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Route Forecasting based Authentication Scheme Using A* Algorithm in Vehicular Communication Network

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Abstract: Researchers have developed several authentication techniques for route predictions based on user requirements. These techniques estimate the shortest path and available resources in vehicular communication networks. In the current research, the existing authentication techniques for vehicular communication are compared and their inadequacies are identified. Then, new authentication technique based on route forecasting are presented for vehicular communication networks, with the service provider anticipating alternate routes for customers if the current routes have more network traffic congestion. By presenting the most efficient route, the suggested model allows users to maximize their time efficiency. Using A* algorithm, VCN agent seeks path with less network traffic congestion. This algorithm determines the shortest path between a source and a destination. Users are provided with several options by the service provider. User accepts the finest option that meets their needs. This method allows the service provider to deliver at least 15 routes within three seconds. This strategy is beneficial when a significant number of vehicles are stuck in traffic and consumers require network resources to utilize their time effectively

Keywords: Vehicular Communication Network, Route prediction based authentication scheme, Network traffic congestion, Network Traffic Index.

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1 Introduction

As the growing demand for traffic efficiency, it is crucial for user to obtain route which has less network traffic congestion. To meet the goal, various authentication schemes have been raised. Such schemes are helpful for confidentiality, Integrity, security and forecasting purpose. Without such authentication schemes, communication between vehicles can't be possible. Auhentication schemes verify the authenticity of vehicles and users. These schemes reduce duplicacy and loss of message, verify the sender's and receiver's identity. Authentication schemes are responsible for route planning. It validate messages and protect information from different kind of security attacks. Such techniques enhance security feature in VCN through digital signature and cryptography. Network resource aware route planning authentication schemes. based on route planning. Such schemes are responsible for establishing communication between those vehicles which are on the same route. Efficient message cooperative authentication schemes are responsible for protecting information from free riding attacks. Conditional privacy preserving authentication schemes are basically used to solve privacy issue. Anonymous authentication schemes works for message failure. Scalable privacy preserving authentication schemes are based on cryptography. Cryptography means to attach public and private key with message for encryption and decryption. Sender have to send messagewith public key and receiver have to decrypt message with private key. Main reason behind this scheme is to verify the sender's and receiver's identity. Edge computing-based privacypreserving authentication schemes works on device to device communication. It consists of whole process from vehicle registration to vehicle verification. Such schemes verify the authenticity of vehicle. It check that vehicle have licensed or not.

Beta distribution based update and revocation schemes are based on monitoring behaviourof vehicle. It check that nodes are suffered from different kind of security attacks or not. Signature based authentication schemes are basically used for verify the authenticity of message. Identity based batch verification schemes enhance the security features ofvehicular communication. Token based authentication schemes enable user to enter their credential and start vehicular communication process. Such scheme maintain security of information so that unauthorized user can not access it.

All authentication schemes have its own importance. These schemes makes VCN more smart and reliable.

Due to the specific features and advantage of different authentication schemes, user expectthat any authentication scheme should work for user. Which help them to utilise their time by getting the best route which has less network traffic congestion. For fulfil user requirement, we propose route forecasting based authentication scheme which offer best route to user to avoid network traffic congestion. In this scheme, there is a service provider who works for

suggesting multiple routes to user through A* algorithm. User can choose one of them according to their need.

Route forecasting based authentication schemes has shown many outstanding advantages, it saves time of user and increase user satisfaction rate. VCN provides an effective way of communication between vehicles. Authentication schemes makes it more secured and reliable. Route forecasting based authentication schemes save time of user by offering best possible optimal routes. Such scheme help user for identifying the multiple routes which have less network traffic congestion and user have to choose one of them. Such schemes works well in case of network throughput, processing time and execution time.

Main Contribution in this paper are as follows

Analyze different authentication schemes which are used in vehicular communication.

Propose route forecasting based authentication schemes.

Use A* algorithm for finding the route which has less network traffic congestion.

2 Literature review

Several research work has been proposed by different researchers during the decade. Yuchen Wu et al [1] propose distributed algorithm for packet forwarding. It helps communication between vehicles. Simulation results shows that this scheme works well for large number of vehicles in a network. In Prong Yu et al [2] use the concept of cloud computing into vehicular communication network so that vehicle can share bandwidth resource, storage resource as well as computational resource. Kan Zheng et al [3] use vehicular cloud network to make vehicular communication moreeffective. They use Semi Markov decision process for validating the performance of vehicular cloud network. Yi Ren et al [4] use concept of device to device communication in vehicular communication networks. Simulation result verify the feasibility of this scheme and make communication more secure and reliable. Ali A Siding et al [5] propose scheme of allocation of resources in a vehicular cloud network. This scheme fulfill the latency requirement of V2V links. Simulation results show that it has great performance over half duplex scheme. Wei Yang et al [6]use resource allocation policy for enhancing security in vehicular communication networks. They propose max- min secrecy rate problem and this problem has been mathematically formulated. Numerical results validate the optimality of this problem. Shengjie Guo et al [7] propose cascade Hungarian channel assignment algorithm for solving resource allocation problem. Simulation result validate the efficiency and effectiveness of this algorithm over traditional scheme. To enhance the efficiency of video streaming, Hao Zhou et al [8] investigates scalable video coding. Simulation result verify the accuracy of this system and reduce computational complexity. By Le Liang et al [9] reviewed about wireless resource allocation in vehicular cloud network. They highlight reinforcement learning approach for solving resource optimization problem. Xujie Li at al [10] propose resource allocation scheme based on vehicular communication networks. They present an immune algorithm. Simulation result validate the efficiency of proposed system. We can applied this algorithm in optimization of vehicular user equipment communication networks. Muhammad Noor A Rahim et al [11] reviewed about vehicular network technologies namely dedicated short range communication and cellular based vehicular networks. This paper provides a quick review about different resource allocation strategy in vehicular cloud network. Haojun Yang et al [12] propose semi-persistent scheduling algorithm for information exchange between vehicles. Simulation result validate the efficiency and great performance of this system. Kecheng Zhang et al [13] investigate about usage of radio resource allocation in vehicular networks. This scheme reduce transmission delay and offer an effective communication between different vehicles. Muhammad Ibrar et al [14] propose AI based vehicle to everything network using software defined vehicular based fog computing. Simulation result shows that this scheme utilize maximum resource at fog layer and reduce delay time. Vartika Agarwal et al [15] use the concept of secured scheduling and assign task to the resources. Such technique fill the gap between vehicular communication. These techniques help for proper vehicular communication in a specific network. Vartika

Agarwal et al [16] proposes a multitype vehicle identification scheme from a real-time traffic database in 2021. Once the multitype has been identified, the service provider can offer the user a subscription plan based on their needs. Sachin Sharma et al [17] reviewed various vehicular communication systems in 2022. Such program's are crucial to the vehicle communication system. Azam et al [18] propose various authentication schemes for vehicular adhoc network. Such authentication schemes have to deal with privacy, security and reliability. For vehicular communication. Muhammad Elahi et al [19] proposes PKI-based authentication techniques . Such strategies are created to guarantee a just and effective transportation system. Ryuet al [20] propose Chebyshev chaotic map for efficient authentication. This scheme works 44 timesfaster in comparison of other scheme. Prasanta Kumar Bal et al [21] propose resource allocation security scheme by using a hybrid machine learning technique. This technique works well in caseof efficient resource utilisation and less energy consumption. Hongcheng Huang et al [22] propose temporal computing resource allocation scheme. This scheme can improve efficiency of computing resource allocation. Elmer R. Magsino et al [23] propose a roadside unit allocation scheme and compare its performance with traditional scheme. Amit Rathee et al [24] execute spectrum sharing and power allocation approach for vehicular network. Here D2D based communication between vehicles are proposed. Mahantesh et al [25] propose resource allocation scheme for vehicular cloudnetwork. They use a generic algorithm for the implementation of this scheme. Urmila bhanja et al [26] propose short term traffic flow prediction method. experimental result validate the effectiveness and efficiency of this method. Minglei song et al [27] propose traffic analyzing scheme for reducing accidents. The experimental results validate the throughput and accuracy of this method.

TABLE I. Comparative Study

Scheme	**Accuracy**	**Advantage**	**Future Scope**
Distributed Algorithm [1]	70%	Solve the problem of packet forwarding and buffer allocation	Modify the algorithm for improvingdata delivery packet in a network
Game Theoretical approach [2]	75%	Sharing of bandwidth, storage and computing resources across vehicles.	We can improve this scheme forreduction of service dropping rate.
Optimal computation resource allocation scheme [3]	80%	Improve performance in terms of resource allocation.	Modify this scheme for making morerobust, reliable and secure.
D2D communication to support V2V communication [4]	80%	Optimal performance of D2D system.	Reduce computational complexity forimproving this scheme
Resource allocation scheme [5]	85%	Low transmission rate High performance	Modify the scheme for betterperformance
Max-min secrecy rate scheme [6]	90%	Improve communication between vehicles	Use deep learning approach for betterperformance
Cascade Hungarian Channel Assignment Algorithm [7]	80%	Improve throughput and reliability of vehicular networks	Improve vehicular communicationthrough scheduling
Tabu search based metaheuristic algorithm [8]	85%	Improve performance and reduce computational complexity	Modify this scheme for more accurateresult
Deep reinforcement learning approach [9]	90%	Improving network Efficiency	Use mathematical approach for better performance
Route Forecasting Based Authentication Schemes **[Proposed scheme]**	98%	Less network traffic Congestion	Modify this approach for better result

From TABLE I, we can see that this scheme has better accuracy and has less network traffic congestion which is far better than in comparison of other algorithm. Several authentication schemes are introducing for validating and fulfill the requirement of users. Most authentication schemes are based on security as well as utilization of resources. These schemes authenticate and validate users. There are different authentication schemes

which is used for validating the authenticity of resources.

Network resource aware route planning Authentication Scheme

Route planning is an important function for vehicular communication network. Without route planning communication between vehicles can't be possible. Suppose two vehicles are connected through sensors in a route but one vehicle stay out of route. Instead of those vehicle, other vehicle come to the path. Communication should automatically start between those vehicles which are on the route. Local dynamic map is a component which is used for collecting static and dynamic information around vehicle and pass the information from one vehicle to another. We can combine it with network access object and take this information as input and design better authentication scheme. LDM with NC object nor only used for path selection but also for network selection [Figure 1].

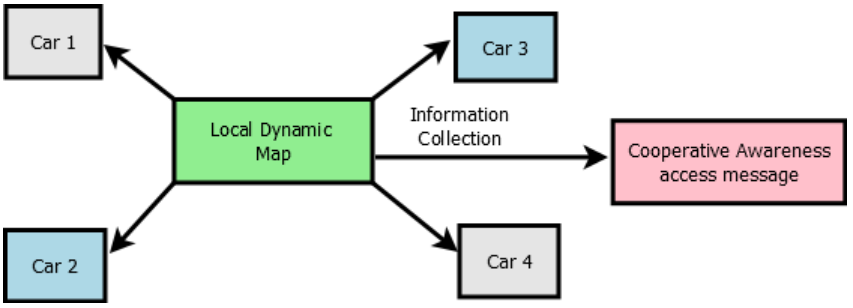

Figure 1. Network resource aware route planning authentication scheme.

Efficient Message Cooperative Authentication Schemes

This scheme reduce duplicity of message. Sometimes different vehicles working on the same messages. This scheme remove redundant message and secure information from free-riding attacks. Free- riding attacks are those attacks in which an attacker generate token and break whole vehicular authentication process. This scheme try to identify token and remove it from the vehicular communication process.

Anonymous Authentication Schemes

This scheme reduce message loss when density of vehicle is about 200/km2. It improves authentication process between vehicles. It uses cooperative authentication method and categorize it into two parts. First one is failure report based and second one is success report based. Failure report based approach report invalid beacon messages whereas success report based approach report about valid beacon messages.

Cryptography Based Authentication Schemes

This scheme is based on public key and private key. Public key is used by those vehicles which sends message. Whereas private key is used by those vehicles which receive message. Such keys are used for encryption and decryption.it maintain the confidentiality of an information.

Signature Based Authentication Schemes

With this scheme, digital signature is attached with messages. Such signature are used for validating the authenticity of an information. Sender send message with this signature. Receiver receive message and send digital signature to sender which is the

confirmation for the sender that receiver has receive the message.

Verification Based Authentication Schemes

With this scheme, RSU works as a mediator between vehicles. When sender send message, RSU verify the message and check priority of message. If message is regarding any emergency or accident, RSU send this message first and ensure that message has been delivered to the destination promptly.

Conditional Privacy Preserving Authentication Schemes

This technique is basically able to solve privacy as well as a security requirement of whole vehicular communication network. It is based on message authentication code. Here Vehicle can generate the authenticity of messages using different keys.

Edge Computing based Privacy Authentication Schemes

In this scheme, various vehicles exchange data with each other through device to device communication. It consists of 5 phases from vehicle registration to vehicle verification. This scheme is highly useful for obtaining information from another vehicle. In case of any accident or emergency, this system can deliver the appropriate information to the appropriate user at the appropriate time. This scheme is able to prevent accident or other mishappening which can occur at any time due to the unavailability of an information.

Scalable privacy preserving Authentication Schemes

This scheme is based on hybrid cryptography. It is more secured and scalable in comparison of other authentication schemes. This scheme works for those vehicles which are equipped with sensor unit and on-board unit, sensor unit and on board units are smart devices who is responsible for verification and validation of message as well as user.

Identity based batch verification schemes

This scheme enhances the security and efficiency of automatic dependent surveillance broadcast. It reduce computational costs as well as transmission overhead. This scheme is responsible for verifying the identity of sender and receiver who is responsible for vehicle to vehicle communication. This scheme check that from which route message has been delivered to one vehicle from another vehicle. This scheme analyze modification done by attackers for destroy the confidentiality of an information.

Beta distribution-based reputation update and revocation schemes

This scheme is able to detect various types of security assaults which disrupt the confidentiality and security of an information. This scheme works well for recognizing different kind of cyber security attacks. If any unauthorised user or attacker try to destroy or change the information. This scheme can easily detect it. This scheme protect whole vehicular communication network from attackers or hackers. This is safe and secure and able to maintain the integrity of an information.

Route Forecasting based authentication scheme (Proposed Scheme)

Due to network traffic congestion lot of time has been wasted. Major research gap we found in the study to utilize user's time in case of network traffic congestion. So we propose route forecasting based authentication scheme in vehicular communication

network. By selecting the route with the least amount of network traffic congestion, this system enables users to make the most of their time. Service provider offer multiple options to the user and user have to choose one of them. This scheme offer excellent processing time, execution time as well as bandwidth availability.

3 Proposed Methodology

Consider there are n number of routes available to reach destination. Destination is denoted as y. VCN agent collect user's data from real time traffic database and generate network traffic index. Network traffic index measure level of traffic congestion. Range of network traffic index lies between (0, ∞). User enter path and agent authenticate user is licensed or not. If user is licensed and demand for network traffic, VCN agent forecast alternate route which have less no of traffic congestion. It depends on user choice whether he will accept that route or not. For route forecasting agent choose A* algorithm. (Figure 2).

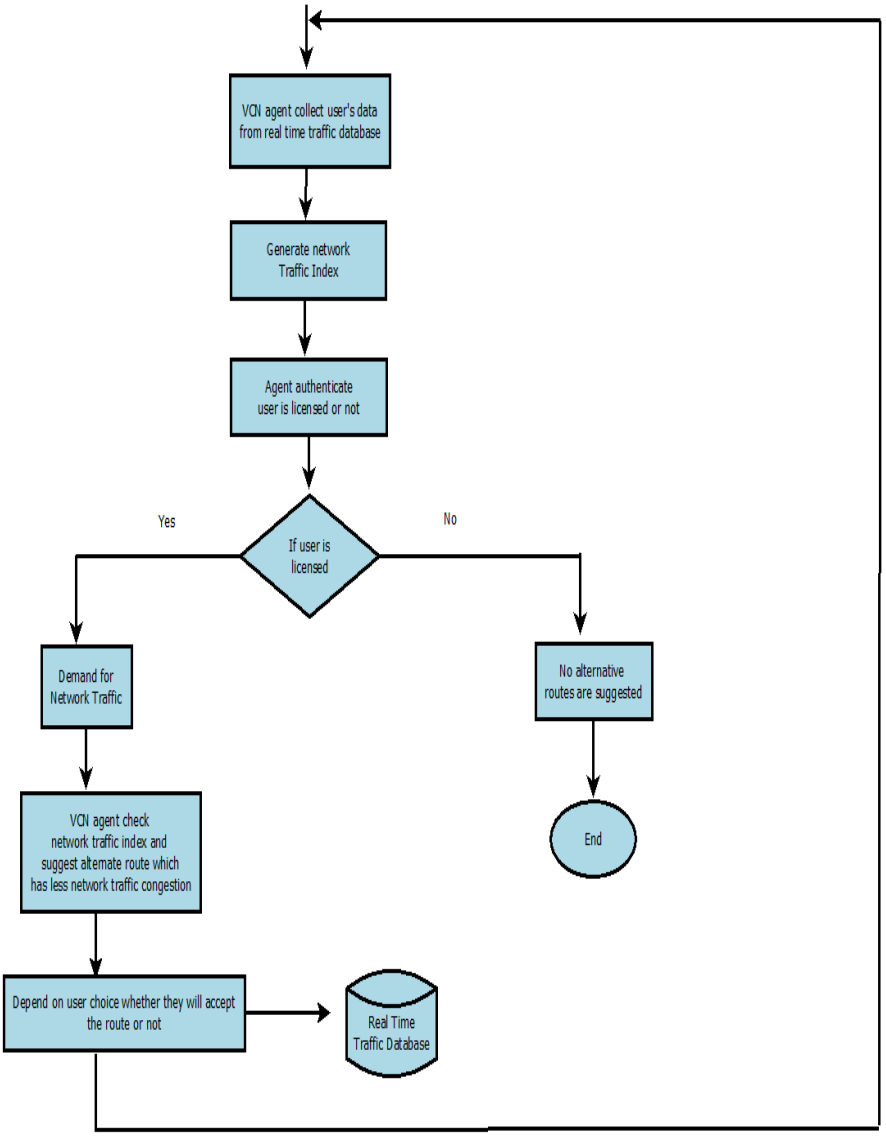

Figure 2. Network traffic congestion and validation process.

A* is a searching algorithm for finding the shortest path between source and

destination. This algorithm will find the least cost outcome for a problem. In our research, this algorithm help us to find the best route which has less network traffic congestion.

Equations used in A* algorithm

$$f(n) = g(n)+h(n) \quad (1)$$

g(n) = distance from current route to goal.
h(n) = heuristic function
f(d,c) where d stands for destination route and c stands for current route.
Total route means user pass the no of routes from source to destination.

$$Tp(\text{Total Path}) = c \quad (2)$$

Here, user have to start from the current route and reach the goal node.
Total cost is calculated by the heuristic function. gscore means the cost incurred from passing route to a goal node.

start = s
goal = g
A*(s,g,h) where s = start, g = goal, h = heuristic function
gscore: = infinity (3)
gscore[s] =o
fscore means the cost of cheapest route
fscore: = infinity (4)
fscore[s] : = h(s) (5)
c = lowest fscore
c = g
s. remove(c)
for each neighbor of current
gscore: = gscore[c]+h(n) (6)

From Figure 3, we can see that VCN agent search those route which has less network traffic congestion. Target means the destination of user. Initial vehicle means source from where vehicle have to start its journey. VCN agent offer shortest path to every user which has less network traffic congestion problem.

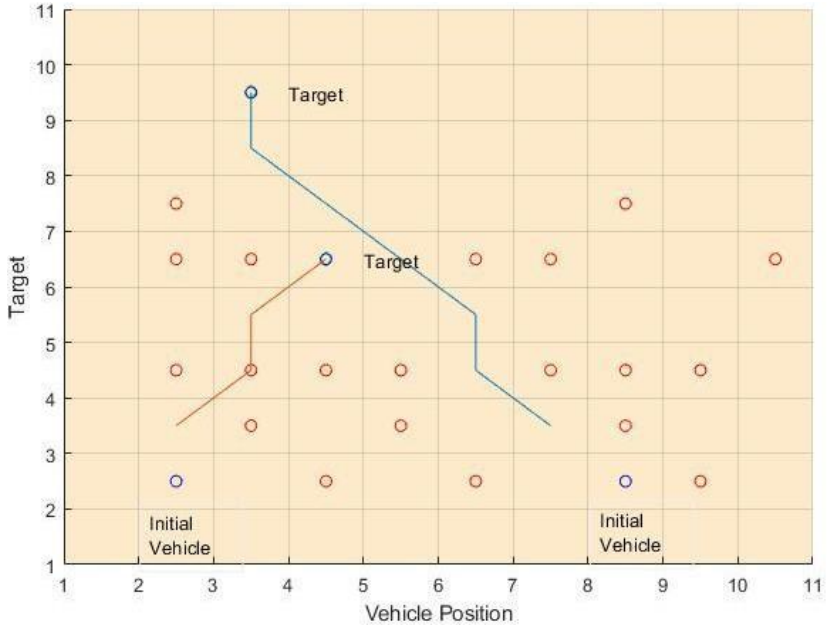

Figure 3. Path searching using A* algorithm

A* algorithm

1. Make an open list containing starting node, starting node means position of user on the path.
   a. If user is already in the path which have less no of traffic congestion
   b. Make a closed empty list
2. Put the current path in the list and check its neighbors
   For each neighbor of the current path:
   a. If neighbor has a less network traffic congestion in comparison of current node. Then replace neighbor with this node as the neighbor's parent.
   b. Else if check all the neighbor of the current route and replace neighbor with the node which have less traffic congestion.

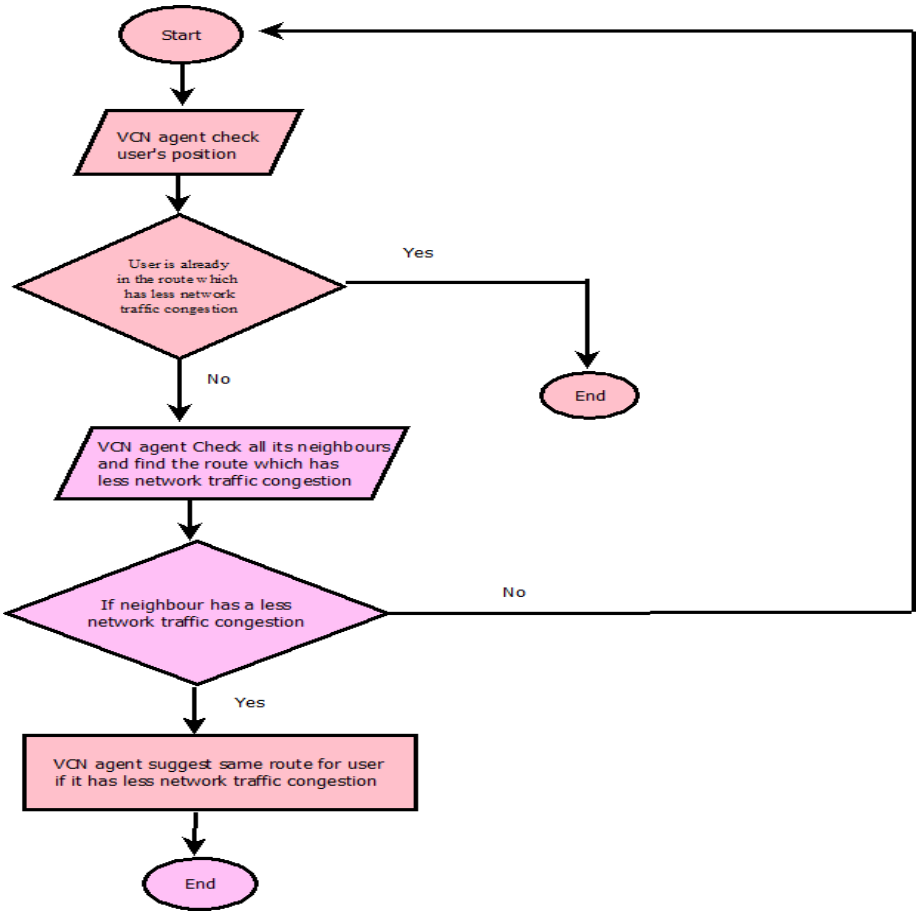

Figure 4. Working of VCN agent.

From figure 4, we can see the working of VCN agent. Here VCN agent check user's position. If user is already in the route which has less network traffic

congestion. VCN agent check all its neighbours and find the route which has less network traffic congestion. From Figure 5 and Figure 6, we can see that no shortest path exists from source to destination.

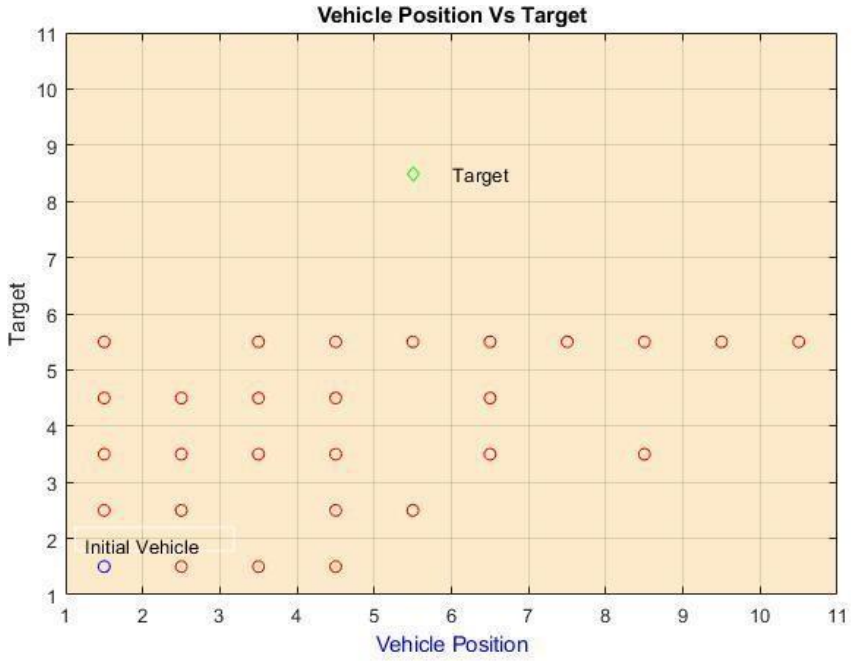

Figure 5. Path searching using A* algorithm.

Figure 6. No path found by VCN agent.

4 Performance Metrics

For performance evaluation (Table II), we use following parameters processing time, network throughput, Execution time, Bandwidth Availability and Delivery of Network Services. These parameters are basically used for validating the performance of the system.

- **Forecasting accuracy:** This scheme can predict all the possible routes for user which has less network traffic congestion. But user can choose only one of the route. So service provider need to exclude the redundant routes as large as possible to provider user the best route. The evaluation criteria of forecasting accuracy is shown as

Forecasting = (Nr * 100)/Tr (7)

Where Nr represent the number of redundant route and Tr represent the total number of route offered by service provider.
(5*100)/10 = 50

- **Forecasting Integrity:** Forecasting integrity is used to evaluate integrity of thoseroute which is chosen by user from list of routes suggested by service provider.

Integrity = (Cr *100)/Tr (8)
= (2*100)/10
= 20

Where Cr represent the route which is chosen by user from list of routes suggested by service provider and Tr represent the total number of route offered by service provider.

- **Processing time:** Time required to detect suitable path for vehicle.
From figure 7, we can see that service provider allocate 15 routes to users within 3 seconds. Within 4 seconds, service provider allocate 5 routes. Within 5 seconds, service provide allocate 5 routes. Number of routes may vary, and it depend on network traffic congestion.

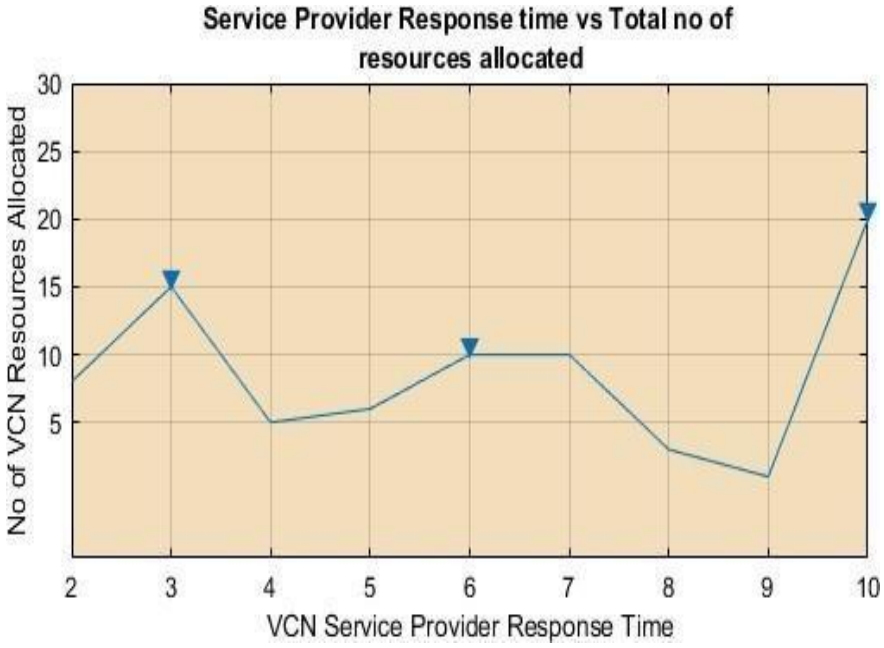

Figure 7. Service provider response time vs Total no of VCN resources allocated

Table II. Performance metrics

Parameters	***Value***
Forecasting accuracy	50
Forecasting integrity	20
Processing time	3 Sec
Network throughput	3 Sec
Execution time	10 Sec
Bandwidth availability	15 routes
Delivery of network services	4 routes

- **Network throughput:** No. of path allocated within limited time.

  From figure 8, we can see that within 3 seconds there are four users who accept the route suggested by VCN service provider and there are 5 users who accept the route suggested by service provider within 4 seconds. No of users may vary and it depend on the route suggested by VCN service provider.

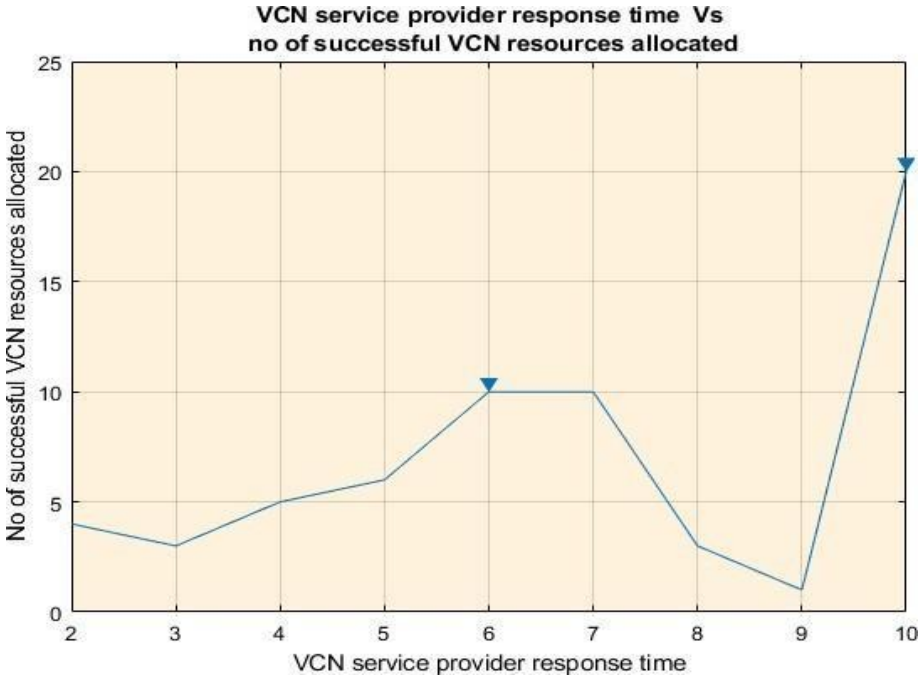

Figure 8. VCN service provider response time vs no of successful VCN resources allocated.

- **Execution time:** Time taken by the service provider to execute the task.
  From figure 8, service provider takes 2 to 10 seconds for route allocation.
- **Bandwidth availability:** Network resources demand by user and the availability of resources within a time. It means allocation of network resources according to user demand by the VCN service provider. We can see service provider allocate 15 routes within 3 seconds. These routes are according to user need.

Table III. Performance comparison of route prediction based existing methodologies

Technique	***Execution time***	***Throughput/Accuracy***	***Delivery of network services***
FRCNN [16]	3 - 40 sec	85 - 95%	95%
Hybrid algorithm approach [24]	80 - 90 sec	80%	80%
Generic algorithm [25]	40 sec	20 sec	40%
A* algorithm [Proposed scheme]	2 - 10 sec	3 sec	98%

- **Delivery of Network Services:** Quality of service provided by VCN agent. It means user satisfaction rate after taking service of VCN service provider. Figure 8 illustrates that service providers allocate 15 routes within 3 seconds but according to user, there are 4 best routes which fulfill their need.
  From Table III, we can see that proposed scheme works well for suggesting route which has less network traffic congestion with 98% accuracy. FRCNN technique detect 85-95% accuracy and takes 3-40 seconds for identifying type of vehicle. The delivery of network services rate is 95%. Hybrid algorithm approach has 80% accuracy and result of genetic algorithm depend upon density of vehicle.

5 Conclusions

After reviewing about various authentication schemes, we propose route forecasting based authentication scheme. In this scheme, when user need a path which has less network traffic congestion. VCN service provider help them to utilize the path according to their need. A* algorithm is used by VCN service provider for finding the suitable path which has less network traffic congestion. The suggested work is simulated in terms of processing time, resource allocation success, total number of resources allocated, service provider quality, etc. Table I and Table III show that the proposed scheme offer 98% accurate result which is far better than in comparison of other scheme.

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