USC Viterbi
School of Engineering
Center for Cyber-Physical Systems and the Internet of Things

Towards a Decentralized Data Marketplace for Smart Cities

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Invited paper presented at the 1st International Workshop on BLockchain Enabled Sustainable Smart Cities (BLESS 2018)

Internet of Things (IoT) in Cities

- Applications and uses for IoT, involving real-time data streams, are growing:
  - Vehicular traffic sensing
  - Parking Meters
  - Security
  - Air quality monitoring
  - Smart Trash Cans

IoT 1.0 and Challenges

- IoT 1.0: A single organization deploys and maintains devices, network, middleware, cloud-based processing, end-user application

- This is a data siloes approach that does not scale and inhibits technology deployment.

- Cities are leery of single-vendor lock-in

An IoT Community Marketplace for Smart Cities

For more details, please visit http://i3.usc.edu/

Interoperability at the Data Layer

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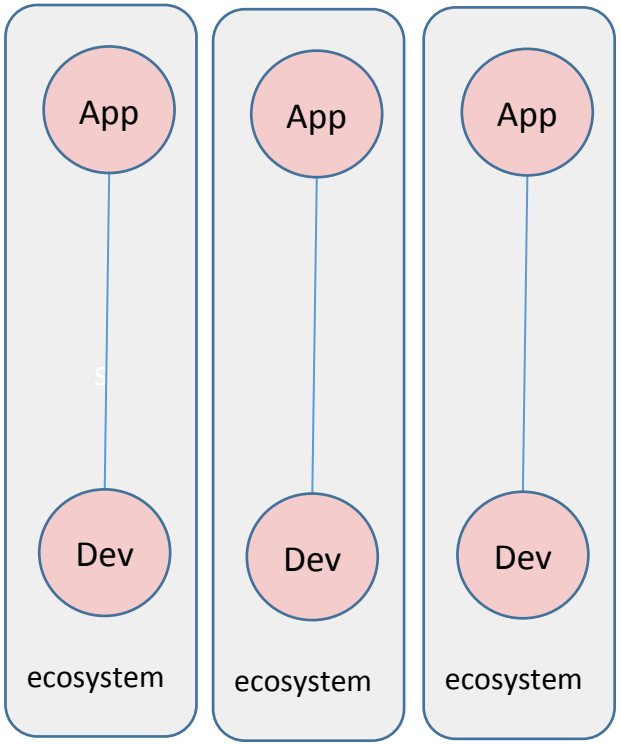

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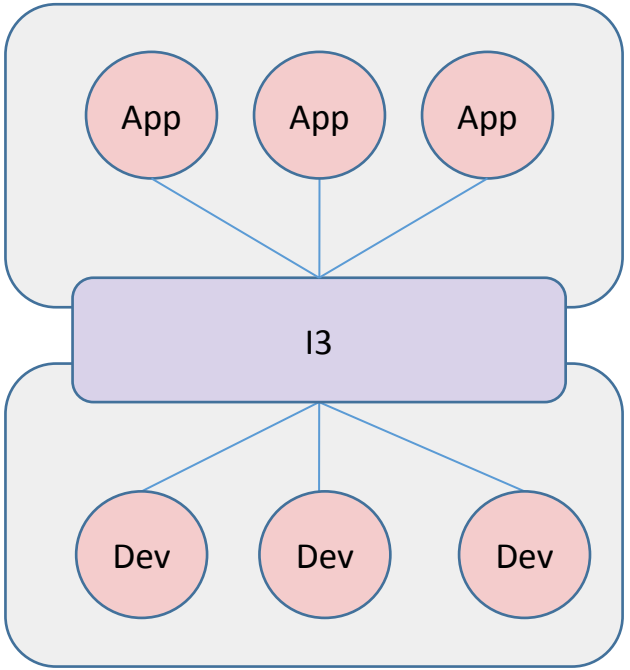


http://i3.usc.edu/

Blockchain has introduced new capabilities

- Digital Micropayments and Incentive Mechanisms
- Decentralized Ledger
- Smart Contracts
- Trust without Third Parties
- Token Curated Registries
- Decentralized Identity Management

In this paper, we are exploring whether and how we can build a truly decentralized IoT data marketplace for smart cities, and what such a marketplace would look like.

What does Decentralized mean? What are the possible Benefits?

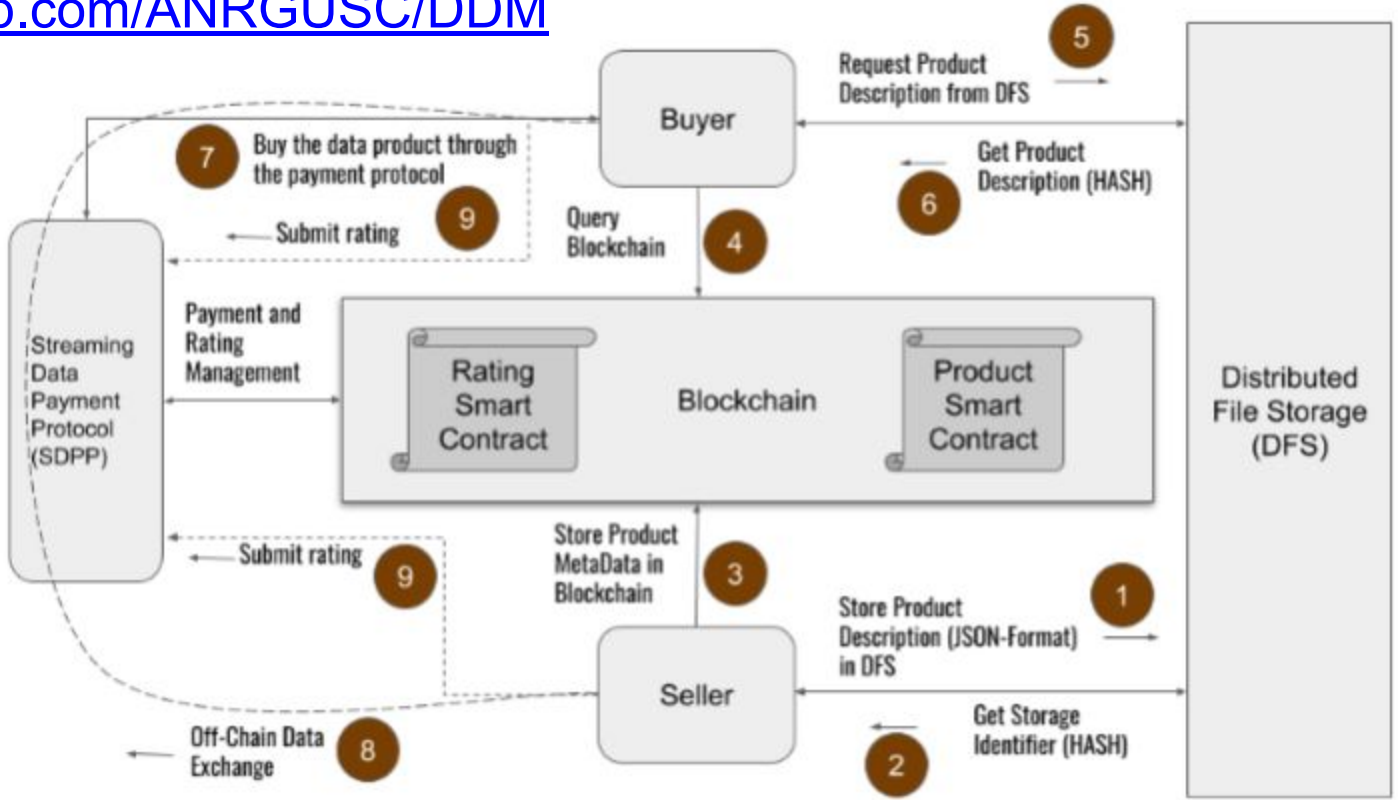
- The marketplace doesn’t depend on a central server hosted by a “trusted” third-party
  - Resistant to data tampering
  - Minimize manipulation of ratings, recommendations
  - Eliminate monopoly power of market platform operators

- Peer to peer data connections with seamless payments for streaming data

Decentralizing Data Marketplaces

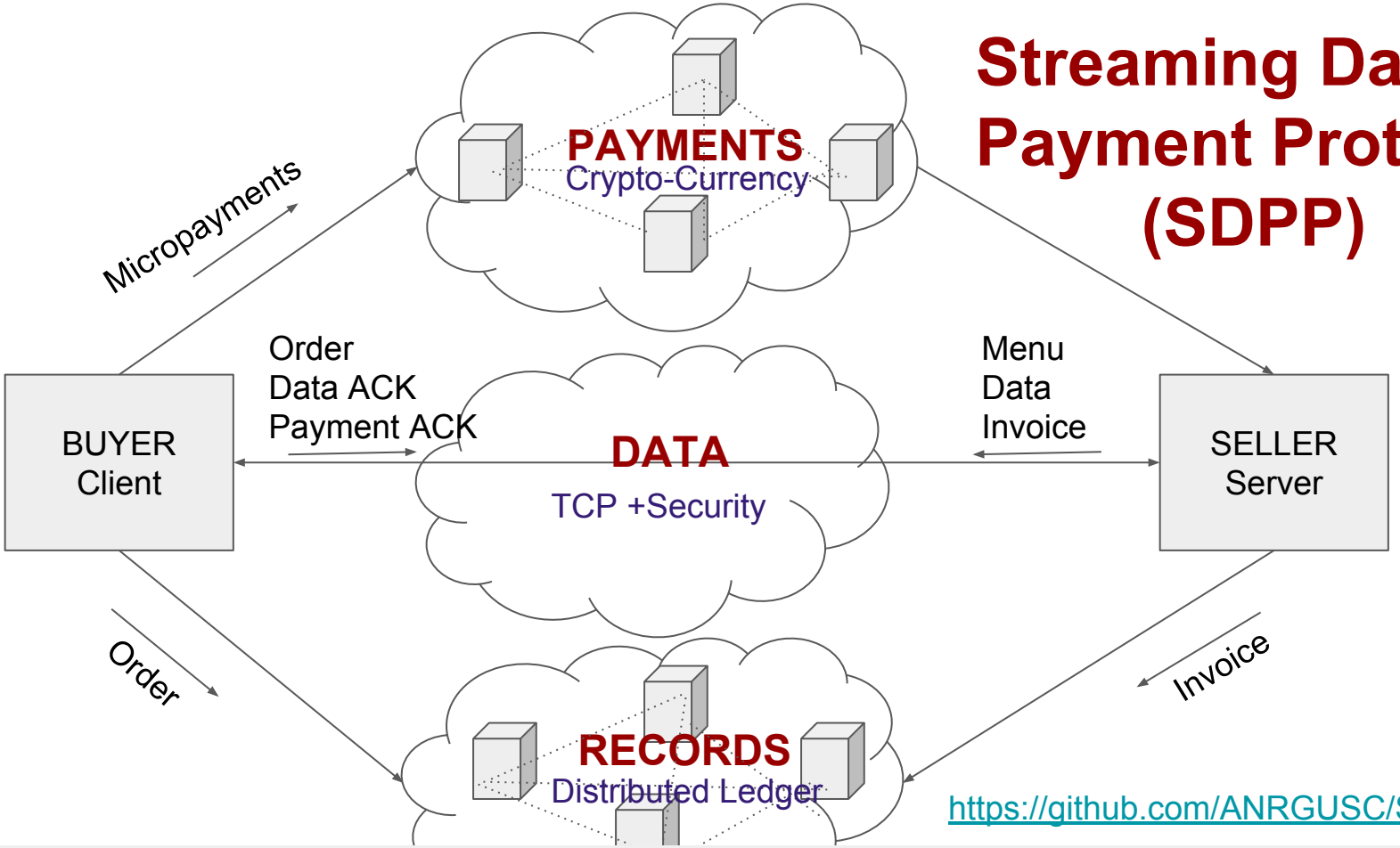
Decentralized Data Marketplace (DDM)

https://github.com/ANRGUSC/DDM



Gowri S. Ramachandran, Rahul Radhakrishnan, Bhaskar Krishnamachari, "Towards a Decentralized Data Marketplace for Smart Cities," Invited paper at The 1st International Workshop on BLockchain Enabled Sustainable Smart Cities (BLESS 2018), Kansas City, MO, USA, Sept. 19, 2018, held in conjunction with the 4th IEEE Annual International Smart Cities Conference (ISC2 2018).

Streaming Data Payment Protocol (SDPP)



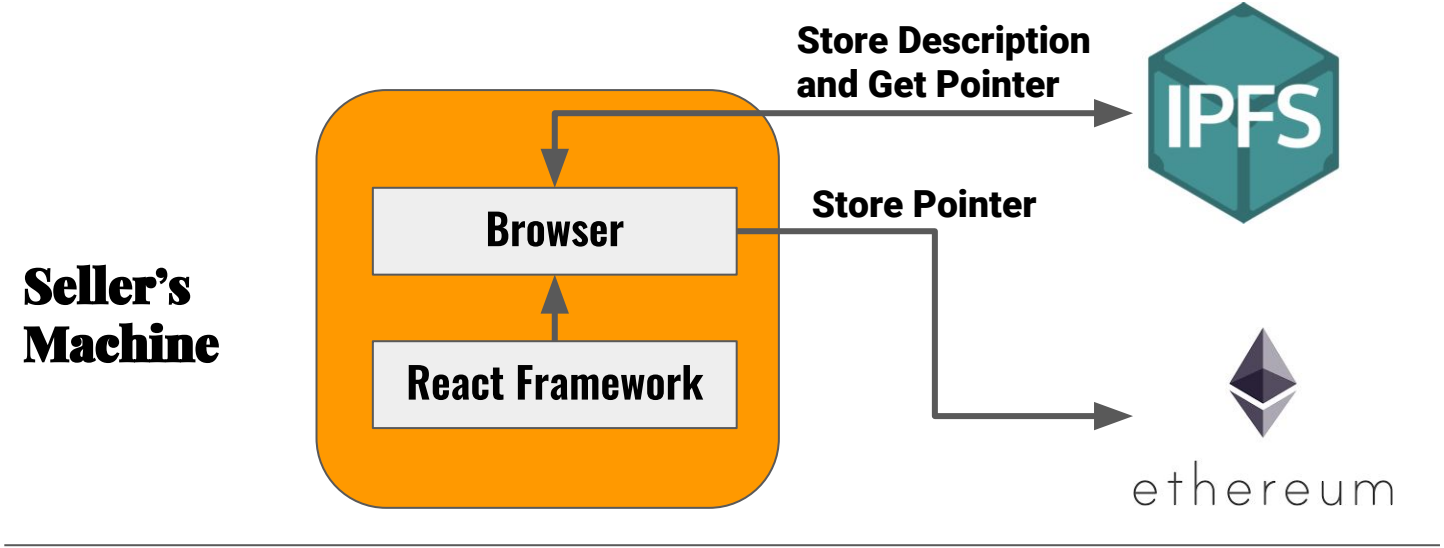
https://github.com/ANRGUSC/SDPP

Rahul Radhakrishnan, Bhaskar Krishnamachari, "Streaming Data Payment Protocol (SDPP) for the Internet of Things" BIoT 2018: The 1st International Workshop on Blockchain for the Internet of Things, held in conjunction with IEEE Blockchain, Halifax, Canada, 2018.

Proof of Concept Implementation of a Decentralized Data Marketplace

- We have built a proof of concept including:
  - Ethereum smart contract for posting and querying seller data
  - Metadata stored in IPFS, pointer on the blockchain
  - Front-end built using Javascript (React JS framework) - compatible with web browsers but not talking to a centralized web server
  - Pairwise buyer-seller interaction: data streaming and payment using SDPP - JS client using websockets to communicate with Python server

Pavas Navaney helped with Ethereum, Front-end design by Tianbo Zong, Winny Huang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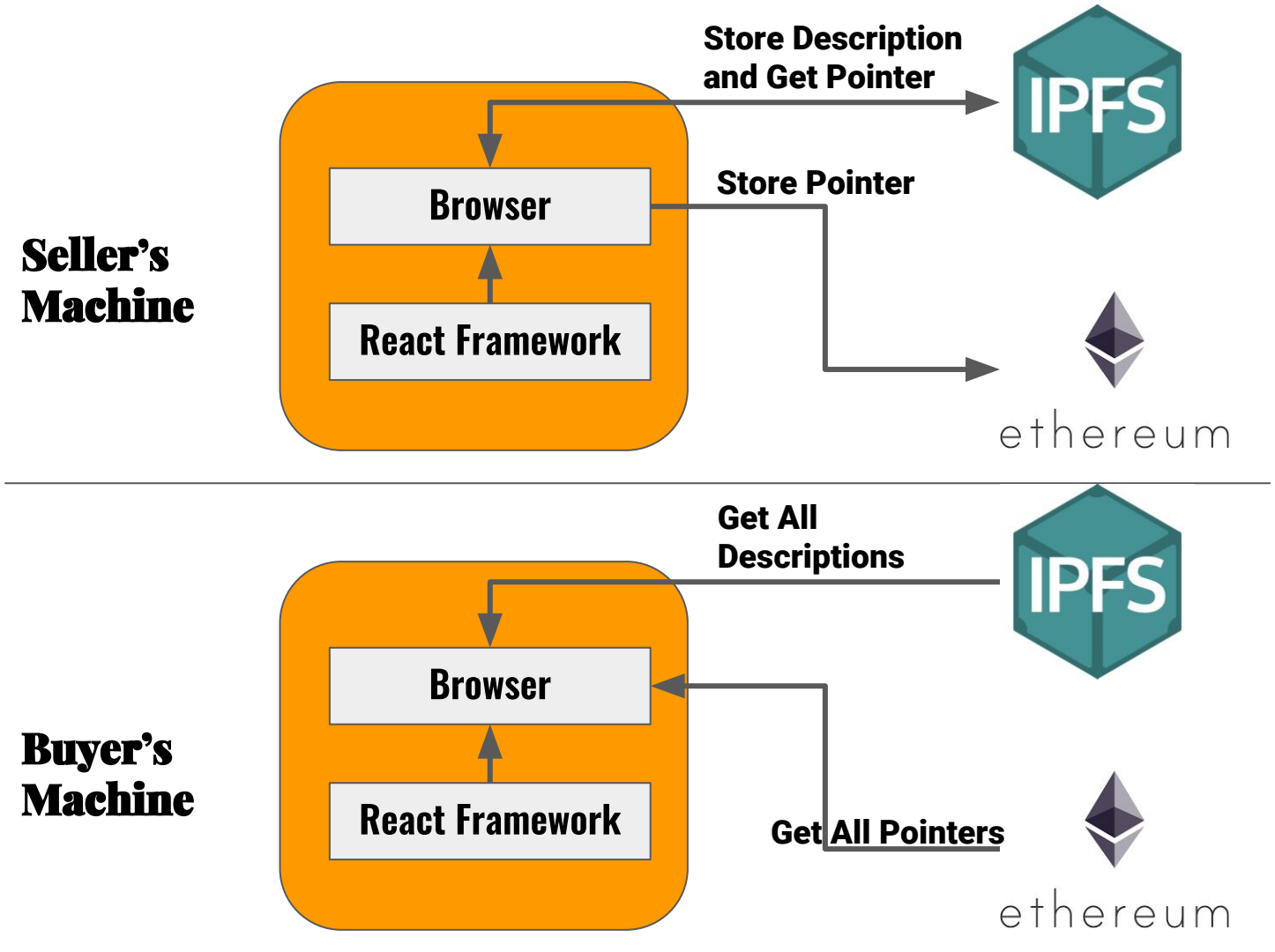
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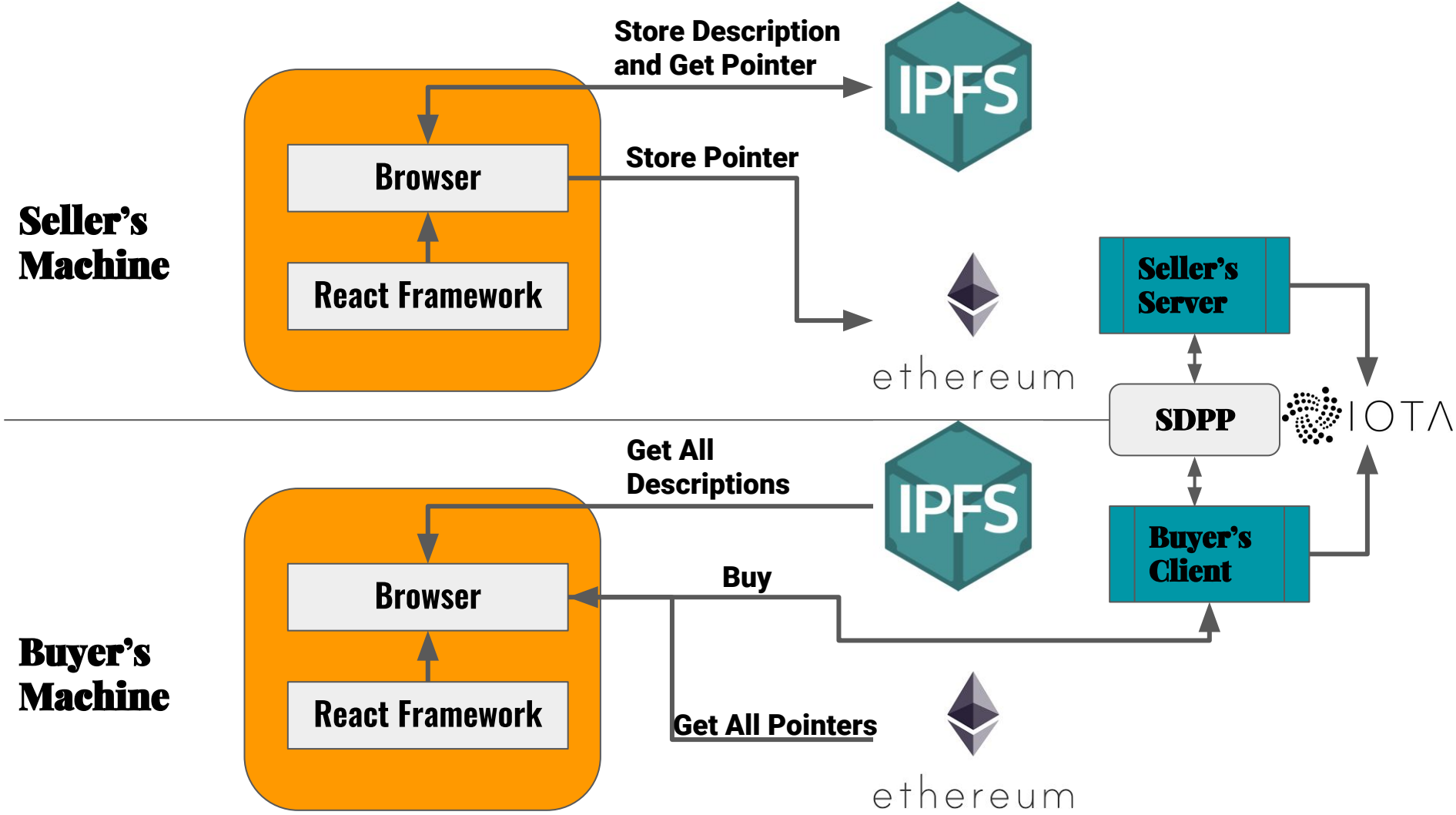
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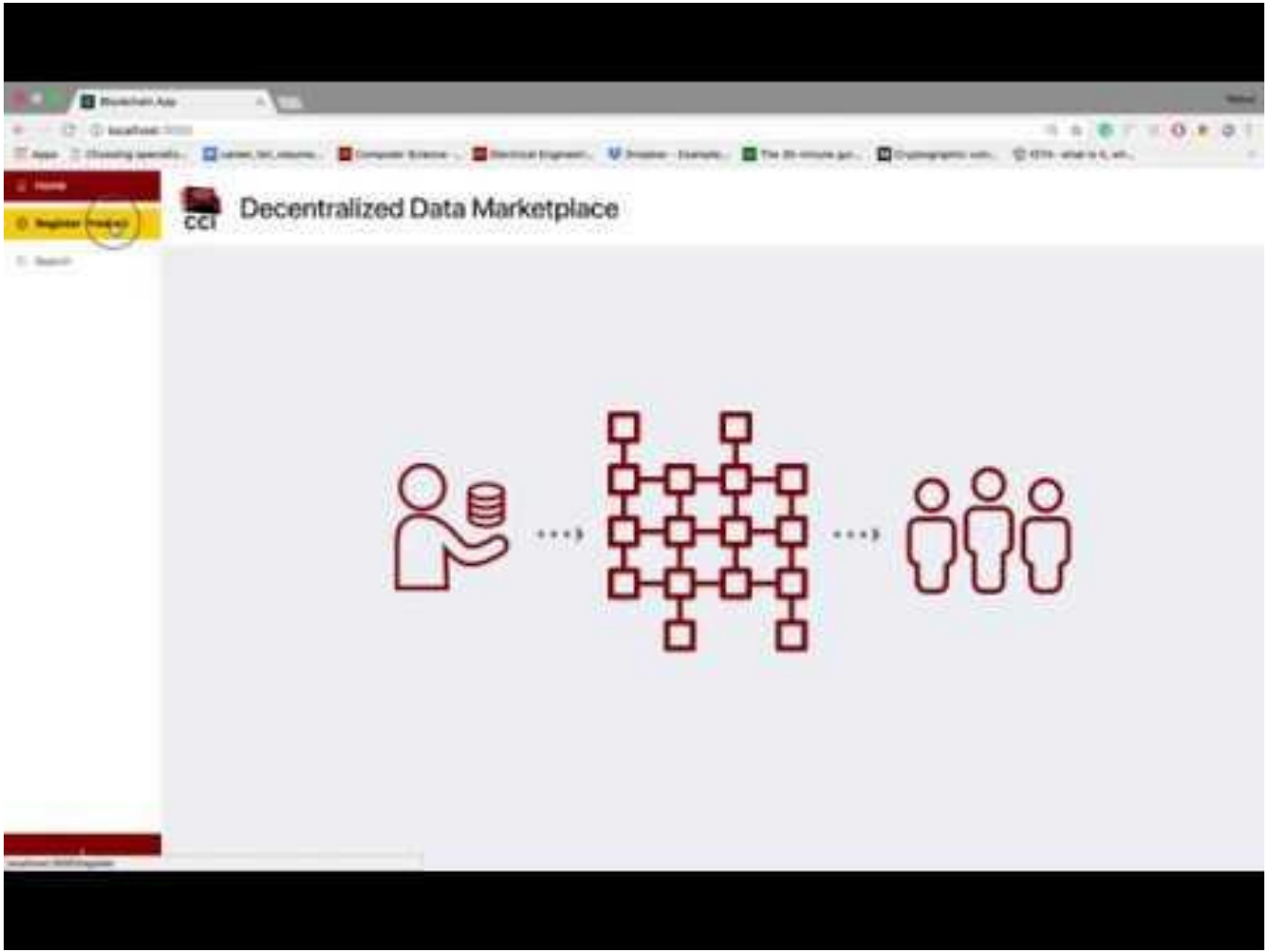
Decentralized Data Marketplace

Conclusions

- We have developed and demonstrated what to our knowledge is the first Blockchain-based decentralized marketplace for IoT Data

- We are working to develop and incorporate decentralized reputation and curation mechanisms to prevent Sybil attacks and spamming

- Other open topics to be explored include decentralized search engines for large-scale marketplaces, incorporating privacy and data use policies, and connections to edge computing and stream processing for data analytics