin that the Lightning Network cannot match, owing to transactions not needing to be ultimately settled on the main BTC chain, and not involving Lightning watchtower nodes.

Finally, since SoftNote do away with the traditional batching methodology of layer twos and replace it with an approach involving transfer of ownership of Bitcoin wallets, they may happen independently of an internet connection, with cryptographic confirmation being made later when internet becomes available.

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SWIFT

SWIFT – The Society for Worldwide Interbank Financial Telecommunications is a member-owned cooperative headquartered in Belgium, connects approximately 11,000 banking and securities organizations in more than 200 countries and territories, maintains an active presence in all major financial centres, is only a messaging network and does not hold funds or manage member accounts, is controlled by central banks from the G10 countries, used to impose political/economic sanctions on their own member banks in countries like Iran and Russia, pushes the "need for regulatory attention to prevent a new form of intermediation and potentially monopolistic behaviour", is a centralized messaging database that requires a high degree of trust compared to immutable blockchain data.

Ripple - Various attempts using cryptocurrencies to disrupt Swift's monopoly on cross border payment facilitation, fast settlement of financial transactions and currency pair swaps have been made with varying degrees of success. The Swift system was developed in the 1970s and is widely considered to be slow, expensive, and antiquated in its application and is ripe for disruption. The most notable application of cryptocurrency technologies to disrupt this space has been by Ripple Labs, who have developed a suite of technologies designed to replace Swift at a protocol level and modernise international financial settlements.

Ripple Labs has several products that can be utilised together or independently including 'xCurrent' and 'xRapid' in addition to its native token XRP. xRapid allows for real-time settlement of cross border transactions in a fraction of the time of the traditional Swift system by facilitating an swaps with real time exchange rates and guaranteed liquidity and utilises xCurrent as part of this process. xCurrent when used in isolation from xRapid helps to speed up fiat/fiat swaps by streamlining the messaging protocol process between both parties by connecting to legacy nostro and vostro accounts.

Whilst Ripple's technology is impressive there are many flaws in its design and execution which makes remittances and cross border payments utilising Tectum's SoftNote system and Bitcoin superior. Firstly, from an investor's perspective XRP itself could be argued to be not needed, or at least, is token value agnostic. The liquidity of the XRP token is what allows the Ripple technology to facilitate payments, not the value of the token itself, and for this reason, the XRP token struggles to accrue value. As a result of XRP having little utility in and of itself, the price is highly volatile and therefore institutions are not incentivised to hold the token other than for the duration of the liquidity provision process, they may opt to not hold the token at all and leave the provision of liquidity to exchange service providers. Bitcoin offers a better store of value. Bitcoin is widely regarded as the premier crypto asset, and therefore has the most intrinsic value and liquidity. With the option to utilise Bitcoin locked up within SoftNotes to facilitate instant remittance payments and exists, there is no reason to choose XRP.

CBDCs undercut XRP's use case, however it is likely Bitcoin will strengthen because of the introduction of CBDCs as individuals and institutions seek autonomy and privacy. In addition, XRP is highly centralised. Ripple Labs has complete control over the XRP ledger protocol as well as their other products and therefore exposes users to counterparty risk. Bitcoin has no such risk, and SoftNotes are also decentralised in application shielding users from regulatory risk and manipulation. XRP has many fees that may not be apparent to users in the first instance. Bitcoin once moved into the SoftNote system can be moved for free, and the creation of a SoftNote has a one-time minting fee clearly visible to users. Ripple issues XRP and can create more. Bitcoin on the other hand has a hard cap of 21 million, and Tectum's native token TET (used to mint new SoftNotes) is hard capped at 10 million tokens. Furthermore, TET is only used to mint new SoftNotes and is not required after this point.

The Lightning Network – Lightning Network (LN) is a layer-2 solution built on top of Bitcoin. LN was created in response to scalability issues - the speed and cost of Bitcoin transactions. LN works by setting up a payment channel between two parties, where only the first and last transaction are put on the Bitcoin blockchain. Any number of transactions between the first and last will happen off chain, which means those transactions are not limited by the Bitcoin protocol. To start a payment channel, both parties must commit an amount of Bitcoin. That Bitcoin is held and cannot be released as long as the payment channel remains open. The total amount of Bitcoin that can be transferred through this channel is limited by the total amount of Bitcoin committed. The initial BTC commitment requires time and expense. Subsequent transactions can only take place between those channels. Since LN is mostly targeted at micro-transactions through LN-enabled wallets, which are not very user friendly. This aspect has been confirmed to us by several LN wallet holders in El Salvador. LN has been faced with several vulnerabilities. These include: Griefing attacks: Funds aren't lost, but it causes the victim's Lightning funds to be frozen so that the payment channel cannot process any transactions; Flood and loot: Attackers force many victims to claim their funds from the blockchain at the same time (flood). The attacker uses this congestion to steal funds that were unable to be claimed before the deadline (loot); Time-dilation attacks: An attacker lengthens the time a victim becomes aware of new blocks by delaying block delivery; Pinning attacks: An attacker tricks a victim into closing their LN channel improperly and steals individual transactions.

In comparison to Lightning Network, SoftNotes do not have the issues of:

- Payment channels BTC Commitment requirements

- LN vulnerabilities/attacks

- Off chain channel transactions that aren't written to the BTC blockchain

CRISPMIND
Intellectual property management

TECTUM

COMPETITION

⊕ Swift

SWIFT

- Low Compatibility with other systems making international transfers slow and costly
- Limited transactions per seconds at 29,000

✦ ripple

RIPPLE

- Good compatibility with other systems through IOU's however this is reliant on established B2B trust
- limited transaction speed at 1500 therefore unsuitable for micro payments

LIGHTNING NETWORK

- Still tries to move bitcoin on the BTC blockchain so limited in speed and throughput
- Reliant on user owned channels and watchtower systems
- Has failed in El Salvador due to lack of scalability and has required 3 extra layers reducing customer trust

V. SoftNote - Tectum components

Introducing SoftNotes, a system designed to ameliorate the scalability issues of Bitcoin whilst preserving its pristine positive qualities. In 2020 SoftNote were invented, SoftNotes are digital banknotes that represent ownership of Bitcoin wallets and carry access to Bitcoin inside, fully visible on any Bitcoin explorer. The SoftNote system possesses the decentralization, security and transparency of Bitcoin but also offers high scalability from the lighting-fast tectum blockchain. As a result, Bitcoin can now be transferred instantly, anywhere, without fees or delays. SoftNotes holding Bitcoin are truly the ultimate monetary system. SoftNotes, are designed to ameliorate the scalability issues of Bitcoin whilst preserving its pristine positive qualities and are digital banknotes that represent ownership of Bitcoin wallets. SoftNotes are transported on the fastest blockchain in the world - Tectum. The SoftNote system possesses the decentralization, security and transparency of Bitcoin but also offers high scalability from the lighting-fast tectum blockchain. As a result, Bitcoin can now be transferred instantly, anywhere, without fees or delays. SoftNotes holding Bitcoin are truly the ultimate monetary system.

1. **SoftNote Overview**

The SoftNote bill is the Flagship product of Tectum's service and product offerings. SoftNotes provide Bitcoin with a viable method to scale to hundreds of thousands or even more than a million transactions per second. SoftNotes take a radically different approach to competitive Bitcoin scaling solutions such as the Lightning Network, and as a result suffer none of their limitations but offer several novel advantages.

Firstly, the SoftNote system is significantly simpler in its design than Lightning, with therefore less points of failure and vulnerability. In addition, SoftNotes add a layer of privacy to Bitcoin that the Lightning Network cannot match, owing to transactions not needing to be ultimately settled on the main BTC chain, and not involving Lightning watchtower nodes. Finally, since SoftNotes do away with the traditional batching methodology of layer twos and replace it with an approach involving transfer of ownership of Bitcoin wallets, they may happen independently of an internet connection, with final cryptographic finality being made later when internet becomes available.

A SoftNote is essentially a bearer instrument representing ownership of a Bitcoin wallet address, or some amount of BTC liquidity sitting within a wallet address. SoftNotes are pre-filled with a defined amount of liquidity to be transferred at lightning speed using the Tectum blockchain. Once hand over of the SoftNote QR image and a six-digit pin occurs either via email, mobile, or even printed on paper, the new owner secures their ownership cryptographically by entering the pin into the SoftNote platform, and a new random pin will be generated known only to them. Since this handover has taken place off chain, it is virtually frictionless, untraceable, and anonymous. This means that Bitcoin can be used in a peer-to-peer manner, with ownership moving off the main Bitcoin chain, speeding up its processing speed to a virtually unbounded capacity and with zero fees.

SoftNotes are a digital product representing a store of value; however, when unfilled with currency, have no intrinsic value. SoftNote bills are categorised and distinguished by unique serial numbers and denominations. When TET is used to mint SoftNotes, the user is given unfilled SoftNote bills, which must later be filled with liquidity if intended to function. The SoftNote system creates the ability to penetrate the retail market with cryptocurrency payments and can be regarded as 'the first transactionless payment system'. This transactionless nature facilitates instant payment capabilities and a zero-fee policy for the end user. We define transactionless as referring to the fact that no recording of traditional transactional data takes place on the Tectum network. The SoftNote in 'non-wallet' form also demonstrates most traditional 'physical cash' properties. It can be printed on paper, doesn't require the confirmation of its native network (for example, Bitcoin), does not require the internet to conduct payments and has no sender fees or geographical boundaries.

Furthermore, it can be used as a payment on a person-to-person basis or through a messenger application such as WhatsApp as a picture file. However, unlike physical cash, it utilises a passcode for transfer purposes and thus disables it from being accessed by an unauthorised possessor. On the wallet, SoftNote bills function digital cash-like manner and therefore intuitive person-to-person transfers can take place.

SoftNote bills are:

- Transaction-less in that they replace a traditional blockchain transaction with a 'handover' procedure.
- User-less in that they do not require the recipient to be an existing user of the Tectum blockchain.
- Network-less in that handover may be don't independently of an internet connection.
- Wallet-less in that the SoftNote itself can function as a self-contained wallet and does not require the user to use any third-party wallet applications, generate a wallet address with a unique private key or even use the proprietary Tectum wallet application.

2. **SoftNote bills use three chains of blocks on the Tectum base layer.**

i.   Genesis chain (large and slow)

ii.   Payment chain (lightweight and fast)

iii.   Dynamic chain (clusters)

3. **The end of the SoftNote lifecycle**

Neobanks typically pay 1 – 1.5% interest per month on deposits and offer an alternative to legacy centralised banking infrastructure. They are an emergent banking sector where they may allow unlicenced entities to operate using their banking licences, meaning that they are essentially a wholesale merchant service for Fintech enterprises. As an example, Solaris bank in Germany offers a wholesale debit card to fintech start-ups. These type of product offerings can assist Tectum leverage its SoftNote system in innovative new ways. Using a Neobank as a liquidity provider, SoftNotes filled with Bitcoin or stable coin value can be converted to virtual debit cards at the point of burning. This creates a crypto to fiat off-ramp that may not require KYC and gives greater flexibility to users of the SoftNote platform, particularly merchants accepting SoftNotes at the point of sale.

4. **Comparison between SoftNotes and cold (paper) wallets:**

SoftNotes are sometimes comparted to a traditional 'paper' or 'cold' wallets. There are however some important differences that make SoftNotes superior as a medium of exchange of crypto currency than paper wallets. What makes SoftNotes different from a Bitcoin paper wallet:

- Cold wallets have one unique private key that is known to both the sender and the receiver.

o The private key cannot be re-generated meaning that the sender may withdraw funds from the wallet before the receiver has a chance to move the funds to a secure address.

- Cold wallets do not have a friendly end user interface which allow for an easy transport of value. This means that the interface is too cumbersome to function as a method of payment particularly in a retail context.

- SoftNotes have an immediate and accessible proof of funds, whereas a cold wallet requires the user to verify liquidity on chain themselves with a slower and more cumbersome user experience.

- Cold wallets fundamentally hold cryptocurrency, whereas SoftNotes are designed to both hold and move cryptocurrency with minimal trade-off in security and privacy. In fact, security is enhanced by virtue of the SoftNote generating a new cryptographic pin code at the point of ownership transfer.

- Cold wallets have only one type of interface – QR code or wallet address, and the associated private key.

In summary SoftNote bills allow for high velocity exchange of monetary value whereas cold wallets can only securely store value.

5. SoftNote bills have three categories of interface – Imported/Balance-Based, Exported/Native and Hybrid mode interfaces.

1. Balance-Based mode, or Imported modes of operation model:

Note that: 'Imported' in the context of Balance-Based SoftNotes refers to SoftNotes that are imported to the Tectum SoftNote wallet.

-        The Balance-Based mode is designed for retail and micropayment applications. This mode tokenises the SoftNote and exchanges balances between the recipient and the payer. Balance based mode is designed to help Bitcoin break the retail barrier.

-        Tectum Wallet (Balance Based mode): Once imported, SoftNote balances in various crypto currencies enter 'Balance based mode'. This means that they are aggregated into a total balance per crypto currency, rather than showing the nominal balance of each SoftNote bill. For example, 100 SoftNote bills at 0.01 BTC each become an aggregated balance of 1 BTC in the On-Chain SoftNote wallet.

-        SoftNote Ultimate: Is a QR code which gives access to your balance with the help of a pin code which is known only to the user. Merchants can accept payment from users by scanning the QR code and having the user input their pin into a Tectum proprietary Point of Sale device or Software. The system will then mint a SoftNote of the appropriate denomination and transfer to the merchant.

2. **Native or Exported modes of operation model:**

Note that Exported in the context of SoftNotes refers to SoftNotes that have not been imported into the Tectum Wallet in Balance-Based mode. Four types of Off-Chain interfaces. The Native mode is made to support enhanced anonymity and privacy for Bitcoin users.

-        Wildcard interface – that is, a SoftNote printed onto paper or stored as an image. Handover of a Wildcard SoftNote requires no access to connectivity of any kind for either the sender or the reciever, but does trade off some security, as the receiver cannot generate a new SoftNote Pin code until connectivity is obtained.

-        The proprietary SoftNote wallet

-        The SoftNote Vault. The SoftNote Vault is an off-chain wallet that does not store the SoftNote owners Tectum userid and is therefore user-less.

-        Offline interface – Where a SoftNote user has no access to the internet but does have access to a phone line, a sender and receiver may meet in person. The sender has a SoftNote serial number and its associated pin code. The receiver accepts the printed (wildcard) SoftNote QR or serial number and subsequently dials a toll-free number to access a phone interface. The phone interface presents a verbal automated response that allows the receiver to enter the sender's SoftNote serial number and pin. The system will then allocate a new pin code known only the receiver and the transaction is complete.

3. **Hybrid mode of operation model**

This is a hybrid mode between balance based and native mode designed for maximum convenience whilst retaining as many of the privacy advantages of Native mode as possible.

- Hybrid mode uses SoftNote bills in their original native form but implements balance-based mode when values go below the smallest nominal denomination for SoftNotes. For example, for a payment of $1.05 then $1 may be sent as a native SoftNote, and the remainder send via a balance-based mode. When sufficient balance-based remainders are acquired, they are reconciled and exchanged for a full SoftNote. Hybrid mode is the most advanced implementation of the SoftNote system. Hybrid mode is under development (as of April 2023), and currently the SoftNote wallet (https://wallet.SoftNote.com/) operates based on the balance-based system, so that it may be used to facilitate retail payments. The native mode is implemented in the SoftNote vault (https://SoftNote.cash/en).

6. **SoftNote private key security model:**

SoftNote sovereignty is protected using an encryption method utilising zero knowledge proofs known as the 'SCGS' (SoftNote Cryptographically Guaranteed Soverignty') model. SCGS is a way to being able to transfer ownership of the underlying private key associated with the BTC address linked to a given SoftNote without exposing the private key to any party. The only entity that may gain access to the underlying private key is the current SoftNote owner, and only if the SoftNote is burned which removes the SoftNote from circulation and exposes the private key of the underlying BTC wallet. Under the SCGS model it is impossible for any entity, including any node in the Tectum blockchain, to gain access to the SoftNote private keys maliciously or while providing the compute infrastructure powering the Tectum blockchain and SoftNote interface.

Note that for green stripe SoftNotes with a shared pool of BTC liquidity backing them, the underlying BTC private key is never exposed to any SoftNote owner during burning, as this would compromise the security of all the other SoftNotes linked to that address. In this instance, the Tectum system will move the liquidity associated with that given SoftNote to a new BTC address using its in-built BTC node at the point of burn. This will result in slower transaction finality in this scenario. Green stripe SoftNotes are intended for very small denominations of BTC and therefore are less likely to be burnt.

Under SCGS, a smart contract (SC1) generates BTC keys for a given SoftNote using a private key that is first encrypted using the first stage of double encryption with commutative ciphers. The BTC public key is not encrypted and both public and private keys (encrypted using the first stage of double encryption with commutative ciphers) are released onto the blockchain attached to the SoftNote serial number.

When a burn request is made, the burner's public key is sent to a second smart contract (SC2), which processes the second stage of double encryption with commutative ciphers using the burner's public key but decrypts the first stage of double encryption with commutative ciphers. This allows the burner to use their private wallet key to decrypt the second stage of double encryption with commutative ciphers and obtain the private BTC keys. This is considered burning the SoftNote. Once the SoftNote has been burnt, the serial number is re-assigned a new BTC wallet using the first stage of double encryption with commutative ciphers.

This process allows for the secure generation and transfer of BTC keys for a given SoftNote, with the added security of double encryption. The use of commutative ciphers in the encryption process ensures that the keys can be decrypted in any order, providing flexibility for the burner to use their private key to decrypt the encrypted information.

Overall, this approach allows for secure handling of BTC private keys for SoftNotes on the Tectum blockchain.

7.   SoftNote security steps:

1) SC1: BTC keys are generated (using private access modifiers) for a given SoftNote however the private key is generated using the first stage of double encryption with commutative ciphers (using SC2 public keys), BTC public key is not encrypted.

2) Both public keys and private key (now encrypted with first stage of double encryption with commutative ciphers) are released onto the blockchain attached to SoftNote serial number.

3) When burn request is made, burners public key is sent to SC2, SC2 then processes second stage of double encryption with commutative ciphers using burners public key but decrypts first stage of double encryption with commutative ciphers.

4) Burner uses his private wallet key to decrypt second stage of double encryption with commutative ciphers and now has the private BTC keys. The SoftNote is now considered burnt.

5) Burnt SoftNote serial number is then re-assigned a new BTC wallet using stage 1

1.   SoftNote beneficiaries:

SoftNotes have a beneficiary structure to encourage utilisation, minting, remunerate underlying Tectum blockchain nodes and incentivise liquidity providers. The structure of beneficiaries is as follows and each beneficiary is eligible for 20% of SoftNote revenues. Note that SoftNotes only generate revenues when they are received by merchants who are charged a 1% fee to receive them (undercutting competitors such as VISA and Mastercard).

-    1. Minter – the person that spends a TET token to create a SoftNote

-    2. Liqudity Provider – the user that transfers liquidity into the SoftNote

-    3. Changer – is a form of liquidity provision but instead of filling a SoftNote with liquidity, they provide a large number of small denominations SoftNote bills to the system as change.

- 4. ISO – person/entity that brings minter/liquidity provider into Tectum. This could be a business/government/person.

- 5. Tectum blockchain – entire blockchain cluster dedicated to servicing SoftNote operation gets 20% from every SoftNote paid in TEC. The subnet cluster that provides the transaction into the blockchain splits this reward with the master node and elect nodes that validate the transaction. The subnet cluster gets 50%, the Elect node gets 25% and the master nodes share the remaining 25%.

2. SoftNote NFTs.

SoftNotes may be used as a meschanism of storing and transporting NFTs. SoftNotesoftnote may be minted to represent ownership of some real world or digital asset, with the ownership of this asset being transferable like ownership of any other SoftNote. SoftNotes will allow these NFTs to be 'reminted' so that they become fractionalised over many individual SoftNotes, with each new SoftNote representing an ownership share in the original piece. This functionality allows for high value digital assets such as high value digital artwork, or the ownership rights to real world assets such as real estate to be fractionalised and tradeable on secondary markets, opening arbitrage opportunities as well as lower entry price exposure to high value assets. In addition, SoftNotes may be minted to display 64x64 pixel representations of digital images, viewable through native SoftNote interfaces. The underlying storage of NFT data such as high-resolution digital images may be stored within Tectum's proprietary NoSQL storage solution within the Tectum blockchain infrastructure, with the SoftNote itself storing a hash of this data.

VI. Network Protocol: Commutation of Channels vs. Commutation of Packets

Tectum network protocol is a proprietary low level internet protocol based on socket connections. This means the network protocol is functioning on the hardware level.

1. **Formation of blocks**

Conventional blockchain engines use mining protocols to create a block, which after creation are distributed to all nodes. Therefore, the same block must propagate through the entire network before it can be received, and its contents utilised by the needed recipient. The fundamental disadvantage of conventional block formation protocols is that they there is constant replication and transmission of the same blocks throughout the network making them inefficient. Tectum takes a different approach, the elect node calculates the difference between each successive block and distributes the difference to subordinate master nodes, and the master nodes distribute to nominal nodes. The elect node doesn't send the block, instead it sends a formula that allows the nodes to reconstruct the block themselves in an integer 64 range of numbers. By utilising this reconstruction formula rather than sending the block data, traffic efficiency is increased up to 8 times. This means that the proprietary network protocol sends an instruction to create the next block through the network, with an up to 8x saving in network traffic required. The reconstructed blocks are up to eight times larger on the recipient side once they are reconstructed using the proprietary formula and under Tectum each transaction has its own block.

2. **Commutation of channels**

Conventional network protocols use a commutation of packets principle where every packet is sent out as an individual entity, often bouncing around through the internet until they find their intended recipient. This method is necessary amongst billions of untrusted IP addresses and requires a handshake because the sender and recipient must recognise each other before they can exchange data.

Tectum utilises the principle of commutation of channels. Commutation of channels is a low-level protocol that uses socket connections to connect recipients. A common example of commutation of channels is Wi-Fi which does not need to verify its users once connection is established for the first time.

There are two methods of distributing units of data between peers:

i. **STAR method. STAR works as follows:**

1. Peer 1 sends info to peer 2
2. Peer 2 distributes to the cluster of peers
3. Therefore, Peer 1 does not need to communicate to the cluster directly.

ii. RING method

1. Peer 1 connects to 2, 2 to 3, 3 to 4, 4 to 1

2. Therefore, they connect in a circular fashion with the final peer connecting back to the first.

Tectum implements a hybrid STAR/RING approach where the elect node distributes data to the master nodes in a Ring formation, the master nodes then distribute to their respective nominal node clusters in a Star formation. Nominal node clusters connect to each other using a Ring formation. In general, the node above directs with the cluster of nodes below using the Star principle, and nodes on the same level communicate using the Ring principle. Note that: the terms elect, master and nominal in relation to network nodes are terminology associated with Tectum's Proof-of-Utility consensus.

In summary, the proprietary Tectum network protocol is a new generation of hypernet which functions as an emulated hardwire connection and is a virtual network of commutating channels that make use of socket connections and is therefore socket connection based. As a proprietary network protocol, Tectum allows nodes to reduce the overall network load up to 8 times using its proprietary formula that allows block contents reconstruction and allows for a terminal velocity of the network to more than 1 million transactions per second.

VII. Consensus as a Service (CSS)

1. Private versus Public Consensus models

Tectum CSS represents a hybrid product and a vision for multiple consensus approaches blended in a frictionless product line, starting with proof of utility, which is a public blockchain protocol, and ending with multi signature consensus solutions as a manual form of consensus, where multiple human beings help the system to make decisions and form consensus.

What is private versus public consensus? A consensus protocol is a decision-making policy which uses a uncompromisable set of rules to process digital events. Common examples of consensus mechanisms are POW and POS used by BTC and ETH. Most blockchains in existence use variants of these two consensus mechanisms.

There are two contrasted values in consensus protocols – public and private. Commonly, fully public consensus protocols are protocols which mathematically protect the system from corruption or monopoly by large players, thus guaranteeing the democracy in the system. Attacks include 51% attack amongst other flaws of POW and POS models.

Private consensus protocols are not as sophisticated as public protocols and are designed to protect the interest of select enterprise parties, do not have democracy in mind and their primary mission is to protect the integrity of a given commercial agreement between parties. Examples of public networks include BTC and ETH, one of the best examples of a private protocol would be logistical operations where entities manufacturer, distributor, logistics operator and consumers (who are the most vulnerable counterparty) where 4 nodes write a ledger describing every event in the system and protects consumers from counterfeit goods being sold. Veto rights are the core strength of private consensus protocols. In public consensus protocols, nodes can confirm but do not express an opinion other than a confirmation having taken place with a minimum threshold of confirmations needed to make a transaction final, while in private protocols scenario the confirmation of nodes is required, but in addition to confirmation the nodes also enjoy Veto rights where they are entitled to block the event outright and invalidate the confirmation of other nodes. Public consensus is entity blind, and its core function is to protect the system from double spends, therefore in most cases public systems are limited to the function of processing singular simple transactions. Private networks are faster, more efficient, require less confirmations and each node have more freedom due to Veto rights. Private networks have a wider spectrum of application such as IOT and logistics.

One of the extreme examples of private consensus is the multi signature protocol. Multi signature is a mode of operation where participation – confirmation, disconfirmation or veto is required from a physical human party to approve or block the event. Multi signature consensus approaches vary from simple escrow where three or more parties require to confirm a particular transaction using their custodial privileges to the benefit of one party. Blockchain voting systems are the most extreme form of multi sig systems as they require many parties to vote in favour of one decision and a decision is made based on a simple calculation of 51% of all participants must vote in favour. Every consensus protocol is a low-level smart contract.

Note that Tectum currently employs a private network consensus, however the project roadmap aims for decentralisation of the blockchain as a method for reducing attack vectors to the chain, and to over time reduce the reliance of the chain on any centralised entity.

VIII. Multichain capacities

1. Every smart contract as a discreet chain of blocks

The Tectum blockchain is an aggregator of application blockchains and utilises separate chains of blocks for all its internal workings such as TET, TEC, and SoftNote transactions. The Elect Node takes turns promoting a transaction for validation from each chain. The SoftNote application has its own chain of blocks. SoftNote is a blockchain supported application but does not require a blockchain to function, however the blockchain architecture supplies SoftNotes with a decentralised and trustless underpinning. SoftNote system is supported by three chains of blocks. The first chain of blocks is known as the 'genesis chain'. The genesis chain is a slow blockchain, with relatively large block size which is designed to trace the life of every individual SoftNote, from a minting point to a burning point and all steps in between. Its purpose is to maintain the entire lifecycle of every SoftNote bill. Dynamic blocks are used, and they are altered as updates to the SoftNote are recorded. The genesis chain is the first implementation of the dynamic block principle. The second SoftNote chain is known as the 'Payment Chain'. It records the previous pin code associated with a given SoftNote only and is agnostic to all other details. The third SoftNote chain is called the 'Dynamic Chain' and records the status of a SoftNote. Statuses include 'minted', 'filled' and 'burned'. This third chain may be amalgamated into the first two and be discarded in future based on further testing, however this change will not affect SoftNote operation.

2. NoSQL Search engine

No-SQL database is a lateral database, which can be described as a ledger. The difference between a relational database and a NoSQL database is that a database is regulated by index files which give the data a structure. The Tectum No-SQL database does not have index files, instead they only store the hash of the previous block in addition to the data stored within the current block. Each associated entry has the hash of the last associated data point block number.

This makes searches within the Tectum NoSQL database extremely efficient as compared to a relational database, as a block number is used to pinpoint underlying data location. Tectum makes use of both non-SQL and relational databases synergistically on its lowest bulk data storage layer, this is its differentiating feature, and allows the chain to store large volumes of data or large files, with the hashes recorded in the blockchain on upper two blockchain tiers, but the bulk data being stored on the lowest level.

3. Distributed Storage

Tectum uses a novel storage system that makes use of both its NoSQL and relational database elements. Upon storage, files are split apart, with each part being encrypted, hashed, and stored in parts in random locations across all core nodes incorporating bulk file storage. The hashes are stored in the blockchain ledger and are appended with markers comprised of sequenced block addresses that instruct the system as to how to reconstruct the file if it is required. In summary, the markers allow the system to know how many parts there are to a file, what order to reconstruct them in and where they are stored.

4. Proprietary Hash function

Tectum T12 proprietary hashing algorithm is a hybrid hashing protocol designed to generate a 32-byte number. The actual hash function generates a 20-byte number, and then the proprietary random number generates an additional 12 bytes which is added to the 20-byte hash resulting in 32 bytes. This means that there is a statistically minimised probability of clashing with another hashed value. Random number generating modes are involved in this technology. The proprietary hash function is considered reasonably redundant 32-bit method of one-way encryption. The SHA256 algorithm employed by Bitcoin is massively redundant but is therefore too inefficient to be employed at terminal velocities reaching millions of transactions per second.

5.   Tectum Nodes and blockchain architecture

The Tectum blockchain is comprised of three tiers:

- **Upper Tier:** Forms stack of transactions: a) End-to-end numbering of the bundle of transactions received from Pool of Master Nodes (the process of end-to-end numbering of the bundle of transactions, producing a sequence of hashes); b) Creation of Stack of Blocks using: 1 Txn = 1 block principle (In RAM only); c) Producing the Hash of the last Block; d) Sending the entire Stack of Transactions followed the Hash of the last Block back to the pool of master nodes in order to rid the Network of the burden of sending the entire Stack of Blocks;

- **Second Tier:** Distributing the Stack of Transactions throughout the Network. Pool of Master Nodes repeats the procedure of the Elect Node sending the Stack of Transactions followed the Hash of the last Block to the Network below – every Node creates a Stack of Blocks from Stack of Transactions and produces Hash of the last Block. The Stack of Blocks is added to the Ledger only after the Hash of the last Block produced by each individual Node matches one produced by Elect Node.

- **Third Tier:** Decentralized Database: a) At least 7 server locations; b) Keeps client files; system files, public files, intellectual property related files.

A Tectum network cycle lasts for 200 milliseconds. Each network cycle an Elect Node is selected and can propose transactions. The Elect Node calculates the difference between previous block and current block and creates an integer 64 formula that allows the new block to be created from the previous block. The formula is around 8 times smaller than a raw block which makes the process for the Master Nodes to receive and reconstruct the new block very efficient. The Elect Node sends this formula subordinate Master Node Quorum who create the new block from the previous block and validate the transaction. The Master Nodes distribute the formula to Nominal Nodes who also create the new block.

Tectum network Cycle is a 3-phase event governed by the Topology; the Topology (Network Map) is created at the end of every cycle by the current Elect Node. There are 3 Base phases in every Network Cycle:

- **READ:** A newly elected pool of Master Nodes reads and collects all the transactions and passes them to the new randomly elected Elect Node according to the Network Map formed by the former Elect Node.

- **STOP:** All the events on the Tectum network except service events are suspended while the Elect Node is: Processing the transactions just received from Master Nodes, Forming Stack of Blocks, Creating a new Network Map for the next network Cycle.

- **WRITE:** The Elect Node submits the new Network Map and all the Blocks to the Master Nodes and resigns; Master Nodes update the rest of the Network.

The Tectum blockchain employs a radically different architecture than previous generations and is built from the ground up for speed. Tectum exceeds 1 million transactions per second (TPS) and provides near instant finality and ownership updates across the blockchain network along with distributed levels of access to functional system modules. The Tectum blockchain is comprised of three tiers and instead of storing the data directly on chain, Tectum stores hashes that are mapped back to the original data stored at a lower level with a proprietary distributed database protocol that forms part of the Tectum protocol. This isolates the heavy transaction-related data from the main pipeline by hashing, encrypting, and signing the bundles at the end of every transaction before archival and storage on the lowest level of the blockchain. This makes the event-related data instantly verifiable and publicly accessible both within the network protocol and via the blockchain explorer, with different levels of accessibility provided to different transaction-related modules.

Tectum's Proof-of-Utility consensus mechanism utilises verifiable randomness in innovative ways to elect a new master node over five times per second and a dynamic node rating system to ensure compliance with chain governance rules, meaning that misbehaving nodes are quickly penalised and dropped. Each node creates its own stack of blocks which are hashed and verified by the master node in a way that maximises speed and allows the network to continuously scale as more computing resources are contributed to the chain. Proof-of-Utility does not waste resources with unproductive and energy intensive computation. Work in a POU context means useful actions such as ensuring provable network connectivity, creating new peer to peer node connections, and ensuring high network latency in addition to validating hashes generated by the randomly chosen master node. Essentially work in this context entails each node provably contributing more useful network resources than it consumes making the chain extremely energy and computationally efficient.

The blockchain trilemma asserts that for a blockchain to achieve the scalability necessary to challenge traditional IT stacks at their own game, a trade off in decentralisation must occur. Tectum takes a radically different approach to solving this trilemma than other blockchains, and has achieved an architecture capable of phenomenal speed, with minimal losses to decentralisation or security. Tectum is comprised of three separate blockchain tiers. The top tier forms a stack of transactions ending with a hash of the last block, the middle tier distributes the transaction stack throughout the network, forming blocks, and forming consensus, and the lower tier replicates and stores bulk volumes of data as a decentralised database using a proprietary new distributed database protocol. Tectum's block size is a tiny 120 bytes with each block containing only one transaction. Tectum is therefore the fastest blockchain both on a transaction per second, and a block per second basis. Tectum utilises innovative hashing techniques at all three levels of its blockchain architecture to maintain integrity and consensus whilst minimising the size and volume of packets required to be transmitted across the network. Tectum's speed makes it perfect to act as an Overlay Network to Bitcoin, allowing Bitcoin to scale, and for applications in an Internet of Things context, where a high volume of light weight transactions is required.

6.   Hardware insensitive low level processing infrastructure

The Tectum node software is agnostic to node hardware spec, providing that it exceeds or matches the specified minimum hardware spec. In general, the Tectum system is more sensitive to network latency and throughput than to CPU performance and therefore network latency and throughput is weighted more heavily in the POU rating algorithm than raw CPU power.

The recommended minimum hardware specification to run a Tecum node is as follows:

- CPU: 2 cores, 1.2Ghz

- RAM: 8GB suggested, 4GB minimum

- Hard Disk: SSD required, 200GB or more.

7.   Native TEC Coin and TET Token

TEC

The native token of the Tectum blockchain is known as TEC. TEC is automatically minted by the blockchain when Tectum nodes perform a BTC transaction. If for example, a user opts to move BTC liquidity between Tectum wallets or into a SoftNote, the Tectum BTC overlay node will scan the native BTC mempool to determine the value of the normal fee to perform this transaction would be on the BTC main chain. Tectum then charges the user 20% of this native on chain fee to perform their transaction, then transfers this BTC to a treasury wallet. Since the BTC transaction is happening between wallets associated with Tectum, it can be processed for a hugely reduced cost by the Tectum BTC full node, as it is self-confirmed by the Tectum overlay node and inserted into the mempool ready to be mined into a block. TEC is then minted and provided to the node that processed this transaction. The minted TEC is redeemable for real BTC from the Treasury wallet and represents a share of ownership of the entire treasury wallet. TEC is only minted when BTC is contributed into the treasury wallet, and thus the supply of TEC increases in proportion to the supply of BTC in the treasury. In this way, TEC is a store of value and functions to reward node operators with BTC created by BTC overlay node activity.

At this time TEC is not used as 'gas' for transactions in the same way as other layer one blockchains, however this may change once Tectum transitions to a fully public mode of operation.

TET

TET is a token on the Tectum blockchain that can be used to mint new SoftNotes. Additionally, TET may be used to transfer value between Tectum wallets and does not incur any 'gas' fees to utilize. Once the Tectum blockchain progresses from private mode to public mode consensus, TET will be used in a staking model where the number staked correlates to the Rating Stake Modifier that may be applied to an individual node, affecting its probability of being nominated as Elect Node in a given network cycle.

TET Tokenomics:

- Tectum Emission Token: Utility value and primary purpose is to mint SoftNote bills.

- 10 million hard cap. There will never be more.

- TET is a T12 protocol token but can be migrated to ERC20, TRC20 etc.

- When TET is migrated to another protocol like ERC20 the overall number of tokens remians the same. The migrated tokens are frozen on the Tectum side by a smart contract, and then the same number of tokens are minted on the ERC 20 side by a smart contract.

- TET is designed to circulate perpetually.

- When TET is purchased, they go to the user wallet. When the user mints SoftNote bills, the TET is returned to both a minting account and the bounty account on the Tectum blockchain in a proportion 90/10.

- At the point of minting the TET is withdrawn from the user wallet and are returned to the Tectum network. The Tectum token circulation is designed to work in a 90/10 ratio. 90% of used are recycled back to the minting account and 10% go back to a bounty account however this ratio and process is subject to change to reward node operators more heavily.

- The bounty account is used by the Tectum team to pay for expenses related to development and marketing of the blockchain protocol.

- TET tokes are divisible down to six decimals.

8. **Hybrid protocol Proof of Utility Consensus**

It is envisaged that the Tectum blockchain will decentralise in three phases, starting at a private blockchain model (current configuration) and ending at a fully decentralised public and open source ledger.

Distributed tectum node which will have subnet clusters. POU rating is based on trustworthiness, uptime, hardware capacity, latency (POU Factorial Score). These factors are combined and then the 'Rating Stake Modifier' (RSM) is applied to produce a final probability of becoming the Elect Node. Final probability is known as 'Elect Node Likelihood Quotient' (ENLQ).

Terminology Summary:

- TVRF: Randomness in node choice by protocol: 'Tectum Verifiable Randomness Function' (TVRF). Randomness is currently produced radio frequency received from space (Relictum) using a specialised sensor and converted to a hash value. The radio signal impossible to predict. The zero node has a sensor built in to receive this signal and then create randomness for the blockchain. This will transition to purely algorithmic randomness at the point of decentralisation to eliminate the requirement for specialised hardware.

- PFS: POU Rating (trustworthiness, uptime, hardware capacity latency) – 'POU Factorial Score' (PFS)

- RSM: Probability Modifier overlayed to POU Factorial Score based on TET stake: 'Rating Stake Modifer' (RSM)

- ENLQ: Final Probability of becoming Elect Node: 'Elect Node Likelihood Quotient' (ENLQ)

- MNQ: 12 Master Nodes validating Elect Node transactions: 'Master Node Quorum' (MNQ)

Phase 1: Private 12 node cluster where all node TEC rewards are divided equally.

Phase 2 (public version): Tectum sells an additional 10 nodes using a staking mechanism where 100000 TET gives a node the capacity to go up to 100% rating (providing that other rating factors are sufficiently high). This Phase 2 staking model is known as 'RSM' where nodes stake their TET to the Tectum protocol and a stake of 100,000 TET tokens gives a node the possibility of getting a 100% rating. A 100% rating maximises the likelihood of a given node becoming the Elect Node in each network cycle and thus eligible for maximal protocol rewards. An individual staking number defines a node's rating ceiling. For example, a stake of 1000 TET means that the node rating will never exceed 1%. Note that stake pools are allowed, and community members may stake into an existing node (providing that it does not exceed 100000 TET per node) to share in node rewards. This helps to reduce circulating supply of TET tokens and support a robust TET token economy.

All the nodes created as part of the phase 2 node creation cycle are collectively known as 'Zero Nodes'. Every node has a Tectum account and therefore has a TET address and wallet. Node software is available on GitHub however the protocol will not recognise a node as valid without an approved TET stake. Staking occurs via a smart contract that accepts TET stake and lockup then grants a specific Tectum T12 address permission to function as a full node. Every 0.2 seconds the POU factors are recalculated. Each network cycle, the network map is updated by the master node. The network map connects each node together in a random map and reassess the POU criteria of each node.

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Links