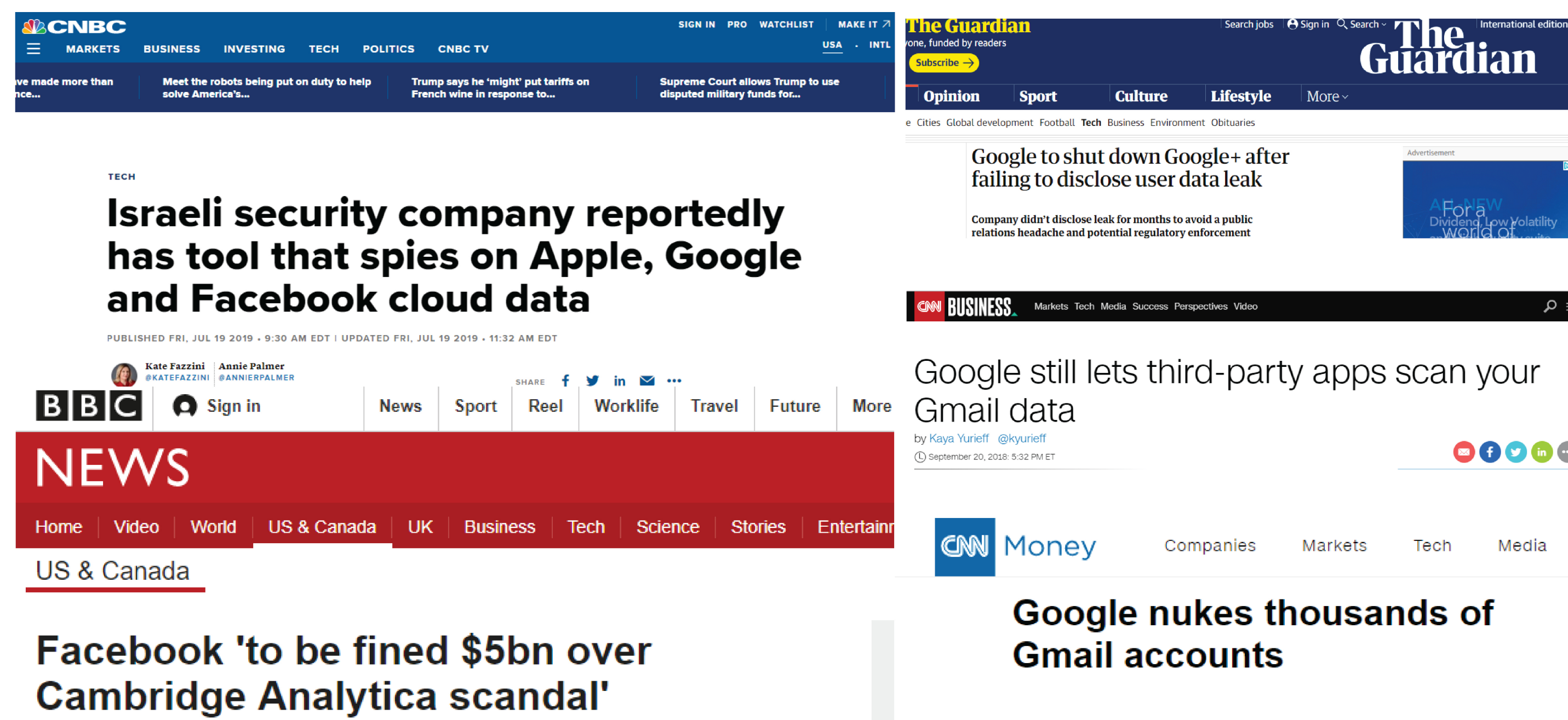


A Blockchain-Based Adaptive Middleware for Optimal Data Storage Selection for Internet of Things

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Large Scale IoT Data Storage Problem

- IoT applications generates **terabytes of heterogeneous data**, which brings storage challenges.
- IoT applications have **different service requirements** in terms of performance, security, privacy, availability and price.
- Relying on a **single cloud storage** puts limits on the applications, which could be alleviated by another storage solution.
- Moreover, **cloud is vulnerable** to data breach, data leakage, data modification and availability.
- Multi-cloud storage architecture has recently been proposed to solve this problem, but this approach has limited impact due to the lack of differentiation between competing cloud solutions.



Leading Question

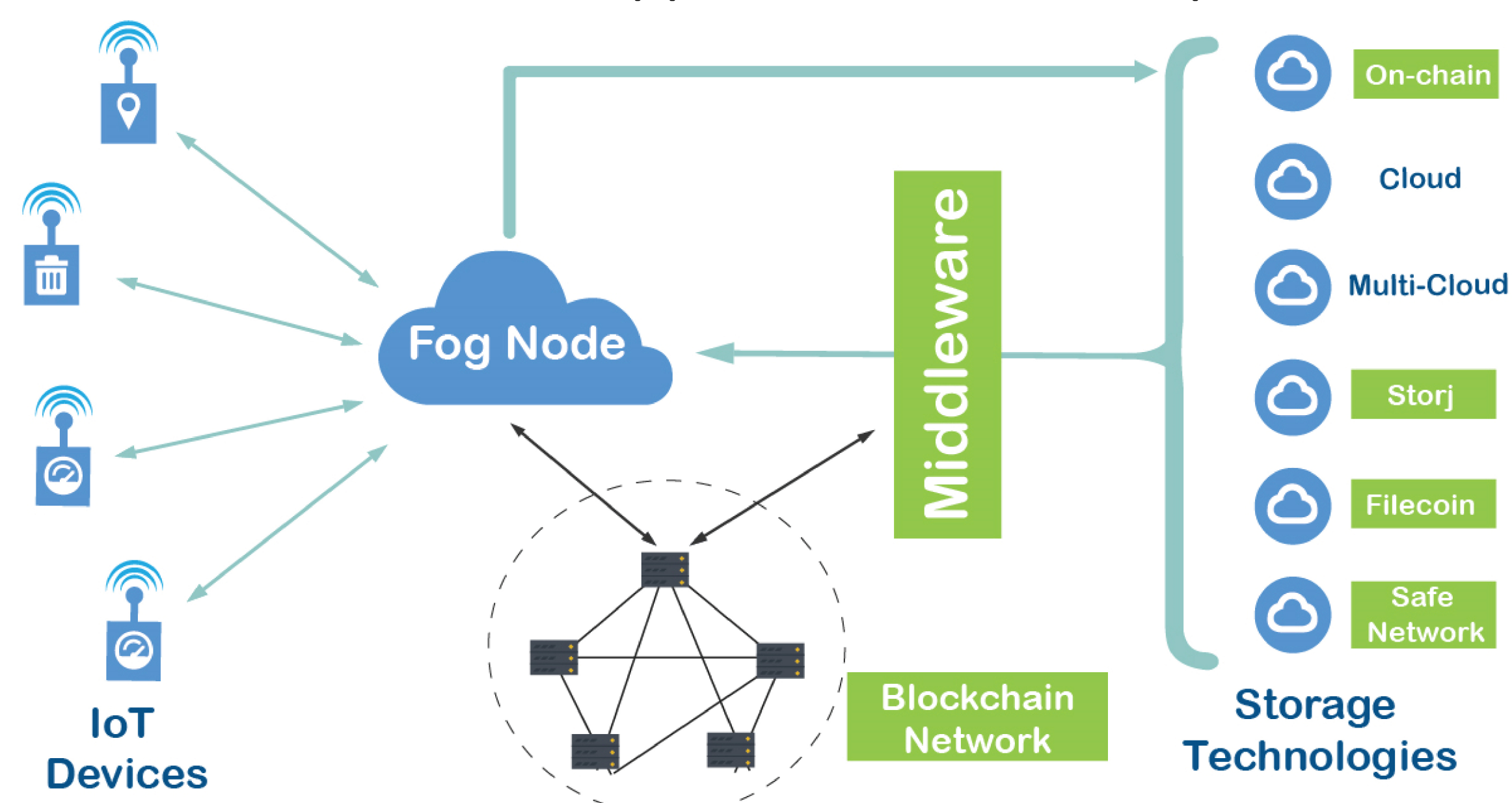
What can be the alternative for Cloud storage and Multi-cloud?

Blockchain-based Middleware

- **Decentralized storage technologies** are popular nowadays. These competing decentralized storage mechanisms range from partially decentralized to fully decentralized to blockchain-based solutions.
- These solutions provide **better security and privacy** as compared to the traditional cloud architectures. Moreover, these decentralized solutions are **lower priced** compared to cloud.
- We want to propose a middleware to perform **intelligent storage technology selection** at the fog nodes.
- Based on the requirement of IoT use cases, the middleware makes a decision about which storage technology should be utilized.
- We formulate an Integer Programming **multi-objective decision optimization problem** to optimally select the data storage for IoT applications. We prove our optimization problem to be **NP-hard**.

Middleware Architecture

- **Fog Nodes** operate near IoT devices edge and assist in performing real-time computation and extraction of time-sensitive information from raw IoT data.
- **Blockchain** is employed to provide traceability and auditability for the IoT data and the storage selection decision.
- **Storage Technologies** represent list of available storage technologies, which we can use to store large scale IoT data.
- **Adaptive Middleware** is directly connected to fog nodes, storage technologies and blockchain network. It continuously monitors the characteristics of storage technologies and select optimal storage solution based on the IoT application service requirements.



Overview of Decentralized Storage Technologies



The table given below provides the comparison between Cloud, Storj, Filecoin and Safe network.

Storage	Decentralization	Blockchain	Smart Contract	Anonymity	Price Decision
Cloud	Centralized	No	No	No	Cloud
Storj	Partially Decentralized	No	No	No	Storj
Filecoin	Fully Decentralized	Yes	Yes	No	Storage Nodes
MaidSAFE	Fully Decentralized	No	No	Yes	Safe Network

Middleware Design Components

