Querio

A Decentralized Protocol for Web Search

January 30, 2024 - Version 2.0

Abstract

We introduce Querio, a *Decentralized Search Protocol* for indexing, updating and caching data through blockchain storage solutions coupled with a decentralized network of content miners. This paper describes the search interface, the topology of the content miners' network, and the economic incentives and mechanisms designed to maintain the network running as a public utility.

1. Introduction

1.1 Motivation

A large number of *decentralized applications (dApps)* are being dispersed throughout the Web 3.0 ecosystem, without a proper way to navigate them. dApps put users in control of their data, yet they are still discoverable through Web 2.0 search engines.

In the current digital landscape, a handful of corporations wield control over data. Web 2.0 search engines are rooted in data monopolies. This centralization grants great power to a select few. At the same time, it raises concerns due to the lack of transparency in data handling and the protection of user privacy.

We envision creating a decentralized solution, designed for the Web 3.0 ecosystem, with the ultimate goal of offering a compelling alternative to the dominance of Web 2.0 search engines. Our objective is to develop a decentralized platform that provides exceptional search results while placing utmost importance on user privacy.

To bring this vision to life, a decentralized search engine, fueled by a network of content miners capable of delivering new content consistently, is essential. In this ecosystem, users conduct queries to sift through large datasets, involving operations such as filtering, pagination, sorting,

grouping, and joining of results. To provide accurate results, it's important to maintain indexes with content continuously updated by the content miners. These miners require a coordinated system and consensus mechanisms, underpinned by economic incentives, to foster a thriving ecosystem.

Querio steps in as a much needed infrastructure layer for Web 3.0, establishing its role as a decentralized search engine geared towards the discovery of multi-chain dApps. Specifically designed for the Web 3.0 environment, Querio aims to be a significant challenger to the current dominance of Web 2.0 search engines.

1.2 Key Features

1. Querio search engine is running on-chain, eliminating the need for conventional cloud storage solutions.

2. Querio facilitates the discovery of decentralized applications (dApps) across multiple blockchains, including Ethereum, Internet Computer, NEAR Protocol, Stellar, BNB Chain, Solana, and Polkadot.

Figure 1: Multi-chain support

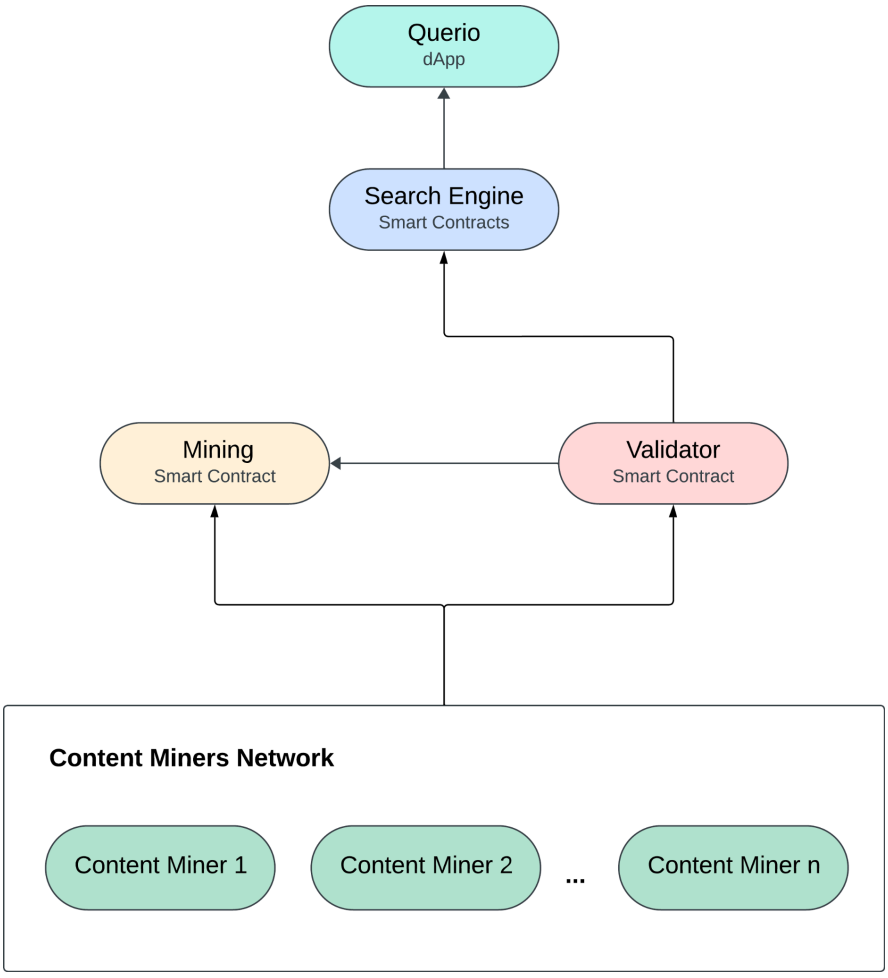
3. Querio empowers users to search and tailor results according to their preferences, and intends to broaden its search capabilities, by connecting Web 3.0 and Web 2.0.

4. Additionally, Querio is designed to respect user privacy, by not storing any user data or search preferences.

2. Design

Querio implements a decentralized protocol, which enables users to query data without having to operate any centralized infrastructure for searching, indexing, caching or updating data. The protocol integrates concepts from distributed computing to establish a network of content miners, facilitating the development of a vibrant content ecosystem for Querio's growth.

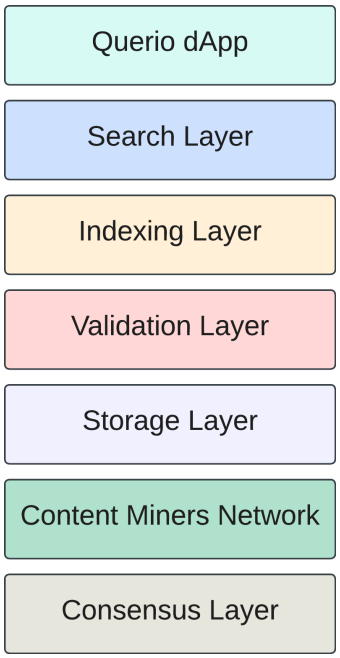
Figure 2: High-level architecture



2.1 Protocol Overview

Querio's operational approach can be divided into a stack of layers, each of which can be considered as conceptually separate yet interconnected, as illustrated in Figure 3.

Figure 3: The Protocol Stack has the following layers:



1. **Consensus Layer** - responsible for executing the smart contract.
2. **Content Miners' Network** - a decentralized network of content miners who provides new content, like new dApps or updates, to the search engine. Initially, this new content undergoes validation and indexing before being utilized by the search engine.
3. **Validation Layer** - defined by a smart contract that validates the content by verifying that the majority of content miners agree on the same content.
4. **Indexing Layer** - content that has been validated gets indexed by the search engine.
5. **Storage Layer** - involves data storage on public blockchains such as Internet Computer.
6. **Search Layer** - provides search capabilities to discover new dApps. The indexed content is organized based on user preferences, enabling filtering and sorting.
7. **Querio dApp** - defines the layer between the user interactions and the search engine.

2.2 Protocol Layers

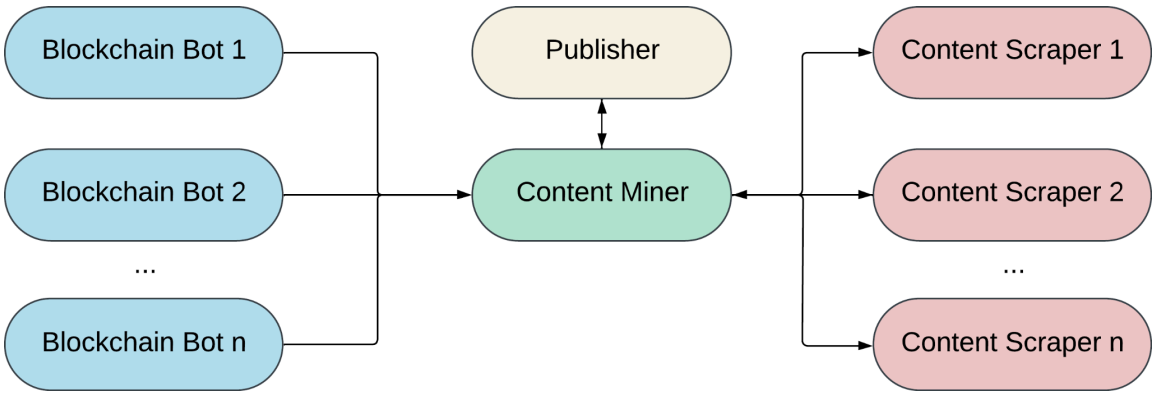
1. Consensus Layer

Querio has several components which require a blockchain-based consensus layer to provide guarantees that mechanisms in the protocol are immutable, irreversible, and can be carried out without the help of a central governing authority. We will use an existing blockchain such as Ethereum for this purpose.

2. Content Miners' Network

Content Miners' Network is a decentralized network comprising content miners who, through seamless communication with blockchain specific bots and content scraper instances, are able to deliver new content to the search engine, such as new dApps or updates.

Figure 4: Content Miner Components



In this dynamic environment, the blockchain bots dispatch tasks to the content miner, specifying the content that requires scraping. Meanwhile, the content scraper instances actively request tasks from the content miner, ensuring a smooth and efficient workflow.

Once the tasks are assigned by the Content Miner, the Content Scraper instances process them and return the updated content to the Content Miner. The Content Miner then handles the content for each new or updated dApp through the Publisher, subsequently forwarding it to the Validator smart contract for further validation and processing.

Content Miner Components

1. Content miners

   Within this decentralized network, every content miner maintains a cache containing all the scraped dApps and their relevant content information. This comprehensive cache ensures efficient access to the stored data for future use and reference.

   During each cycle, the content miner checks the cache for dApps that have been updated within the current cycle and the findings are then sent to the publisher.

2. Blockchain dedicated bots

   Blockchain bots autonomously crawl supported blockchains, facilitating the discovery of new or updated content. Their findings are then used to generate tasks, which are actively dispatched to the content miners for inclusion in their task queues. Each day, these blockchain dedicated bots thoroughly scan the supported blockchains to identify any new or modified content.

   It's important to note that in the future, Querio will extend its support to various blockchains. This expansion means that dApps built on these blockchains will also become searchable through Querio. To achieve this, each blockchain will have its dedicated Querio bot, which will provide the content miners with a list of new or updated dApp URLs specific to that particular blockchain.

3. Content scrapers

   A content miner will run more instances of the content scraper in parallel. This number of instances can be fine tuned according to the content miner's preference.
   Each content scraper instance receives a task from the content miner, which entails scraping a specific dApp URL, processing its content, and subsequently returning it to the content miner. Once a task is completed, the content scraper promptly receives another task from the content miner, ensuring a seamless and continuous workflow.

   Content scrapers, operating under the content miner, are assigned tasks in the form of dApp URL and provide updated content in return.
   The content miner compares the new content with the existing one. If a match is not found, the content miner updates the content.

4. Publisher

   The publisher component takes on the role of requesting the content miner for the list of dApps updated during the current cycle, using the last updated timestamp as a basis. Following this, the publisher forwards these dApps to the validator smart contract for the validation process.

Content Miner Incentives

- Content Miner Onboarding

  The Querio protocol will automatically reward the decentralized miners that feed the search engine with QRO tokens for keeping the data up-to-date. The distribution of rewards will be determined through a reputation system, incentivizing active mining. Querio's multi-chain support enables it to attract users from diverse blockchain ecosystems, accelerating the usage of the platform and enhancing its growth potential. By rewarding miners with QRO tokens, a dedicated and influential team is formed, driving further expansion and contributing to Querio's future success.

  We will establish a comprehensive onboarding procedure for new content miners to join the Querio decentralized network. To become part of the network, prospective miners will need to lock a specific amount of Querio tokens to qualify. The mechanism also retains the authority to exclude a miner based on their overall reputation score, ensuring the network's integrity and reliability. For the configuration of a miner, a detailed set of steps will be provided, offering clear guidelines and instructions for seamless setup and participation.

- Content Miner Rewarding

  The Content Miners' Dashboard will provide comprehensive tracking of each miner's activity, offering valuable insights into their performance. It allows for easy monitoring and analysis of miners' contributions to the network.

  A miner will receive no reward if the content they submit does not match the majority of content submissions. Likewise, if a content miner fails to send any content, they will not receive any reward. These criteria ensure the integrity and active participation of miners in the network, promoting the delivery of accurate and relevant content.

A reward mechanism is set to incentivize community members to participate in running content miners. Its key component is the reputation score, which will determine rewards by using the average score across all cycles. The average calculation for rewards will be determined by dividing the cycle reward by the number of content miners and adjusting each miner's reward based on its reputation score at the end of the cycle.

- Mining Contract

  21% of the total token supply will be governed by the mining contract. Upon the completion of each epoch, the reward will be distributed among miners who contributed valid content.

  Additionally, a portion of the revenue from Querio subscriptions will be transferred to the mining contract. This approach will foster a self-sustaining ecosystem, consistently rewarding those who mine content.

3. Storage Layer

The storage layer describes how data is stored, both on public blockchains such as Internet Computer and within the network of Content Miners.

Initially, any new or updated content is cached within the network of Content Miners. Following this, it is handed over to the validator for processing. Once the data has been validated, it is forwarded for indexing and subsequent storage within the search engine's workers.

4. Validation Layer

The validator smart contract undertakes the crucial task of validating the new content received from the content miners. If the content is present in the majority of content miners, exceeding half of them, it is deemed valid and subsequently forwarded to the search engine for further processing. The validation process takes place at the end of each cycle.

The validator smart contract maintains knowledge of the list of miners through their addresses, ensuring accurate identification and verification during the validation process.
This validator smart contract possesses knowledge of and control over the intervals at which the content miners send content.

5. Indexing Layer

The indexing layer operates by systematically organizing and cataloging data to enable efficient and rapid search queries. Initially, the indexer processes data, breaking it down into manageable tokens, such as words. These tokens are then indexed, creating a reference system that links each token to its specific location in the dataset.

The indexed data is cached in a decentralized manner, stored in the smart contracts of the search engine workers, designed for quick retrieval during searches. As new data is continually added, the indexer regularly updates the smart contracts of the engine workers, to ensure search results are current and relevant.

6. Search Layer

The search engine layer is designed to enhance the discovery of new dApps and webApps integration. It focuses on dynamic, decentralized content management and retrieval ensuring that content is not only added and updated efficiently but also made readily available for search queries.

The search engine achieves this through several key functionalities and components:

1. Dynamic Orchestrator Engine - Smart Contract:
    - This component acts as the central coordinator of the search engine. It is responsible for creating new instances of Worker Smart Contracts as needed.
    - It also updates these worker instances with new or updated content, ensuring that the search index remains up-to-date and comprehensive.
    - Furthermore, the orchestrator returns a list of these worker instances to the frontend dApp, which are then utilized to execute search queries.

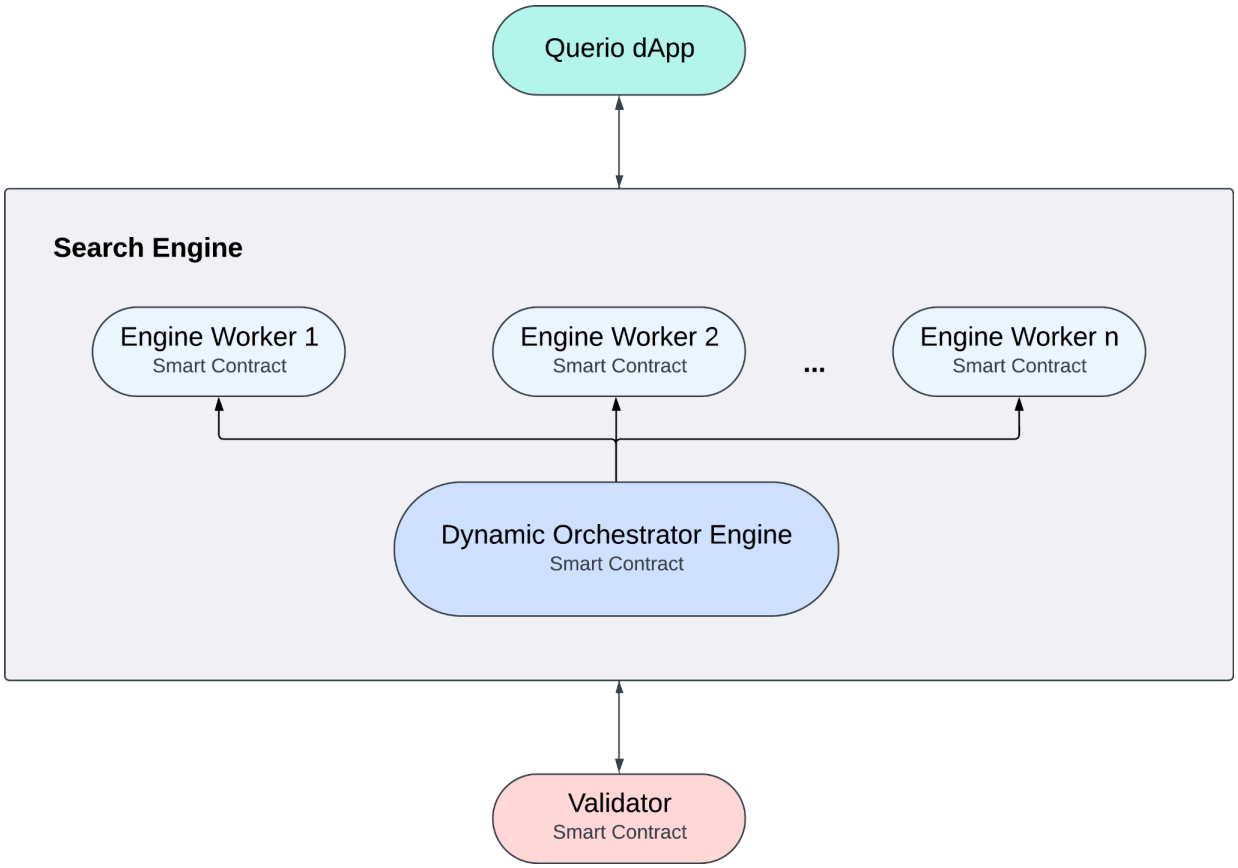
2. Engine Workers - Smart Contracts:
    - Each Engine Worker is a smart contract that specifically handles the indexing of new or updated content received from the Dynamic Orchestrator Engine Smart Contract.
    - It also processes search queries received from the frontend dApp, searching through its updated index to provide fast and relevant results.

In terms of system interactions:

- The search engine layer communicates directly with the validator layer, which plays a critical role in verifying and validating the content before it is indexed.
- Additionally, the search engine interfaces with Querio dApp, which acts as a mediator between the user and the search engine. The search engine layer interprets user queries and provides search results, tailored to user preferences for enhanced filtering and sorting.

Overall, the search engine layer is structured to offer dynamic, up-to-date search capabilities by efficiently managing and responding to the evolving content landscape.

Figure 5: Search Engine



7. Querio dApp

The Querio dApp frontend layer operates on-chain and holds a significant role in the Querio ecosystem. This component serves as the interface between users and the search engine, acting as a bridge that facilitates seamless and tailored search experiences based on user preferences.

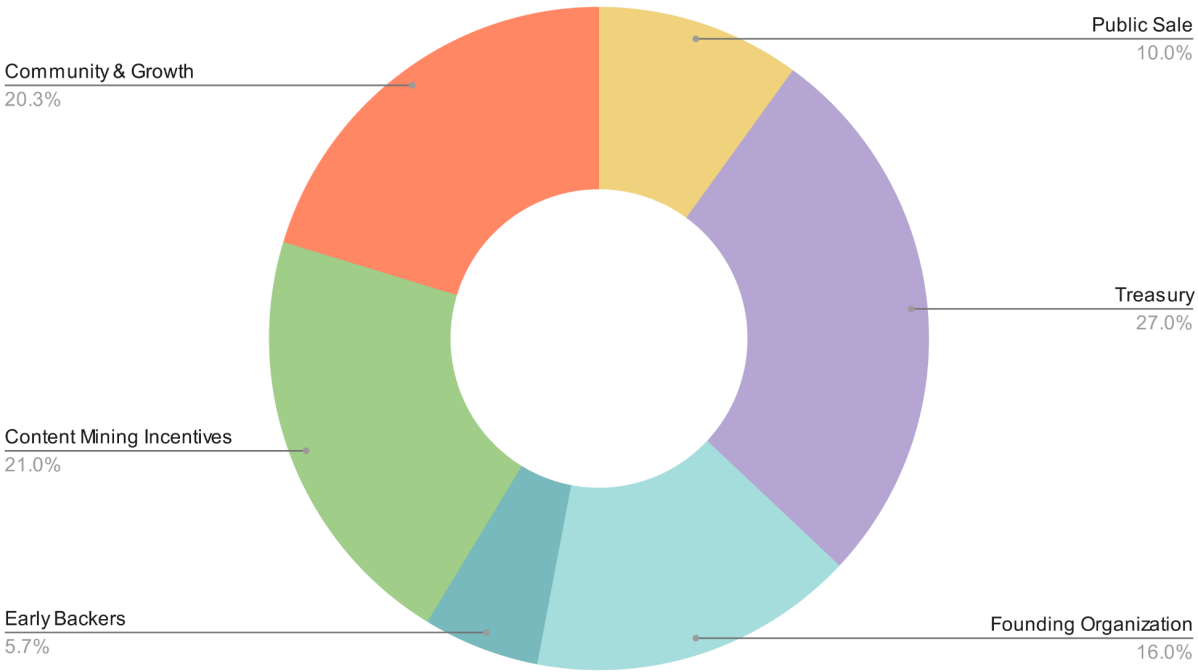
The Querio dApp layer operates with the security and transparency associated with blockchain technology. It can securely manage the interactions with the search engine.

The frontend layer processes user queries and communicates them to the search layer. It is responsible for requesting and receiving search results and presenting them to users in a user-friendly format. Querio is designed to respect user privacy, by not storing any user data or search preferences.

3. Tokenomics

The total supply of QRO tokens is capped at 100 million (100,000,000). This amount will remain fixed throughout the entire lifecycle of Querio. Details of the token allocation are illustrated in Figure 6 below.

Figure 6: Token allocation



Querio has been built since April 2023 by CrossChain Labs, the **Founding Organization**. CrossChain Labs will receive 16% (16,000,000 tokens) of the total QRO token supply, adhering to a 5-year linear vesting schedule.

Following the launch of the QRO ERC-20 token, the *Querio Foundation* will be established, dedicated to fostering the network's growth and continuous development. The foundation will manage the *Treasury* and *Community & Growth* funds, which amount to 42.3% (42,300,000 tokens) of the QRO total supply, designated for future marketing initiatives, the establishment of the future Querio DAO, moderation handled by a 3rd party, community bounties and grants to boost user growth, legal advice, educational programs, and the ongoing development of Querio.

The allocation details for the *Querio Foundation* are as follows:

- **Treasury**: 25% of QRO tokens (25,000,000), that is subject to a 10 year unlocking schedule.
- **Community & Growth**: 17.3% of QRO tokens (17,300,000), vested over 24 months.

Early Backers hold 5.7% (5,700,000) of the total token supply, and includes:

- Presale Participants: Allocated 4.0612% of QRO tokens, with a 24-month vesting period.
- NFT Holders and Early Community Contributors: Allocated 1.13% of QRO tokens, in recognition of their support in Querio's development, with a 24-month vesting period.
- ICRC-1 Liquidity Pool: Allocated 0.5% of QRO tokens for ICRC-1 QRO token version, specifically released for early backers from the Internet Computer community. Additionally, a bridge to ERC-20 will be established, facilitating the conversion of ICRC-1 to ERC-20 tokens at a 1:1 ratio.

Content mining incentives foster a self-sustaining ecosystem, consistently rewarding those who mine content. 21% (21,000,000 tokens) of the total token supply will be governed by the mining contract. Upon the completion of each epoch, the reward will be distributed among miners who contributed valid content. Additionally, a portion of the revenue from Querio services and subscriptions will be transferred to the mining contract.

Public sale could take place through an initial exchange offering (IEO) or/and a community sale. For the Initial Exchange Offering, the QRO tokens will be immediately liquid upon launch.

Income and outgoings

Querio Foundation will receive an income in QRO tokens through various ways, such as promoting dApps & featured placements on the front page, Token Compare subscriptions, premium AI services, Querio Drive storage, Querio Signer subscriptions and NFT transaction fees on Querio Shopping.

These funds will be channeled into marketing initiatives, community bounties and grants to boost user growth, moderation handled by a 3rd party, legal advice, educational programs, and the ongoing development of Querio. Moreover, a portion of the revenue will enable the provision of additional rewards for content miners.

4. QRO token utility

The complexity and diversity of Querio features, outlined in the Querio Roadmap, are designed to establish a strong foundation for a public good that seeks to provide a counterpoint to the prevailing dominance of traditional Web 2.0 search engines. This marks a significant step towards reshaping the landscape of online search.

Consequently, QRO token is set to offer a variety of engaging and practical applications within the Querio ecosystem, enhancing user interaction and the overall functionality of the platform:

- **Access to Tokens Compare premium services**: Tokens Compare provides a platform for analyzing software activities in different blockchains and dApps that have a token representative. It integrates developer activity data from GitHub and financial metrics, with an emphasis on community contributions alongside core team developments. The platform offers free data for a limited number of blockchains and includes premium services accessible through QRO token subscriptions, enabling advanced analysis for other cryptocurrencies.

- **Promoting dApps**: QRO tokens can be utilized to promote dApps within the Querio search results page or to bid for a dApp spot in the featured dApps section on the homepage, increasing visibility and exposure.

- **Content Mining and Rewards**: Content miners are required to lock a specific amount of QRO tokens in order to mine content and earn rewards. The automated miner rewards mechanism will ensure that miners are fairly compensated based on their reputation score, fostering a thriving content ecosystem.

- **Access to Premium AI Services**: QRO tokens serve as a means of subscribing to AI services that will be offered within the Querio ecosystem. Users can leverage tokens to access and benefit from advanced AI-powered functionalities and services.

- **Querio Drive Storage Payments**: QRO tokens can be used for paying for storage on Querio Drive, providing users with a secure and efficient storage solution within the platform.

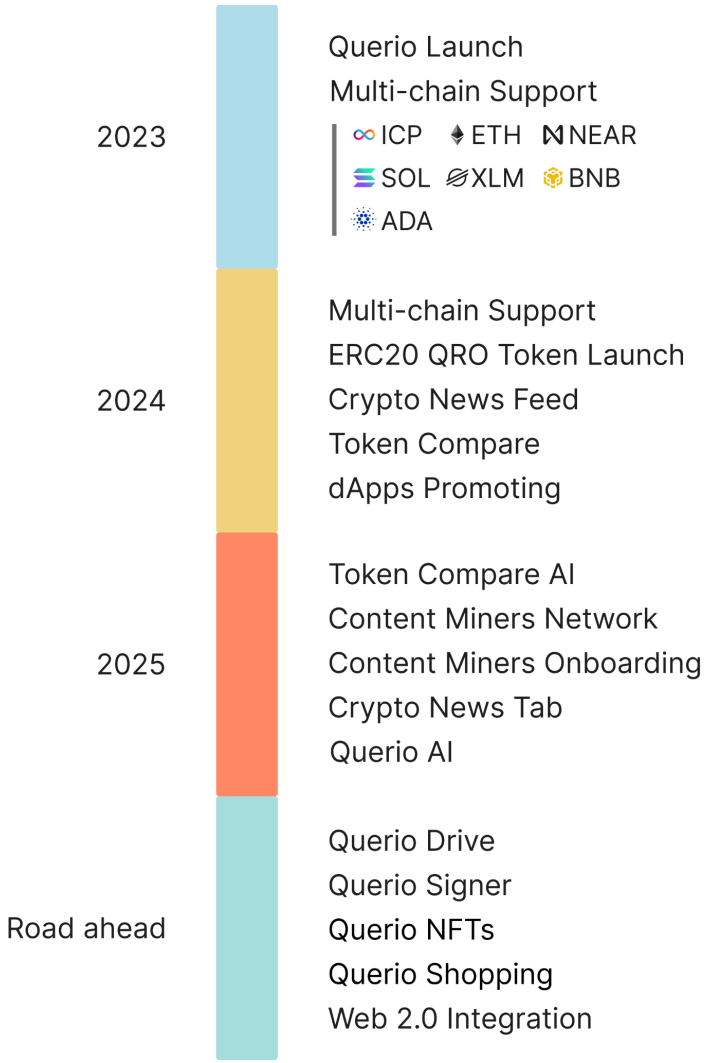
- **NFT Transactions on Querio Shopping**: Within Querio Shopping, users can buy and sell NFTs using QRO tokens. This enables seamless and secure transactions, facilitating the vibrant marketplace for digital collectibles and unique assets.

5. Roadmap

The roadmap for Querio, outlined in Figure 7, provides a structured timeline and detailed plan for the platform's development and feature releases. It encompasses the launch of the *decentralized network of content miners*, alongside *miner onboarding*. Key features set to be rolled out include *Token Compare*, which offers a detailed comparison of software and financial activities across blockchains and dApps that have a token representative, and *Token Compare AI,* which leverages artificial intelligence for advanced analytics and insights. The introduction of *dApps Promoting* will spotlight promoted dApps directly to users, while the *Crypto News Feed* feature will aggregate and present the latest news in the Web3 space.

Additionally, *Querio Drive* will provide secure and decentralized data storage options, *Querio Signer* will facilitate decentralized document signing, *Querio NFTs* will offer a dedicated platform for exploring NFTs, and *Querio Shopping* will serve as a marketplace for buying and selling NFT items, and ultimately the integration of Web 2.0 content.

Figure 7: Roadmap



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- **Multi-chain Support** - involves the ongoing integration of dApps developed on various blockchains. This item on Querio's roadmap will be continually expanded as new blockchains appear.

- **ERC-20 QRO Token Launch** - facilitated through an Initial Exchange Offering (IEO). This approach involves partnering with a cryptocurrency exchange platform to offer QRO tokens directly to investors and traders.

- **Crypto News Feed** - designed to aggregate and present Web3 news directly on the Querio homepage. The inclusion of this dynamic component showcases the platform's commitment to supporting the growing Web3 community with tools and resources that are both informative and easily accessible. It fosters a well-informed user base that can make knowledgeable decisions in the fast-paced world of cryptocurrency and blockchain technology.

- **Token Compare** - is an innovative platform designed to disrupt how software activity is compared across various blockchains & dApps that have a token representative. This platform stands out by offering a comprehensive view of both open-source developers' activities sourced from GitHub and financial information sourced from CoinMarketCap.

  A key differentiator for Token Compare is its focus on community contributions, not just on the developments of the core team, as the existing platforms do. This is a significant aspect because community involvement is often a strong indicator of a blockchain project continuity and success. By tracking and analyzing the contributions and activities of the broader community, Token Compare provides a more comprehensive view of the blockchain project ecosystem.

  This feature enables users to gain insights into not only the technical advancements and updates of various blockchain projects but also the level of community interest and participation. Such a dual approach is beneficial for users who are looking to understand the full spectrum of activity and health within a blockchain project, ranging from developer commitment to community enthusiasm and involvement.

  In summary, Token Compare offers a unique and comprehensive way to evaluate and compare tokens by combining detailed information on developer activity with insights into community contributions, going beyond the limited scope of existing platforms that focus mainly on core team activities.

- **dApps Promoting** - enables the possibility to promote dApps that closely match the queried keywords. Matching dApps will appear prominently among the top results. The promoted dApps will be tagged as “Promoted”. Additionally, an auction mechanism will enable users to bid for a dApp spot in the featured dApps section on the homepage.

- Sort By - add the possibility to sort dApps by newest, most popular, recently updated for all the supported blockchains or a particular one.

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- **Token Compare AI** - The AI Predictions module of Token Compare is an advanced feature designed to keep users informed by leveraging both software activity and financial data across a diverse range of dApps and blockchains that have a token representative. This module uses the power of artificial intelligence to analyze vast amounts of data related to blockchain projects.

- **Decentralized Network of Content Miners** - this will empower content miners to provide verifiable content that will supply Querio's search engine with the latest dApp data, ensuring that search results remain up-to-date. Once validated the content will fuel the search engine of Querio. The validation process of decentralized content will be designed to be reliable and trusted. The functional architecture comprises several components, such as content miners, blockchain specific bots, content scrapers and the publisher.

- **Content Miners Onboarding** - create the platform that enables users to become miners and keeps miners updated on their incentives and ranking. This involves establishing the mechanism to incentivize miners to join the decentralized network of content miners.

- **Crypto News Tab** - introduce a new tab on the search results page, enabling users to search for Web3 news. This feature not only allows for real-time news searches but also offers the capability to explore an extensive archive of cryptocurrency news.

- **Querio AI** - bring the power of artificial intelligence into the Web 3.0 world. Querio's knowledge will feed the Querio AI module with data already collected from the multitude of blockchains it supports. Alongside UX/UI creation for the new module, the Querio team will build the software architecture of Querio AI that aims to establish a robust and well-structured foundation for the AI module's functionality and performance. This module will continue its development in 2026.

Road Ahead

- **Querio Drive** - empowers users to easily store data on Internet Computer, providing a user-friendly solution. It is set to compete with existing data storage solutions such as IPFS and Arweave, and to become a competitive and viable alternative in the decentralized data storage market.

- **Querio Signer** - is a module of Querio, designed to offer decentralized document signing capabilities. It facilitates the exchange of contracts and signed documents, streamlining and decentralizing document-based processes. Querio Signer aims to revolutionize how agreements are executed in a decentralized digital environment.

- **Querio NFTs** - an additional tab in the Querio search results page for searching through NFTs. This function allows users to easily explore and discover NFTs across various platforms, offering a streamlined and efficient way to engage with the growing world of digital collectibles and art.

- **Querio Shopping** - is envisioned as the ultimate marketplace for NFT transactions. Enables users to effortlessly explore and engage with NFTs, offering a user-friendly experience that opens up a world of endless creativity and digital ownership in the NFT space.

- **Web 2.0 Integration** - bring Web 2.0 & Web 1.0 content to Querio and start offering a compelling alternative to existing Web 2.0 search engines.