Smart Contract Based Decentralized Parking Management in ITS

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Overview

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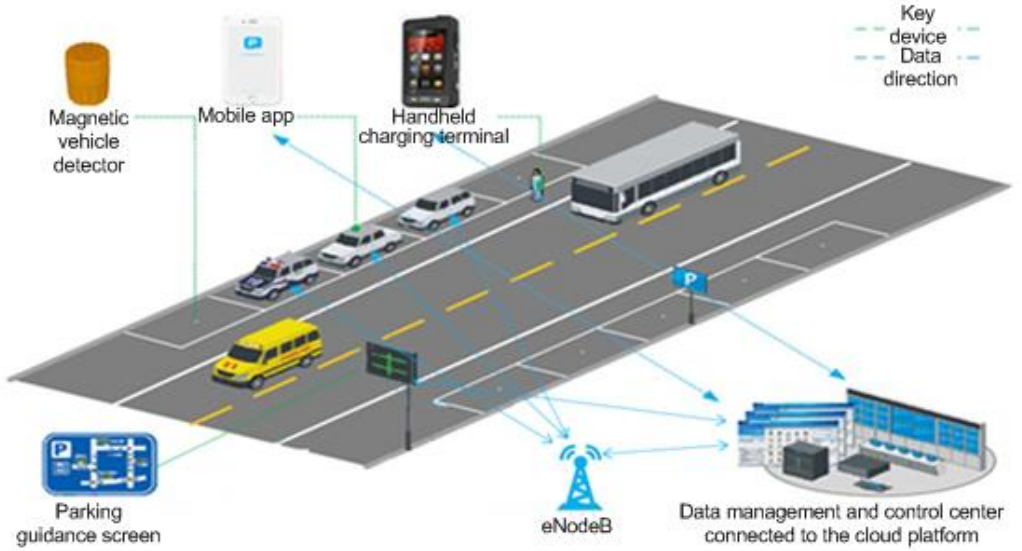
Parking

- Due to rise in the number of smart vehicles on the road, ITS is becoming a necessity.
- Problem of Parking: Much more prominent in urban areas and major causes of traffic congestion and air pollution
- Finding space: Much more difficult and frustrating to the drivers.

Source: styleweekly.com

Problem Statement

- Current cloud based Parking Services are prone to single point of failure
- Have availability issues.
- Customers does not have freedom to compare
  - Quality and
  - Cost of services
- Installation and Maintenance are costly.
- Lack of transparency



Source: China Unicom Shanghai

Motivation

- Implement a Decentralized System to provide
  - High availability.
  - Transparency to the system.
  - Common Platform to service providers and customers.
  - Better parking services to the drivers.
- Enable Individuals/small parking lots provider a platform to provide the service.
- Removing the need of trust on untrusted and unknown parties.

Related Work

- There exist a significant number of work for centralized parking management using technologies such as
  - Wi-Fi.
  - WSNs. [12, 15, 18]
  - RFID. [10]
  - IoT [3,5,14]

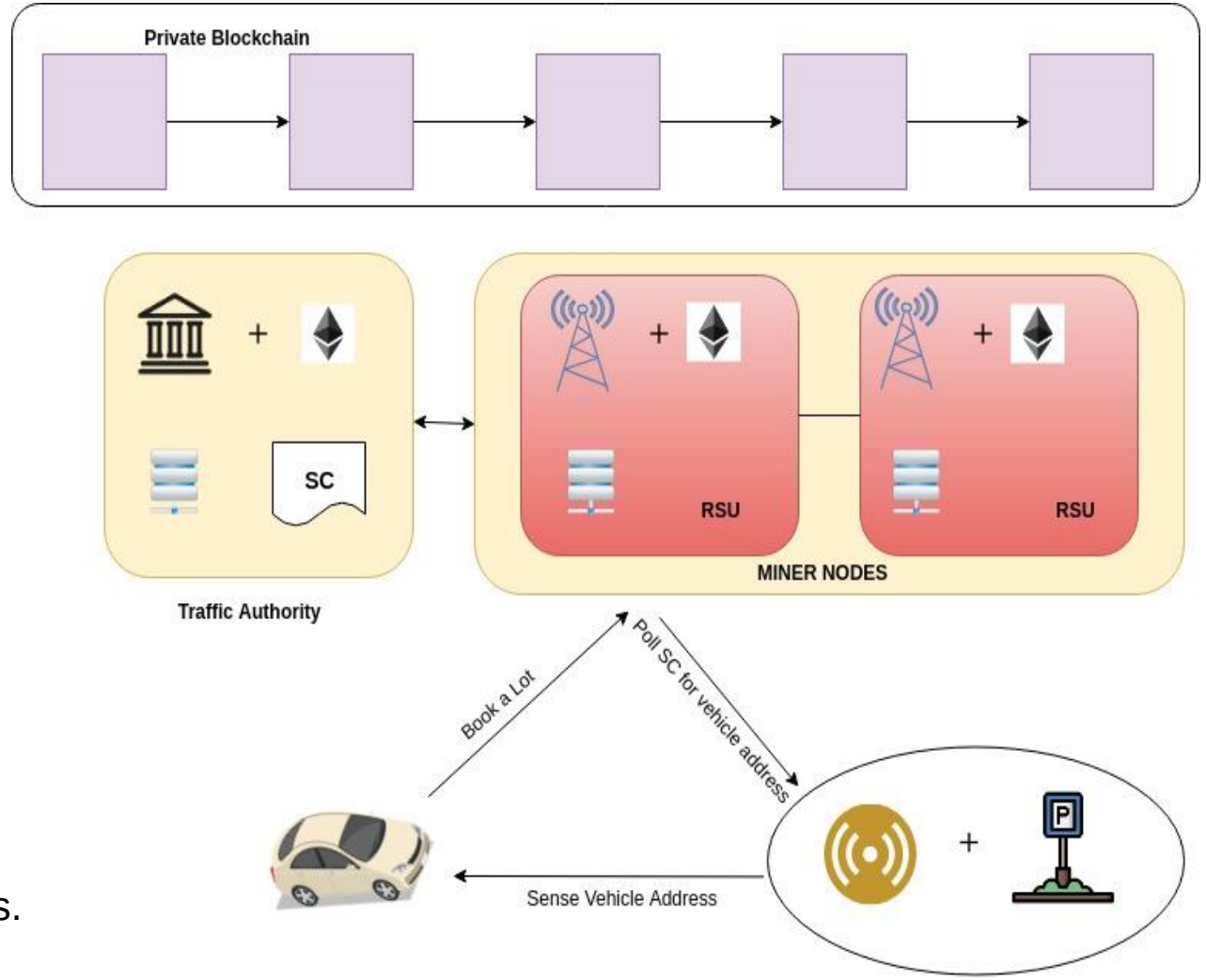
- Very Few Studies proposed decentralized architecture. [1]

- No significant contribution in the domain of parking management systems using blockchain technology [2]

- Blockchain with smart contracts has the potential to felicitate security (from inside and outside attack), availability, reliability, and trust in the parking systems

Proposed System Architecture

- **Traffic Authority :**
  - Deploys RSU and Smart Contract,
  - Does vehicle registration,
  - Does parking lot registration.
- **RSUs:**
  - Primarily maintains the Blockchain .
- **IoT Device at Parking Lot :**
  - Senses the vehicle address and checks status from the blockchain.
- **Intelligent Vehicle :**
  - Executes transactions for various Parking processes.



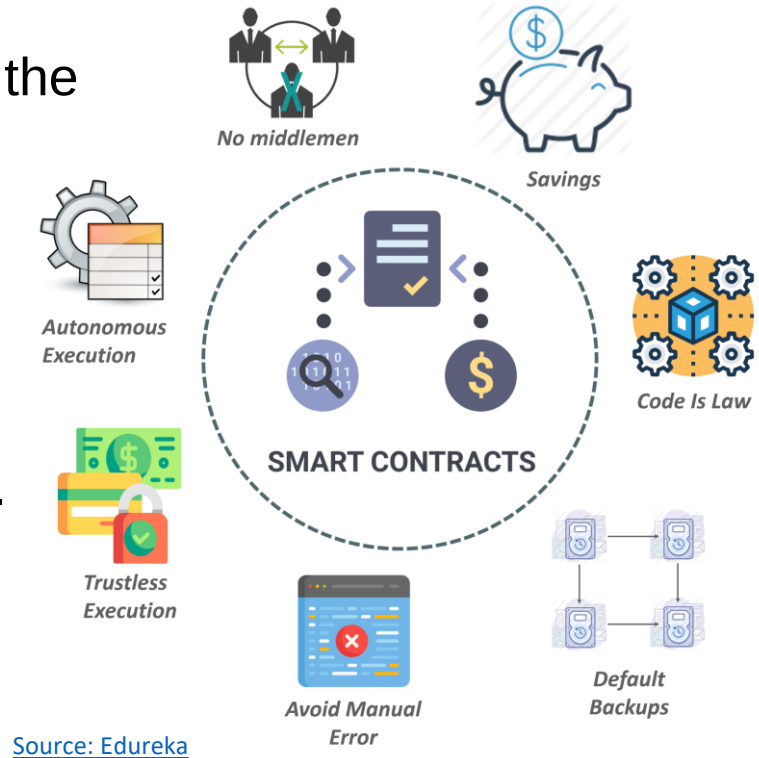
Blockchain Technologies Used

Ethereum:

- Public permissionless blockchain platform allows to setup a private and permissioned instance of the chain.
- Supports smart contracts (application specific code deployed on the blockchain).

Smart Contract:

- A bunch of self-executable code sitting on top of a blockchain.
- Consists of well-defined conditions and their corresponding actions.
- Triggered by the Transactions.



Source: Edureka

Experimental Setup

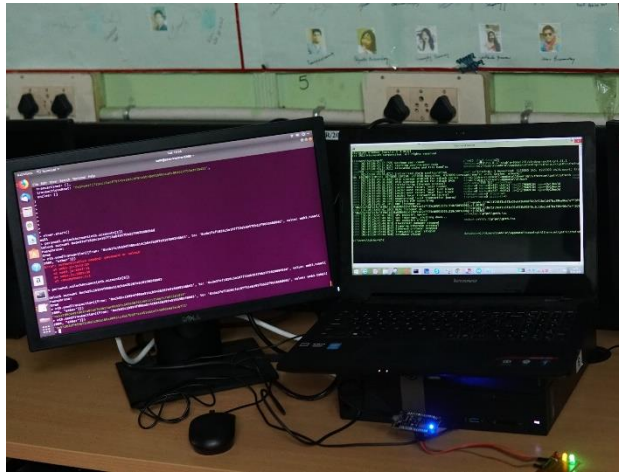


Fig. 3. Full node and miner setup

Fig. 4. Vehicle OBU

Fig. 5. IoT device at parking lot

Table 1. Devices and their Role

Device name	No. of device	Geth version	Role
Dell-Vostro (8 GB RAM, i7-7700 CPU, 1 TB HDD)	1	v1.8.17-stable release	RSU/TA
Lenovo G-5080 laptop (4 GB RAM, Intel Core i5 processor, 1 TB HDD)	1	geth-linux-amd64-1.8.22	RSU
Raspberry Pi 3	1	geth 1.8.18 ARMv7	Vehicle OBU
nodeMCU	1		IoT device

System Characteristics

- Search for availability of a parking lot in an area.
- Can view the price charged by a parking lot.
- A driver can book a parking lot.
- A driver can cancel a booking.

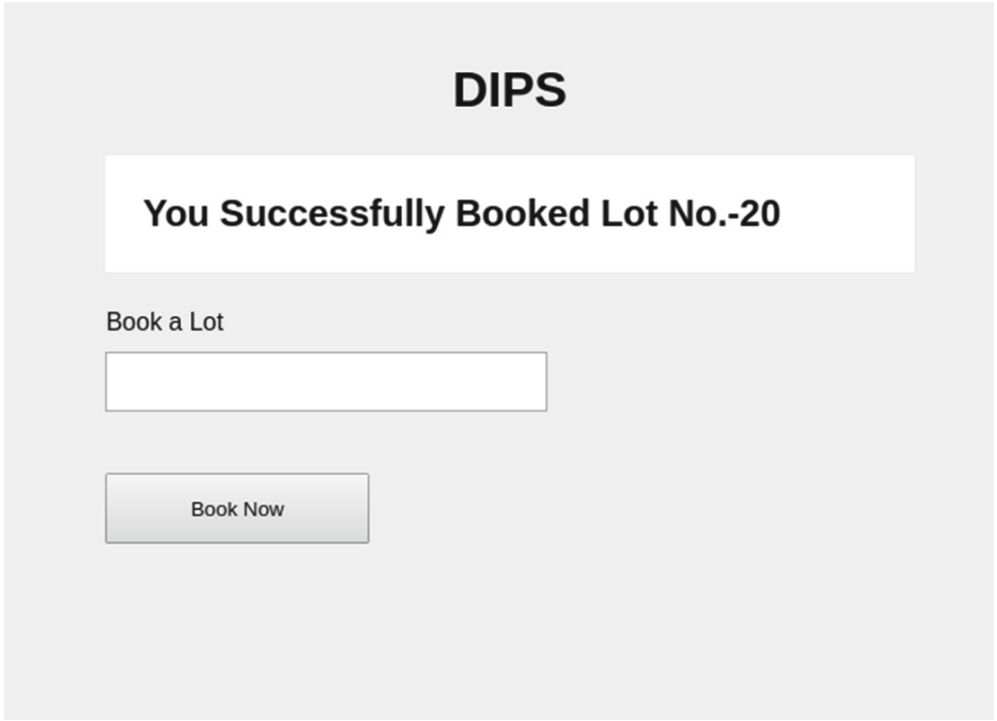


Fig. 6. GUI at the vehicle end

Results

- We analyze the performance by evaluating the average throughput
- Consider throughput as the number of successful transactions per second
- Average throughput = An average of throughput over execution time.
- Batch of Tx = 1, 10, 50, 100, 250, 500, 750, 1000, 1100, 1200, 1300, 1400 and 1500
- Average was calculated over five independent runs for each set of transactions.

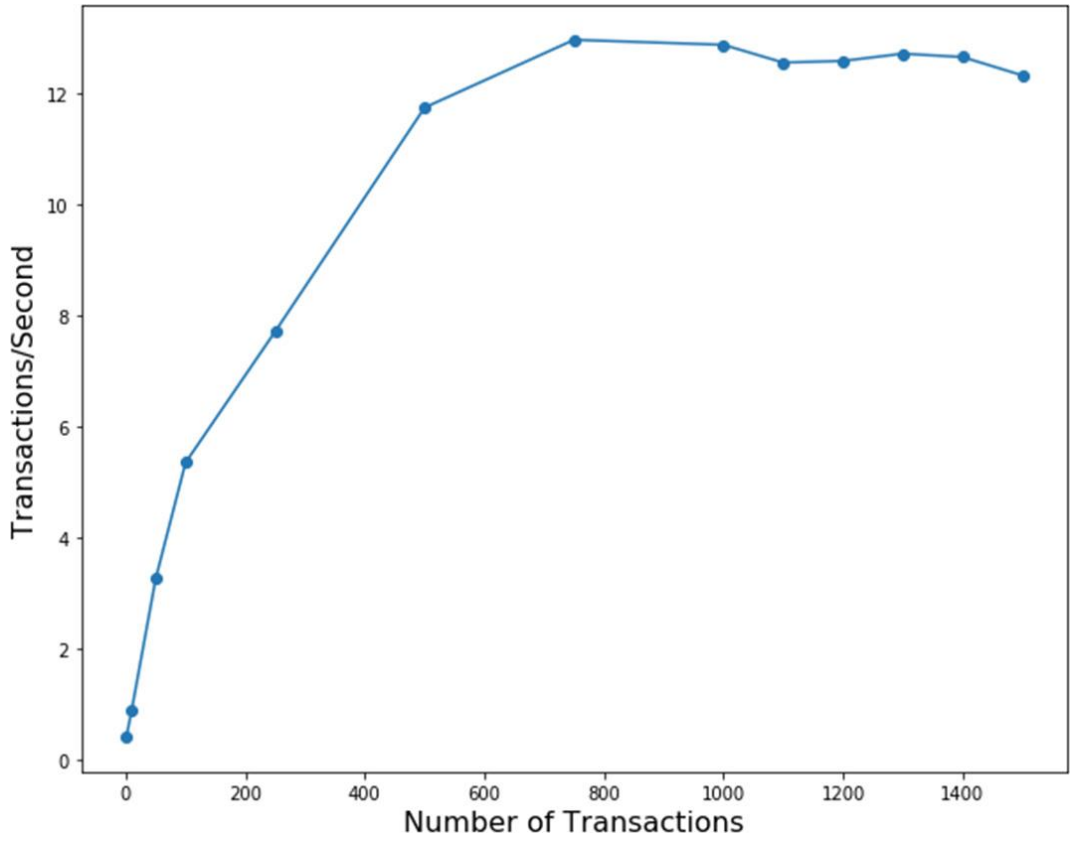


Fig. 7. Average throughput

Discussion

From the results, we can say that

- The behavior of the proposed system follows the properties of ethereum blockchain and performance remains same.
- Even for large set of transactions the average throughput is almost consistent.

Conclusion

- Our work presented a framework and a prototype implementation of a decentralized parking management in ITS using blockchain.
- Proposed system allowed drivers to find the best parking lot of their choice.
- It can provide common platform to various PZMs to attract vehicles to use their parking area thus helping them to generate money.
- The lower transaction throughput and the power consuming PoW based consensus mechanism used for maintaining true decentralized blockchain can be a bottleneck in its public grade implementation.

Future Work

- As a future work, we will try to integrate more features in our current system and will introduce more decentralized ITS related services.
- We will also explore other low power consuming consensus mechanism s for implementation.

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