TENCON 2019
17-20 October 2019
Hotel Grand Hyatt, Kochi, Kerala
Technology, Knowledge, and Society

A Blockchain-Based Approach for Usage Based Insurance and Incentives in ITS

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Overview

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- Motivation
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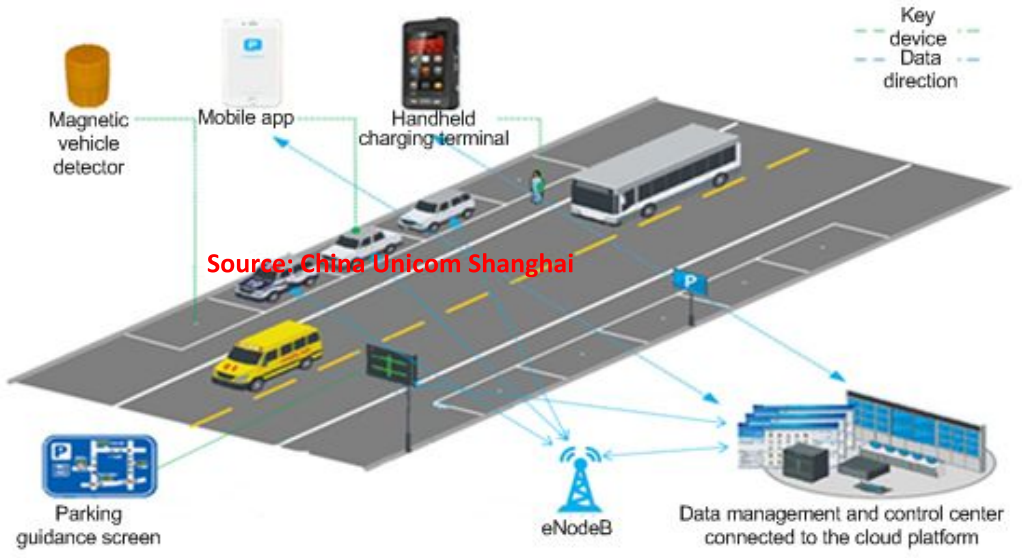
- Conclusion

Usage Based Vehicular Insurance

- With rise in the number of vehicles on road, market for vehicular insurance is also increasing.
- Traditional vehicular insurance approaches relies on historical data for deciding premiums which does not fit well in today's context.
- UBI in vehicular insurance- A vehicular insurance paradigm using IoT and Telematics:
  - More practical in today's context.
  - Premiums are decided based upon driving behaviour.
  - Also, known as Pay How You Drive(PHYD).
- UBI in vehicular insurance can help reduce frequency of road accidents and provide drivers value added services.
- It help insurance companies obtain near real time driving behaviour of the drivers.

Problem Statement

- Challenges in current vehicular insurance approaches are:
  - Lack of transparency.
  - Involvement of multiple parties makes proceeding tedious.
  - Ensuring integrity of documents is yet another challenge; fake documents are often used for fraudulent claims.
  - Much involvement of manual labour; time consuming.



Motivation

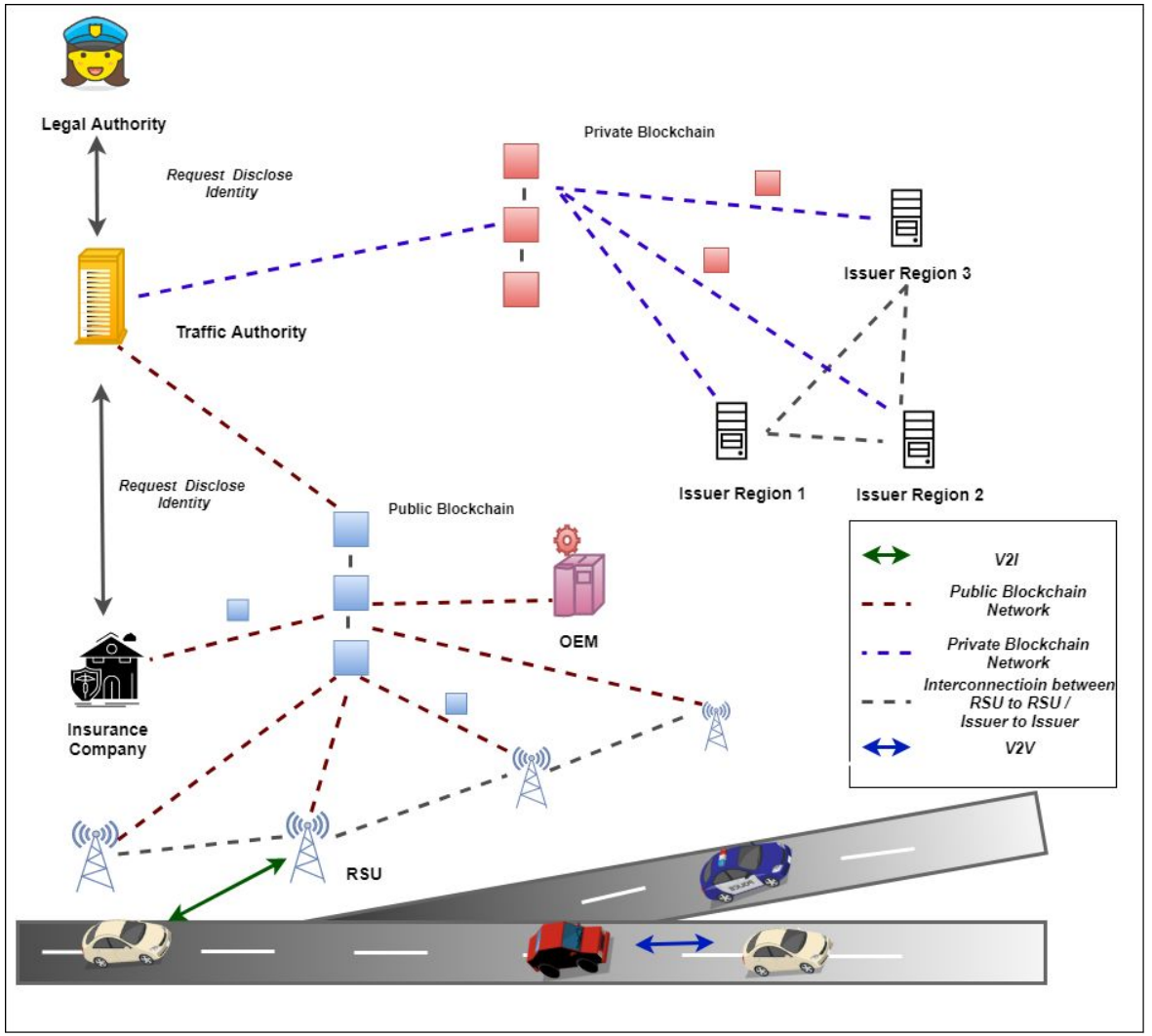
- Implement a Decentralized Usage Based Vehicular Insurance framework to provide:
  - High availability.
  - Transparency to the system.
  - Reduce paper works and manual labor.
  - Reduce insurance frauds, and faster settlement of claims.
  - Easing investigation procedures.

Related Work

- There exist a number of works using UBI and Telematics for vehicular insurance:
  - In[5] authors describe the prospects of telematic devices for UBI. They mentioned about its positive impact on the driving behaviour.
  - A smartphone based application for vehicular UBI is introduced in [6]. The application notifies the driving behaviour of a driver allowing them to take preventive measures.
  - More telematics based approaches for vehicular UBI are discussed in [4,7,8].
- No significant contribution in the domain of Usage Based Vehicular Insurance using decentralized technologies such as blockchain.

Proposed System Architecture

- Traffic Authority :
  - Does vehicle registration,
- Vehicles:
  - Equipped with sensing and communication facilities. OBU store the keys for communication
- RSUs:
  - Infrastructure deployed by TA.
- Issuer:
  - Provides short term blockchain addresses to the vehicles.
- OEMs:
  - Provides necessary firmware updates .
- Insurance Company:
  - Deals with insurance plans and premiums of their customers.
- Legal Authorities:
  - Comprises of police and court, responsible for investigating cases such as frauds, hit and run. .



Smart Contracts Used

- registrationSC:
  - Contains a list of valid permanent addresses assigned to a number of registered vehicles. The contract is deployed on the (priBC).
- tempaddrSC:
  - Contains the details of the list of addresses assigned against a permanent address and is deployed by the TA on (priBC).
- issuerSC:
  - Contains the list of valid issuers spread over the geographical area. The contract is deployed by the TA on (pubBC)
- policySC:
  - A smart contract deployed by the insurance company specifying the rules of an insurance policy. It is deployed by the insurance company on the (pubBC).

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Transaction Generation

- Event Triggered Transactions(ETTs):

$$\mathbf{ETT} = [(TID)T_s((ETT_{data})(P_{data})](Sig)$$

- Periodic Update Transaction (PUTs):

$$\mathbf{PUT} = [(TID)T(_s)S_{data}](Sig)$$

Generic Algorithm for Incentive Reward and Premium Lease

- Increase vehicle score if driver maintains a said driving behaviour.

- Periodically incentivise the driver with a lower premium and credit reward when the score reaches the threshold,
  or else,
  Punish the drivers with higher premium

Algorithm 1 Generic Algorithm for Incentive Reward and Premium Lease

N : Registered Vehicle (RV)
S : Set of all RV belongs to Insurance Company
F : Set of all vehicle related parameters(that should not exceed a limit such as no. of harsh brakings) determining the vehicle score
p : A parameter that belongs to F
threshold : Maximum limit of acceptance $\forall p \in F$
cutoff: Minimum score required to receive reward and premium discount.

Require: $RV_i.score \leftarrow 0$

```
for RV_i in S do
    for all p in S do
        if RV_i.p ≤ threshold.p then
            RV_i.score ← RV_i.score + 1
        else
            RV_i.score ← RV_i.score − 1
        end if
    end for
    if RV_i.score ≥ cutoff then
        rewardCreditScore(RV_i.address, RV_i.score)
        lowerPremium(RV_i.address)
    else
        highPremium(RV_i.address)
    end if
end for
```

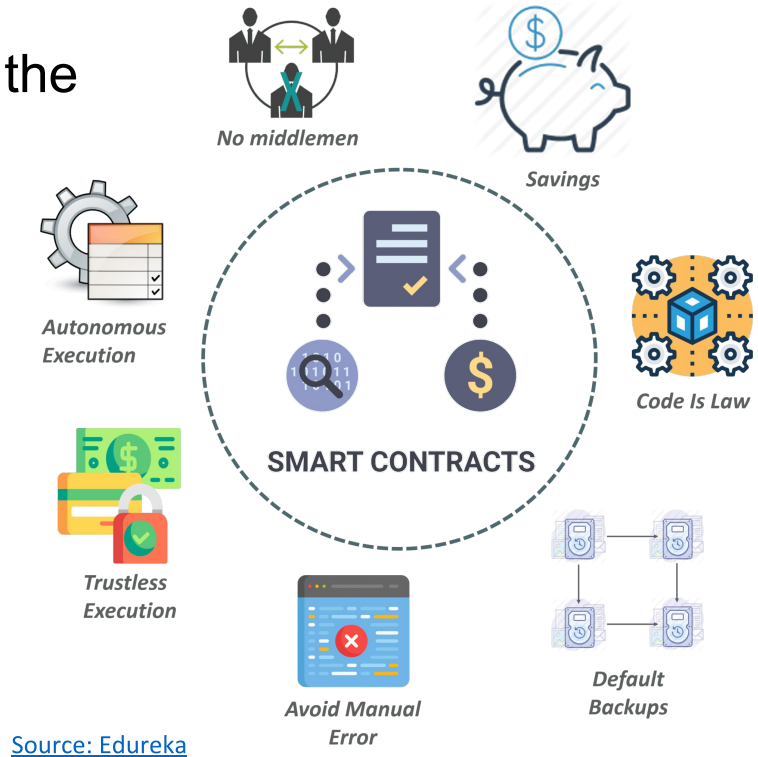
Blockchain Technologies Used

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.

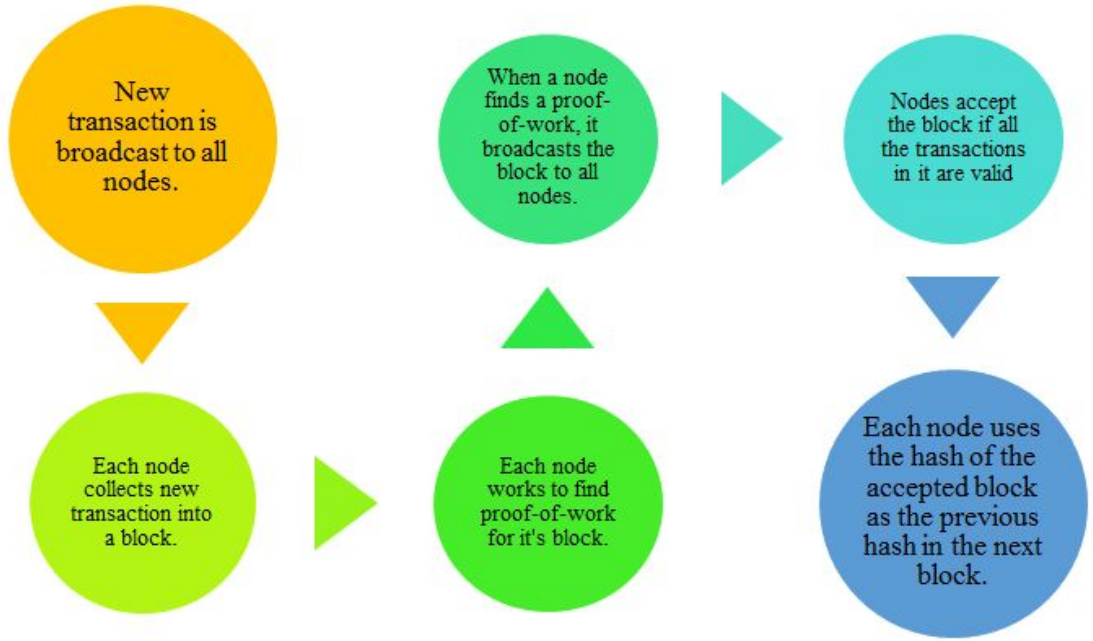


Source: Edureka

Consensus Mechanism Used

Proof-of-Work (PoW):

- Use PoW consensus mechanism for agreeing onto the state of the data
- Have a variety of nodes such as full node, miner node, light node.
- In PoW mechanism, miners are responsible for maintaining the blockchain.
- Miners perform cryptographically hard and computationally resource intensive operations.



Source: EtherWorld.co

Experimental Setup

Fig. Testbed

Device Name	Specifications	Role
Dell-Vostro PC	(8GB RAM, i7-7700 CPU, 1 TB HDD)	RSU/TA

Fig. Testbed Details

Results

- We analyze the performance by evaluating a set of performance parameters
  - CPU Utilization.
  - Temperature
  - Power Consumption
  - Clock Frequency

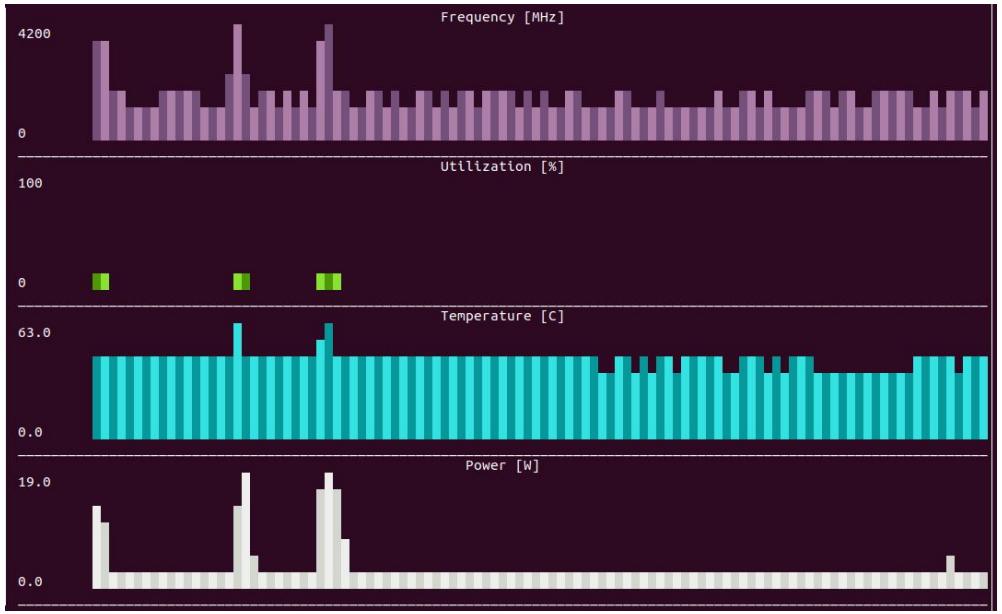


Fig : Performance Plots in Idle Mode

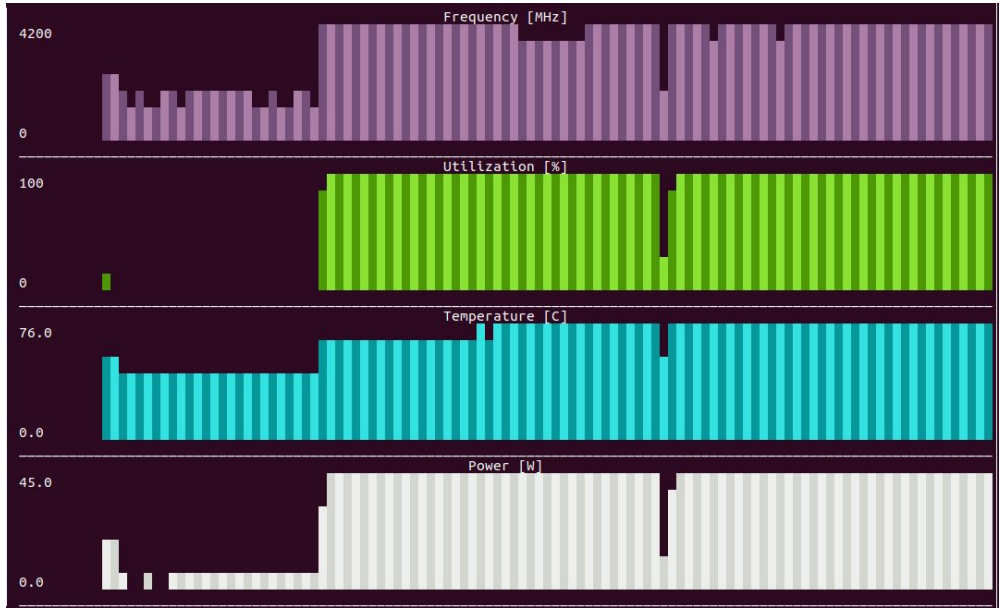


Fig : Performance Plots when RSU Node is mining

Discussion

From the results, we can say that

- The performance plots demonstrates our choice of PoW as the consensus mechanism, a resource intensive and power consuming mechanism.
- Although the PoW algorithm turns out to be power consuming and expensive, it provides much higher security against several types of attacks and provides decentralization in a true sense.

Conclusion

- Our work presented a framework and a prototype implementation of Usage Based Vehicular Insurance in ITS using blockchain.
- Proposed system motivates drivers to drive well for getting incentives.
- It can provide common platform to various stakeholders of the system such as the drivers, insurance company, OEMs and the legal authority.
- The power consuming and expensive 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.
- We will also explore other low power consuming consensus mechanisms for implementation.

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