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RIDE
Rights of Internet of Everything

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Governing Decentralized Complex Queries Through a DAO

Overview

1. Introduction
2. Hypercube DHT
3. DAO Framework
4. Conclusion

Introduction

General Problem → Possible Solution

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- increasingly used to create **common, decentralized** and **trustless** infrastructures
- high data **availability**, but also **integrity**, **auditability**, **confidentiality**
- ability to **automate and enforce** processes (through smart contracts)

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2) there are **no diffused efficient mechanisms to query** a certain type of data, that do not involve **centralization** (e.g. index data in a central database)

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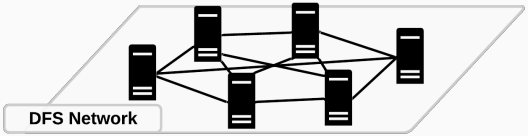
- A **Decentralized Autonomous Organization (DAO)** → **smart contracts** to manage rewards and organizational decisions.

Hypercube DHT

Multiple Keyword Search

DFS **P2P** network → IPFS is using **Content Based Addressing**, i.e. items are directly queried through the network rather than establishing a connection with a server



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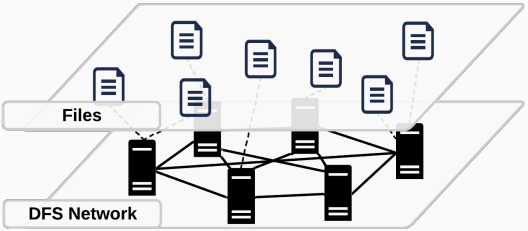

The P2P network that runs the IPFS protocol, stores and shares files in the form of **IPFS objects** that are identified by a **Content IDentifier (CID)**, obtained through an **hash** function.

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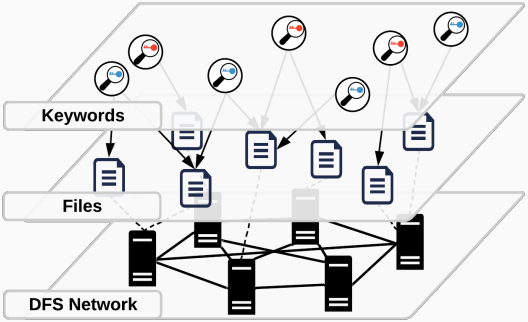

We can **map keywords** to any **IPFS Object** $o \in O$ using a keywords set $K_o \subseteq W$ (keyword space W).

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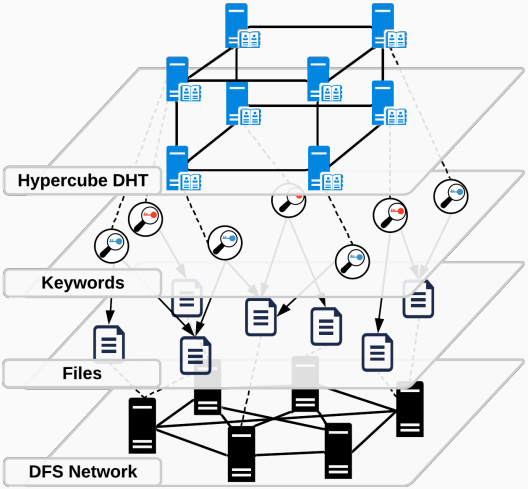

A DHT can be exploited to perform **multiple keyword based queries**. In particular one that takes the form of a r-dimensional **hypercube** $H_r(V, E)$.

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- E.g.: $o = QmbW...MnR$, $K = \{\text{“Wikipedia, Rome”}\}$
  $h(Wikipedia) = 3, h(Rome) = 5$
  K is represented by $u = 000101 \Rightarrow$ **DHT stores (000101,*QmbW...MnR*)**

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- network topology $\rightarrow$ $H_r(V, E)$ **hypercube**
- **V** set of vertices that represent **logical nodes**
- **E** set of edges formed when two vertices differ of only one bit (they are also network **neighbors**), e.g. 1011 and 1010.

Keywords Queries

- **Pin Search** - $\{o \in O \mid K_o = K\}$
  gets all and only the objects associated with a keyword set K
  e.g. *pinSearch({Wikipedia, Rome})* = (*000**1**01*,*QmbW...MnR*), (*000**1**01*,*QmbP...3Lx*), ...

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- **Superset Search** - $\{o \in O \mid K_o \supseteq K\}$
  also gets objects that can be described by keywords sets that include K
  e.g. *superSetSearch({Wikipedia, Rome})* = (*000**101**,QmbW...MnR*),
  (*000**111**,QmbZ...aaD*), ...
  with a limit l of objects.

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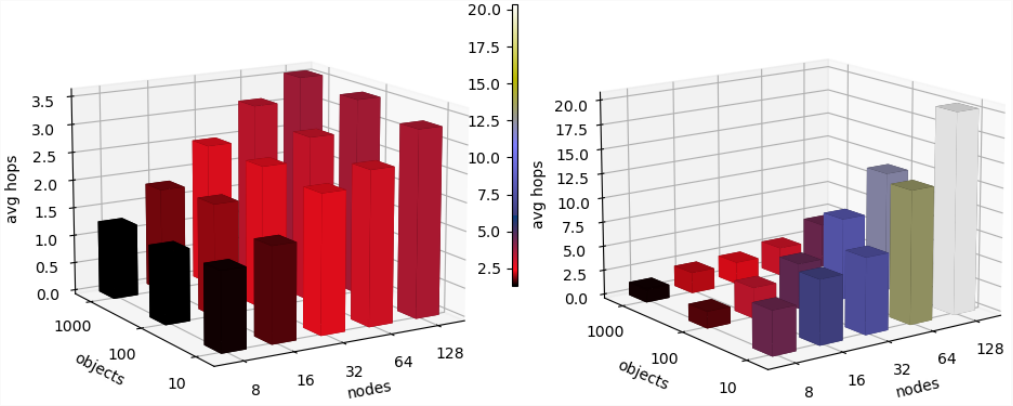
- For each type of test → 50 repetitions

Pin Search

Superset Search



- order of the **logarithm of the hypercube logical nodes number** $\rightarrow \frac{\log(n)}{2} = \frac{r}{2}$

- plus the average hops to get from the **responsible node** to all the nodes that that include *K*, until the **limit** *l* is reached

DAO Framework

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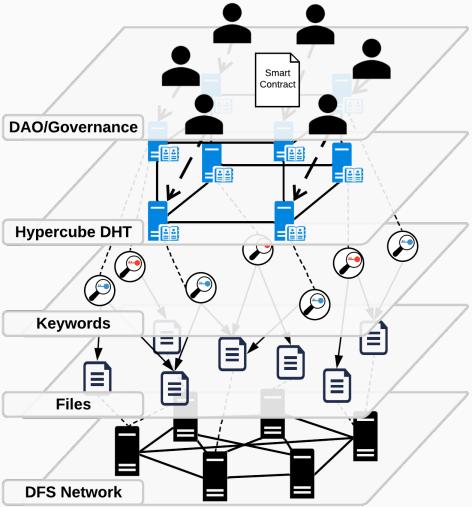
- Smart contracts can be used to **automatize** and **supervise** the exchange of digital or physical assets, e.g. **tokens**, and to allow the management of a DAO.
- **Decentralized Autonomous Organizations** (DAO) → members can make proposals and also vote those through transparent mechanisms.

DAO Framework → Fifth Layer



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- **Members Registry** - Any account holding any amount of token can lock some of (or all of) these tokens for a desired amount of time through a specific time-lock contract.
- **General Voting** - This contract allows any member to make a **proposal** and gives everyone the opportunity to submit a suggestion to **vote** regarding that proposal. A member **vote weight** is proportional to the amount of tokens locked.
  For instance, DAO members can vote to transfer some staked tokens to a specific account in the case of issuing a bounty.

Use Cases

- **DeFi-based rewarding** - Using a DeFi protocol such as Uniswap, the DAO's token can be automatically exchanged and new Liquidity Pool (LP) tokens will be minted. By locking these LP tokens, the DAO members enable the growth of the token in value and credibility (as a form of auto-financing).

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- **Unique DAO vs. DAO islands**
  - unique DHT network is governed by a single DAO, with the purpose of assisting different DFS, DLTs and other storages
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- **Decentralized IPFS-search** - By monitoring the file addition logs, these nodes can download these newly added files and extract the metadata in order to obtain keywords that are then stored in the hypercube DHT with the associated CID.

Gas cost

Smart Contract	Operation	Cost (gas)
ERC20	transfer()	51167
TokenTimelockProxy	lockTokens()	232024
TokenTimelock	release()	25626
Voting	submitProposal()	133501
Voting	submitSuggestion()	114523
Voting	vote()	142848
Voting	executeProposal()	56991

Table 1: DAO smart contracts operations cost in terms of gas.

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- **DAO** → related to the economic sustainability and development of the above system.
- DAO ERC20 tokens allows to reward nodes that have actively contributed.
- Future works → "pay-per-query" model and load balancing with a more realistic content distribution.