

# QUADRANS WHITEPAPER

REV.01

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# 1 Abstract

Begun in 2012, the Quadrans project uses the innovative blockchain technology to support the shift of paradigm from centralised to decentralised systems.

The Quadrans project has both scientific and ethical goals.

The scientific goals highlight the advantages of blockchain technology and its role in the upcoming digital revolution among other opportunities, including identifying the elements that enable the advancement of blockchain into our society.

**Ethically, the project considers fundamental the principles of transparency, integrity, security and ownership of data in open decentralised environment.**

To handle both the scientific opportunities and ethical aspects of Quadrans project, the creators of Quadrans have established a Foundation to continue the scientific development of the infrastructure and educate the communities on the use of blockchain technology.

# 2 Introduction

After 5 years of research conducted by a team of software and hardware experts, the early version of Quadrans blockchain officially began business operations pioneered by Foodchain S.p.A., a company incorporated in 2016 with the purpose to enable traceability, transparency and authenticity of information along food supply chains through the use of blockchain technology.

In recent years, innovations have driven the need for an advanced digital environment to accommodate the emergence of new technologies and trends, such as decentralised applications (dApps), Smart Contracts and the use of IoT devices.

As integration and interoperability between technologies is becoming a priority, the creators of Quadrans have committed to build an accessible blockchain infrastructure to help new technologies develop and enhance how we live, work and relate to one another.

In order to pursue this objective, Quadrans Foundation was officially formed in August 2018 and acknowledged by the Swiss local authorities to guarantee the continuous, inclusive and ethical advancement of Quadrans technology into our communities. Today the Foundation collaborates with institutions, Government agencies and academic partners around the world to achieve its mission.

Quadrans infrastructure is a public and open source blockchain designed to overcome the scalability challenge and reduce the instability of operational costs that affect existing blockchains.

With significant designing effort, the current Quadrans protocol achieves high throughput in a secure way while maintaining decentralisation. Quadrans consensus mechanism uses three types of service nodes located throughout the network, called Masternodes, Miner nodes and Lightnodes and is designed to reduce energy consumption.

The ability to speedup business practices through Smart Contracts has the specific aim to support the creation of new business models and promote an efficient, reliable and affordable use of the infrastructure.

**Quadrans ecosystem runs on two types of cryptographic elements called Quadrans Token (QDT) and Quadrans Coin (QDC) to serve different yet related functions within the network.**

As an accessible and open source software, the community plays a vital role and the Foundation considers this a very serious matter. To promote a virtuous and sustainable use of the system, participants are rewarded for their internal service to the network according to a secure incentive-distribution structure defined by the Quadrans protocol.

## **2.1 THIS WHITE PAPER**

The purpose of this White Paper is to define the role of Quadrans Foundation and describe the current status of Quadrans infrastructure. In addition, the last section of this document provides insights into the development work that is being carried out to further improve the existing Quadrans technology.

## 3 Quadrans Foundation

Quadrans Foundation is a non-profit organisation based in Canton Ticino, Switzerland with headquarter in Mendrisio, via della Torre, 2 – 6850.

The Statute of the Quadrans Foundation and its Boards describe the scope and governance of the organisation and is available on our website (<https://quadrans.io/f/statuto>).

### 3.1 MISSION AND VISION

The mission of the Foundation is to conduct the continuous upgrade and promotion of Quadrans technology to enable efficient collaboration and support transparency and traceability of data by providing a reliable tool for communication, governance and business.

From the initial idea to the current times the vision has never changed: we want Quadrans blockchain to become the foundational technology at the core of an accessible, reliable and efficient infrastructure to improve the organisation of our society beyond geographical boundaries.

### 3.2 OUR GOALS

Quadrans Foundations has set out and pursue the following goals to achieve its mission to:

- support the creation of decentralised protocols and applications to facilitate interaction between individuals, businesses and institutions;
- encourage enterprises from every sector to adopt Quadrans and enable growth and economic progress;
- use Quadrans as an efficient and secure layer within business structures;
- collaborate with institutions, Government entities and academic partners around the world for the development of a digital infrastructure model for data management;
- support the creation of Smart Contracts, digital libraries and global standards;
- use an energy-efficient protocol to promote sustainability and reduce environmental impact through the reduction of CO2 emissions;
- accommodate the upcoming digital revolution through education and encouragement on the use of Quadrans blockchain.

### 3.3 ACTIVITIES

Quadrans Foundation is supported by contributions such as sponsors and donations from individuals and organisations that share the same vision. We ensure that the Foundation's resources are used in accordance with our goals, under the supervision of the Federal Tax Administration (FTA) office of the Swiss Federal Department of Finance (FDF).

Quadrans Foundation operates to support collaborations between businesses, institutions and individuals, and has been acknowledged by the Swiss cantonal authorities as a subject that pursues activities for the benefit of the general public and

The primary activities that the Foundation conducts in order to pursue its mission are outlined in the following sections.

#### 3.3.1 Research

Numerous experts and researchers are involved in the R&D activities and support the use of Quadrans in the academic world.

The Foundations gathers international groups of researchers to ensure the technological progress of Quadrans blockchain technology.

#### 3.3.2 Technology upgrade

Since the beta version of Quadrans was first deployed, many improvements have been done. Continuous upgrade is vital, especially in a fast-paced technological landscape.

From time to time, the Foundation provides users with the tools to conduct upgrades and maintenance activities to Quadrans infrastructure however users are totally independent to use the technology with no obligations or restrictions.

The Foundation is committed to the constant development of Quadrans technology and being an open source software, developers around the world can contribute to the improvement and upgrade of Quadrans through various support lines.

#### 3.3.3 Education

Educating the future communities of users is fundamental for the digital revolution to take place in a thoughtful and correct manner. We consider blockchain as a foundational technology and Quadrans provides opportunities to drive positive changes and embrace the digital revolution as an active player and not a passive subject.



All the members of the Foundation put efforts into raising awareness and conducting engagement activities such as courses and workshops for the dissemination of knowledge.

The Foundation also provides guidance and full support to ensure a correct interaction with the system and harness the full potential of Quadrans blockchain.

### **3.3.4 Quadrans for the Community**

Quadrans is an accessible public network and anyone, from startups to large organisations, can use it for deployment, execution and performance of dApps and Smart Contracts to create new data models and valuable data streams.

Quadrans rewards active users according to a scheme of incentives that encourages an ethic and virtuous use of the system. For example, incentives for sharing new Smart Contracts or funding activities for projects of high interest to the community.

The Foundation supports activities and organisations that represent the public interest and improve technology proliferation across the community. These include innovation hackathons, academic activities (priority to researches), incubators, startups and any other activity that empowers circular economy and environment sustainability.

An example is the free timestamping tool that Quadrans Foundation released in September 2019 to allow owners of documents to confirm their ownership and prove their integrity using Quadrans blockchain.

## **3.4 GOVERNANCE MODEL**

No company or centralised organisation controls Quadrans infrastructure, as it is maintained and improved by its members with the support of a diverse global community of contributors.

The organisational structure of the Foundation includes the Board of Trustees and specific internal bodies (Boards) that head the major functional departments.

According to article n. 6 of Quadrans Statute, the Board of Trustees can form and appoint new operative Boards to address specific areas and pursue the objectives of the Foundation in the most efficient way.

Each new Board is raised to fulfill a clear mission under the supervision of the Foundation, according to the needs that arise from time to time.

The following section describes the roles of the Boards that are currently operating.

### **3.4.1 Board of Trustees**

The Board of Trustees collegially direct the Foundation through executive decisions, assisted by the internal operative Boards. As a non-profit organisation, the resources of the Foundation are allocated by the Board of Trustees in order to achieve the goals set and create value from the support provided by the contributors.

The Board of Trustees is formed by three founders of Quadrans Foundation: Mr. Marco Vitale (President and Founder), Mr. Brunello Pianca (Co-Founder) and Mr. Davide Costa (Co-Founder).

### **3.4.2 Crypto Board**

The Crypto Board is in charge of the scientific R&D and continuous upgrade of Quadrans core technology. (see the Crypto Board settlement document <https://quadrans.io/f/cryptoboard>).

### **3.4.3 Legal & Governance Board**

The Legal & Governance Board addresses the use of Quadrans infrastructure in compliance with the legislative framework and advise the Foundation on opportunities that can benefit the community and public institutions. (see Quadrans Legal & Governance Board settlement document [https://quadrans.io/f/legal\\_governance](https://quadrans.io/f/legal_governance)).

## 4 Quadran's in Industry 4.0

Emerging technologies such as blockchain, Internet of Things (IoT) and Artificial Intelligence (AI) are playing a key role especially in the economic sector of the Industry and will have a major impact on businesses and communities during the upcoming 4th Industrial Revolution.

The digital transformation cannot happen in a seamless way without the suitable tools - in this scenario we see an opportunity to make innovative technologies work together fluidly.

Decentralised systems are expected to have a widespread impact on the structure of our society. New business models are giving up the centralisation of information to models that give ownership of ideas, values and processes to those who create value in economy and benefit from the changes brought by the new trends.

Quadran's provides an opportunity to create value from an open and decentralised source of information. The network agrees upon via a consensus mechanism and without the need to trust intermediaries.

A major challenge is to achieve decentralisation within the systems while ensuring efficiency, security and data verification and protection. By leveraging on the power of decentralised consensus, Quadran's promotes transparency to encourage collaboration between cyber-physical systems.

Each user contributes to the creation of valuable data streams to positively impact businesses processes, productivity and quality. Also, the ease of sharing trustworthy information using auditable Smart Contracts makes Quadran's an economically viable solution as this reduces the cost of coordination between parties and enables accountability and operational efficiency.

In the following part of this White Paper we will provide a description of Quadran's technology.

## 5 Quadrans infrastructure

Quadrans is a public blockchain infrastructure that runs Smart Contracts and decentralised applications (dApps), with particular focus on improving the major challenges that blockchain ecosystems are facing today such as security, interoperability, scalability and high operational costs. Below is a description of the key features on which Quadrans is built on.

### 5.1 OPEN & PUBLIC

As an open source technology, anyone may contribute to Quadrans development in a collaborative manner by providing technical support for the upgrade and expansion of the network and accelerate the technological development of the infrastructure. The principle of openness drives adoption and increases transparency of processes and products, which is fundamental for the establishment of a strong digital environment.

Everyone is encouraged to join, use and support Quadrans to empower ideas and create new data models.

### 5.2 DECENTRALISED

We strongly believe in giving the power back to the community and decentralisation moves the power over data away from a restricted group of people or entities that centralise the decision making.

In Quadrans, data is stored on each participating node across the blockchain network according to precise rules defined by Quadrans protocol. These rules are publicly consultable and this approach is native to Quadrans infrastructure.

### 5.3 DISTRIBUTED

Quadrans distributed data storage has a copy of the ledger replicated across multiple nodes of the network.

Nodes are geographically spread across the world in desktop computers, laptops, servers, cloud services and other different types of devices (even small, low cost and low power consumption single board computers like the popular Raspberry Pi and Orange Pi Zero) that run a simple software.

Today, individuals, businesses and public organisations (such as universities, research institutions and the Public Administration) are already part of the network. By installing a node, they actively participate to making the infrastructure more secure and decentralised and at the same time, access the benefits that Quadrans offers. The software for the installation of a Quadrans node is available free of charge on Quadrans website to anyone who wants to be part of the network.

## 6 Quadrans architecture

Quadrans is an open source, public blockchain-based ecosystem in which a list of small datasets, called blocks, are linked together via cryptography and broadcast across the network at virtually-regular intervals.

### 6.1 TECHNICAL OVERVIEW

Every new block is generated with the same structure of all the other blocks (except for the genesis block) and contains:

- a block header;
- list of transactions.

The essential information included in each new block contains two parts:

1. The hash digest of the prior block in the chain. This process contributes to enable the immutability of information recorded in Quadrans blockchain - if a tampering with the previous block occurs, any node of the network can identify the malicious attempt by computing the digest of any block generated after the attack and flag the discrepancies between the tampered block and the official one;
2. The hash digest of the state. This allows nodes of the network to verify that they all have the same copy of the state.

Before discussing transactions, we provide below a simplified description of the state: we can imagine the state as a huge collection of boxes (containing data) with an address (a string with a hexadecimal format) attributed to each.

In the state, the address identifies the box. Some of these boxes contain only Quadrans Coins (QDC), or more precisely, an amount of QDC linked to that address. QDC are used as the internal utility in Quadrans ecosystem and the details of their use will be explained in the following section of this document. Other boxes contain software programs called Smart Contracts and data handled by them.

The state represents the shared memory of a computer.

Transactions describe the way these boxes interact. Any transaction that is included in a block triggers a modification of the state. There are four main types of transactions that:

1. move QDC from one box to another;
2. create new boxes containing only QDC;
3. create new boxes containing Smart Contracts;
4. send inputs to the Smart Contracts, which:
  - a. modify accordingly the data they handle;
  - b. (possibly) send inputs to other Smart Contracts.

The Smart Contracts activated by other Smart Contracts perform their instructions immediately upon receiving inputs. Before considering any other transaction, the full effect of any transaction on the state must be concluded. This effect can be a deep modification of the state, since in principle a Smart Contract could activate dozens of others, each of them activating more.

To reach an optimal use of computational resources, any transaction requires the use of QDC. The amount of QDC used to include a transaction in the blockchain (and performing the state modifications it triggers) is called gas.

Smart Contracts are written in a stack-based bytecode language interpreted by the EVM (Ethereum Virtual Machine). The instructions in this programming language are called “opcodes”. An interesting feature of the EVM language is that it is Turing complete, meaning that, theoretically, all operations on data are possible (some of them might need a program much longer than expected).

Usually, programmers do not use opcodes directly, therefore Quadrans uses high-level languages such as Solidity, allowing users to produce opcodes from compiled scripts.

A more detailed description of the development that Quadrans is undertaking is shown in Quadrans Yellow Paper.

## 6.2 ETHEREUM LEGACY

The evolution of Quadrans blockchain began from a fork of the open source structure created by Ethereum Foundation. The Ethereum source code has been re-engineered to accommodate new and unique features. Quadrans has its roots in Ethereum blockchain, therefore it maintained Ethereum-born

elements such as the EVM to run Smart Contracts and the consensus mechanism based on the Proof of Authority (PoA) used by the Ethereum Rinkeby network to provide scalability of transactions.

Quadrans is fully interoperable with any data flows and ensures compatibility and transferrable features with Ethereum and Ethereum-like ecosystems to allow a seamless and immediate transition of existing solutions into the Quadrans blockchain.

## 6.3 QUADRANS ECOSYSTEM

The Quadrans Blockchain runs on two cryptographic elements, Quadrans Tokens (QDT) and Quadrans Coins (QDC), designed as utilities to ensure the correct functioning of the infrastructure and support a suitable use in the industry.

The combined use of QDT and QDC is a game-changing feature that has been designed to minimize the economic impact on the use of the system and support the formation of a reliable environment that ensures operational efficiency.

### 6.3.1 Quadrans Token (QDT)

A fixed number of 600 Million QDT have been generated and perform the following functions:

- serve as a collateral to users for the recognition of Masternodes and Miner nodes within the network. Anyone that possesses QDT becomes a Token Holder. With a certain amount of QDT, a Token Holder may activate a Miner node or a Masternode;
- regulate the distribution of new QDC as a reward for the participation to the network. All Token Holders are rewarded with QDC according to the transactions processed by Quadrans infrastructure.

QDT have been generated in compliance with the standardized Ethereum ERC20 tokens. This decision was made to consolidate the security of the QDT. QDT are hosted on Ethereum blockchain, chosen for its stability and large-scale adoption.

The Quadrans Tokens supply is capped at 600 million QDT, they cannot be minted or burnt and they have no timelock on them. All the characteristics of the QDT can be viewed on Ethereum explorer at this address: <https://etherscan.io/token/0x9adc7710e9d1b29d8a78c04d52d32532297c2ef3>

Token Holders may join or leave Quadrans network as they wish and with no restrictions.



### 6.3.2 Quadrans Coin (QDC)

QDC are primarily used as “gas” by the users for Smart Contracts execution. Quadrans allows users to transact instantly using QDC and therefore are necessary for operations to take place and information to be recorded onto Quadrans blockchain.

The non-volatile nature of the Quadrans Coin allows users to perform transactions at nearly-neglectable operational cost all the time. Among others, this feature discourages hoarding and financial speculation.

QDC can be obtained from actively participating to Quadrans ecosystem through the activity of Miner nodes and Masternodes and as a reward for contributions like bounty programs or beta testing. Since QDC is native to Quadrans blockchain, they can be transferred by performing transactions from one address to another.

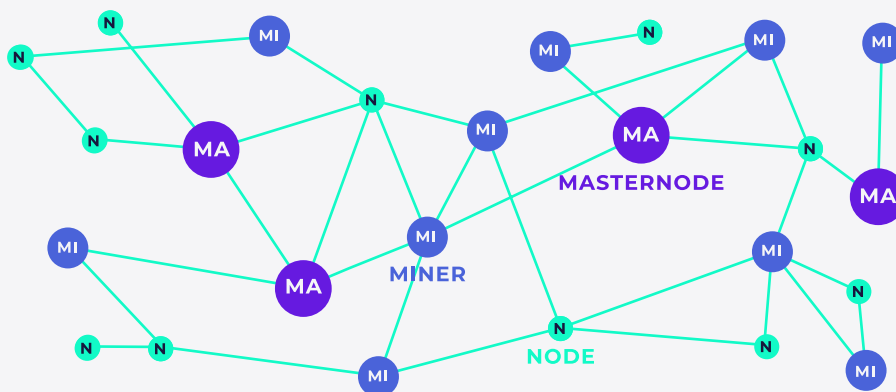
## 6.4 MINTING QUADRANS COINS

QDC are generated according to Quadrans minting protocol in order to maintain a balanced ecosystem for operations.

At the time of writing this White Paper, Quadrans blockchain is minting an average of 1 QDC per day. QDC are minted every time a block is closed (Epoch) with an average time of 5 seconds to close a block.

## 6.5 QUADRANS NETWORK

The Quadrans network is composed by three types of nodes. **Masternodes**, **Miner nodes** and **Lightnodes**. The section below describes their functions and their relation with Token Holders.



### 6.5.1 Masternodes

Masternodes dispatch incoming transactions to achieve the network consensus and keep up to date the state of the network. The maximum number of Masternodes that Quadrans network can host is 2.500.

The tasks performed by a Masternode are:

- dispatching incoming transactions;
- authorizing blocks, achieving consensus within Quadrans network.

To be recognised as a Masternode, a Token Holder needs to:

- own enough Quadrans Tokens (100.000 QDT);
- join Quadrans network by installing a node.

### 6.5.2 Miner nodes

At the moment Miner nodes perform the same function of Masternodes and actively participate to the consensus mechanism. The objective is to support the growth of the network in order to accommodate the improvements to the consensus mechanism described in Quadrans Yellow Paper.

To be recognised as a Miner node, a Token Holder needs to:

- own enough Quadrans Tokens (1.000 QDT);
- join Quadrans network by installing a node.

### 6.5.3 Lightnodes

Lightnodes are nodes of the network that does not perform mining operations. As Quadrans blockchain is open and public, anyone can run a Lightnode and contribute to the expansion of the network, increasing data decentralization and distribution.

### 6.5.4 Quadrans Mainnet and Testnet

Quadrans has a Testnet that users can use to trial new applications under different conditions and conduct analysis such as operational cost estimates before moving to Quadrans main network (Mainnet). The use of the Testnet is free and QDC intended for testing are dispensed by the QDC faucet available on Quadrans website.

## 6.6 CONSENSUS ALGORITHM

The current consensus mechanism is based on Proof of Authority (PoA), however it presents some similarities with Proof of Stake (PoS), since users need to hold a minimum amount of Quadrans Tokens (the stake) to participate to the network as validators. Active validators are put in a queue and they sign new blocks according to the queue order.

This significantly increases the system capacity to process larger volumes of on-chain transactions and achieve high scalability without sacrificing security and decentralisation.

Most popular blockchains perform very energy-intensive operations in order to reach consensus and update the status of the ledger. The current consensus algorithm used by Quadrans reduces the power consumption required to solve the computationally intensive work preserving high transaction speed and promoting environmental sustainability.

This protocol is being improved further, as described in Section 9.4, to achieve an even more efficient throughput without compromising the security of the network. Before achieving full implementation of the protocol as described in Section 9.4., the protocol needs to undergo an intermediate step.

This regards the engagement of nodes during the consensus phase. The automated identification of the wallet address and the QDT associated to a node enables Quadrans Smart Contract to verify that a node is associated to a wallet address containing the minimum amount of QDT required to participate to the consensus as a validator.

## 6.7 DATA SECURITY

Quadrans blockchain is a temper-proof and secure system that uses cryptography to protect data storage, in which integrity of information is ensured by the entire community of users.

In a decentralised system there is no central point of failure. The larger the network, the grater the resilience from a cyber-attack.

Data on Quadrans blockchain cannot be tampered, and a strong signature algorithm makes impossible to modify a transaction sent by a wallet. Also, any changes to the blockchain is visible to the whole network and any unauthorised modification is immaterially detected.

## 6.8 SMART CONTRACT LIBRARY

Quadrans can also be considered a Smart Contract infrastructure. The upload of new Smart Contracts requires QDC. This will limit the overuse of the shared memory ("state") of the network in an effort to reduce the bandwidth and storage capacity required.

One of our goals is to create a common shared library to be used by developers for the creation of new Smart Contracts and reduce the accumulation of duplicated Smart Contracts stored on Quadrans blockchain. This will also improve the security of Smart Contracts since this library will contain only secure and validated functions and will help developers build new dApps faster.

Smart Contracts need QDT and QDC to be deployed on Quadrans blockchain, however only QDC and QDC-related tokens are needed to execute them.

## 6.9 TOKENIZATION OF ASSETS ON QUADRANS

Quadrans supports the tokenisation of assets on its blockchain infrastructure. As fully compatible with Ethereum, Quadrans supports all the token standards, either fungible and not fungible. Users can create their own ready-to-use token using the Smart Contract library built and released open by Quadrans Foundation.

## 7 Token Economy

Quadrans system is powered by the gas (QDC) used to run transactions. The overall gas consumed is then used to reward active Token Holders, incentivising them to perform new transactions.

The purpose of the QDT is to ensure incentives for Token Holders as they contribute to the generation of new QDC (see section 6.4 Minting Quadrans Coins), necessary for running transactions on Quadrans. As the network grows, the demand for QDC is likely to increase. Thus, the QDT constitutes an important element that drives the generation of new QDC and establish a virtuous cycle for sustainability of operations.

All Token Holders are rewarded with QDC under the Quadrans protocol for their contribute to the Quadrans economy. To encourage a balanced use of the infrastructure, the incentive formula is weighted towards Token Holders who own a greater number of QDT.

### 7.1 PROPOSED TOKEN DISTRIBUTION

A total of 600 million of QDT have been generated.

The majority of QDT will be distributed through Airdrops across the community to drive technology adoption and help onboard users. No action such as ICO, token sales or similar is planned - Airdrop QDT are distributed for free by Quadrans Foundation and subject to KYC (Know Your Customer) procedure as per internal due diligence and in line with the principle of transparency.

The proposed QDT distribution is as following:

-  70% Airdrop
-  15% Quadrans Foundation Reserve
-  10% Foodchain & Technical partners
-  5% Early Adopters



The Airdrop will issue a total of 420 million QDT (70%) in multiple phases.

90 million QDT (15%) will be used by the Foundation to serve general interests and pursue public utility goals to benefit the worldwide community (see section 3.3.4 Quadrans for the Community).

The early Quadrans technology was designed and pioneered under Foodchain S.p.A. to pursue the idea of creating a blockchain infrastructure for public use, later on the Foodchain team decided to transfer the technology to Quadrans Foundation.

The technology transfer included 60 million QDT (10%) to be left with technical partners and supporters of the initial idea and another 30 million QDT (5%) with the early adopters.

## 8 Coin economy and reward

Quadrans reward mechanism is designed to allow Token Holders, Miner nodes and Masternodes to be rewarded for their service to the network, with an amount of QDC that is proportional to the QDT held, every time new QDC are generated.

The distribution of QDC is regulated by an algorithm every time a block is closed (Epoch). QDC of each Epoch are stored on a Smart Contract, and they are sent to Quadrans Token Holders on a monthly basis. The distribution of newly minted QDC is defined by the Quadrans protocol, according to the activity made by Token Holders (including mining nodes) during the previous month. As mining nodes participate to the consensus mechanism, Masternodes and Miner nodes are rewarded with more QDC compared to non-mining Token Holders.



QDC intended for reward are sent to wallet addresses registered on an active node to simplify the distribution of the reward.

## 9 Quadrans work in progress

The state-of-the-art of the current Quadrans infrastructure described in the previous sections constitutes only the starting point of our ongoing research and development and establishes a clear pathway toward the advancement of Quadrans technology.

This section provides an introduction to the main improvements that are being made to Quadrans blockchain. Further details are outlined in Quadrans Yellow Paper.

### 9.1 DIGITAL SIGNATURES

Quadrans blockchain is designed to support interoperability between users with different characteristics, from IoT devices to end users. For this reason, Quadrans uses different digital signature algorithms so each user can achieve its own balance between security and computational effort. This only occurs at transaction-signing level, since Quadrans firmly requires high level of security at block-signing level where each block is signed with Post-Quantum digital signatures. Considering the relative proportion between blocks and transactions, users can use signatures that are more space-consuming even at block level without incurring into a loss of efficiency.

### 9.2 ADDRESSES

Addresses natively support multi-signatures and even more complex access policies. Less complex addresses specify a single public key, however more sophisticated addresses may specify various public keys, even with different signature protocols and a policy concerning which types of signature are required to authorize transactions.

Quadrans addresses are embedded with a common name, which is not required to be human-readable. This can be used to facilitate the identification of the user that owns that specific address. For example, a common name can be associated to an IoT device and can be used to identify the device itself.

### 9.3 CHAIN STRUCTURE

From a technical prospective, Quadrans blockchain is being developed into a set of blockchains. The result is a network in which Miner nodes are divided into shards to work in parallel on the computation of Smart Contracts and achieve a large throughput of executed transactions and, on the other hand, Masternodes work on a higher-level chain, collecting the states reached on each shard to achieve a global consensus.



Moreover, the time is divided into slots of fixed length, and each slot is pre-assigned to a single Miner node and a single Masternode. In order to assign slots, time is divided into Epochs and the information required for the governance of the ledger during each Epoch is stored on a dedicated chain.

## 9.4 CONSENSUS PROTOCOL

Since the chain structure is layered in three different chains, the consensus also follows this arrangement. In fact, consensus is reached at local level between Miner nodes of the same shard and at global level between Masternodes. Consensus at Epoch level is reached in order to organize the next Epoch. The levels are intertwined, as Masternodes rely on the local consensus reached by Miners nodes to achieve both the global end Epoch consensus, and Miners nodes act upon the decision processed by Masternodes to safely reach a consensus on their local chain.

Quadrans Token Holders with enough QDT may compete to become Masternodes during each Epoch. This is a Proof of Stake (PoS) competition and this will result in a list of nodes valid only for one Epoch. This means that on each Epoch change, Masternodes compete against each other's again. After assigning the node set, one (or more) time slot will be preassigned to each node. In that specific time slot, specific nodes will be in charge to sign a new block and add it to the chain.

Token Holders may also compete to become a Miner node (less QDT are required than Masternodes). This is a Proof of Work (PoW) competition and is used to determine the Miner nodes for the next Epoch. At the end of this competition, Masternodes will rank Miner nodes and assign them a shard and a time slot.

## 9.5 SMART CONTRACTS

Smart Contracts are added to the blockchain through dedicated transactions. The right to create a new Smart Contract is obtained by using QDT, however to deploy a new Smart Contract users need both QDC and QDT.

Smart Contracts are divided into three categories, according to the “gas” required for execution:

- **Standard Smart Contracts** – the gas is provided by the user that requests the execution;
- **Autonomous Smart Contracts** – the gas is taken from a reserve of QDC held by the Smart Contract itself;
- **Favored Smart Contracts** – the gas is not taken directly from the user, but it relies on a third-party account. This category of Smart Contracts must be digitally signed by Quadrans Foundation before their deployment.

## 9.6 MINTING

Quadrans minting is developing into a process regulated by an algorithm at each Epoch block that checks the previous Epoch and estimates the amount of QDC to be minted in the next Epoch. QDC of each Epoch are stored on a Smart Contract, and they are sent to Quadrans Token Holders at each Epoch change. The distribution of newly minted QDC is regulated by Quadrans protocol according to the amount of work Token Holders (including mining nodes) have made during the last Epoch. As Masternodes and Miners nodes participate to the consensus mechanism, they collect more QDC compared to non-mining Token Holders.

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