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# Blockchain Enabled Machine Learning Approach to Enhance Intelligent Transportation System

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# Abstract

Traffic management is still a congestion issues globally. Driving violation is increasing day by day in the developing countries. It lead traffic congestion and road accidents. We could observe from starting that to manage the traffic by a central managing authority was always a problem, to improve the society traffic-signal system was introduced. These days we have required a high-class transportation system to get better society. New technology can help to achieve the desired objective. So let's formulate the problem definition first then we will discuss the solution which will be given by the purposed model. So the problem is to deploy the public confidential & personal data in ML system model to achieve the objective which is the advantages of intelligent transportation systems and also to ensure the privacy concern issue avoidance. This research-work is focusing on the approach of traffic administration & management with the help of machine learning and blockchain. There is even some deep learning, federated learning, neural network concept and artificial intelligence emerge technologies is adopted to overcome the concern traffic issues on humanity and societies.

## Table of content



### LIST OF TABLES

**List of figures:**

## Chapter 1: introduction

The success of transportation system (ITS) relies on the quality traffic information. Nowadays, Rapid growth of population, industrialization and modernization are leading the increasing number of vehicles on roads and the roads are limited. Transportation operation is categorized into two parts Advance Traffic Management System (ATMS) and Advanced Traveler Information System, both the system highly desired accurate and reliable traffic information. Transportation capabilities are not improving as per demand. Hence road congestion and traffic jams have increased and safety procurement management is not considered seriously. The increasing no of vehicles is one of the key factors of this challenge. There are limited no of highways, roads and streets, and additionally some driver used to offend the traffic laws and inadequacies of public transportation are other factors which leads the traffic congestion, which is responsible for the noise and air pollution, increasing fuel consumption, wear and tear of cars and road, stress and frustration of citizens and drivers. Generally traffic congestion is applied where traffic regulations violence is the usual. So it is essential to develop the roads and highway network infrastructure well organized, which could allow the smooth running of traffic. Considering all the concern related to transportation system, it is recommended to think of a solution to overcome these concerns and manage the traffic. These days government is planning so many mega smart cities, which will be high-tech development of old city indirectly where transportation system, water management, disaster management, pollution control and management will be key factor of up gradation. Government Municipalities Corporation, companies, and researcher have proposed many solutions regarding the transportation problem. Some of them solutions are using adaptive signals, autonomous vehicle technology, vehicles-to-infrastructure smart corridors, car sharing, and real time traffic feedback, tracking pedestrian and multi-model solution. Various of these solution is based on internet of thing (IoT), Deep reinforcement learning, federated learning, blockchain technology, wireless sensor network (WSN), and data analytics (DA) approaches.

There is also some partial solution like construction of new roads, bridges, tunnels, flyover, and bypass-ring and performing road rehabilitation.

Traffic congestion leads to an excess vehicle on roadways simultaneously, it causes the slower average speed and longer trip time, this is the major concern in the transportation planning and traffic management [1]. It is not possible to solve this issue completely, but this issue could be overcome. If road users get notified about road & traffic from any trusted source in advance (beginning of trip), it will help to minimize the traffic congestion opportunity and will allow the user to make appropriate decision during their journey. This information will be quantifiable measure of congestion (traffic), it can be represented by estimating some related parameters like travel time and traffic density. The huge amount of data is generating every day on the traffic-management network, and data used to collect by the intelligent cameras and sensors. So data collection is easy but processing, storing, analyzing and handling is challenging. Developing system models and controller for this concern can be challenging endeavor.

Maintaining privacy, confidentiality, authentication and administration of data is always a concern interest, in the purposed model, I have set these concern interest as objective of ITS. To achieve the objective we need to understand the offline geographical and social factors that have an impact on traffic dynamics, social temporal factors like weekend, holidays, occasional social gathering have an influence on traffic. There are also online potential influence such as Google map which provide source data for transportation analysis and forecasting.

Machine learning (ML) has scope that UEs (user equipment) data are valuable for training models, which will be enhance and improve the user experience, however the UEs data are privacy sensitive in nature so that it is risky to log the data from datacenter for model training. Federated Learning which is distributed machine learning is a great solution to address the dilemma: only intermediate gradient value used to send instead of sending row data. There are several reason to support federated learning with the advances of edge computing, large amount of computing resources equipped at edge, a centralized datacenter is no longer a need. Uploading the huge amount of data took huge amount of time, it can be reduce and model training can be completed in a distributed fashion.

## Chapter 2: Literature Review

Today machine learning (deep learning & federated learning) along with blockchain is new development and its emerging is responsible for transforming the human life very rapidly. To train the deep neural network was difficult computational process, in 2006 that moment where efficient training methods is start to develop [2].Since especially deep learning and federated learning has excelled in diverse level of tasks, mostly in the situations where input data are unstructured, highly dimensional, and where non-linear representations are needed to succeed exceedingly[3]. Areas such as robotic grasping [4], audio generation [5], and object detection [6], [7], [8] were shown the effects of deep learning based solution.

Since early 1970s, short-term and long-term traffic forecasting has been a major part of ITS, most of research interest was focus on developing methodologies that could use to model traffic characteristics such as density, travel time, volume and speed and resultant anticipated traffic condition produced which can be considered as classical approaches, like cellular automation. After a long time application of data driven approaches become the keynote in this area of literature, verity of quality algorithms and forecast model approaches were purposed by researcher, most of them was parametric approaches (model-based methods where model structure is predetermined based on certain theoretical assumption and the model parameters could be compute with empirical data). With the rapid globalization and modernization, the amount of traffic data are growing, most conventional approaches were found insufficiency under the irregular traffic conditions, complex road settings, like in face of extensive both the datasets (structured & unstructured). After improvement the weights has been placed to smart intelligence-based computational approaches recently which include Bayesian and neural network, evolutionary and fuzzy techniques. Different neural network architectures support different data representation, and are one of the investigating core points. During from past few years, respective studies has been successfully applied in traffic forecast and reasonable performance achieved. Huang proposed a brief review with multitask learning [7]. His study focused on critical review of the deep architecture network algorithms for traffic flow prediction, and a multi-task regression layer was used for unsupervised feature learning. In another study, it provided a general review on traffic flow prediction with big data, and a deep learning approach which has a stacked auto-encoder (SAE) model. We learn generic traffic flow features, and this was trained

in a greedy layer-wise fashion. These representative studies adopted the deep learning methodology, but the temporal-spatial correlation is unobvious. In the several studies, researcher attempted to extend deep learning theory into large transportation network analysis, however a deep restricted RNN and Boltzmann machine architecture were used to model and predict traffic congestion evolution rested on real traffic dataset. Federated learning is recently introduced by Google, it is decentralized learning approach in which training is performed over a federation of distributed learners, and decentralized training is performed for denaturalized interface. Main objective of this learning methodology is to keep the training dataset where it is generated and perform the model training locally at every individual learner in the federation. After training local model, every individual learner transfers its local model parameters, instead of raw training dataset, to an aggregating unit. The aggregator utilize the local model parameters to update a global model which is eventually fed back to the learner benefits from the datasets of the other learners only through the universal model, shared by the aggregator, without explicitly accessing their privacy-sensitive data.

Deep learning focus to extract complex features from high-dimensional data and used them to construct a model that relates inputs to outputs. Deep learning architecture generally used multi-layer networks so more abstract features are computed as nonlinear functions of lower-level features.

Below I have purposed an effective model of Intelligent Transportation System which will be insure our data privacy while collecting from sensors and cameras data, authentication, mobile wireless network communication (model training), traffic forecasting (long term & short term), and computational offloading.

## Chapter 3: existing surveys on Blockchain and machine learning

First introducing several existing literatures reviews and investigating the blockchain techniques from many different perspectives. The author in [1] introduces blockchain technology, along with the key requirements, consensus mechanisms, evolution, types and existing blockchain platform. The author in [2] investigates the decentralization technique consensus mechanisms in blockchain. Like Byzantine Fault Tolerance (BFT)-Based consensus protocols, virtual mining protocols, Nakamoto, protocols, Hybrid protocols and parallel consensus protocols series. The author in [3] investigates the application of permission-less blockchain on network layer. Then considering the

system requirement and performances, like anonymity, low computational cost and topology hiding, to improve the system efficiency and security they presents the design of permission less blockchain on network layer. The authors in [4] present blockchain-based approach for security issues, such as authentication, access control, data and resource Provenance, integrity assurance and confidentiality. Due to key characteristics of blockchain like decentralization, temper-resistance, and security many researcher work on the application of blockchain and provided comprehensive survey on various scenarios, such as smart cities [5], edge computing system [6].

On the other hand many researchers have widely worked on ML techniques in communication and networking. The authors in [7] applied ML algorithm in self-managing cellular networks. To improve more robust and intelligent algorithms, they provide brief comparison between the commonly ML algorithms and certain self-organizing networks (SON) metrics for proper ML algorithm selection for each SON function. The ML algorithms application have been also comprehensively investigated for the other network scenarios, like optical communication and networking [8], software defined network (SDN) , wireless sensor network (WSN) [9], cognitive radio networks. Deep learning (DL) is a potential tools to add intelligence to network communication system in large scale computational network environment. The authors in [10] discussed the application of deep learning algorithms for several network layers, such as traffic balancing, routing layer path search, data link layer access control/resource allocation and physical layer modulated/coding. The authors in [11] discuss the Deep learning (DL) algorithms applied in various new growing wireless technologies like IoT, BIG DATA for achieving the desired data-analytics in and applications. Motivated by the successful result oriented machine learning application in many practical tasks like image and voice recognition, image recognition, AI enables transportation etc. A large number of researches published on application of ML for specific areas in wireless communication and network. The authors in [12] investigate systematic reviews on ML-based traffic classification and object detection discusses the all aspects like pro-and cons and needful requirement that apply DML in the traffic classification. In [13] the author investigates intensively the overview of the current DL algorithms for different network traffic control aspects. To address the security issues, the authors in [14] highlighted a survey on ML and data mining

(DM) methods applied in intrusion detection system (IDS), which is critical section of monitoring various threats.

There are some research work is done on Emerging of ML and blockchain in various application. The authors in [15] provide very brief survey on blockchain application for AI, which include ML and other intelligence algorithms. They discussed the existing blockchain technology application, protocols and platform targeting AI areas. However this purposed model of intelligent transportation system is ML (deep learning + federated learning) and blockchain driven which is aimed to achieve an ideal transportation optimality and reduces the losses which is occurs due to bad traffic administration and management. Federated learning is used to train the data-model in distributed computational network, deep learning is applied to use the data learning and perform the optimality and predictions of various transportation components, and blockchain is applied to ensure the privacy in public network, authorization administration and many more.

## Chapter 4: Motivation of integrating machine learning and blockchain in communication and networking systems

However the both technologies ML and blockchain is promising technologies in network communication security. There are still some consideration problem is there. The limitation of **Blockchain applied in communications and networking systems:**
Apart from the high-demanded potential of blockchain, there are some challenging issues that restrict its major application in communication security and networking communication echo systems. The each three points out those blockchain systems can only at most have two of three properties like scalability, decentralization, and security. Generally decentralization enables the system to be fault tolerant, collision resistant, security guarantees the immutability and the attack resistant, and scalability addresses the ability to process transactions having huge data.
However the number of transactions are increasing, the scalability issue becomes a severe bottleneck and limits the practical developments of blockchain. To resolve the scalability issues, block size increasing, pruning, and off-chain are purposed for enabling practical applications, but these methods have own respective problems like where to use the off-chain methods and which data should have to pruned. Implementation and administration of communication and networking system which are based on blockchain usually need to consume much time and resources. With the rapid-rocket speed personal data storing in blockchain-based communication systems, privacy

leakage is another critical issue is increasing. Now day's blockchain applications require has transactions and smart contracts to produce metadata, which may be used to produce some information, even if the data itself is encrypted.

**The limitation of machine learning applied in communication and networking system:**

ML technology approach have provided sufficient benefits across a range of fields and area of applications, however, there are still some challenging problems to enhance the intelligence and flexibility managements of networking infrastructure and communication system which targeted massive users diversified quality of service (QoS) requirements.

Usually the ML-based technical solutions demands large amount of training data, which has to implement at a centralized network controller having appropriate storage resource and computational capability for information collection. In current communication system ML-models may not suitably available for accessing the large amount of data. Apart from that aggregating data from heterogeneous network for ML-training is also a challenge. To solve these issues, a distributed ML architecture in which federated learning enable central server controls the all process of training model and the distributed user's trains the models along with their datasets independently is purposed [29]. In other words we can say that to performing the distributed training model independently we are using the most advance version of ML techniques which known as federated learning or distributed machine learning.

In networking communication system, security and privacy preservation of confidential private data in open-public network are critical factor for using ML-based methods. ML systems are centralized architecture systems so there is prone to hacking, so the probability to achieve the high level security is not showing here. We all know that training data usually involves a large amount of credential information which is personal, so if the data breach may leads the privacy concern issues. How will put the training data into ML models to protect them from hackers is main concern. In additional, the nature of ML system is centralized. One major stacking technology needs to have a universal vision of the resources for collecting large datasets, creating complex models and solving several types of tasks, are often non-scalability, ineffective operation, and easy to suffer failure problems. To make ML-system more effective I have integrated it with the blockchain so the purposed model of intelligent transportation could achieve the

Desired objective, especially to avoid the centralized model training methods and privacy concern is the key issues. Let's discussed how the blockchain and ML integration is able to avoid the issues and capabilities to provide a secure trustworthy communication ecosystem for intelligent transportation system. Here the basic concept of technology (ML & blockchain) is not mentioned due to overcome the subject matter and purposed the idea with possible words and time limits.

## Chapter: 5 the Proposed Model

The purposed model is a hybrid model, for better understanding we can conclude that the model is combination of ML system and blockchain. It was need of the system ecosystems requirements to ensure the security, privacy and model training independently. Let's discuss the some basics international methods of ITS design then we will easily able to evaluate our purposed model.

### 5.1 Principal of structure methods for ITS architecture:

There are two methods to develop ITS architecture globally: structure analysis method and object-oriented analysis method (The national ITS architecture, 2001). Both methods are significant neither of them is superior to others, and both of them have their own characteristics. The structure analysis method is simple, clear and relatively mature and complete specifications set and standard has been generated. The process-oriented analysis method by the structure methods accords with the thinking habit of people and tends to be easily accepted and understood. The structure analysis method could be summarizing as analytical hierarchy, functional modularization and correlation, top-down layer-by-layer decomposition and abstraction. The system analysis process and construction is progressively described by its stages, this method of analysis contains three stages: requirements analysis, system model and physical model. These three stages correspond to the user service definition, logic architecture and physical architecture respectively.

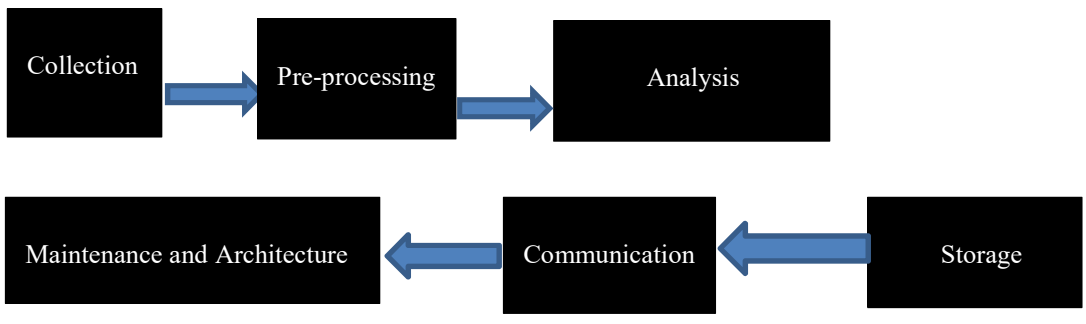


Fig 5.1 principal component of ITS communication

## 5.2 Machine learning and blockchain based Intelligent Transportation System:

Purposed ITS model is based on ML system and blockchain, where ML system is responsible for various types of value added services like data and model sharing, security and privacy, decentralized intelligence and trust for decision making and blockchain feature helpful to perform these services respectively for shared transparent and distributed ledger, immutable, irreversible and auditable record, decentralized p2p communication, cryptographically secured digital ledger, sequential and time stamped and consensus-based updating.

Federated learning is suitable for model training independently in distributed communication networking ecosystem and blockchain have capabilities to perform operation in secure environment. Its reduces the data breach risk in public domain by using high level cryptographic function for encryption and decryption of confidential private data during sending and receiving across the network. Blockchain enables various features of intelligent transportation system which make it outstanding like energy trading, outlier detection etc.

Deep learning also contribute the outstanding partnership to enhance the intelligent transportation system along with edge computing resource network, and the most valuables advantages of using deep learning along with edge computing network is to provide scalability and availability of data to the mobile user across the network.

## 5.3 The benefits of machine learning and blockchain for each other:

Blockchain is able to benefit the ML for model-sharing, security and privacy, decentralized intelligence over edge computing network, and trusted decision making. Specifically, in the large scale database in a secure and temper-resistant situations and ensure data confidentiality and auditability of the collaborative training process. It provides training to ML model via cryptographic techniques so sharing the confidential data is secure. A Blockchain solution enables the structural decentralized infrastructure to ensure secure access control without trusting external central entities. Leveraging the blockchain, ML (federated learning) is able to train, learn and derive decision on local

device securely in distributed and decentralize communication networks. Let's briefly discuss their capabilities:

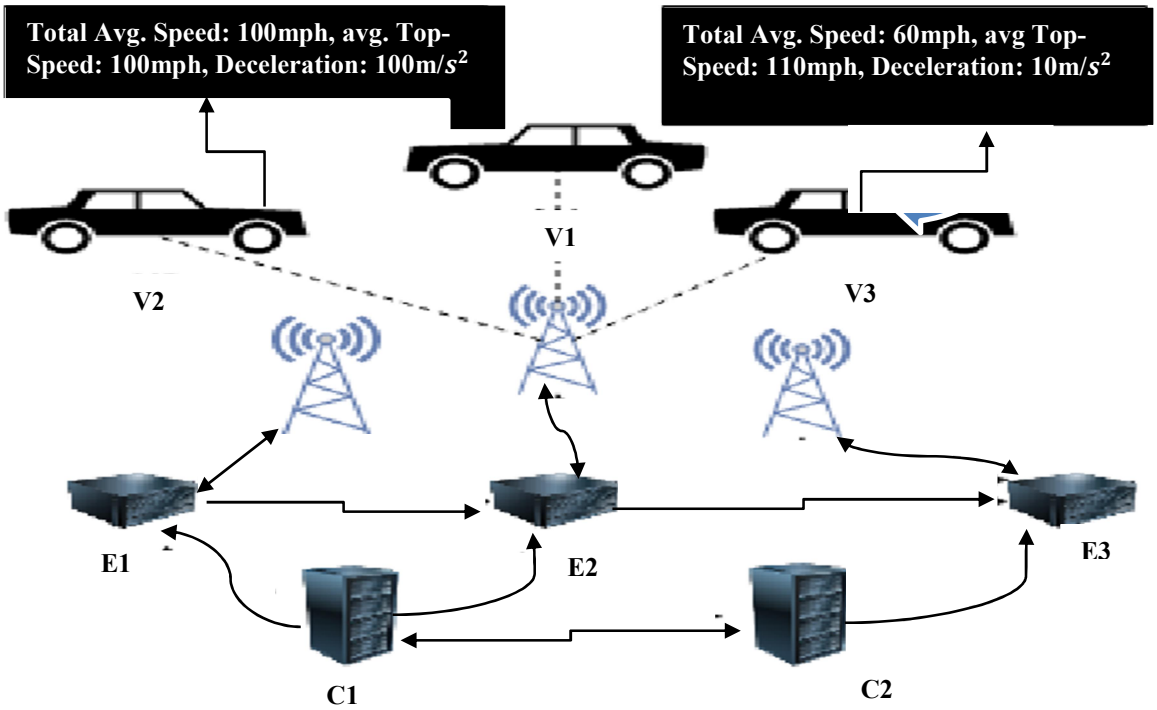



**Fig 5.2 Example Scenarios**

**(1)Data and model sharing:** blockchain technology has a unique characteristics to encourage individual to share data in secure, decentralized, and distributed ledger along with dataset and capable to provide more available data for training ML models. Here it is recommended to apply distributed machine learning (federated learning) approach to train the model independently. The blockchain-based model sharing system data enables users to have the ownership of their data and trained model. However the operation cost and privacy issues, the ever-increasing data in communication and networking systems could be enable the storing off the data into chain, only the keyword tags or data references are stored for checking the authenticity and accuracy of chain data.

Table - 1: features of blockchain which helps machine learning for secure computation.

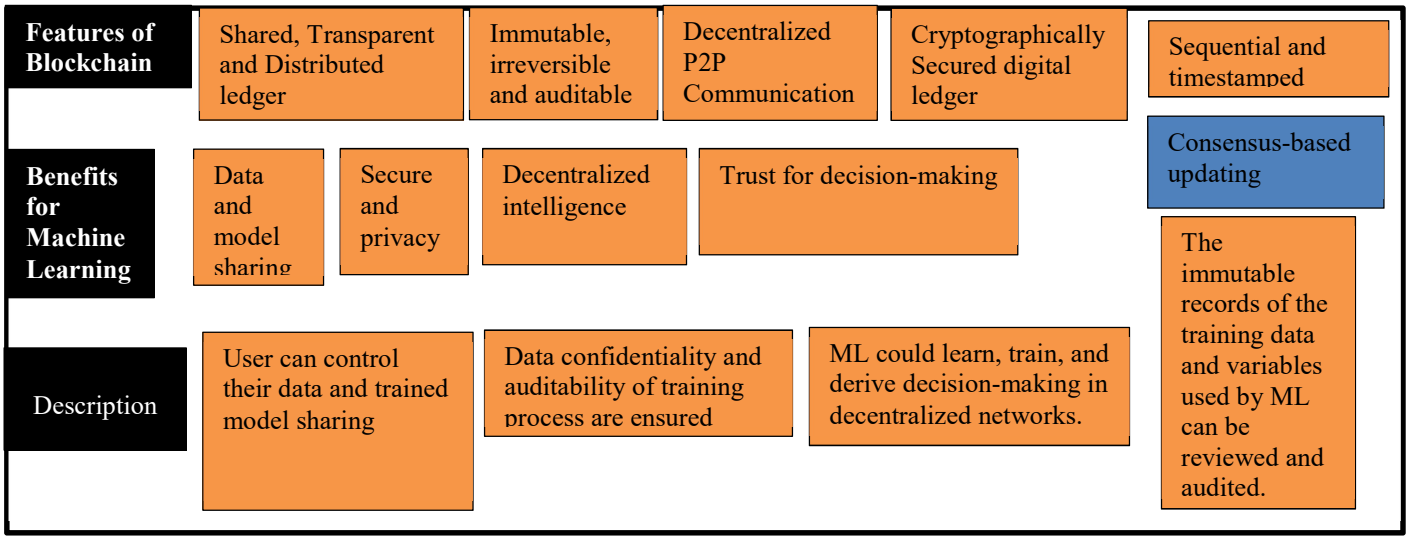
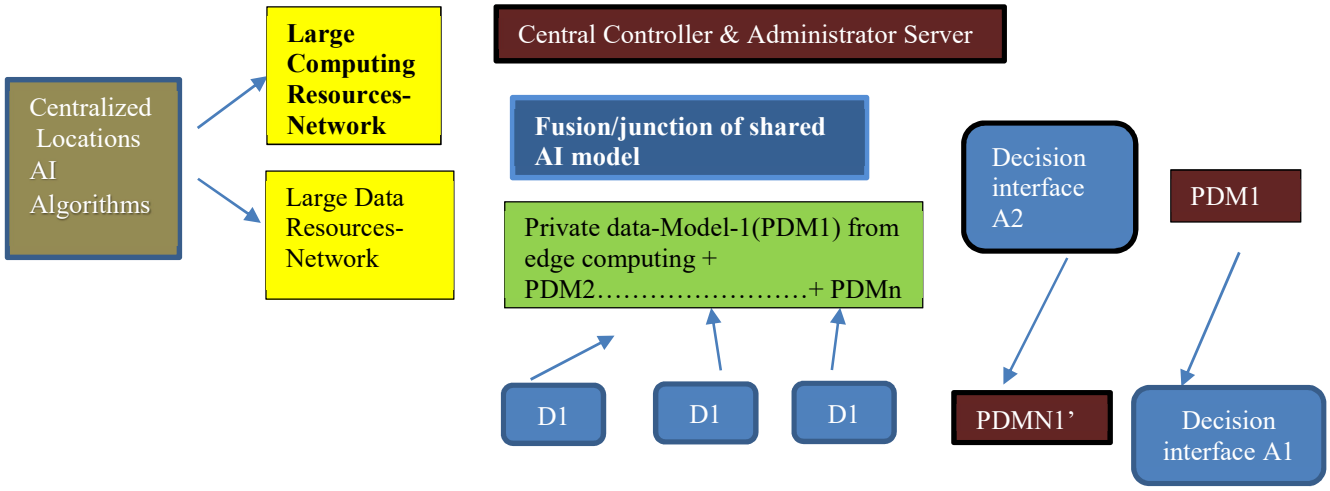



Fig 5.3 the raw illusion of various machine learning architectures: A denote centralized-ML architecture in which a core-central server processes the collected data using computational resources; B denote distributed-ML architecture in which a central server controls the process of training data-model and distributed users train the modes with their dataset independently; C represents decentralized blockchain-based ML architecture without any central controller of data and model sharing [14]




**A** **B** **C**

**(2)Security and privacy:** cryptographic-modules embedded in blockchain are sufficient for enhancing the security and privacy of ML-system-based solution in communication and networking systems. Blockchain solutions ensure data confidentiality and auditability of the collaborative training process and the trained ML model using cryptographic techniques. Some timeout-checking and monetary penalty mechanisms of blockchain can also applied in ML solution to provide auditability of the collaborative training process.

**(3)Decentralized intelligence:** the blockchain has decentralized nature which provides the fundamental protocols to enables the decentralized-ML application, ML-system could learn, train, and derive decisions making on end user devices in decentralized and distributed network by applying blockchain on edge or fog computing network. Smart contract and DAPPs is able to available the new way to data-model the communication between different entities in an ML application.

| Role | Belong to which layer | Responsibility | Rewards |
|---|---|---|---|
| Data/service provider, data owner | | Providing data, algorithms, compute, storage, etc. | Ocean tokens for providing data/service |
| Data/service consumer | | Accessing to publisher data/services, giving signal to curators | |
| Marketplaces, data commons | | Running metadata store, secret store | Transaction fees |
| Data service curators | Curation layer | Signaling the relative value of data/service | Ocean tokens for curating |
| Data service verifier | Verification layer | Data/service verification | Ocean tokens for verification |
| keepers | Keeper layer | Currently running nodes in network | Ocean tokens for chain keeping |

Table-2: key role in ocean ecosystem

**(4)Trusted decision making:** ML application in communication and networking systems, blockchain considered as a feasible solution. Blockchain techniques provide the transparent and immutable records of the training-data, process and variables used by ML-system application for their decision-making process to be reviewed and audited any times by authorized nodes from administration network. So in this way the ML application process could be easily audited and system performance can significantly improve.

Blockchain-based solution have the potential-capacity to act as the backbone for preparing a decentralized, transparent, and secure and trusted ML-based communications and networking systems.

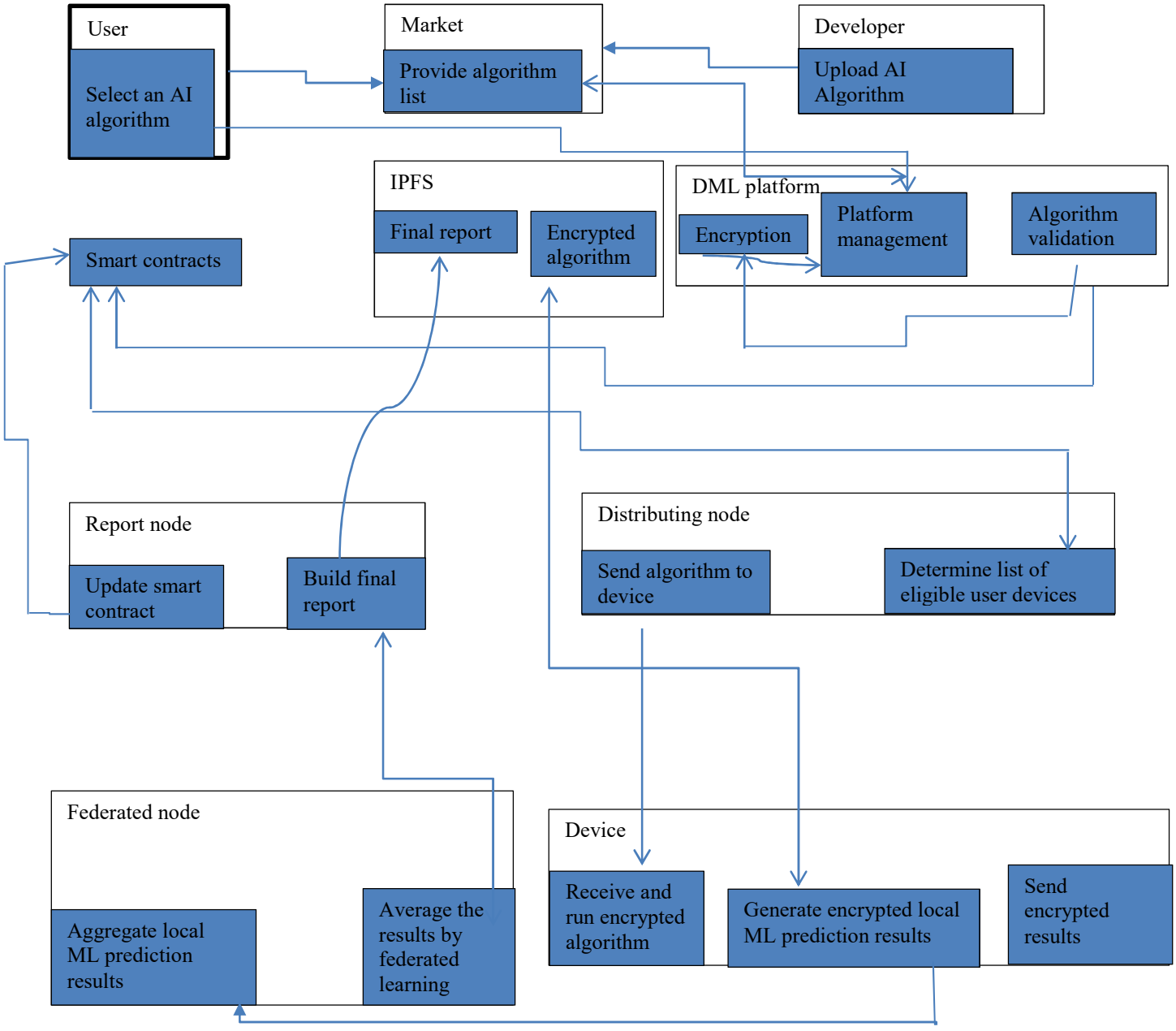


Fig 5.4 Deep machine learning protocol flow chart based on smart contracts for enhancing intelligent transportation system [19]

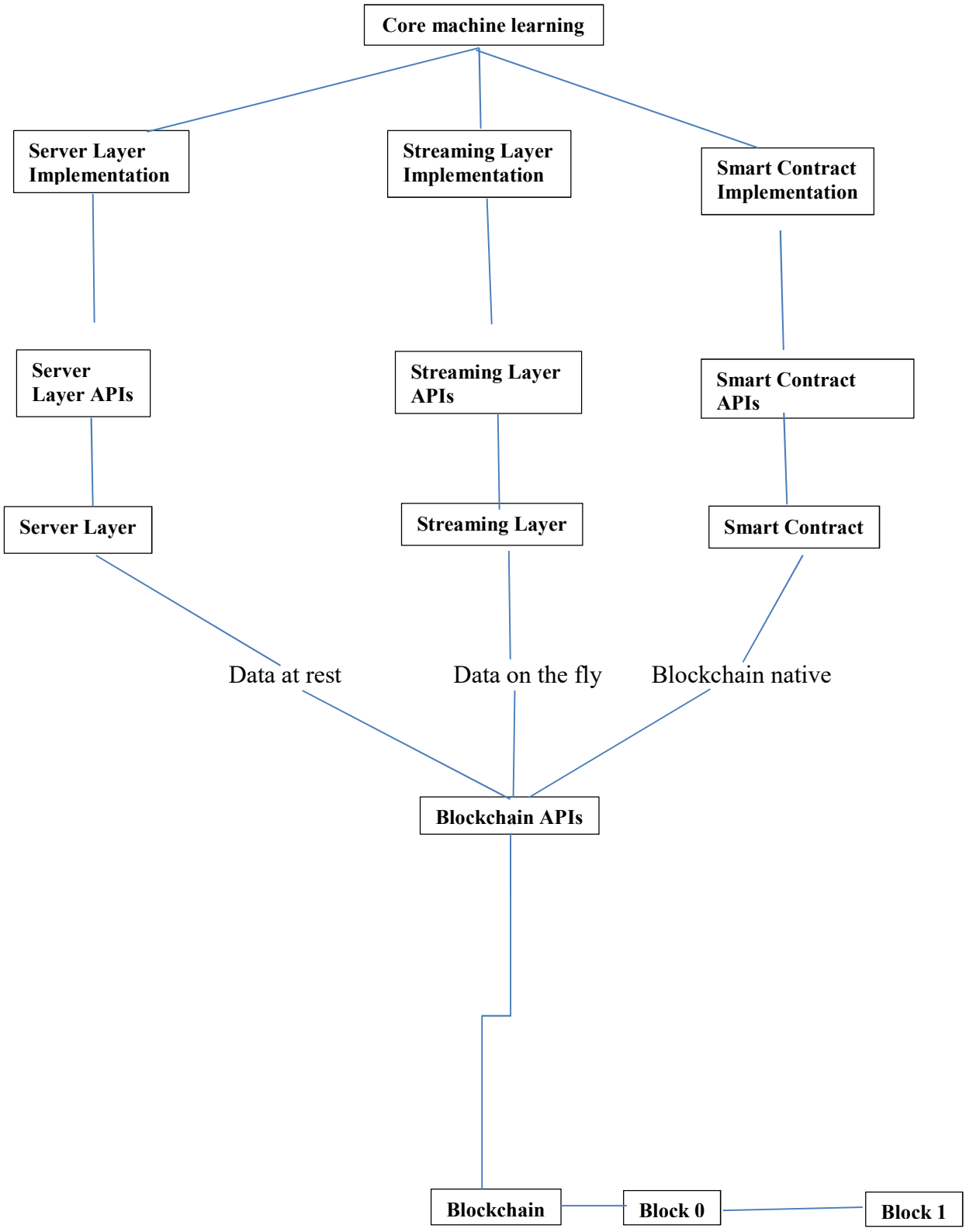


Fig 5.5 the analytical framework for trustable machine learnings [30]

## Computational Model

The edge computing model is shown in fig.1 which has one ECSP (edge computing service provider) and mobile users, i.e. the miners. ECSP are owner of edge computing resource which is distributed

Across the all network to provide the mobile users computing resource services.

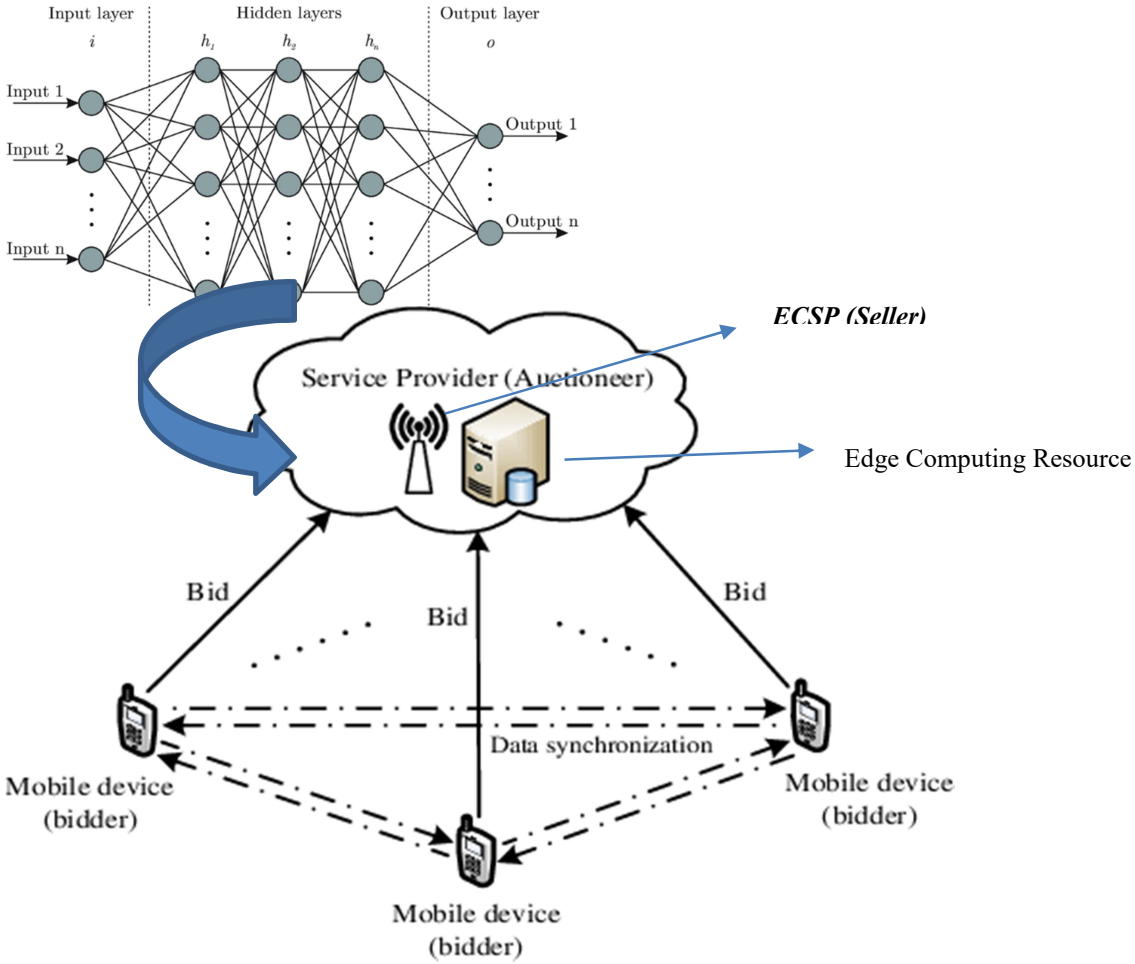



Fig 5.6 system model of edge computing in mobile blockchain network [19]

| | | |
|---|---|---|
| **Distributed Learning** | • The goal is to provide a holistic estimation of the parameters under study.<br>• The global model is not fed back to the local learner | Distributed learning in wireless sensor network |
| Parallel learning | • The goal is to accelerate the learning process and scale up the algorithm<br>• Data is not massively distributed among learners<br>• There is no communication constraint consideration | Distributed learning in datacenter environment |
| Ensemble learning | • The goal is to make available an optimal model by learning from a hybrid model.<br>• There is no communication constraint consideration | Bagging, Boosting, and stacking algorithm that can be used in remote sensing, face recognition and so on. |
| Federated learning | • The Objective is to perform the model training using the naturally (edge computing/ mobile users)<br>Distributed datasets over learners (Users)<br>• The Universal model/central model is fed back to the local learners for their use<br>• There are network constraints such as privacy, security, power and bandwidth limitations in accessing the data | • Edge computing and cashing<br>• Autonomous driving<br>• Federated ML for spectrum management<br>• Coexistence of heterogeneous systems<br>• Federated ML in 5G core network |

**Table 2: Features, Design Goals and Applications of Federated ML and Other Distributed Approach**

**Algorithm 1: Connected vehicles algorithm (for blockchain based ITS with outlier detection)**

```
Data: position =p, average speed= v, basic vehicles information=bvi, basic driver information=bdi:
Number of towers=I
while true do
    if any tower in range, then
        while I>=1 do
            Connect to i^th tower
            i-1
            End
            Gather all data
            Encrypt the data with AES
            send the data to all towers
        End
    End
```

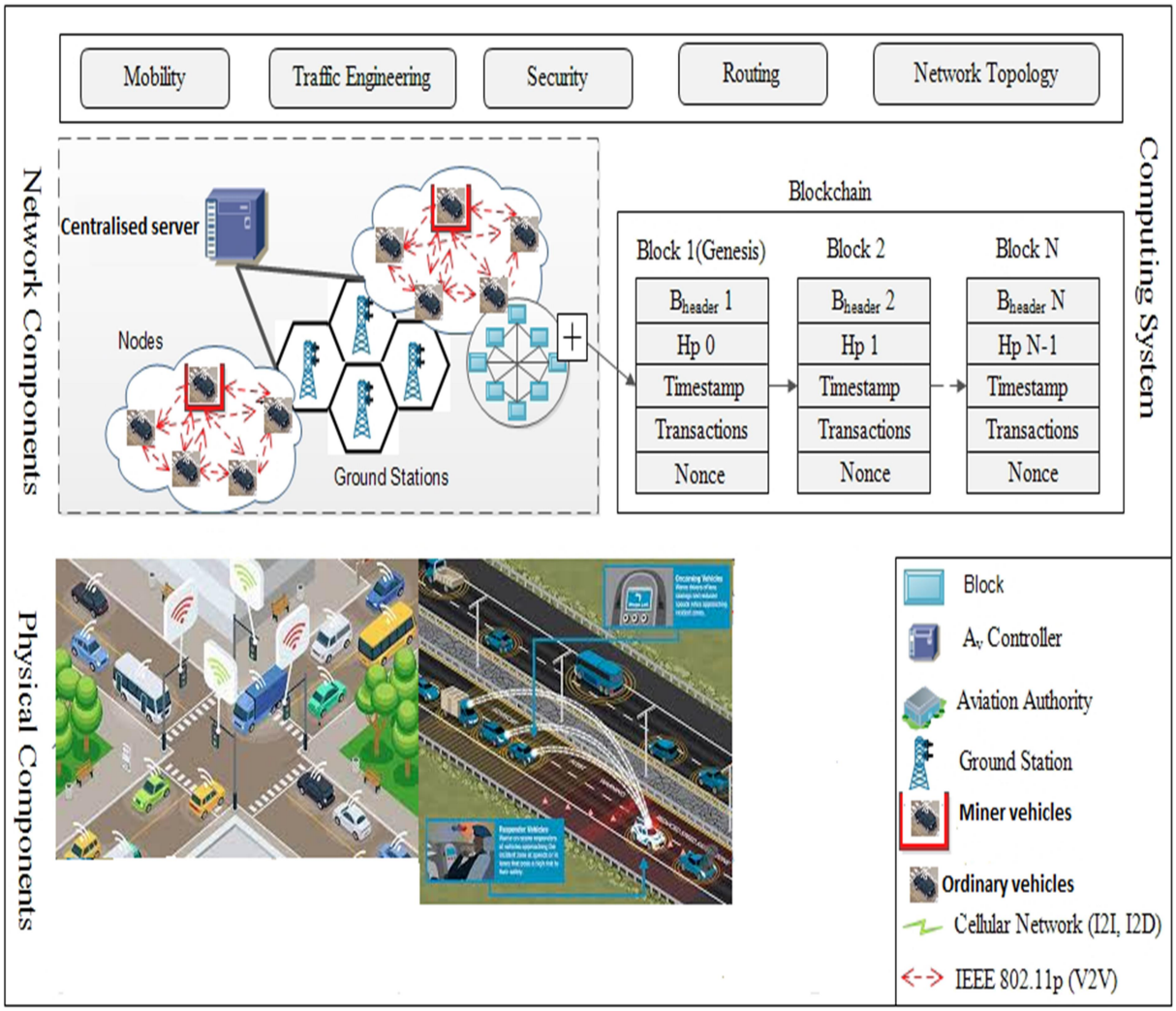



**Fig 5.7 Connected vehicles algorithm [19]**

**Algorithm 2: Edge network algorithm (for blockchain based Intelligent transportation system with outlier detection)**

```
Data: Encrypted data from connected vehicle
while true do
        Decrypt the data;
        If integrity test then
                pass through outlier detector;
                While data! =anomalous do
                        Distribute the data to all edge nodes
                        create block for blockchain
                        Add block to blockchain
                End
                Update node table
        End
End
```

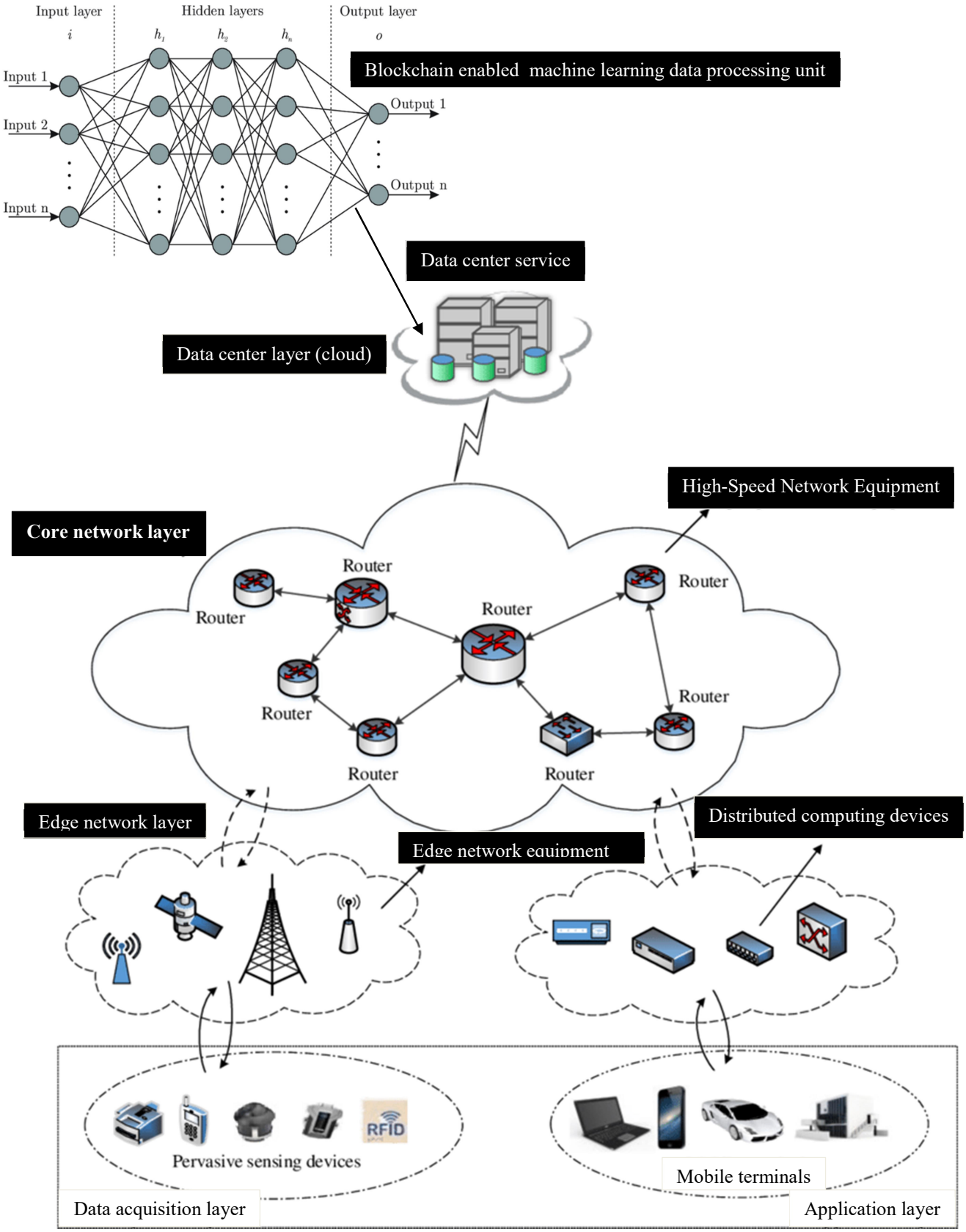


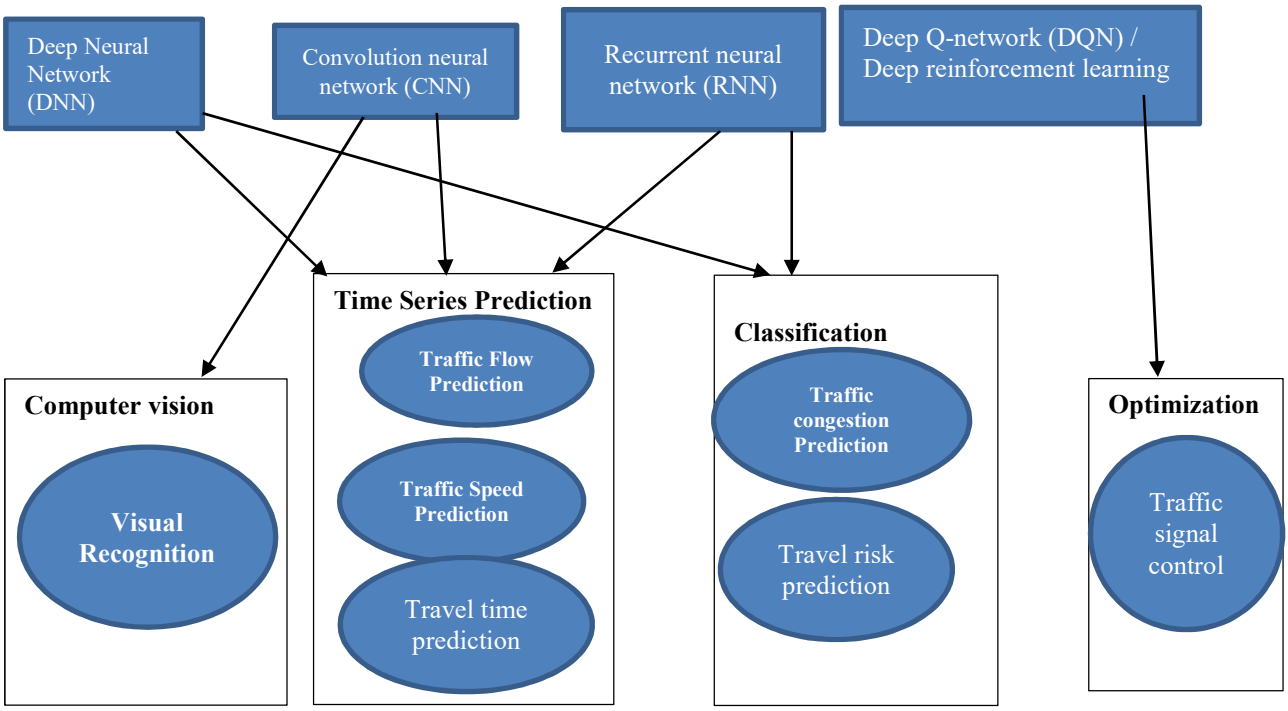

Fig 5.8 operational diagram of Intelligent Transportation System [21]

Algorithm 3 Core network algorithm
(For blockchain based ITS with outlier detection)

```
1:      Data: blockchain from edge node
2:      while true do
3:          if integrity test then
4:              Fetch data from node table
5:          Run reputation model
6:          Update reputation model
7:          Fetch blockchain from nodes
8:          Run validation and reach consensus
9:          Update new block
10:         Reach consensus and update
12:         Blockchain
13:         End
14:     End
```

**Deep neural network for Intelligent Transportation System:**

In recent year, deep learning has witness of success in computer vision, speed recognition and natural language processing. They are outstanding new records of accuracy in a great number of applications. Then it is natural practice to apply the deep learning models as a classifier or predictor in ITS to enhance the accuracy and intelligence of ITS.



## Chapter 5 Results and Analysis

There are several library available in open source environment, by using them we can find out the results like traffic prediction, driver driving pattern, license plate reorganization, travel time prediction, visual recognition from audio and video, traffic speed prediction, traffic flow prediction, traffic congestion prediction, travel risk prediction and traffic signal protocols. There are very less library available to find out the ensuring the security and confidentiality in the distributed public network, especially in the decentralized distributed network communication infrastructure.

However blockchain has a secure operational mechanism to deliver own services, especially in edge computing communication systems. Federated learning along with blockchain has privacy preserving capabilities which help to achieve confidentiality, authorization and accountability along with integrity containing an ideal intelligent transportation system.

So it conclude that there are several hidden features are silently available in the integrated blockchain machine learning computational approach , we need to explore as depth as possible to overcome the cost & effort demanded transportation system.

**Tools for simulation:** Cisco packet tracer and MDE tool has been used for the intelligent transportation system virtualization to integrate the blockchain with machine learning to enhance the feature of ITS.

## Chapter 6 Summary and Conclusion

The “blockchain enable machine learning approaches to enhance intelligent transportation system has substantial potential to make change the society at large scale. Our life is fully dependent on transportation system, current transportation operation activity is not reliable and user centric. There is different way to make our transportation as per today’s requirement and expectation, integrating blockchain along with machine learning for enhancing the intelligent transportation system is capable to full-fill the major requirement and user-expectation. There are huge number of research is coming out regularly related to enhancing the transportation utility but new way of better transportation options and fuel management is still a consideration problems. Drones and air transportation are on high demand

## 6.1 Summary of findings

(1) **Deep learning implementation for Intelligent Transportation System**: there are various multi-layer perceptron and library which implemented to extract the information from the collected data from various sensors. It also enables the dedicated-fast computing which allow the quick processing and response.

(2) **Blockchain**: blockchain helps for the computational offloading and secure computational environment which is dedicated and manage of the mobile user. It is also responsible for the decentralized computing and user's data integrity and authentication. It also allows detecting malicious phenomenon in the computation.
Outlier detection and energy trading is shining advantage of blockchain which make it more futuristic and user friendly.

## 6.2 Future research direction

There are so many knocking opportunity is waiting to explore in the area of Intelligent Transportation System with the help of machine learning and blockchain. What will be need in future for smart cities and ITS is unpredictable but we can do so many good things to make our society better in future. Some future research directions are (a) analyzing public attitude along with biometric details (b) perception from cyber sources (c) energy trading during the journey (d) autonomous driving (e) Smart parking with threat detection etc...

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